ABS Consulting

September 2013

The Development of Risk and Readiness Assessment Models for MSHA and Industry
Consolidated Final Report

Submitted to the Mine Safety and Health Administration under Contract #DOLJ124R24842

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Executive Summary

The mission of the Mine Safety and Health Administration (MSHA) is to administer the provisions of the Federal Mine Safety and Health Act of 1977 (Mine Act), the MINER Act of 2006 and to enforce compliance with mandatory safety and health standards as a means to eliminate fatal accidents; to reduce the frequency and severity of nonfatal accidents; to minimize health hazards; and to promote improved safety and health conditions in the Nation's mines. Following a mine emergency preparedness and response Holistic Gap Analysis, MSHA identified the need for the development of risk and readiness assessment models for MSHA and Industry. On September 5, 2012, MSHA awarded a contract to ABS Consulting to support the development of risk and readiness assessment models for the coal mining industry to help prevent major mine emergencies and improve emergency response. MSHA's objective is to evolve theoretical concepts for risk and readiness assessment into simplified tools that can applied by MSHA and Industry for use at operational levels. To effectively assess risk and readiness across MSHA and Industry, MSHA called for five separate models to be developed. The first was a risk assessment model for mine operators to use to prevent major mine emergencies. The second was a model for assessment of preparedness of mines for emergency response. The remaining three models were readiness assessment models for specific entities to respond to mine emergencies: 1) Mine Rescue Team Readiness, 2) Responsible Persons Readiness, and 3) Government and Industry Readiness.

ABS Consulting assembled a team of consultants with experience developing risk and preparedness assessment tools for other government agencies and industries to support this effort. The team also included a mining subject matter expert (SME), Dr. Christopher Bise, with almost 40 years of experience in planning, engineering, operation, management, teaching, and research aspects of mining and occupational and environmental health and safety.

A thorough literature review of historical mine disasters, common hazards, and emergency response best practices was conducted to support development of the models. A team of reviewers was assembled to research information on mine disasters to identify risk, preparedness and readiness factors that could be incorporated into the models. Hundreds of disasters, resulting in thousands of mine worker deaths, have occurred in mines over the last century, and most have occurred in underground coals mines. From 1900-2006, 11,606 underground coal mine workers died in 513 U.S. underground coal mining disasters (an incident with five or more fatalities). In the past 25 years alone, there have been nine major mine disasters across the United States. An examination of those nine major disasters and a review of the loss-control failures that led to each incident provided a clear picture of the most common causal factors, and a better understanding of where to focus emergency planning and response improvement efforts. Research was also conducted to identify preparedness factors related to major mine disasters. These factors were grouped into the following categories: planning, exercises, training, stakeholder outreach and engagement, and capabilities. The literature review also examined best practices for risk, readiness, and preparedness assessment models from other countries and industries; specifically, Australia, South Africa, and the aviation industry.

Following initial research and preparation, the team developed a set of assumptions for each of the models with MSHA and established working groups to evaluate various types of models. Mindful of the

purpose of the models and associated assumptions, the ABS Consulting team assembled a working group of risk experts to evaluate various types of models. The team evaluated each model type based on level of simplicity, quantitative aspects, and ability to effectively assess risk and readiness. Once the appropriate model type was selected, the team began developing the model framework and identifying risk and readiness factors based on available literature and SME input. The risk assessment model framework was developed based on ABS Consulting's SOURCE™ incident investigation methodology. In addition to identifying risks, this framework allows for trending analysis and leading indicators for potential incidents. The framework for the preparedness and readiness models was developed based on an extensive literature review of the MINER Act and other MSHA regulations and guidance documents, as well as industry best practices for emergency preparedness and response.

Following development of assumptions and frameworks for each model, the team organized formal workshops and working sessions with SMEs to provide input on critical success factors, validate assessment criteria and assist in building out the models. The Underground Coal Mine Risk and Readiness Assessment Workshop was held at the National Mine Health and Safety Academy in Beaver, West Virginia on April 3-5, 2013. Industry representatives including mine operators and emergency responders were invited to review the models in their current state and contribute feedback to further develop the models. Following the Underground Coal Mine Risk and Readiness Assessment Workshop the ABS Consulting project team incorporated input from written suggestions and group discussions into the risk and readiness models.

While the first four models were reviewed at the SME Workshop by representatives from the mining industry and emergency responders, the Government and Industry Readiness Assessment model required input from government officials and representatives from industry associations. The project team met with MSHA officials and representatives from the mining industry to develop the government and industry readiness assessment model. MSHA reviewed the draft risk, preparedness and readiness models and provided feedback to the project team on August 21, 2013. ABS Consulting incorporated all suggested changes and submitted the final version of all models to MSHA on August 29, 2013.

The scope of this project was to design and develop the risk, preparedness and readiness models that mine operators and MSHA could use to manage risks in an underground coal mine, to assess the preparedness of all entities in responding to a mine emergency and to assess the readiness of various response resources with executing the established emergency response plans. Before the models can be used, it is recommended that they be calibrated to ensure that the models produce accurate, consistent and meaningful results. Following calibration, MSHA should develop a deployment strategy that takes into account sharing of the assessment results across the industry and with MSHA, reporting of the assessment results, and the issues of anonymity among those mines reporting results. Once deployed, it is also recommended that the models be tested over a period of time to ensure that the trends resulting from a series of assessments can be accurately interpreted and the models adjusted accordingly.

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Introduction

The mission of the Mine Safety and Health Administration (MSHA) is to administer the provisions of the Federal Mine Safety and Health Act of 1977 (Mine Act), the MINER Act of 2006 and to enforce compliance with mandatory safety and health standards as a means to eliminate fatal accidents; to reduce the frequency and severity of nonfatal accidents; to minimize health hazards; and to promote improved safety and health conditions in the Nation's mines. Following a mine emergency preparedness and response Holistic Gap Analysis, MSHA identified the need for the development of risk and readiness assessment models for MSHA and Industry.

On September 5, 2012, MSHA awarded a contract to ABS Consulting to support the development of risk and readiness assessment models for the coal mining industry to help prevent major mine emergencies and improve emergency response. MSHA's objective is to evolve theoretical concepts for risk and readiness assessment into simplified tools that can applied by MSHA and industry for use at operational levels.

To effectively assess risk and readiness across MSHA and Industry, MSHA called for five separate models to be developed. The first is a risk assessment model for mine operators to use to prevent major mine emergencies. The second is a model for assessment of preparedness of mines for emergency response. The remaining three models are readiness assessment models for specific entities to respond to mine emergencies: 1) Mine Rescue Team Readiness, 2) Responsible Persons Readiness, and 3) Government and Industry Readiness.

This report describes the model development process, including a comprehensive literature review and subject matter expert workshop, and presents an overview and methodology for each of the risk and readiness assessment models. Each model is included in the Appendices.

Model Development

ABS Consulting assembled a team of consultants with experience developing risk and preparedness assessment tools for other government agencies and industries to support this effort. The team also included a mining subject matter expert (SME), Dr. Christopher Bise, with almost 40 years of experience in planning, engineering, operation, management, teaching, and research aspects of mining and occupational and environmental health and safety. The ABS Consulting team relied on information gathered from a literature review, input from the team's mining SME, and feedback from industry representatives during workshops and working sessions to develop the risk and readiness assessment models. The following sections outline the model development process.

MSHA Vision

At the start of this effort, MSHA and ABS Consulting met to discuss MSHA's vision and basic assumptions for the models. MSHA representatives shared their vision of a simple to use tool for mine operators to use to assist them in identifying major risks and assessing preparedness to respond to mine emergencies. From these discussions a charter for the Underground Coal Mine Risk and Readiness Assessment Models project was developed:

> *To supply the mining industry with a pro-active toolset for underground coal mine operators to self-assess:*
>
> *the risks associated with your mine and methods to prevent major mine emergencies,*
> *your preparedness to respond to an emergency, and*
> *the readiness of your rescue teams, responsible persons and the Government and industry to execute your emergency plan.*

Figure 1: Project Charter

Literature Review

ABS Consulting conducted a thorough literature review of historical mine disasters, common hazards, and emergency response best practices to support development of the models. The report is organized into four sections, summarized below: 1) History of Major Mine Disasters, 2) Summary of Mine Hazards, 3) Summary of Preparedness Factors for Response to Major Mine Disasters, and 4) Use of Risk and Readiness Assessment Models among Other Organizations.

A team of reviewers was assembled and organized into groups to collect data from an assigned source type: 1) Published Paper/Article, 2) Incident Investigation Report, or 3) Best Practice. Information collected in the review was captured and compiled using a Microsoft Access database designed for this project to help guide the review process and ensure the collection of relevant and consistent data.

Hundreds of disasters, resulting in thousands of mine worker deaths, have occurred in mines over the last century, and most have occurred in underground coals mines. From 1900-2006, 11,606 underground coal mine workers died in 513 U.S. underground coal mining disasters (an incident with five or more fatalities). While significant progress has been made since the early 20th century, including the creation of a number of mine associations and regulatory agencies, as well as changes in mine safety and health regulations, there are still improvements to be made as mine disasters continue to occur.

In the past 25 years alone, there have been nine major mine disasters across the United States. The literature review report provides a summary of each of these nine disasters and a review of the loss-control failures that led to each incident. Examining each of these nine incidents at once provides a clear picture of the most common causal factors and a better understanding of where to focus emergency planning and response improvement efforts.

Research was also conducted to identify preparedness factors related to major mine disasters. These factors were grouped into the following categories: planning, exercises, training, stakeholder outreach and engagement, and capabilities. Examples of planning preparedness factors include: a well-designed emergency response plan with clear lines of authority and communication protocol, testing plans and emergency response systems on a regular basis, delegating responsibilities and defining roles prior to the incident, and planning for backup teams and efforts. Experts agree that simply having a contingency plan alone is not sufficient to be prepared for an emergency; the plan must be exercised and tested by those responsible for responding to emergencies. Exercises should be conducted in situations that simulate actual underground mine environments and conditions typically present in an emergency. During the exercises, bottlenecks in response procedures can be identified and removed.

Another critical preparedness factor is training, ensuring individual readiness of the people working in underground coal mines. Standardized curricula for teaching competencies should be developed, along with assessment methods for determining competency. Basic mine rescue training includes first aid, map reading, mine gases, ignition sources, the importance of adequate rock dusting, electrical and equipment safety, dust and ventilation, roof and rib control, communications, breathing apparatus, rescue and firefighting equipment gas sampling, ventilation control construction, etc. Mine rescue team training may include verbal content for radio communications; rapid exploration and navigation ability in reduced visibility; advanced first aid, life support systems, and multiple-casualty extrication; specialized firefighting and knowledge of the ventilation effects of fires; and incident command, problem solving, and decision-making.

Preparedness must include stakeholder outreach and engagement well before an emergency occurs. Mine operators should not wait until an event occurs to meet a key response organization for the first time. Stakeholder outreach factors include sharing resources with other operators and coordination with fire rescue/inert gas vendors and other first-responders. Families and friends in the surrounding community are also impacted by mine emergencies. Mine operators should establish family liaisons and outline the duties and responsibilities of those assigned to support families.

Capabilities (personnel, equipment, and facilities) are the final preparedness factor outlined in this report. Many preparatory measures involve physical preparations, such as stockpiling equipment and supplies and organizing response personnel. Suggested best practices and capabilities to improve preparedness include: communications systems, fire detection equipment, gas detection capabilities, Miner Act-compliant SCSRs/SCBAs, escapeway aids, and evacuations kits containing rope, chemical lightsticks, drinking water, chalk, SCSRs, a first-aid kit, brattice curtain, mine map, handheld multiple gas detector, and radio or pager phone.

The final section of the literature report summarizes best practices for risk, readiness, and preparedness assessment models from other countries and industries; specifically, Australia, South Africa, and the aviation industry. Australia's mining industry appears to be a leader in the use of a risk-based approach to mining operations. Improvements in mine safety in Australia over the last 15 years are largely attributable to the systematic and team-based use of risk assessments applied to equipment design, mining operations, and managing emergency response. The South African Mining Industry uses a risk assessment approach similar to Australia, although less detailed. South African mine operators use a qualitative model, such as the 4x4 likelihood and severity matrix, to assess risk. In addition to mining best practices from other countries, this report presents a comparison to another industry – aviation; an industry heavily reliant in licenses and certifications and haphazard in its management of the risks. Appendix A presents the literature review report in its entirety.

Initial Development

Model Assumptions

Following initial research and preparation, the team developed a set of assumptions for each of the models with MSHA and established working groups to evaluate various types of models. Assumptions for each individual model are presented in the tables below. In addition to model-specific assumptions, MSHA identified a few key overarching assumptions for all five of the risk and readiness models. The first was that the models must be easy to use. An easy to use model has clear instructions, familiar terminology, and a user interface that is easy to navigate and provides a print-friendly version for completing the assessment. Next, MSHA declared that the models shall not be contractor-led; rather, the mine operator (or other entity being assessed) shall conduct the assessment. Finally, MSHA assumed that the risk and readiness assessment models would take just a few hours to a half day to complete. All three assumptions emphasized the need for simplicity in the design of the models.

Risk Assessment Model Assumptions

Table 1 below outlines the assumptions used to develop the Risk Assessment Model.

Table 1: Risk Assessment Model Assumptions

	Assumption
Industry	Underground coal mines, including large and small operations • Large = More than 36 underground employees • Small = 36 or less underground employees
Purpose of model	For mine operators to use to prevent major mine emergencies.
Decision to be made with the tool	Where in the spectrum of risk does my mining operation stand? How is the risk profile at my mine changing over time? What corrective action, would improve our risk profile?
Who will see the risk assessment results?	Primary audience is the mine's management for decision-making purposes. Inspectors or investigators may ask to review the assessments.
Level of difficulty	The risk management model must be a simple model (e.g., checklist) that can be applied by industry for use at the operational level. The model will focus on hazards that precipitate mine emergencies.
Physical location of the model's use	On location at the mine site, including the office and other locations at the mine site, including underground locations.
Model Format	The risk assessment tool needs be in a format that allows for easy download from the MSHA website.
Composition of team which uses the assessment model	An example team composition: • The Mine Foreman, • a Shift Supervisor, • a Mine Examiner (Shift Inspections), • the designated Responsible Person(s), and • a Mine engineer.
Frequency of use	MSHA will recommend that every mine use the risk assessment tool at least once every three months. This recommendation would results in four assessments in a 12 month timeframe for each mine operation.
Amount of time the team will devote to performing the risk assessment	Initial assessment may take one day to complete; and, subsequent assessments will be designed to take less than one-half day to complete.
Formal education and tech-savvy of individuals using the model	Mixed education levels (limited formal education to trade school, 2-year associate degree, or 4-year baccalaureate degree). Medium computer tech-savvy.

Preparedness Assessment Model Assumptions

Table 2 below outlines the assumptions used to develop the Emergency Preparedness Assessment Model.

Table 2: Preparedness Assessment Model Assumptions

	Assumption
Industry	Underground coal mines, including large and small operations. • Large = More than 36 people employed (people working underground) • Small = 36 or less people employed (people working underground)
Purpose of model	For mine operators to assess the scope and level of preparedness of the entire emergency response system / community to respond to a mine emergency. The model will be informed by Emergency Preparedness factors that are critical to a successful emergency response and/or prescribed by regulations. The tool, in the form of a categorized checklist, will be qualitative in nature with results that can provide a snap shot of the level of preparedness at the time of assessment, and sufficient data to determine trends in preparedness over time. It will also highlight areas that require corrective actions.
Level of difficulty	The mine emergency response preparedness model must be simple enough to be used by mine operators at the operational management level.
Physical location of the model's use	On location at the mine site office and underground locations.
Composition of team which uses the preparedness assessment model	The assessment team may consist of: • The Mine Foreman (Certified Competent Person), • a Shift Supervisor(s), • a Mine Examiner (Shift Inspections), • a Responsible Person(s), and • a Mine engineer if available.
Frequency of use	MSHA will recommend that every mine use the risk assessment tool at least once every three months. This recommendation would results in four assessments in a 12-month timeframe for each mine operation. Some data gathering may be conducted as part of pre-shift inspections and other periodic requirements per legislation.

	Assumption
Amount of time the team will devote to performing the preparedness assessment	1-2 days to complete the assessment.
Formal education and tech-savvy of individuals using the model	Mixed education levels (limited formal education to trade school, 2-year associate degree, or 4-year baccalaureate degree). Medium computer tech-savvy.
Method	Instructions on application and use of model, scoring of the checklist, and general approach for corrective action.

Mine Rescue Team Readiness Assessment Model Assumptions

Table 3 below outlines the assumptions used to develop the Readiness Assessment Model for Mine Rescue Teams.

Table 3: Mine Rescue Team Readiness Assessment Model Assumptions

	Assumption
Industry	Underground coal mines, including large and small operations. • Large = More than 36 people employed (people working underground) • Small = 36 or less people employed (people working underground)
Purpose of model	For mine operators to assess the readiness of Mine Rescue Teams, including: • the adequacy of staffing, equipment, training and exercises (KSA) to execute the Mine Emergency Response Plan, • the up-to-date status and adequacy of training and exercises. The tool, essentially in the form of a checklist will be informed by Emergency Preparedness factors that are critical to a successful emergency response and/or prescribed by regulations for Mine Rescue Teams. The tool will be qualitative in nature with results that can provide a snap shot of the level of preparedness at the time of assessment, and sufficient data to determine trends in preparedness over time.
Level of difficulty	The Mine Rescue Team Readiness model must be simple enough to be used by the mine operators at the operational management level.
Physical location of the model's use	On location at the mine site office above ground.

	Assumption
Composition of team which uses the assessment model	The assessment team may consist of: • The Mine Foreman (Certified Competent Person), • a Shift Supervisor, • a Mine Examiner (Shift Inspections), • a Responsible Person(s), • Mine Rescue Captains, and • Mine engineer if available.
Frequency of use	Quarterly Readiness Assessments, annual status and planning review.
Amount of time the team will devote to performing the readiness assessment	1-2 hours quarterly review for compliance to plans and personnel status, less than one-half day for the team to complete a status review, which includes planning review and team member contact and training/exercises status updates.
Formal education and tech-savvy of individuals using the model	Mixed education levels (limited formal education to trade school, 2-year associate degree, or 4-year baccalaureate degree). Low-to-medium computer tech-savvy.
Method	Instructions on application and use of model, scoring of the checklist, and general approach for corrective action.

Responsible Persons Readiness Assessment Model Assumptions

Table 4 below outlines the assumptions used to develop the Readiness Assessment Model for Responsible Persons.

Table 4: Responsible Persons Readiness Assessment Model Assumptions

	Assumption
Industry	Underground coal mines, including large and small operations. • No differentiation by size
Purpose of model	For mine operators to use assess the readiness of Responsible Persons to execute an emergency preparedness plan, including: • the adequacy of Mine Emergency Planning in terms of compliance to legislation and regulations, • the scope of the emergency plans, including guidance, protocol, concept of operations, and procedures to support the duties of the Responsible Person in the event of a Mine Emergency, • the extent to which the plans are implemented with regard to staffing, communications networks, hierarchy, systems to ensure effective execution, and • the up-to-date status of maps, mine conditions, personnel/crew

	Assumption
	records and their competencies and immediate location/status and intensity of responsible person training and exercises/ competency to use system. The tool, essentially in the form of a checklist will be informed by Emergency Preparedness factors that are critical to a successful emergency response and/or prescribed by regulations for those people assigned as the Responsible Person. The tool will be qualitative in nature with results that can provide a snap shot of the level of preparedness at the time of assessment, and sufficient data to determine trends in preparedness over time.
Level of difficulty	The Responsible Person Readiness model must be simple enough to be used by the mine operators for use at the operational management level.
Physical location of the model's use	On location at the mine site office above ground. However, the assessment will both designated responsible person operating above ground and the individual designated to be the lead below ground.
Composition of team which uses the assessment model	The assessment team may consist of: • The Mine Foreman (Certified Competent Person), • a Shift Supervisor(s), • the Responsible Person(s), and • Senior management
Frequency of use	Quarterly Readiness Assessments, six month status and planning review.
Amount of time the team will devote to performing the assessment	1-2 hours quarterly review for compliance to plans and personnel status, less than one-half day to complete a status review, which includes planning, systems and procedural review and stakeholder contact information/ status updates.
Formal education and tech-savvy of individuals using the model	Mixed education levels (limited formal education to trade school, 2-year associate degree, or 4-year baccalaureate degree). Medium computer tech-savvy.
Method	Instructions on application and use of model, scoring of the checklist, and general approach for corrective action.

Government and Industry Readiness Assessment Model Assumptions

Table 5 below outlines the assumptions used to develop the Government and Industry Readiness Assessment Model. The model includes four assessment areas: a) Districts, b) Coal Safety and Health Headquarters, c) Mine Emergency Response Coordinator, and d) Industry. Assumptions apply to all four areas unless noted otherwise.

Table 5: Government and Industry Readiness Assessment Model Assumptions

	Assumption
Industry	Underground coal mines, including large and small operations. • Large = More than 36 people employed (people working underground) • Small = 36 or less people employed (people working underground)
Purpose of model	For the government and industry representatives to use to assess the readiness of the people, equipment and processes from government and the mining industry at large. The tool, essentially in the form of a checklist will be informed by Emergency Preparedness factors that are critical to a successful emergency response and/or prescribed by regulations for those people from the mining industry and government officials involved in an emergency response. The tool will be qualitative in nature with results that can provide a snap shot of the level of preparedness at the time of assessment, and sufficient data to determine trends in preparedness over time.
Level of difficulty	The Government and Industry Readiness model must be simple and convenient enough to be used by the MSHA officials.
Physical location of the model's use	Coal Safety and Health Districts – Each District Office Coal Safety and Health Headquarters – Headquarters Mine Emergency Response Coordinator – Pittsburgh Mine Emergency Station Industry – Pittsburgh Mine Emergency Station
Composition of team which uses the assessment model	Coal Safety and Health Districts – District Manager and team Coal Safety and Health Headquarters – Chief of Division of Safety and team Mine Emergency Response Coordinator – MERC and team Industry – MERC
Frequency of use	The full assessment to be performed annually.
Amount of time the team will devote to performing the readiness assessment	Half a day to a day to complete.
Formal education and tech-savvy of individuals using the model	Mixed education levels (limited formal education to trade school, 2-year associate degree, or 4-year baccalaureate degree). Medium computer tech-savvy.
Method	Instructions on application and use of model, scoring of the checklist, and general approach for corrective action.

Model Framework

Mindful of the purpose of the models and associated assumptions, the ABS team assembled a working group of risk experts to evaluate various types of models. The team evaluated each model type based on level of simplicity, quantitative aspects, and ability to effectively assess risk and readiness. Once the appropriate model type was selected, the team began developing the model framework and identifying risk and readiness factors based on available literature and SME input.

Risk Assessment Model Framework

The risk assessment model framework was developed based on ABS Consulting's SOURCE™ incident investigation methodology[1]. In addition to identifying risks, this framework allows for trending analysis and leading indicators for potential incidents. The model is comprised of three assessment categories: Base Risk, Activity Risk, and the Mine's Safety Culture. Within each category are subcategories (e.g. procedures, workplace conditions) and specific factors that must be scored. The model includes a description of each factor and questions to help frame the user's thoughts. The risk assessment model was fully developed into a draft model for review and prioritization and ranking of major categories at the Underground Coal Mine Risk and Readiness Workshop.

Readiness Assessment Model Framework

The framework for the preparedness and readiness models was developed based on an extensive review of the MINER Act and other MSHA regulations and guidance documents, as well as industry best practices for emergency preparedness and response. This review resulted in a long list of readiness and preparedness critical success factors that were best organized into the following categories: a) People, b) Equipment (Resources), and c) Process. The team identified subcategories within the People, Equipment, and Process categories for each of the emergency preparedness and readiness models. The models were left open-ended for development of preparedness and readiness critical success factors for each subcategory at the Underground Coal Mine Risk and Readiness Workshop.

Subject Matter Expert Workshops

Following development of assumptions and frameworks for each model, the team organized formal workshops and working sessions with SMEs to provide input on critical success factors, validate assessment criteria and assist in building out the models.

Underground Coal Mine Risk and Readiness Assessment Workshop

The Underground Coal Mine Risk and Readiness Assessment Workshop was held at the National Mine Health and Safety Academy in Beaver, West Virginia on April 3-5, 2013. Industry representatives

[1] Vanden Heuvel, Lee N., Donald K. Lorenzo, Laura O. Jackson, Walter E. Hanson, James J. Rooney, and David A. Walker. *Root Cause Analysis Handbook, a Guide to Efficient and Effective Incident Investigations.* Brookfield, Connecticut: Rothstein Associates, Inc., 2008. Print.

including mine operators and emergency responders were invited to review the models in their current state and contribute feedback to further develop the models. The workshop invitations that were distributed to industry by MSHA are provided in Appendix B.

ABS Consulting conducted three 4-hour workshop sessions over the three days. Approximately 15 industry representatives attended each session. The workshop covered four of the five models: Risk Assessment, Emergency Preparedness, Mine Rescue Team Readiness, and Responsible Person Readiness. The project team later conducted separate meetings with government and industry representatives to develop the Government and Industry Readiness Assessment Model. Appendix C presents read-ahead materials for each session. Appendix D provides the presentation materials used during the workshops.

Risk Assessment Workshop

The Risk Assessment Workshop was held on Wednesday, April 3, 2013. The risk assessment model was fully developed prior to the workshop as a draft model and presented to the workshop participants for prioritization and weighting of major risk categories. Table 6 provides a list of workshop participants.

Table 6: Risk Assessment Workshop Participants

Name	Title/ Company
Kent Armstrong	Global Business Development Manager, Draeger Safety
Chris Bise	West Virginia University
Terreal Blankenship	Patriot Coal Services, LLC
William Dean	Mine Rescue Trainer, PA Bureau of Mines
Harvey Ferrell	Mine Consultant
Jim Judd	Arch Coal
Jeff Kerch	Mine Rescue Trainer – Electrical Program Manager, PA Bureau of Mines
Jeff Kravitz	MSHA
Travis Lett	Manager of Emergency Preparedness, Patriot Coal
Larry Olsen	Arch Coal
Tom Patterson	Peapody Midwest
Rodney Shabbick	SMRT Team, PA Bureau of Mines
Jeff Stanchek	Mine Rescue Trainer, PA Bureau of Mines
Trina Tate	MSHA
Terry Theys	Director of Safety Engineering & Risk Management, Alpha Natural Resources
Jim Vicini	Chief Inspector, Arch Coal, Inc.
Chris Whitt	VA DMME

The workshop began with a brainstorming exercise where the participants were asked to describe the conditions of a "safe" and "unsafe" mine. Next, participants received hard copies of the Base Risk Model Worksheet and Recommendations Worksheet for review. The workshop group conducted a comprehensive review of the eleven base risk categories and subcategories, along with recommendations for each. Participants were asked to evaluate each subcategory and vote "yes" or "no" to the following questions: 1) is this sub-category understandable; 2) are the terminology appropriate for the mining industry; and 3) are the "questions to help frame your thoughts" sufficient? Major deficiencies or inconsistencies were discussed amongst the group, while minor edits or suggestions for improvements were written down.

Once all eleven base risk categories were reviewed, the participants were asked to prioritize and weight the categories, which would be used to build the risk assessment calculations for the model. The categories were ranked by the entire group using a voting tool and then weighted via an exercise where participants distributed "$100" across the eleven categories.

Finally, workshop participants were asked to review the Activity Risk Worksheet to assess the existing activities that can occur at a mine which would increase the risk of the mine, make suggestions for additional activities, and develop layers of protection to prevent an accident from occurring because of a particular activity. All written and verbal feedback from the workshop exercises were incorporated into the final version of the Risk Assessment Model.

Emergency Preparedness, Mine Rescue Team Readiness, and Responsible Person Readiness Assessment Workshop

The Emergency Preparedness, Mine Rescue Team Readiness, and Responsible Person Readiness Workshops were organized into two sessions – Mine Rescue Team and Responsible Person Readiness on Thursday, April 4 and Emergency Preparedness on Friday, April 5. Table 7 shows the list of attendees for the preparedness and readiness sessions.

Table 7: Emergency Preparedness and Readiness Workshop Attendees

Name	Title/ Company
Kent Armstrong	Global Business Development Manager, Drager Safety
Rob Asbury	Alpha
Charles L. Barton	MSHA
Chris Bise	West Virginia University
Terreal Blankenship	Patriot Coal Services, LLC
Hagel Campbell	MSHA
Allen Clark	VA DMME
Bob Clay	MSHA

Name	Title/ Company
Wayne Davis	VA DMME
Harvey Ferrell	Mine Consultant
Carroll Green	VA DMME
Jeff Kravitz	MSHA
Travis Lett	Manager of Emergency Preparedness, Patriot Coal
Brian Keaton	Alpha Natural Resources
David E. Smith	MSHA
Jim Vicini	Chief Inspector, Arch Coal, Inc.
Chris Whitt	VA DMME

The preparedness and readiness model frameworks were developed prior to the workshop; however the models were left open-ended for development of preparedness and readiness critical success factors during the workshop. All three models followed the same framework and were organized into three main categories - a) People, b) Equipment (Resources), and c) Process. The project team developed subcategories (e.g. Competencies, Training, Leadership) within the main categories to help frame the workshop discussion. Through individual brainstorming exercises and group discussion workshop participants generated a comprehensive list of preparedness and readiness critical success factors by subcategory.

Next, participants received a printed list of the critical success factors they developed and were asked to select the top five most important factors (where 1 is the least important and 5 is the most important) within each subcategory, as well as weight each subcategory within People, Equipment, and Process by distributing "$100" across the subcategories. The same brainstorming, ranking, and weighting exercises were used to build out all three of the preparedness and readiness models. In addition to the input gathered during the workshop, a number of workshop participants volunteered to review the post workshop draft models and provide feedback, particularly around the terminology and scoring criteria for each preparedness and readiness critical success factor.

Post Workshop Feedback

Following the Underground Coal Mine Risk and Readiness Workshop the ABS Consulting project team incorporated input from written suggestions and group discussions into the risk and readiness models. In addition, the team reached out to industry expert, Bruce Watzman, from the National Mining Association, to conduct a final review of the risk model. Mr. Watzman reviewed the safety culture assessment criteria thoroughly and recommended the following changes: 1) Remove criteria from scoring criteria which relate to the number of citations a mine has incurred; 2) Add safety culture criteria which separates a mine with "3-strong" safety culture to "4-thriving" safety culture by making it so that the mine must have completed some form of a safety culture assessment before they can rate

themselves a 4 or 5. All of the feedback received was incorporated into the final version of the Risk Assessment Model.

The majority of the team's post workshop effort was put into developing scoring criteria for each of the preparedness and readiness critical success factors generated at the workshop. Once the Emergency Preparedness, Mine Rescues Team Readiness, and Responsible Person Readiness models were complete, they were distributed to the volunteers from the SME workshop for review. Each model was reviewed by at least three industry SMEs. Feedback was provided and was incorporated into the final versions of the models, which were delivered to MSHA on June 28, 2013.

Government and Industry Participation

While the first four models were reviewed at the SME Workshop by representatives from the mining industry and emergency responders, the Government and Industry Readiness Assessment Model required input from government officials and representatives from industry associations. The project team first met with MSHA officials on May 14, 2013 to introduce the government and industry model framework and better understand government's role in responding to major mine emergencies. Table 8 provides a list of the MSHA officials who attended the meeting.

Table 8: Government and Industry Readiness Meeting Attendees

Name	Department
Jeff Duncan	EPD
George Fesak	Technical Support
George Gardner	Technical Support
Mike Hancher	MNM
Jeff Kravitz	Technical Support
Joe Main	Assistant Secretary
Patricia Silvey	Deputy Assistant Secretary
Kevin Stricklin	COAL

MSHA officials agreed to organize the model by people, equipment, and process but recommended assessing the government at three levels: Headquarters, Districts, and Technical Support. In addition, the Assistant Secretary, Joe Main, suggested developing the model as a timeline – starting with the incident and working through each phase of response. MSHA officials provided a list of internal contacts and references such as the Headquarters Mine Emergency Response Guidelines and District Mine Emergency Response Plans to assist in developing the model.

A working session on May 23, 2013 followed the initial meeting where a select group of MSHA officials and the project team reviewed the organization of the model, recommended pertinent references for review, and walked through the timeline of emergency response events. While MSHA's input was vital for developing the government assessment model, the team still lacked information from industry representatives to develop the industry readiness assessment piece of the model. Attempts to schedule meetings with industry representatives at United Mine Workers of America (UMWA) and the Bituminous Coal Operators' Association (BCOA) were unsuccessful; however, the team was able to meet with Bruce Watzman from the National Mine Association on June 18, 2013. Mr. Watzman reviewed and provided comments on the existing models and offered input into developing the industry readiness

model. He emphasized that industry's key role in terms of readiness was with providing a sufficient number of certified mine rescue teams. As such, the industry readiness portion of the model focuses in this area.

Upon completing the draft models for government and industry readiness, the team scheduled a meeting with MSHA officials on August 1, 2013 to approve the revised model assumptions and review the completed models. In addition to terminology revisions, MSHA reviewers made recommendations for a number of emergency response events to be added to the models and rearranged event order within and across the three levels of government. In addition, the working group concluded that the Technical Support level should be replaced with the Mine Emergency Response Coordinator (MERC) and events revised to match MERC responsibilities. The final version of the Government and Industry Readiness Assessment Model was produced and submitted to MSHA on August 15, 2013.

Risk and Readiness Assessment Models

MSHA reviewed the submitted risk and readiness models and provided feedback to the project team on August 21, 2013. ABS Consulting incorporated all suggested changes and submitted the final version of all five risk and readiness assessment models to MSHA on August 29, 2013, which are presented in Appendices E – I.

- Appendix E – Risk Assessment Model and Methodology
- Appendix F – Emergency Preparedness Assessment Model and Methodology
- Appendix G – Readiness Assessment Model and Methodology for Mine Rescue Teams
- Appendix H – Readiness Assessment Model and Methodology for Responsible Persons
- Appendix I – Readiness Assessment Model and Methodology for Government and Industry

Recommendations

The scope of this project was to design and develop the risk, preparedness and readiness models that mine operators and MSHA could use to manage risks in an underground coal mine, to assess the preparedness of all entities in responding to a mine emergency and to assess the readiness of various response resources with executing the established emergency response plans. Before the models can be used, it is recommended that they be calibrated to ensure that the models produce accurate, consistent and meaningful results. Following calibration, MSHA should develop a deployment strategy that takes into account sharing of the assessment results across the industry and with MSHA, reporting of the assessment results, and the issues of anonymity among those mines reporting results. Once deployed, it is also recommended that the models be tested over a period of time to ensure that the trends resulting from a series of assessments can be accurately interpreted and the models adjusted accordingly.

Calibration

Calibration of the models is necessary to ensure that they will produce consistent and meaningful results. During the calibration phase, the models should be used at selected mines to solicit feedback in the following areas.

1. **Validate the assumptions** – The assumptions used to development the models should be validated during calibration. Specifically, the assumptions about the composition of the team that would conduct the assessment, along with the frequency and amount of time the assessment actually takes, should be validated. Changes to the models should be made based on the results of this validation.
2. **Simplicity of the models** – Users of the models should be able to complete an assessment without facilitated assistance. The directions contained in the models, as well as the scorecards, should be clear, easy to understand and provide sufficient information for the assumed user to complete the assessment. The models should not be too long so as to create a burden to complete; yet they should contain sufficient details to enable mine operators to identify specific areas of strength and areas for improvement.
3. **Terminology** – While the models were developed for underground coal mining operations, and using input from SMEs with experience working in underground coal mines, terminology used in the models should be reviewed to ensure its relevancy to the industry.
4. **Factors used in the models** – The factors contained in the risk, preparedness and readiness models were developed from research and from SME input during workshops and interviews. These factors should be carefully reviewed during calibration for completeness and relevancy. Additionally, each factor contains scales that describe the relative state of risk, preparedness or readiness. The language contained in these scales should be reviewed to ensure that they are consistent among the various factors and that the language is accurate.
5. **Weighting of individual factors** – Each of the factors contained in the models are weighted based on their relatively importance. The relative weights were determined during workshops where SMEs reviewed each of the factors and assigned weights. During calibration, these

weights should be examined to ensure that the weights reflect the relative importance of the factors in each model.

Deployment of the Models

1. **Use of the Models** – MSHA should developed guidance on the use of the models to clearly communicate to the industry the intent of the models. MSHA should clearly communicate whether the use of the models would be voluntary or required. The assumptions used to develop these models should be helpful in preparing communications to the industry.
2. **Means of Deployment** – The models can be completed electronically or by paper survey method. MSHA should consider the various means to deploy the models including, posting them on MSHA's web site, direct mailing to all mine operators, or distributing to individual mines upon request.
3. **Reporting Assessment Results –** The mining industry is concerned about how the assessment results will be used by MSHA or other industry groups. MSHA should work closely with the industry and labor organizations to determine if the assessment results would be shared or reported and if so, how to ensure anonymity. One option is the use of a third-party data-clearing house where mine operators could submit assessment results anonymously. The third-party could then generate trend information to share with MSHA and the mining industry to further improve mine safety. Further, MSHA should develop clear guidance on how an assessment conducted at a particular mine would be used during an investigation in the event of an actual mine emergency.

Testing and Use of the Assessment Results

1. **Interpretation of Trends –** Once the models have been calibrated and deployed, and the issues with reporting the assessment is resolved, MSHA should consider how trend information would be used and communicated to the mining industry to improve mine safety. For example, trends with a particular readiness factor could be communicated as "safety alerts" to the mining industry or be used to target studies to further explore the issue. Trends could also be used, to celebrate improvement in mine safety across the industry. Issues with anonymity aside, MSHA could consider establishing an award program to recognize mine operators who have made significant improvements in safety, including improvement in the safety culture in their organizations, much like the "5-star crash ratings" used in the automobile industry or the sanitary ratings used by health departments in the restaurant industry. MSHA, or the third-party data-clearing house, could also provide information to individual mine operators illustrating how the results of their assessment compare against the industry.
2. **Continuous Improvement of the Models –** The models should be reviewed on a regular schedule to make improvements to the factors and scales and adjust the weights. Opportunities to review the models include real emergencies where hindsight into risk, preparedness and readiness becomes clearer. The models could also be reviewed following Mine Contests, or could even become scoring criteria for these contents.

Appendix A – Literature Review

ABS Consulting

December 2012

Literature Review of Mine Disasters and Emergency Planning and Response; Risk and Preparedness Factors

Submitted to the Mine Safety and Health Administration under Contract #DOLJ124R24842

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Executive Summary

This report provides a detailed look at the history of underground coal mine disasters and recommended preparedness factors for emergency planning and response to mine disasters based on current practices around the world. The report is organized into four sections: 1) History of Major Mine Disasters, 2) Summary of Mine Hazards, 3) Summary of Preparedness Factors for Response to Major Mine Disasters, and 4) Use of Risk and Readiness Assessment Models among Other Organizations.

A team of reviewers was assembled and organized into groups to collect data from an assigned source type: 1) Published Paper/Article, 2) Incident Investigation Report, or 3) Best Practice. Information collected in the review was captured and compiled using a Microsoft Access database designed for this project to help guide the review process and ensure the collection of relevant and consistent data.

Underground coal mining is an inherently dangerous undertaking. During the period 1900-2006, over eleven thousand underground coal mine workers died in 513 U.S. underground coal mining incidents involving five or more fatalities. Since the early 20th century, the creation of a number of mine associations and regulatory agencies, as well as changes in mine safety and health regulations have vastly improved practices. However, there are still improvements to be made as mine disasters continue to occur.

In the past 25 years alone, there have been nine major mine disasters across the United States. This report provides a summary of each of these nine disasters and a review of the loss-control failures that led to each incident. A thorough understanding of the hazards and causal factors will lead to the development of a more robust risk model.

Research was conducted to identify preparedness factors related to major mine incidents. This report includes a summary of preparedness factors, grouped into the following categories: planning, exercises, training, stakeholder outreach and engagement, and capabilities. Similarly, these factors will lead to the development of preparedness and readiness assessment models.

Planning preparedness factors include: a well-designed emergency response plan with clear lines of authority and communication protocol, testing plans and emergency response systems on a regular basis, delegating responsibilities and defining roles prior to the incident, and planning for backup teams and efforts.

Experts agree that simply having a contingency plan alone is not sufficient to be prepared for an emergency; the plan must be exercised and tested by those responsible for responding to emergencies. Exercises should be conducted in situations that simulate actual underground mine environments and conditions typically present in an emergency. Conditions for miners in a disaster scenario often include serious injuries, diminishing air supply and light and significant

uncertainty regarding activities underway to secure their rescue. Knowledge and exercises provide an opportunity for team coordination and an understanding of above surface and below surface activities to reduce anxiety levels and support calm and objective decision-making. During the exercises, bottlenecks in response procedures can be identified and removed.

Another critical preparedness factor is training, ensuring individual readiness of the people working in underground coal mines. Standardized curricula for teaching competencies should be developed, along with assessment methods for determining competency. Basic mine rescue training includes first aid, map reading, mine gases, ignition sources, the importance of adequate rock dusting, electrical and equipment safety, dust and ventilation, roof and rib control, communications, breathing apparatus, rescue and firefighting equipment gas sampling, ventilation control construction, etc. Mine rescue team training may include: verbal content for radio communications; rapid exploration and navigation ability in reduced visibility; advanced first aid, life support systems, and multiple-casualty extrication; specialized fire fighting and knowledge of the ventilation effects of fires; and incident command, problem solving, and decision-making.

Preparedness must include stakeholder outreach and engagement well before an emergency occurs. Mine operators should not wait until an event occurs to meet a key response organization for the first time. Stakeholder outreach factors include sharing resources with other operators and coordination with fire rescue/inert gas vendors and other first-responders. Families and friends in the surrounding community are also impacted by mine emergencies. Mine operators should establish family liaisons and outline the duties and responsibilities of those assigned to support families.

Capabilities (personnel, equipment, and facilities) are the final preparedness factor outlined in this report. Many preparatory measures involve physical preparations, such as stockpiling equipment and supplies and organizing response personnel. Suggested best practices and capabilities to improve preparedness include: communications systems, fire detection equipment, gas detection capabilities, Miner Act-compliant SCSRs/SCBAs, escapeway aids, and evacuations kits containing rope, chemical lightsticks, drinking water, chalk, SCSRs, a first-aid kit, brattice curtain, mine map, handheld multiple gas detector, and radio or pager phone.

The final section of this report summarizes best practices for risk, preparedness, and readiness assessment models from other countries and industries; specifically, the Australian and South African mining industry and the aviation industry. Australia's mining industry appears to be a leader in the use of a risk-based approach to mining operations. Improvements in mine safety in Australia over the last 15 years are largely attributable to the systematic and team-based use of risk assessments applied to equipment design, mining operations, and managing emergency response. The South African mining industry uses a risk assessment approach similar to Australia, although less detailed. South African mine operators use a qualitative model, such as the 4x4 likelihood and severity matrix, to assess risk.

Introduction

Scope

The purpose of this literature review is to gather information to inform the development of risk, readiness, and preparedness assessment models for underground coal mines. This review focused solely on underground coal mines; therefore, surface mines and mines for resources other than coal were not considered. Reviewers gathered information from incident investigation reports on recent major underground coal mine disasters; minor occupational injuries were not included. Nine mine disasters were identified, meeting the criteria of recent, major, and occurring at an underground coal mine. Researchers focused review efforts on hazards and causal factors leading to these nine disasters.

Further research was conducted to identify preparedness factors to improve emergency planning and response. Reviewers looked at preparedness activities that were lacking in past mine disasters, those currently in place, and those recommended by industry or other stakeholders. Preparedness factors were collected for mine operators, industry, and mine rescue teams. Finally, reviewers gathered information on best practices in the use of risk and preparedness/readiness assessment models. Best practices were recorded from other countries (e.g Australia, South Africa) and industries (e.g. aviation). These best practices for risk and preparedness models combined with an understanding of major mine hazards and recommended preparedness factors will lay the foundation for the risk, readiness, and preparedness assessment models for underground coal mines.

Methodology

The information presented in this report was gathered from existing studies, industry publications, academic databases, regulatory documents, and other physical and electronic sources. A team of reviewers was assembled and organized into groups to collect data from an assigned source type: 1) Published Paper/Article, 2) Incident Investigation Report, or 3) Best Practice. Information collected in the review was captured and compiled using a Microsoft Access database (Figure 1) designed for this project to help guide the review process and ensure the collection of relevant and consistent data.

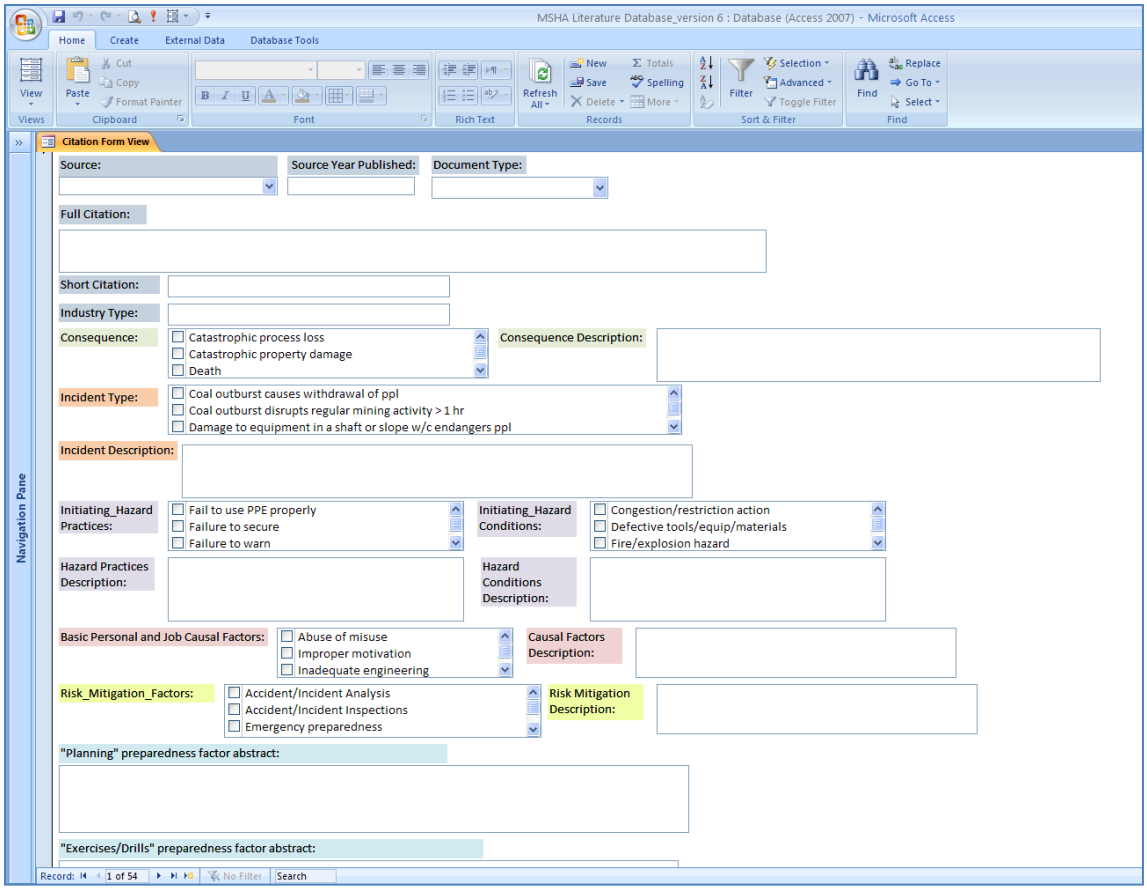

Figure 1: Literature Review Database

The Access database is organized into two main sections: features of major mine disasters and common or recommended preparedness activities for emergency planning and response. The first portion of the database uses elements of the Loss Causation Model (Appendix A – Loss Causation Model) to describe major mine disasters. The Loss Causation Model, proposed by Frank E. Bird, Jr. and George L. Germain in the early 1980s, is a "domino-effect" model that describes accidents as a chain reaction that begins with lack of control combined with causal factors to result in an incident, and ends in a loss. Using this model as a reference, the database considers risk mitigation factors, causal factors, hazard practices and conditions, incident types, and consequences to summarize major mine disasters.

The second portion of the database focuses on emergency planning and response. This section is organized into six preparedness factors: planning, exercise/drills, training, policy/procedures, stakeholder outreach, and capabilities. Each preparedness factor has a separate field in the database to capture current and recommended preparedness activities for mine operators, industry, and mine rescue teams. Together, the major mine disaster descriptions and preparedness factors provide the necessary data for a comprehensive literature review on mine disasters and emergency planning and response.

History of Major Mine Disasters

Hundreds of disasters, resulting in thousands of mine worker deaths, have occurred in mines over the last century, and most have occurred in underground coals mines. A recent NIOSH report on Underground Coal Mine Disasters by researchers Brnich and Kowalski-Trakofker provides coal mine disaster statistics over the last century. From 1900-2006, 11,606 underground coal mine workers died in 513 U.S. underground coal mining disasters (Brnich, M. J., and Kowalski-Trakofker, K. M., 2010). MSHA defines a disaster as an incident with five or more fatalities. Table 1 presents a summary of underground coal mine worker fatalities by type of disaster, from 1900 through 2008. As can be seen from this data, explosions and fires have a history of causing higher incidence of significant fatalities then the other incident types.

Table 1: Number of Underground Coal Mine Worker Fatalities by Type of Disaster, 1900-2008

Incident Type	Number of Events	Number of Fatalities	Average Fatalities by Incident Type
Explosion	420	10,390	24.74
Fire	35	727	20.77
Haulage	21	145	6.90
Ground fall/Bump	14	92	6.57
Inundation	7	62	8.86
Other	17	199	11.71

The industry has shown continuous efforts to improve mine safety over the years. Significant progress has been made since the first decade of the 20th century; a decade that witnessed 16 mine disasters (primarily explosions) that resulted in 2,070 deaths (Brnich, M. J., and Kowalski-Trakofker, K. M., 2010). Much of this progress can be attributed to changes in mine safety and health regulations, as well as the creation of the Bureau of Mines in the early 20th century and the other associations and regulatory bodies that followed over the years. Still, there are improvements to be made as mine disasters continue to occur. In the past 25 years alone, there have been nine mine disasters across the U.S. A brief description of each of these nine disasters is provided below. A detailed description of each disaster, including a summary of the loss causation factors that led to each incident, is provided in Appendix B – Loss Causation Analysis

Wilberg Mine Disaster (1984): On December 19, 1984 a major coal mine fire broke out at the mouth of the 5th Right longwall section of the Wilberg Coal mine in Orangeville, Utah. According to the United States Mine Rescue Association (USMRA), minutes after the fire broke out, smoke and lethal gases traveled 2,400 feet down the Fifth Right tunnel to the working face of the longwall. One miner escaped, but eighteen miners and nine company officials were trapped and killed. In the spring of 1987, MSHA ruled that the Wilberg fire was caused by a faulty air

compressor, allowed to run unattended in a non-fireproofed area. MSHA issued thirty-four citations against the mine's operator, Utah Power and Light and Emery Mining Company; nine of the citations were for violations that directly contributed to the disaster. MSHA itself received strong criticism from the United Mine Workers of America (UMWA), in part for failing to issue these same citations when it inspected the mine only days before the fire. The union also questioned MSHA's focus on the cause of the fire rather than the cause of the deaths, insisting that miners died, not because there was a fire, but because they had no escape route.

Loveridge No. 22 Mine Disaster (1986): On February 6, 1986, a coal pile collapsed at the Loveridge No. 22 mine in Marion County, West Virginia. According to the USMRA, seven company and contractor officials walked to the top of a raw coal pile to inspect the damage in the rails of a tripper belt structure discovered the day before. Five minutes into the inspection, a section of the coal pile that was four to six feet in diameter suddenly collapsed, suffocating five individuals and injuring two others. MSHA investigators attributed the development of the crater to the normal operation of a feeder beneath the coal pile that was designed to move coal from the pile to a processing plant, and attributed the accident to the failure of management to prevent the development of such craters and to detect their existence. MSHA also determined that management contributed to the disaster by permitting people to walk and stand on the coal pile while reclaiming operations proceeded.

William Station No. 9 Mine Disaster (1989): On September 13, 1989, an explosion occurred on Longwall Panel "O" at the William Station Mine, No. 9 Slope, located in Sullivan, Kentucky. According to the USMRA, fourteen miners were present in the longwall recovery area at the time of the explosion. Ten died as a result of the explosion; four escaped despite being exposed to high concentrations of carbon monoxide and smoke. MSHA investigators concluded that the primary cause of the explosion was the failure of management to maintain a sufficient volume and velocity of air in the proper direction in the 4th West entries and longwall face to dilute, render harmless, and carry away methane accumulations in that area.

Southmountain No. 3 Mine Disaster (1992): On December 7, 1992, an explosion occurred on the 1 Left section of Southmountain Coal Co. Inc's No. 3 Mine at Norton, Virginia. According to the USMRA, eight miners were killed and another miner working in an outby area was injured. The methane explosion resulted in sufficient forces and flames to suspend and ignite coal dust in 1 Left. The coal dust explosion continued to propagate the entire distance of the No. 1 West Main entries to the surface area of the mine. MSHA investigators concluded that an open flame from a cigarette lighter found on the mine floor was the ignition source. Persons

were smoking in the mine, and the operator's smoking search program was not effective. One cigarette pack containing nine unsmoked cigarettes was found on a victim located at the point of origin, and ten smoked cigarettes were found in his pockets. In addition, the bleeder system was not examined or maintained to continuously move methane-air mixtures away from the active faces, and ventilation controls, both permanent and temporary, on the active working section had been removed or unmaintained.

Jim Walter Resources No. 5 Mine Disaster (2001): On September 13, 2001, two separate mine explosions occurred at the Jim Walter Resources No. 5 Mine in Brookwood, Alabama, killing 13 miners. According to a NIOSH report on underground coal mine disasters, the first explosion occurred after roof fall at a scoop battery charging station. The fall damaged a scoop battery and ventilation controls, and an arc flash from the damaged scoop battery ignited methane. The explosion damaged critical ventilation controls and injured four miners who were working in the affected section. Three of the miners escaped while the fourth was left behind because of the seriousness of his injuries. The second explosion occurred as 12 miners made their way to rescue the miner left behind. This explosion was most likely caused when a signal light system ignited methane in the track entry. At least 12 miners were killed by the second explosion, and the miner left behind from the initial explosion did not survive. MSHA admonished the mine owner, Jim Walter Resources, for having "no responsible person who took control of the situation" during the accident. The agency also declared the mine's firefighting plan inadequate.

Sago Mine Disaster (2006): On January 2, 2006, an explosion occurred at the Sago Mine in Tallmansville, West Virginia, killing 12 miners. According to the USMRA, a methane ignition in a recently sealed area of the mine triggered an explosion that blew out the seals and propelled smoke, dust, debris and lethal carbon monoxide into the working sections of the mine. One miner was killed by the blast. Sixteen escaped. Twelve were unable to escape and retreated to await rescue behind a curtain at the face of the Two Left section. Mine rescuers found the trapped miners approximately 41 hours later. By that time all but one had succumbed from carbon monoxide asphyxiation. MSHA identified root causes as: 1) The 2 North Main seals were not capable of withstanding the forces generated by the explosion, 2) The atmosphere within the sealed area was not monitored and it contained explosive methane/air mixtures, 3) Lightning was the most likely ignition source for this explosion with the energy transferring onto an abandoned pump cable in the sealed area and providing an ignition source for the explosion.

Following the disaster, the UMWA emphasized a need for better regulation in: requirements for seals, mine rescue teams, emergency shelters, communications, MSHA responsibilities as a watchdog, tracking devices, oxygen, and mine operator responsibilities.

The Sago Mine Disaster is unique in that it occurred at a time when U.S. mine safety was setting new records annually, and the mine management, for the most part, was following industry standards and procedures. The shock that hit the industry, as a result of the Sago Mine disaster, ushered in significant changes in mine safety through federal legislation (e.g. The MINER Act of 2006).

Darby No. 1 Mine Disaster (2006): On May, 20 2006, an explosion occurred at Darby No. 1 Mine in Harlan County, Kentucky killing 5 miners and injuring another. A NIOSH report on underground coal mine disasters describes the incident: after the afternoon shift ended, two miners stayed behind to cut roof straps near a ventilation seal in the return airway. At the same time, the midnight shift crew was entering the mine. Shortly after the afternoon shift crew reached the outside, an explosion occurred in the mine. The two miners performing the cutting work died in the explosion, and three miners from the entering midnight shift crew died while trying to escape. One miner survived and was able to travel part of the way towards the mine entrance wearing his self-contained self-rescuer (SCSR); he was later rescued. According to the USMRA, the accident occurred because the operator did not observe basic mine safety practices and because critical safety standards were violated. Mine management failed to ensure that proper seal construction procedures were utilized in the building of the seals at the A Left Section. Mine management also failed to ensure that safe work procedures were used while employees attempted to make corrections to an improperly constructed seal. Furthermore, mine management failed to adequately train miners in escapeway routes and proper SCSR usage.

Crandall Canyon Mine Disaster (2007): On August 6, 2007, a major coal bump or bounce occurred on the Main West pillar section at Crandall Canyon Mine in Carbon County, Utah. According to MSHA, six miners were killed in a catastrophic coal outburst when roof-supporting pillars failed and violently ejected coal over a half-mile area. Ten days later, two mine employees and an MSHA inspector perished in a coal outburst during rescue efforts. MSHA attributed the disaster to inadequate mine design, flawed engineering analysis, inadequate engineering management review, and withholding of information and failure to revise mining plan following prior coal bursts.

Upper Big Branch Mine Disaster (2010): On April 5, 2010, a massive coal dust explosion occurred at the Upper Big Branch Mine-South in Montcoal, West Virginia. According to the MSHA Fatal Accident Report, the explosion was the largest coal mine disaster in the United States in 40 years, killing 29 miners and injuring two. MSHA identified the source of the explosion as a small amount of methane, likely liberated from the mine floor, accumulated in the longwall area due to poor ventilation and roof control practices. The physical conditions that led to the explosion were the result of a series of basic safety violations. While violations of particular safety standards led to the conditions that caused the explosion, the unlawful policies and practices implemented by PCC/Massey were the root cause of this tragedy. The evidence accumulated during the MSHA investigation demonstrates that PCC/Massey promoted and enforced a workplace culture that valued production over safety, including practices calculated to allow it to conduct mining operations in violation of the law. MSHA identified specific management practices of the mine operator that led to the explosion as: failure to perform required examination adequately and remedy known hazards and violation of law; maintaining two sets of books to conceal hazardous conditions; intimidating miners to prevent MSHA from receiving evidence of safety and health violation and hazards; failure to provide adequate training to workers; and establishing a regular practice of giving advance notice of inspections to hide violation and hazards from enforcement personnel.

Summary of Mine Hazards - Basic and Immediate Causes

Most of the coal mine disasters in history can be traced to one or more hazards or causal factors. Investigators and researchers take different approaches to categorizing hazards, but ultimately they want to know what led to the incident and the resulting loss. A thorough understanding of the hazards and causal factors will lead to the development of a more robust risk model.

The Loss Causation Model illustrated in Appendix A – Loss Causation Model is one approach to describing mine incidents and identifying hazards. The model is organized into three stages: the "pre-contact" stage (first three dominos), the "contact" stage (incident domino), and the "post-contact" stage (loss domino). Oftentimes, emphasis is on the fourth and fifth dominos, incident and loss; but to further reduce coal-mine disasters, efforts must be taken to stay away from conditions which, under many circumstances, may result in an undesired contact or incident. Authors of the Loss Causation Model, Bird and Germain, proposed that preventing the first three dominos from falling is the key to accident prevention, along with the understanding that there is a shared responsibility between management and workers for workplace safety.

The review team utilized the first three dominos of the Loss Causation Model: 1) Lack of Control, 2) Basic Causes, and 3) Immediate Causes, to analyze incident investigation reports for the nine major mine disasters in recent history and identify loss-control failures that led to each disaster. The first domino, Lack of Control, represents those steps not taken by management which result in a failure to maintain acceptable standards, such as proper training, rules, communication, inspections, or recordkeeping. Any mistakes here enable incident progression. The second domino, Basic Causes, are those shortcomings of personnel or the design of the job or workplace which further amplify hazards. An example of a personnel basic cause is lack of skill, while an example of an inadequate job factor would be poorly maintained equipment. Finally, the third domino, Immediate Causes, is the combination of substandard practices and/or conditions which will trigger the incidents. A substandard practice would be the failure to use lock-out / tag-out on electrical equipment being repaired, while a substandard condition would result if the environment were allowed to deteriorate, making an explosion hazard possible.

Table 2 provides a summary of the loss-control failures specific to recent mine disasters; Appendix A – Loss Causation Model includes a comprehensive list of loss-control failures.

Table 2: Loss-Control Failures of Recent Mine Disasters

	LACK OF CONTROL								BASIC CAUSES								IMMEDIATE CAUSES													
	Failure to Maintain Compliance with Standards for:								Personal Factors			Job Factors					Substandard Practices								Substandard Conditions					
	Leadership & Administration	Management Training	Planned Inspections	Task Observations	Emergency Preparedness	Organizational Rules	Employee Training	Engineering Controls	Lack of Knowledge	Lack of Skill	Improper Motivation	Inadequate Leadership or Supervision	Inadequate Engineering	Inadequate Purchasing	Inadequate Maintenance	Inadequate Tools, Equipment, Materials	Failure to Warn	Failure to Secure	Making Safety Decives Inoperable	Removing Safety Devices	Using Defective Equipment	Failing to Use PPE Properly	Improper Position for Task	Servicing Equipment in Operation	Inadequate Guards or Barriers	Inadequate or Improper Protective Equip	Inadequate Warning System	Fire & Explosion Hazards	Poor Housekeeping: Disorder	Inadequate Ventilation
Wilberg	X				X		X	X	X			X	X			X				X		X			X	X	X	X		
Loveridge No. 22		X										X											X							
William Station No. 9			X					X			X	X	X				X													X
Southmountain No. 3	X		X					X			X	X	X						X	X					X			X	X	X
Jim Walter No. 5				X	X				X			X	X					X								X				
Sago		X	X		X			X	X				X	X												X	X		X	X	
Darby	X	X					X		X	X	X	X	X					X				X			X					
Crandall Canyon						X		X				X	X				X								X					
Upper Big Branch	X										X	X			X			X			X			X		X		X		X

By examining hazards and causal factors involved in recent mine disasters, a number of observations can be made. First, Table 2 reveals a total of thirty separate loss-control failures across the nine major disasters. Second, it is apparent that some disasters have more associated causal factors than others; for example, fourteen different factors were identified in the Wilberg disaster and just three in the Loveridge disaster two years later. Still, it only takes one loss-control failure to cause a disaster. Finally, some loss-control failures are more prevalent in mine disasters than others. Leadership and Administration and Engineering Controls are the most common loss-control failures in the first category, Lack of Control. This is usually attributed to a flaw in the management team. Similarly, Inadequate Leadership or Supervision and Inadequate Engineering are the most frequent loss-control failures under the second category, Basis Causes. Lastly, substandard conditions outweigh substandard practices in the Immediate Causes category, with Inadequate Guards or Barriers being the most common loss-control failures.

Summary of Preparedness Factors for Response to Major Mine Disasters

Preparedness can be defined as the state of being prepared or the state of adequate preparation for an emergency or other undesired but predictable event (Merriam-Webster, 2012). The Federal Emergency Management Agency (FEMA) describes preparedness as “being ready” for an emergency (FEMA, 2012). One of the most developed types of preparedness is "Disaster Preparedness," defined by the UN as involving "forecasting and taking precautionary measures prior to an imminent threat when advance warnings are possible" (Kent, 1994). Preparedness comprises understanding the threats, constructing the scenarios, determining the responses, planning the capability and capacity to execute the response, and implementing the plan – training, equipment, communication, governance, etc. Preparedness can be thought of as a system that includes stakeholder outreach and engagement, policy and procedures, a contingency plan, mine operator capability, non-mine operator capability, team training and exercise, and evaluations. Once preparedness plans are developed, readiness is a measure of the ability to execute plans on demand.

To be prepared for an emergency, concrete actions should be taken as preparatory measures. These measures can include physical preparations, such as stockpiling equipment and supplies, as well as conducting training and drills for people involved in the emergency response. For example, fire extinguishers are provided in public buildings, evacuation plans developed and posted, and fire drills are conducted to ensure that the building occupants are ready for a fire, should it occur.

Research was conducted to identify preparedness factors related to major mine disasters. This section includes a summary of preparedness factors grouped into the following categories: planning, exercises, training, stakeholder outreach and engagement, and capabilities.

Planning

Developing and practicing contingency response plans for mining emergencies is considered a critical preparedness factor.

NIOSH suggested that the use of information in emergency response plans could be improved (Alexander, 2012). Incorporating an auditing system, such as that found in ISO 9001-type systems, which could provide mechanisms for continuous improvement, can do this. Internal audits of emergency response plans could identify where information needs to be corrected or updated or where processes and procedures need to be revised. External audits of these plans could be used to ensure compliance with established emergency response procedures. External auditors would observe use of the emergency response plans during exercises or by reviewing port-incident responses to a real emergency. In all cases, lessons learned must be incorporated into revisions to emergency response plans. Clear lines of authority and responsibility are absolutely necessary for inclusion in emergency response plans. Mine Emergency Command System (MESC) functions must be addressed in mine emergency plans as well.

Mine Rescue Guidelines developed in 2011 provide mine operators with an approach to developing emergency response plan, stressing that effectiveness, not efficiency, is the key to successful mine rescues (Cliff, 2011). All plans and emergency response systems should be tested on a regular basis and any capability gaps and procedural bottlenecks to an effective response identified and removed. During an actual emergency response, the chain of command must be clear and not disrupted. Access to planned resources must be available 24 hour a day. Cliff (2011) also suggested that mine operators should use the results of risk analysis of past mine emergencies to identify detailed scenarios for which to prepare.

One of the most important elements of an emergency plan is a communication protocol that includes notification of key officials—and especially responders—immediately after discovery of an emergency (Conti, 2005). Communication, protocol, and leadership skills can be taught, and assessing those skills occurs either through simulated practice or real events. A competent person, with training and experience, on-site is key to ensuring that the actions in the response plan are carried out. Having a single "responsible person" with the capability (external to the person such as systems and procedures) and ability (personal knowledge, skills and abilities) to take charge of a situation, know what to do, have situational awareness and manage the operation is one of the most critical requirements to deal with the confusion that immediately follows a disaster. In addition to training, the individual's knowledge must be current to the minute of who is on site, where they are, and the status of all first responders.

Conti, Chasko, Wiehagen, and Lazzara (2006) addressed planning factors for responses to fires in mines in their report, *Fire Response Preparedness for Underground Mines*. The report includes a checklist for underground coal mine fire preparedness and response along with a written emergency plan with communications protocol for notification of key officials and responders, surface organization, facilities, and outside sources of assistance for support purposes.

The Mine Safety Technology Commission, chartered after the Sago and Darby incidents, in their Report to Congress, suggests that mine operators should systematically identify the risks for an explosion, fire, or inundation at each mine (Grayson, 2006). The commission also recommended that a comprehensive approach, founded on the establishment of a culture of prevention, be used to focus employees on the prevention of all accidents and injuries.

Many mines are small and/or in remote locations and not able to support the full range of services necessary to support an emergency. In this case, mine management should establish resource sharing agreements with other mines and local first responding agencies. The agreements should also take into account allocation of assets and resources to prevent duplication and capability gaps. This level of coordination will also require extensive communications planning and it is necessary to test and exercise the Preparedness Plan as a system of participating entities.

Researchers at the University of Wollongong in Australia identified ways of optimizing the information collection and reporting processes used in emergencies in underground coal mines to ensure rapid and effective response, minimizing the risk to life. The main findings of this project were that the emergency management systems (EMS) often used seemed to be no more than a paper document that had not been properly tested. Most mines had not formally identified what information would be necessary in an emergency; particularly, what would be required to ensure rapid re-entry for rescue purposes. There is an urgent need to define the minimum information requirements. Incident action plans (IAP) must include actions, person responsible for carrying out the action, and the status of the action. IAPs must be reviewed at regular meetings, including status of outstanding actions (Cliff, 2010).

Emergency management is the collective arrangement of personnel to plan for, mitigate/control, respond to and recover from an emergency. It provides for a structured framework for completing all perceived activities in an emergency situation. Emergency management ensures a solid, complete and collaborative arrangement of personnel, resources and services. The West Virginia Office of Miners' Health, Safety and Training and West Virginia University - Mining Extension Service developed a comprehensive preparedness planning manual for underground mining operations (WVU, 2008) and suggested that emergency preparedness plans should include:

- risk management activities,
- prevention and/or control measures,
- response procedures and guidelines, and
- recovery efforts.

Each of these components requires training, drills and periodic revisions. A well thought out emergency preparedness plan can alleviate confusion that is often present during an emergency response. The major benefit of an emergency preparedness plan is that it requires the mining operation to consider the types of risks the operation might face.

The success of the emergency preparedness plan depends heavily on the support of the chief executive officer or owner of the mining operation. Usually, the safety director/manager at the mining operation is given the overall responsibility for developing the plan. A person from upper management should be on the team. This person demonstrates management's commitment to the plan and can provide the necessary budgetary resources for completing the plan. People from the following departments or functions should be members of the planning team:

- General Mine Manager/Superintendent
- Mine Foreman
- Maintenance Manager/Supervisor
- Labor Representative
- Safety Manager/Director
- Human Resources Manager
- Engineering Manager/Supervisor
- Security Director

A mission statement, developed by the highest ranking member of management should be included in the emergency preparedness plan to define the purpose of the plan and indicates that it will involve the entire operation.

The management team should also review plans on a regular basis to ensure that they are current. This review consists of any company plans and policies as well as any state or federally mandated regulations. A few of the MSHA required plans include:

- Mine Emergency Notification Plan (30 CFR Part 49.9)
- Mine Emergency Evacuation and Firefighting Program of Instruction (30 CFR Part 75.1502)
- Various Training Plans (30 CFR Part 48)
- Duties of the Responsible Person (30 CFR Part 75.1501)
- Emergency Response Plan (Miner Act, Section 2)

Internal plans of the mining company that are reviewed include:

- Safety and health policies
- Fire prevention and protection plans
- Evacuation procedures
- Stockpile safety procedures
- Security procedures
- Mutual aid agreements
- Insurance plans
- State and federal emergency response actions

In developing or revising the emergency response plan, it is important that the planning committee meet with the following agencies:

- Local emergency management group
- Fire department
- Local and state police
- Emergency medical services
- Telephone and other utility companies
- Supply vendors (including food caterers and motel owners)
- American Red Cross
- Other local community organizations
- Drilling operators

Table 3 presents the key components of a mine emergency preparedness plan (WVU, 2008).

Table 3: Mine Emergency Preparedness Plan Components

Mine Emergency Preparedness Plan

• DESIGN:
  ○ Include all types of emergencies that effect mining operations.
  ○ Who will lead and make decisions?
  ○ What procedures are in place?
• CORE ELEMENTS OF THE PLAN:
  ○ Planning – management and labor explore options to prevent or reduce consequences
  ○ Prevention – risk assessments and analysis
  ○ Preparation – training, drills, revisions
  ○ Response
  ○ Recovery
  ○ Agreements with other mines and first responders

- PLANNING TEAM:
  - Director/manager
  - People from various departments
  - Upper management
  - Labor representatives
  - Recorder/secretary
- REQUIRED PLANS:
  - Notification plan 30 CFR 49.9
  - Emergency evacuation and firefighting instruction 30 CFR 75.1502
  - Training plans 30 CFR 48
  - Duties of the responsible person 30 CFR 75.1501
  - Emergency response plan
  - Communication plan
- ANALYZING CAPABILITIES AND HAZARDS:
  - Stakeholder engagement / involvement
  - Internal/external resources – Do we have the needed internal and external resources and capabilities to respond?
  - People
  - Equipment
  - Facilities
  - Organizational
- RISK ASSESSMENT:
  - Evaluate hazards in mining operation. A hazard is an event leading up to or causing a major mine emergency. Good sources include historical knowledge, accident reports, and inspection reports.
  - Risk analysis – hazards most likely to occur and to produce the worst consequences – target for immediate actions.
  - Identify type of risk and root cause.
  - Consequence rankings
  - Probability rankings
  - Types of emergencies

The West Virginia Office of Miners' Health, Safety and Training and West Virginia University - Mining Extension Service planning manual offer a recommended approach to developing, testing and implementing emergency preparedness plans (WVU, 2008). This approach is presented in Table 4.

Table 4: Mine Emergency Preparedness Planning Approach

A Recommended Approach to Emergency Preparedness Planning

• DEVELOP THE PLAN
  ○ Direction and control
  ○ Communications
  ○ Facilities and arrangements
  ○ Incident command system
  ○ Emergency response procedures
  ○ Response time
  ○ Miners on shift
  ○ Training
  ○ Equipment
  ○ Outside resources
  ○ Recovery phase
• TEST THE PLAN
  ○ Table top exercise - annually
  ○ Functional exercise – every 90 days
  ○ Full scale – every 3 years
• IMPLEMENT THE PLAN
  ○ Build awareness – new and seasoned employees
  ○ Educate/train – annually, refresher
  ○ Test procedures
  ○ Lessons learned – collect and incorporate

During the Technology Transfer Seminar in 2010, mining experts discussed important factors for mine emergency preparedness (Kravitz, 2010). These factors include conducting risk assessments and analysis for mitigation actions, identifying hazards (including fire), assessing risks involved with hazards, and identifying management actions to eliminate, control, and reduce risks. Protocols for administering the risk management processes should also be developed and implemented.

Mine operators should plan for contingencies in Emergency Response Plans by developing "What If" scenarios. This provides the context for developing response procedures. Planners should also include a Mine Emergency Organizational Structure, surface surveys of the mine that identify key underground locations on the surface. Contact information for knowledgeable surveyors must be included in plans and be kept up to date. Mine operators should also check the reliability of any electronic GPS devices to ensure these devices work during inclement weather.

The Mine Safety Technology and Training Commission developed a management plan to address the significant hazards identified by risk analysis and stressed that simple regulatory compliance alone may not be sufficient to mitigate significant risks (Mine Safety Technology and Training Commission, 2006). The Commission recommended developing strategic workforce and succession plans to identify and plan for key personnel requirements. Key team management positions such as team coordinator and trainer should also be identified, and in some cases full-time mine rescue personnel may be justified. Mine operators should develop mine rescue management plans that look at the hazards, decisions, and actions that could be taken for any given situation by miners, managers, mine rescue teams, and incident management teams. Using a risk management-based process, more likely scenarios would be assessed for hazards and interventions taken to reduce the risks.

MSHA representatives have identified important preparedness factors. Mine operators should consider the following factors when developing emergency response plans (MSHA 2010):

- Family member support (facilities, food, etc.),
- Pre-arrangements with a mine rescue team, including response times, availability/level of competency/quality,
- Entrapment planning including, driller availability, surveyor availability, missed hole back-up plan, pre-located key underground locations on the surface above the mine,
- Plans for miner location or extracting injured miners; mine emergency organizational structure (Command Center management/staff),
- Ensure that new technology and equipment is compatible and interchangeable, and develop SOPs.

Other research provides insights into how mine operators can best be prepared to make decisions about the types of problems common to emergency response by focusing on the importance of situation-specific knowledge versus mental process skills (Vaught, Brnich, Mallett, 2004). In a mining context, both approaches have value and should be considered as interrelated. Many of the lessons learned stress sharing and delegating responsibilities, and defining roles prior to the incident to avoid confusion and overload. Mine operators should plan for backup teams and efforts prior to the emergency (e.g. fresh people, supplies). Mine operators should also develop a strategy for having appropriate personnel available when required. Planners should develop a list of who should be contacted during the emergency and the people cleared to go underground. Planners should also ensure that the mine map is always current. To improve preparedness, mine operators should have a well-designed emergency response plan and should practice responding to emergencies.

Exercises

Most experts agree that simply having a contingency plan alone is not sufficient to be prepared for an emergency. An effective method of improving preparedness is to test the emergency

response system during an exercise (Cliff, 2011). The plan must be exercised and tested by those responsible for responding to emergencies. During the exercises, capability gaps and procedural bottlenecks can be identified and removed.

Exercises should be conducted in situations that simulate actual underground mine environments and conditions typically present in an emergency. Responders should participate in quarterly drills and practice donning Self-Contained Self Rescuer (SCSR) devices. Drills should include situations requiring rescuers to communicate while wearing SCSRs, which has proven to have a positive effect on miners' skills (Alexander, 2012). Mine operators should conduct annual mine-wide emergency response exercises so that all personnel are aware of the actions that need to take place. Mine operators should also include self-rescue drills to help improve the skills of individual miners. Fire drills are an important part of the plan and are required at 90-day intervals or more frequently. The main purpose of the drill is to test certain aspects of the emergency plan (Conti, 2005). Mines need to regularly carry out emergency training exercises that require the convening of incident management teams and the interaction with offsite stakeholders (Cliff, 2011).

Some best practices for emergency response exercises include conducting outdoor firefighting drills that involve hands-on use of fire extinguishers, hoses, and other equipment and navigation in poor visibility conditions such as smoke filled areas (Bealko, Alexander, Chasko, and Grayson, 2009). Conti, Chasko, Wiehagen, and Lazzara (2006) also endorse exercises and drills that involve the hands-on use of firefighting equipment, simulated response to fires involving battery-charging station, conveyor belt drive, or power center, as well as hands-on practice in extinguishing liquid and solid fuel fires with portable fire extinguishers and water.

The use of contests to test responder's skills is also a common practice. In the Saskatchewan Mining Association's Annual Emergency Response/Mine Rescue Skills Competition, for example, sixteen teams of six mine rescue professionals from mines in the province compete against one another in surface and underground competitions (Livingstone, 2012). One team coordinator describes the event: "They do a firefighting component (that's using handheld fire extinguishers), another event is what we call a 'surface problem' (which is a main problem that could consist of high-angle rope rescue, search and rescue, etc.), there's a practical skills (which could be anything from wearing our self-contained breathing apparatus, to rope, to rescue, to how to tie knots), there's a first-aid component and then you write an actual, practical test as well as a gas test."

In 2006, the Mine Safety Technology and Training Commission studied ways to improve mine safety. The commission identified three key skill/knowledge areas that are critical to the ability of miners to escape or be rescued during a mine-wide emergency (Mine Safety Technology and Training Commission, 2006). These areas include:

- Knowledge of Escape/Rescue Technologies
- Mine-Specific Knowledge
- Escape/Rescue Conceptual Knowledge

In addition to contests required by federal regulations, (30 CFR Part 48) which include participation at least annually in two local mine rescue contests, the commission suggested that operators should devise exercise plans that will help them practice all aspects of emergency response. The commission members suggested that it is important that these drills exercise the plans that mines intend to use in the event of an emergency, to include testing procedures for family relations, media relations, and command center management. Operators should then use the results of the exercises to refine their plans. Command center exercises that include interactions with teams should be conducted regularly, and at least a few command center personnel should train with their mine rescue teams (Mine Safety Technology and Training Commission, 2006).

In their research on mine emergency response, one expert discussed the efficacy of using simulations in a classroom or in the offices at a mine site to train both command center personnel and other individuals involved in response: "All the little things that seem to be taken for granted - you run personnel through a couple of exercises and you suddenly find out, 'I never thought of that.' And [the exercise] brings all these little things to the front" (Vaught, Brnich, Mallett, 2004).

Training

A critical component of preparedness is the individual readiness of the people working in underground coal mines and the people involved in the response to a mine emergency. This section provides an overview of important training factors.

NIOSH conducted research on strategies for improving escape and rescue from underground coal mines. Researchers identified competencies for all mine personnel, including (Alexander, 2012):

- Basic mine rescue skills and practices in relation to contest and real-life rules, first aid, map reading, mine gases, ignition sources, the importance of adequate rock dusting, electrical and equipment safety, dust and ventilation, roof and rib control, communications, breathing apparatus, rescue and firefighting equipment gas sampling, ventilation control construction, etc.
- Verbal content for radio communications.
- Rapid exploration and navigation ability in reduced visibility (smoke or dust) while working under apparatus.
- Advanced first aid, life support systems, and multiple-casualty extrication (e.g., an EMT or paramedic on each team).
- Specialized fire fighting and knowledge of the ventilation effects of fires.
- Gas analysis, sampling, and trend analysis.

- Incident command, problem solving, and decision-making.
- Refuge chamber rescue.

NIOSH researchers also identified some additional skills that would enhance escape and rescue, including:

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

Standardized curricula for teaching competencies should be developed, along with assessment methods for determining competency. Minimum proficiency levels should be established for all miners, with remediation training required for those falling short of the minimum levels. Individuals assessing the training and competency levels should also receive some form of assessor qualification (Alexander, 2012).

The training should be realistic and simulate, as much as possible, the actual conditions and environment that miners would encounter during a mine emergency. Centralizing mine rescue team training at especially designed training facilities could facilitate this (Alexander, 2012).

While mine rescue contests are important parts of training, these contests rules need to change to be more realistic, held in real or simulated coal mines and emphasize realistic conditions expected in a mine emergency. The contests need to assess emergency response skills and provide on-the-spot mentoring (Alexander, 2012).

Mines need to significantly increase the training carried out in emergency preparedness and response especially in the management of incidents. There is also a need to define an industry wide competency for control room operators. The use of duty cards to list roles and responsibilities are helpful when assigning personnel roles that they are not familiar with at a junior level (Cliff, 2011).

NIOSH researchers also identified additional improvements that should be made to escape and rescue training (Alexander, 2012). These include:

- Increasing emphasis on developing individual miner self-rescue evacuation skills.
- Standardizing safety-rescue techniques. Safe-rescue could be improved by better prioritization, combining resources and a focus on real-life training and rapid response methods rather and contents.
- Incident command system training could be improved by standardizing the curriculum and teaching methods and including ICS use in exercises and drills.
- Self-escape or seek refuge decision-making training.

- Changing air supply on SCSR without removing facemask.
- Training in use of refuge alternatives should be quarterly.
- Self-escape vs. refuge chamber decision making training.
- Competency in giving and receiving emergency warning messages.
- Basic training in radio use.
- Supervisor competencies in how to use communications and tracking systems.
- Expectations training while wearing SCSRs.
- Skills among mine rescue teams varied widely – no link between content performances an emergency performance has been established.
- Cross-training of mine rescue skills needed among 6 team positions. Only small percentage of mine rescue teams adopt this practice.
- Training enhancement needed among all coal mining rescue training facilities.

In 2012, NIOSH identified 166 mine rescue teams in the United States. To maintain the skills of these teams, 120 mine rescue teams need to be trained each year. There are ten coal mining training facilities in the U.S. but these facilities are not sufficient to meet the training demands of mine rescue teams. Two additional training facilities are needed (Alexander, 2012).

NIOSH also published Information Circular 9481, which pertained to fire rescue preparedness in underground mines. NIOSH suggested that training in fire detection is critical. Also, evacuation and escape routes must be known and understood by all miners and suggested that drills and exercises be conducted in smoke-filled conditions. Hands-on practice on the use of fire extinguishing devices should be conducted on a regular basis (Conti, 2005). Federal regulations (30 CFR 75.383) include requirements to walk escapeways and participate in fire drills every 90 days. On-the-job training and exercises simulating real emergencies are a best practice.

An inventory of mine rescue training facilities was conducted in 2009. A report documenting the inventory include a list of standardized skills training for basic mine rescue competencies (Bealko, Alexander, Chasko, and Grayson, 2009). This training includes:

- basic mine rescue,
- contest and real-life rules,
- first aid, map reading,
- mine gages,
- dust and ventilation,
- communications,
- breathing apparatus,
- rescue and fire-fighting equipment,
- gas sampling,
- ventilation control.

The report also included a list of basic mining skills and knowledge, including;

- roof and rib control,
- shoring and cribbing standing support,
- sources of ignition,
- the importance of adequate rock dusting,
- equipment safety,
- electrical do's and don'ts,
- problem-solving and decision-making,
- advanced first aid and life support systems,
- specialized fire fighting,
- ventilation effects of fires,
- gas analysis, sampling, and trend analysis,
- location and transport of injured miners (thermal imaging cameras),
- incident-command,
- utilizing back-up teams,
- heavy object removal,
- confined space rescue,
- vertical-rope rescue,
- still and swift water rescue.

Conti, Chasko, Wiehagen, and Lazzara (2006) also suggested that training preparedness factors include: classroom-based simulations on critical decisions and communication; training in the use of fire extinguishers, water hoses, and firefighting procedures through fire drills and safety meetings; on-the-job-fire prevention training including walk-around inspections, periodic machine maintenance, good housekeeping practices; basic fire chemistry; assessment of the size of the fire, types of portable fire extinguishers, hose lines, water nozzles, and compatibility of fittings; mine evacuation procedures and scenarios; understanding the operations of fire sensors and suppression systems.

Training miners to escape (or be rescued) during a mine emergency must be based on a comprehensive emergency response plan that is risk-based and mine-specific. All mine operators must prepare for emergencies and train miners thoroughly on their emergency response/rescue plan(s) (Grayson, 2006). In order to better identify "training for preparedness" needs, the industry needs to improve methods of evaluating miners' competencies. The performance of miners, mine managers and responsible persons on the surface should be evaluated during emergency response drills and mock-disaster exercises. In addition, actual mine-wide emergency incidents and near-miss events should be analyzed to identify "lessons learned" (Grayson, 2006).

A security and emergency response superintendent at a mine in Esterhazy pointed out that while each team member is required to train a minimum of 90 hours a year it is not uncommon for them to get up to 200 hours of training a year due to the demands of competition and personal development (Livingstone, 2012). Mine rescue training is multi-discipline. "The mine rescue people are first-responders, so that's a 40-hour first aid course. They have to be familiar with, first and foremost, their breathing appartus." Mine rescue training at the Esterhazy mine is continuous and includes mine ventilation, vehicle stablization, groundcontrol, and rope rescue skills (Livingstone, 2012).

As broader sets of skills are recognized as being relevant to team capability, training requirements, resources and contests should expand to include them (Mine Safety Technology and Training Commission, 2006). For example, the inclusion of pre-shift and first-aid in contests. Mine rescue teams are required to participate in a minimum of two mine rescue competitions per year. While it is preparation and participation, not winning, that most enhances readiness and builds camaraderie within and across teams, the belief that winning is achievable is a strong incentive for teams to work hard and improve their skills. Mine managers, MSHA officials, and mine rescue teams should receive formal training in using the functionally-oriented Incident Command System (ICS) for directing responses during mine emergencies. This is the state of the art and current standard in emergency response. It can be tailored to the type, scope, scale, complexity, and dynamism of the incident.

In 2008, MSHA published a Mine Rescue Team Training Guide. This guide contains training modules designed to help instructors provide advanced/refresher mine rescue team training required under 30 CFR Part 49 for coal mines (MSHA, National Mine Health and Safety Academy, 2008). The modules and objectives for each are shown in Table 5.

Table 5: MSHA Mine Rescue Team Training Guide – Training Modules

Training Module Objective	Objective
1) Surface Organization,	The mine rescue team will be able to identify the components of an effective mine rescue and recovery surface organization and the role the team plays in this structure;
2) Mine Gases	The mine rescue team members will identify the physical properties and characteristics of gases they may encounter during rescue and recovery work. They will identify where the gases are normally found, how to test them, and the meanings of their findings;
3) Mine Ventilation	The mine rescue team members will understand how air is coursed through a mine and be able to identify ventilation

	controls, take air measurements, and build or alter ventilation controls when ordered to do so by the officials in charge;
4) Exploration	The mine rescue team members will be able to prepare for and perform underground explorations under rescue and recovery conditions;
5) Fires, Fire fighting, and Explosions	The mine rescue team will be able to competently assess underground conditions during a mine fire and after an explosion, and be able to properly fight a fire;
6) Rescue of Survivors and Recovery of Bodies	To provide the mine rescue team members with recommended procedures for rescuing survivors and recovering bodies following a mine disaster;
7) Mine Recovery	The mine rescue team will be able to effectively participate in a recovery operation after a mine disaster;
8) Mine Rescue Activity Book	This contains training activities that are suggested for use in conjunction with the Advanced/Refresher Mine Rescue Training Modules to help trainers build competent mine rescue teams.

Federal regulations outline training requirements for mine rescue team members, including participation in mine rescue contests and mine rescue training (30 CFR Part 48). Team members are required to be knowledgeable about operations and ventilation of each mine covered. Training for essential mine rescue skills includes working in heavy smoke conditions, firefighting and fire hose handling, calibration and use of gas detectors, bench testing apparatus, and first aid (MSHA, 2012).

When it comes to organizational performance, practitioners of knowledge management are already beginning to realize that worker knowledge is as fundamental to success as is technology. Almost one-third of the interviewees suggested that preparing for the worst meant having responders who were properly trained (Vaught, Brnich, Mallett, 2004). They also considered it critical to have appropriate preparations in place at the mine site. In the emergency itself, in the initial stages, there's always a lot of confusion. However, with well-trained responders and appropriate preparation, confusion can be minimized. As pressure increases, people start to ignore communication that is central to task performance. Thus, the absence of critical knowledge, such as ventilation arrangements or who has gotten onto mine property, escalates the complexity of interactions. Research suggests that good stories are the key to minimizing pressure and improving sense-making, and one individual proposed that mine operators have mine emergency response veterans come to their mine and talk about their past experiences, especially those regarding critical phases of events. When asked the most difficult situation he found himself in, the responses suggest that situations concerning people (alive or dead) and livelihoods are seen as the hardest conditions under which to make decisions. For this

reason, training in operating and decision-making in emotional/stressful environments would likely prove beneficial. "Every incident is totally different, but still, there is a pattern that you go by - statistics is what guides your decision-making. It's reaction to an action. And it's one of the things that we have so much trouble teaching people, is to watch trends, not numbers. A number excites everybody, and it's so hard to get them to understand that very low numbers can be extremely dangerous if they're increasing. And so, it is necessary to teach people trending, these are decision-making devices" (Vaught, Brnich, Mallett, 2004). During the interviews, experts argued that personnel should be trained not only in the development of an emergency response plan, but in its implementation as well.

Mark Radomsky and his team at the Pennsylvania State University developed a training program to supplement and support the training required under federal and state laws, the provisions of the MINER act of 2006, and the standards in Title 30 CFR, and related policies and guidelines issued by MSHA (Radomsky, 2009). Since training must be repeated often, there is a regular need for new training materials. This supplemental training program, titled Escape and Evacuation: a Miners' Education and Training (E&T) Tool Box includes two full length videos, a tool box talk series, and two emergency scenarios. A handbook was developed to provide some suggestions regarding the planning and design of a mine emergency preparedness training program that uses the videos and the materials in this handbook. The handbook is organized into three parts. Part I includes a Video User's Guide for the two videos, titled Mine Emergency: Demonstration of Evacuation Procedures, and Mine Emergency: Demonstration of an Escape. Part II introduces the Tool Box Talk Series consisting of twenty tool box talks, and accompanying quizzes, and Part III includes two mine emergency scenarios. Education and training, with an emphasis on practice and drills, is the best strategy to minimize loss.

The Tool Box Talk Series contains important topics to improve preparedness, including;

1. Coal mine atmospheres
2. Preventing mine fires and explosions
3. Dangers of water in a mine
4. How to communicate in a mine emergency
5. Escape or seek refuge
6. How to use Self Contained Self Rescuers (SCSR)
7. Purpose of lifelines
8. Know your emergency response plan
9. Know your escapeway map
10. How to don the CSE SR-100 SCSR
11. Switching to another SCSR
12. Miner responsibilities during a fire / fire drill
13. Primary and secondary escapeways
14. Care and transport of injured miners

15. Zones and communications
16. Role of the responsible person
17. Use of tethers during an emergency

Stakeholder Outreach and Engagement

Responses to mine emergencies involve many different organizations. To be prepared for an emergency, mine operators should not wait until an event occurs to meet a key response organization for the first time. Preparedness must include stakeholder outreach and engagement well before an emergency occurs.

Stakeholder outreach and engagement before, during, and after a mine emergency is critical to the successful management of a mine emergency. Mine operators should increase the level of stakeholder involvement and cooperation (Alexander, 2012). Emergency response involving multiple teams, many of whom may not share common practices and similar skills is important to building trust. Additionally, sources of outside technical expertise should be arranged far in advance of an emergency (Conti, 2005).

A mine emergency impacts more people than just the miners involved. Families and friends in the surrounding community are also impacted. As such, mine operators should establish family liaisons and outline the duties and responsibilities of those assigned to support families (Kravitz, 2010-2). Arrangements should be made in advance for families at facilities, including food, shelter and counseling. Means to provide information to families should also be considered.

A mine rescue team coordinator noted that the emergency preparedness gained through training and competition even benefits the communities from which the mine employees are drawn: "The members of those teams are traditionally involved in the community somehow, whether it be as first responders, or volunteer firefighters, or whatever, so the training that they're getting within the mine-site setting certainly goes a long way within each and every one of everybody's communities" (Livingstone, 2012).

The Mine Safety Technology and Training Commission suggested that MSHA, NIOSH, state agencies, industry, and the mine rescue associations should collaborate to conduct a system-wide assessment of teams' locations, availabilities, and capabilities (Mine Safety Technology and Training Commission, 2006). The findings of this assessment should be compiled as a knowledgebase that is regularly updated. This assessment could then serve as a basis for identifying gaps in capability and opportunities to fill them. It could help to facilitate the development of broader forums for information-sharing across operators and teams. Some resources are already available. For example, NIOSH does examine on the order of 100 teams per year. Likewise, MSHA maintains a Mine Emergency Operations database that contains information about mine 101 emergency services, mine emergency teams and federal, state and

local contacts in proximity to a specific mine. While information garnered from these sources is available, it is not broadly and systematically disseminated, especially to the level of mine rescue teams and their trainers, and may not be in a form and level of detail that is actionable by them. Further, industry should support joint training between teams. In cases where metal/non-metal, coal and surface mines are near each other, formal agreements should be developed to assure support during incidents. Mine rescue teams should pursue formal mechanisms for augmenting their capability with specialized expertise, such as through agreements with physicians, paramedics, or firefighters. Mine operators should explore integrating local first responders into their mine emergency response organizations.

Stakeholder outreach factors include sharing resources with other operators (chromatographs, mine rescue teams) and coordination with fire rescue/ inert gas vendors (MSHA, 2010). MSHA also recommended the creation of an Alliance Committee or Stakeholder Partnership to address mine rescue gaps and on-going concerns on a continuing basis. This organization should provide a vehicle for vital information to be communicated to mine rescue stakeholders (MSHA, 2012).

When asked how decisions are made and who makes them, experts responded that it is usually a unified situation with State, Federal, union or representative of the miners, and management. One interviewee suggested that an individual should be assigned to taking care of stakeholders during an emergency; for example, coordinating shelter for the mine rescue team and families (Vaught, Brnich, Mallett, 2004).

Capabilities

In order to be prepared for an emergency, concrete actions should be taken as preparatory measures. In addition to those discussed above, other measures include physical preparations, such as stockpiling equipment and supplies and organizing response personnel.

NIOSH Information Circular 9522 included recommended improvements and enhancements to mine safety and rescue equipment capabilities, including (Alexander, 2012):

- The need for consistent types of Self Contained Self-Rescuer (SCSR).
- Improved means of communication while wearing SCSR.
- The location of equipment should be based on "average distance in 30 minutes." Australia uses distance slowest miner can travel.
- Use of Compressed air breathing apparatus (CABA) is increasing.
- The best two-way communications equipment is that which is used for day-to-day operations.
- Tracking systems should be employed to locate trapped miners underground.
- Texting devices/keyboards could be used to improve communications while wearing SCSRs.

- Communications interoperability needs improvement, including the use of non-verbal techniques and the standardization of communications protocols.
- Incident Command System (NIMS) differs from Mine Emergency command system (MECS) and these differences needs to be addressed. NIOSH recommend replacing MECS with NIMS-ICS.

As with communications equipment, the most effective emergency management systems are those that build upon those systems in daily use (Cliff, 2011).

NIOSH Information Circular 9481 includes suggested best practices and capabilities to improve preparedness. Fire detection equipment is important (CO or smoke sensors). A best practice among some mine operators is to use Personal Emergency Device communications system. Continuous Directional lifelines are also a best practice. Strobe lights along escape routes an improve escape. Escape kits should be provided and should include rope, chemical lightsticks, drinking water, chalk, SCSR, first-aid kit, mine map, gas detector, radio / pager. Nourishment should be provided for responders including, sports drinks and fresh fruits good. Military MREs also also good - high carbohydrates and high calorie (Conti, 2005).

Communications equipment is critical during a mine emergency. The Sago Mine incident on January 2, 2006 resulted from an underground methane gas explosion. One miner died instantly from the force of the explosion and eleven others died of carbon monoxide poisoning before rescuers were able to reach them. The preparedness factor lacking in this incident was a working communication device/system. Because communications were cut off by the explosion, rescuers were unsure where the miners were located and whether any had survived; as a result, the trapped miners could not be told they were 700 feet from fresh air and could walk out of the mine. Not surprisingly, one of the resulting MINER Act provisions required that mine operators install wireless two-way communications and tracking systems that link surface rescuers with underground workers (by July 2009), (Kowalski-Trakofler, 2009).

Similarly, another mining incident in 2006 at Darby No. 1 Mine resulted from an explosion and loss was amplified by a lack of equipment. Miners attempted to escape through smoke and toxic gases without appropriate equipment, particularly a breathing apparatus. In response, the MINER Act of 2006 called for caches of self-contained breathing apparatus along esacapeways that supply at least 2 hours of oxygen per miner (Kowalski-Trakofler, 2009).

Improvements can also be made to fire response preparedness. Fire has long been a concern for underground mine workers. A mine fire can occur at any time and can result in a partial or total evacuation of mine personnel and the loss of lives. Fires can grow rapidly therefore time is the critical element. Prompt detection, timely and accurate warnings to those potentially affected, and a proficient response by underground miners can have a tremendous impact on the social and economic consequence of a small underground fire. Fire preparedness and response have

components of technology and people. These components can work synergistically to reduce the time it takes to bring the system back in balance. In particular, mine operators should ensure the following capabilities are provided (Conti, Chasko, Wiehagen, and Lazzara, 2006):

- Gas Detection capabilities – accurate and properly placed sensors.
- Experienced mine personnel in detecting the presence of fire/smoke.
- Warning systems – stench gas, audible or visual alarms, pager phones, telephones, messengers.
- Escapeway Aids – reflectors, continuous lifeline, laser point, high-intensity strobe light.
- Evacuations kits containing rope, chemical lightsticks, drinking water, chalk, SCSRs, a first-aid kit, brattice curtain, mine map, handheld multiple gas detector, and radio or pager phone.

Others also emphasize the importance of communications equipment. Grayson (2006) suggests that the most basic requirement of a post-tragedy communications system is to provide a "hardened" communication link between the underground miners and surface personnel, after a fire, explosion, or inundation. Teams should also pursue formal mechanisms for augmenting their capability with specialized expertise, such as through agreements or relationships with physicians, paramedics, or firefighters.

The Mine Safety Technology and Training Commission in 2006 recommended communication and tracking capabilities such as a hybrid communications system to allow reliable wireless communication enhanced by the leaky feeder backbone or other metallic infrastructure, such as wire-core lifelines, haulage track, and pipes; as well as an RFID-based tracking system that functions with the emergency communication systems. The commission also recommended that adequate resources and protocols be established to minimize response times (Mine Safety Technology and Training Commission, 2006). These protocols include:

1) Notification - teams should employ a formal notification process.
2) Personnel availability - teams should use clear accountability mechanisms so that the status of team members is known at all times.
3) Transportation - teams should have access to a dedicated vehicle and trailer to transport team members and equipments to other mines in case of an emergency.
4) Coordination - operators and mine rescue teams should both have current points of contact, current mine maps, and a means for initial situation briefing electronically..

The Commission suggested that support for emergencies be upgraded. In particular, a trained benchman should be posted at the fresh-air base to handle minor apparatus problems. Each mine should have, on a constant basis, arrangements for competent survey personnel and equipment to be immediately available at each mine to expeditiously identify surface locations for drill sites,

and each mine should maintain arrangements for emergency drilling equipment as part of the mine emergency response plan. The Commission recommends that:

1) improved technology for oxygen provision be pursued so that devices can be practically worn on miners' belts;
2) life lines, preferably with a metal core to facilitate emergency communications, or other direction-indicating devices be installed in all designated escape ways;
3) tag lines be made available at strategic locations in a mine, including near the beginning of all designated escape ways;
4) required oxygen-supply device caches may be located in substantially constructed areas between adjacent designated escapeways;
5) MSHA-approved compressed air breathing apparatuses and refill stations, or other approved oxygen-supplying devices, may be substituted for SCSRs in a mine;
6) the use of strategically located ventilation or escape shafts equipped with escape hoists be incorporated by mines when feasible and consistent with a risk analysis as a strategy to reduce escape times.

A stakeholder presentation in 2010 outlined preparedness capabilities of both people and equipment (MSHA, 2010). Equipment capabilities should include Miner Act-compliant SCSRs/SCBAs, detection capabilities such as mine-wide monitoring systems and mine gas systems (detectors, chromatographs, sampling), and compliant communications and tracking systems. Personnel-specific capabilities include equipped and trained Mine Fire Brigades, and responsible person competency assessment.

MSHA also suggested the use of "Tough Books" and similar technology to transfer information from the exploring team to the backup team (MSHA, 2012). This will also help the Command Center by improving efficiency, getting valid information transferred more effectively, and aiding the decision-making process.

Mine rescue teams are required by federal regulations to include at least two active employees from the covered mine (large) or one active employee from a small mine. The team must include persons with a minimum of three years underground coal mine experience within the past ten year period. Mine operators must provide for two certified mine rescue teams (30 CFR Part 48).

Workers in an emergency environment must be actively involved in developing, refining, and disseminating the group's shared learning while anticipating and responding to challenging conditions. Emergency equipment may include rescue packages, fold-up canvas stretcher, first aid equipment, and mine gas detecting equipment.

Interviewees described the characteristics of a leader in a mine emergency environment. The leader in each case was described as an individual alert to his environment, attentive, and

discerning. It was also thought that this person might excel at incidental learning, retaining information that was instrumental to the escapes. A second characteristic of each leader was the manner in which he took charge. The emerging leader did not "muscle in"; his leadership developed in a natural way. Third, the leaders were decisive, yet flexible. They made decisions, yet if circumstances changed, they adapted. Fourth, the leaders were open to input from others. Fifth, there was logic to the leadership. Decisions were appropriate and congruent with available information (Vaught, Brnich, Mallett, 2004).

Subject matters experts at West Virginia's Office of Miners' Health, Safety and Training, and West Virginia University developed some recommendations for internal and external resources and capabilities, including (WVU, 2008):

- Personnel –
    - miners who are trained in first responder firefighting,
    - fire brigades,
    - mine rescue teams,
    - emergency medical technicians (EMT's) and paramedics,
    - specialized rescue technicians (confined space, hazardous materials, high angle rescue, urban search and rescue, etc.),
    - emergency management group,
    - consider the availability of key personnel on all shifts, including weekends.
- Equipment –
    - fire protection and suppression equipment,
    - Personal protective equipment for firefighters and/or mine rescue teams,
    - communication systems (surface and underground),
    - medical supplies,
    - warning systems,
    - emergency power equipment,
    - specialty equipment (gas chromatograph, air bags, high expansion foam generators, etc.).
- Facilities –
    - emergency command center,
    - mine rescue cleaning area,
    - media briefing area,
    - sleeping quarters,
    - food caterers,
    - families and relative's area,
    - morgue.

Use of Risk and Readiness Assessment Models among Other Organizations

Risk Assessment Models

Australia Mining Industry

The mining industry in Australia appears to be a leader in the use of a risk-based approach to mining operations. Improvements in mine safety in Australia over the last 15 years are largely attributable to the systematic and team-based use of risk assessments applied to equipment design and mining operations. The industry has also adopted a risk-based approach to manage emergency response during an incident and accident investigation (Joy, 2004).

Risk assessment and management often uses system safety principles. This approach has a valuable role in assisting with planning and managing operations, as well as helping equipment manufacturers to supply safer machines. A four-stage process of risk management characterizes the approach used by the Australian mining industry. These risk management steps are as follows:

1. Risk identification—identifying the hazards and the situations that have the potential to cause harm or losses (sometimes called 'unwanted events').
2. Risk analysis—analyzing the magnitude of risk that may arise from the unwanted events.
3. Risk control—deciding on suitable measures to reduce or control unacceptable risk.
4. Implementing and maintaining control measures—implementing the controls and ensuring they are effective.

Methods used by the Australian mining industry for gathering information on hazards include observation, interviews, documentation review, and team exercises. One commonly used method to prompt creative thinking involves the energy concept. Identifying all relevant energy sources present allows assessors to determine all hazards of concern associated with a given operation. The energy types considered are:

- Gravity (Potential)
- Electrical
- Mechanical (Kinetic)
- Chemical
- Pressure
- Thermal
- Radiation
- Biomechanics
- Biological

With the energy sources and hazards identified, the assessors can in turn begin the assessment of the risks associated with each hazard or accident scenario. Other methods or tools for gathering information on hazards are illustrated below.

Table 6: Likelihood of the Event

Likelihood of the event	
A	**Common or frequent occurrence**
B	**Is known to occur or 'it has happened'**
C	**Could occur or 'I've heard of it happening'**
D	**Not likely to occur**
E	**Practically impossible**

Table 7: Maximum Reasonable Consequences

People	Equipment	Production
1. Fatality or permanent disability	$>500K damage	1 day mine production delay
2. Serious lost time injury/illness	$100–500K	1 shift to 1 day delay
3. Moderate lost time injury/illness	$50K to $100K	.4 h to 1 shift delay
4. Minor lost time injury/illness	$5–$50K	1–4 hour delay
5. No lost time	$<5K	<1 hour delay

Table 8: Risk Ranking

	Likelihood				
Consequence	A	B	C	D	E
1	1	1	2	3	4
2	1	2	3	4	5
3	2	3	4	5	6
4	3	4	5	6	7
5	4	5	6	7	7

Table 8 illustrates the method of deriving a risk rank. This table combines the likelihood factors in Table 6 with the consequence factors from Table 7. The numbers are used to rank the unwanted events in order to devise methods to reduce the risks; methods commonly called controls. The discussions occur for the 'unacceptable' risk ranking scenarios (e.g. rank 1–4).

Risk reduction activities fall into the following categories:

- elimination of hazards by removal, reduction or substitution,
- designing machinery and work activities to minimize,
- the release of energy, or to suppress energy releases,
- isolation from the risk by remote operation or guarding or enclosures,
- defining work methods or procedures,
- protecting people with protective equipment and clothing,
- establishing emergency recovery systems to reduce the impact of losses.

Since the early 1990s, the coal mining industry has used various formal techniques to investigate serious losses. The system safety accident investigation (SSAI) techniques constitute one example, developed by E.G. and G. Co. of Idaho Falls, U.S. in conjunction with U.S. Department of Energy for use in the nuclear power industry in the 1970s.

A unique set of concepts drive the investigation process, leading to more effective outcomes. One concept involves the recognition that there is an inherent risk in every activity that is increased whenever a change occurs. When the change is deliberate (e.g. revised procedures, new personnel, improved equipment, etc.) the risk can be returned to its previously accepted level by implementing an effective counter change. However, many changes are unintentional (e.g. behavioral change, component failure, human error) and often are unnoticed or unexpected. Failure to adjust to a change can lead to either planning errors or operational errors, or both.

Once an error has occurred, an unsafe situation exists that could result in an accident if three conditions exist: 1) lack of adequate barriers, 2) an unwanted energy flow, and 3) a target (such as a person or equipment) in the energy flow. This concept considers an incident or accident to be an unwanted energy release where the existing barriers were not adequate. When serious incidents occur they are symptomatic of deficiencies in the safety management system.

The most common risk assessment techniques in Australian mining are listed below.

- Informal risk assessment (RA)—general identification and communication of hazards and risks in a task by applying a way of thinking, often with no documentation.
- Job safety/hazard analysis (JSA/JHA)—general identification of hazards and controls in a specific task, usually for determining the basis of a standard work practice (SOP).
- Preliminary hazard analysis/hazard analysis/workplace risk assessment and control (PHA/HAZAN/WRAC)—general identification of priority risk issues/events, often to determine the need for further detailed study.
- Hazard and operability study (HAZOP)—systematic identification of hazards in a process plant design.

- Fault tree analysis (FTA)—detailed analysis of contributors to major unwanted events, potentially using quantitative risk analysis methods.
- Event tree analysis (ETA)—detailed analysis of the development of major unwanted events, potentially using quantitative methods.
- Failure modes, effects and criticality analysis (FMECA)—general to detailed analysis of hardware component reliability risks.

It is important that any leading practice be flexible and innovative in developing solutions that match site-specific requirements. Well-credentialed risk management frameworks need to be applied for all aspects of the life cycle, including mining, processing and downstream stewardship of minerals and metals products (Aus Gov, 2008). In Australia and New Zealand a generic framework exists for establishing the context, identifying, analyzing, evaluating, treating, monitoring and communicating risk—this framework is the AS/NZS 4360:2004 Risk Management Standard.

Risk management processes within the minerals industry often focus on the incremental risks from the operation of a single facility. Where a single mine operation is remotely located, this approach may be legitimate. The relationships between social, environmental and economic risks are often not clearly defined or easy to clarify—yet they must be incorporated into risk management. Mining project risks need to be considered over long timeframes. During project development phases (feasibility and design), mine closure and rehabilitation objectives need to be defined. This process will require input from regulatory authorities and local community stakeholders. Assurance mechanisms will normally be required by regulators to ensure that funds are available to deal with situations where closure and mine site rehabilitation objectives are not met. Communication of risk must be a two-way process.

The challenge of sustainable development requires the minerals industry to adopt pro-active risk management approaches that recognize, integrate and implement the three pillars of social, environmental and economic sustainability. An enterprise-wide risk framework provides guidance for a systematic, rigorous, integrated, and consistent risk management process to be implemented organization-wide, so that material risks can be identified, communicated and acted on at appropriate levels within an organization. The risk register is the tool most often used to collate risk information. Once established, a risk register should be reviewed and updated on a regular basis. Management can check that strategic and operational plans are appropriately addressing the key risks to the business by using the risk register.

Safety risks are characterized by acute consequences, ranging from first aid, lost time injury (LTI), to permanent disability or single and multiple fatalities. Health risks are those that affect people's health through chronic exposure leading to illness. Some examples of production risk are pit failure or underground collapse, causing ore flow to stop or be restricted; major plant or

equipment failure, causing prolonged plant shutdown; and resources and reserves re-estimation due to fall in metal prices.

The technical approach to risk assessment is to determine the probability of a risk and its consequence. For many environmental, social and sustainability issues, however, this approach to risk fails to recognize the views of stakeholders and can often lead to significant controversy—one side says it's perfectly safe while another says it's too risky. American risk communication specialist, Peter Sandman, developed an approach to risk communication whereby he defines risk by combining 'hazard' with what he terms 'outrage', to give:

Risk = Hazard + Outrage

A well-planned and managed closure process will protect the community from unintended consequences well after the mining. In addition it will be useful going forward for the MSHA risk models to consider the stakeholder perceptions as part of the risk assessment equation.

Emergency response includes the fixed and mobile equipment and human capacity needed to minimize the physical impacts of an event. Fire fighting and mine rescue are typical emergency response capabilities required at an operating mine site. Crisis management is the management structure and capacity needed to support the emergency response team and to manage the indirect consequences of the emergency. Business continuity is the management structures and pre-investment in capacity and other arrangements designed to minimize the period that business is interrupted by the emergency. As with other mitigating controls, there needs to be clear control objectives and performance targets for emergency response, crisis management and business continuity plans and capabilities. The plans and capabilities should also be tested against their respective key performance indicators. Where required to mitigate substantial operational risks, respective emergency response, crisis management or business continuity plans should be referenced in the asset's risk register.

It is also critical to consult with interested and affected parties in the identification, assessment and management of all significant social, health, safety, environmental and economic impacts associated with mine activities. Potentially affected parties need to be informed of significant risks from mining, minerals and metals operations and of the measures that will be taken to manage the potential risks effectively. Emergency response procedures need to be developed, maintained and tested to ensure effectiveness, in collaboration with potentially affected parties.

Australian mines use risk controls, which are systems, processes, procedures, equipment or other organizational capacity that prevent the consequences of the threat from occurring. Controls can be preventive, detective, protective or mitigating.

The hierarchy of controls:

1. Eliminate the risk.
2. Minimize or replace the risk.
3. Control the risk using engineered devices.
4. Control the risk by using physical barriers.
5. Control the risk with procedures.
6. Control the risk with personal protective equipment.
7. Control the risk with warnings and raising awareness.

The Australian Mines Occupational Safety and Health Advisory Board (MOSHAB) developed guidelines to provide an understanding of the process to be followed when carrying out risk management in accordance with the Mines Safety and Inspection Act 1994 and Mines Safety and Inspection Regulations 1995 (MOSHA, 1999). The guidelines provide first line supervisors and safety and health personnel with practical steps to assist in implementing risk management activities. It provides simple Likelihood and Consequence rating scales and combines them in a 5x4 qualitative matrix.

South African Mining Industry

The South African mining industry tends to use a similar qualitative model to Australia although less detailed. Foster, Rose and Talbot described a risk assessment approach implemented by Ingwe Coal Corporation using a 4x4 likelihood and severity matrix (Foster, 1998). Qualitative estimates of likelihood are based on expected frequency of occurrences of daily, monthly, quarterly, and annually. Accident and Health Severity scales span the spectrum from injury/irritant, temporary disability, permanent disability and death. This model provides a coarser assessment than the Australian framework.

In an undated paper after the promulgation of the South African Mine Safety Act of 1996, the Tripartite Working Group on Risk Assessment, published a "Practical Guide to the Risk Assessment Process." This approach described a 4x4 likelihood and severity risk matrix as an example tool as shown in Figure 2 (Tripartite WG, n.d.).

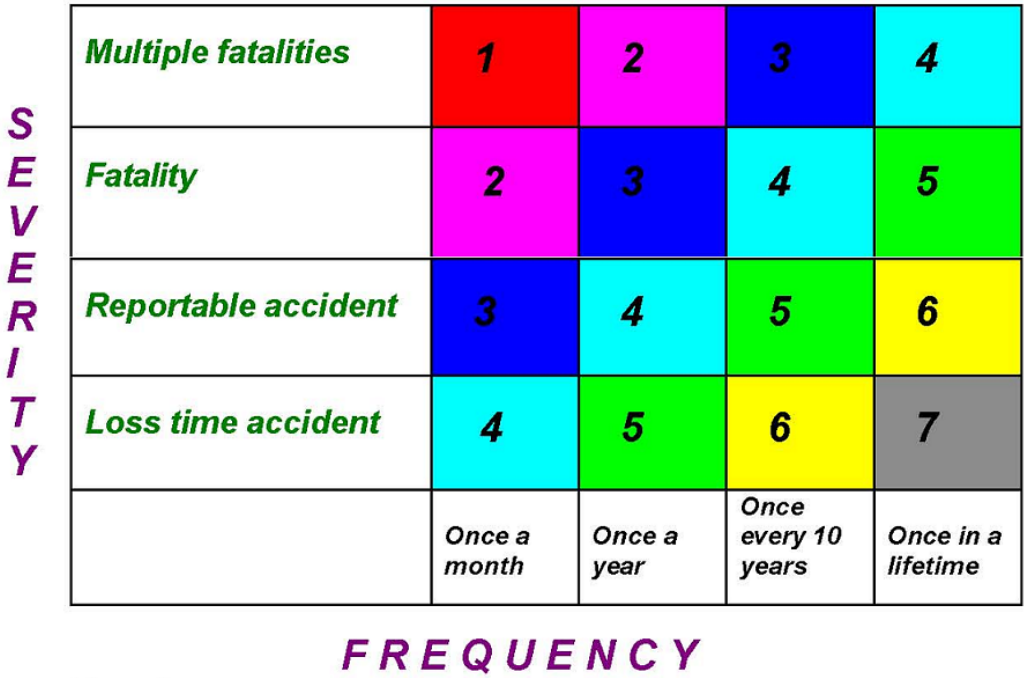

Figure 2: Likelihood and Severity Risk Matrix

The guidelines also provide some definition of the key elements of risk assessment processes. It lists the following ten elements as critical factors contributing to the risk assessment process:

1. Make sure the risk assessment process is practical and realistic.
2. Involve as many people as possible in the process, especially those at risk and their representatives.
3. Use a systematic approach to ensure that all risks and hazards are adequately addressed.
4. Aim to identify the major risks; don't waste time on the minor risks, don't obscure the process in too much detail.
5. Gather all the information you can and analyze it as well as possible before starting the risk assessment.
6. Start by identifying the hazards.
7. Assess the risks arising from those hazards, taking into account the effectiveness of the existing controls.
8. Look at what actually occurs and exists in the workplace and, in particular, include non-routine operations.
9. Include all employees, visitors and contractors.
10. Always keep a written record of the assessment, including all assumptions you make, and the reasons for those assumptions.

The above summary guidance will be carefully considered in the development of the MSHA Risk assessment model.

Aviation Industry

Pilots and engineers have been licensed and are severely restricted in what they may do. Airplanes undergo rigorous certification processes based upon standards often developed as a requirement. Despite the aviation industry's exemplary performance, risk modeling is less standardized and the management of the risks of flying are supported by positive attitudes of stakeholders and managers (Hudson, 2003). Organizations should be:

- Informed: managers know what is going on in their organization and the workforce is willing to report their own errors and near misses.
- Wary: the organization and its constituent individuals are on the lookout for the unexpected, maintaining a high degree of vigilance.
- Just: the organization is normally a ''no blame'' culture, although some actions are agreed by all to be totally unacceptable, deserving some retribution.
- Flexible: such organizations reflect changes in demand and adapt rapidly to changes in circumstances, providing both high tempo and routine modes of operation.
- Learning: organizations expect to have to change, are ready to learn and can do what needs to be done to improve.

Preparedness and Readiness Assessment Models

Queensland's Safety and Health Management System

Safety and health should be an integral part of the management system of mining operations from the first day of planning right through to every aspect of operations. Preventing accidents has many benefits: higher productivity, lower insurance cost, reduced threat of legal actions or fines, improved labor relations, improved morale, and higher staff retention.

SafeGuard, a safety management system developed in Queensland, Australia, provides a guide to assess a mine's safety and health management system, measure its performance and ensure continuous improvement. The elements in the 3rd edition are modeled on the Australian and New Zealand standard AS/NZS 4801;2001, incorporate requirements of ISO 14001;2004, and were developed by the Queensland Government in consultation with the mining industry, labor unions and occupational health and safety specialists (Queensland, 2011).

The guide consists of 17 "elements" each containing specific criteria against which one can assess the management system of a particular mining operation. The elements include criteria related to risk assessments, risk management, and various aspects of preparedness and response. The guide can be used to set up a safety and health management system or audit an existing system to identify strengths and areas for improvement. To use the guide, assessors review the elements and rate a mine's management system using a 5 point scale. A scorecard is provided with the guide.

Next Steps

The best practices, variables, and lessons learned derived from the above analysis and review will be incorporated into the design and development of the risk, preparedness, and readiness assessment models for underground coal mines in subsequent phases of this project.

Appendix A – Loss Causation Model

Over the past 25 years there have been nine disasters, described as a mine accident taking five or more lives, in the nation's underground coal mines. To reduce that number to zero, mine-safety researchers are constantly looking for ways to determine the basic causes for these accidents and, if possible, eliminate them. Over the years, numerous programs have been implemented to address the issue. One strategy, and its many variations, is the loss causation model favored by insurance companies and heavy industry, alike. For nearly 100 years, health-and-safety advocates have attempted to describe the chain reaction which culminates in an accident and, subsequently, some form of loss, as the toppling of dominos. One relevant model, the Loss Causation Model proposed by Frank E. Bird, Jr. and George L. Germain in the early 1980s is shown in Figure 3. This domino sequence builds on H.W. Heinrich's original proposal of five dominos and includes a "pre-contact" stage consisting of the first three dominos, a "contact" stage of the incident domino, and a "post-contact" stage of the loss domino.

Oftentimes, emphasis is on the fourth and fifth dominos, incident and loss; but to further reduce coal-mine disasters, efforts must be taken to stay away from conditions which, under many circumstances, may result in an undesired contact or incident. Bird and Germain proposed that preventing the first three dominos from falling is the key to accident prevention, along with the understanding that there is a shared responsibility between management and workers for workplace safety.

The first domino, Lack of Control, represents those steps not taken by management which result in a failure to maintain acceptable standards, such as proper training, rules, communication, inspections, or recordkeeping. Any mistakes here enable incident progression. The second domino, Basic Causes, are those shortcomings of personnel or the design of the job or workplace which further amplify hazards. An example of a personnel basic cause is lack of skill, while an example of an inadequate job factor would be poorly maintained equipment. Finally, the third domino, Immediate Causes, is the combination of substandard practices and/or conditions which will trigger the incidents. A substandard practice would be the failure to use lock-out / tag-out on electrical equipment being repaired, while a substandard condition would result if the environment were allowed to deteriorate, making an explosion hazard possible.

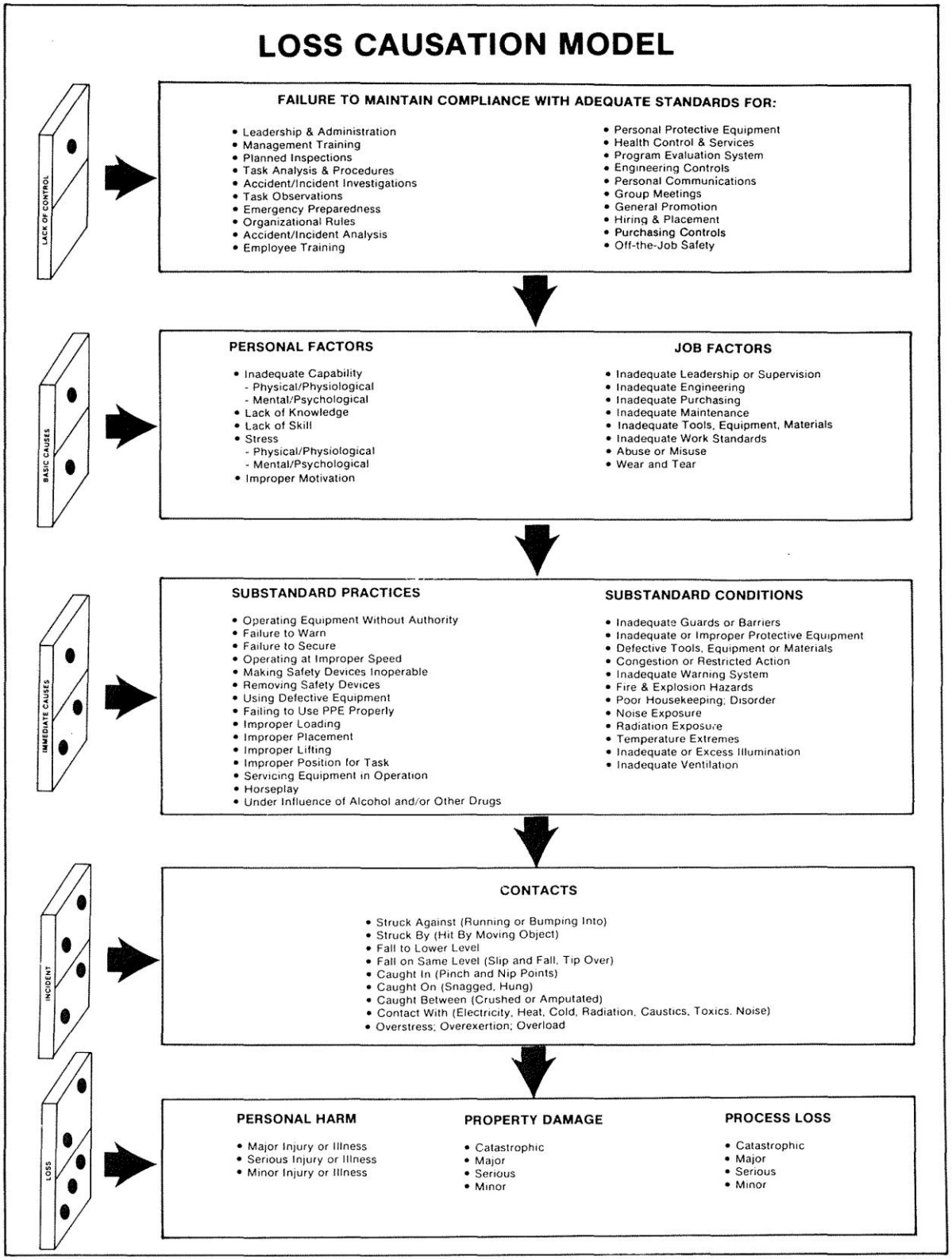

Figure 3: Loss Causation Model (Bird and Germain, 1985)

Appendix B – Loss Causation Analysis of Major Mine Disasters

This section provides a detailed summary of each of the nine recent major mine disasters, including a summary of the event and the loss causation factors that led to the incident. The situational factors of each disaster are broken down and associated with one or more loss-control failure from the "pre-contact" dominos of the Loss Causation Model: 1) lack of control, 2) basic causes, and 3) immediate causes.

Wilberg Mine Disaster

Orangeville, UT; 1984

On December 19, 1984 a major coal mine fire broke out at the mouth of the 5th Right longwall section of the Wilberg Coal mine in Orangeville, Utah. Minutes after the fire broke out, smoke and lethal gases traveled 2,400 feet down the Fifth Right tunnel to the working face of the longwall. One miner escaped, but eighteen miners and nine company officials were trapped and killed. In the spring of 1987, MSHA ruled that the Wilberg fire was caused by a faulty air compressor, allowed to run unattended in a non-fireproofed area. MSHA issued thirty-four citations against the mine's operator, nine of which directly contributed to the disaster. MSHA itself received strong criticism from the United Mine Workers of America (UMWA), in part for failing to issue these same citations when it inspected the mine only days before the fire. The union also questioned MSHA's focus on the cause of the fire rather than the cause of the deaths, insisting that miners died, not because there was a fire, but because they had no escape route.

Situation	**Loss-Control Failures**		
	Domino 1	**Domino 2**	**Domino 3**
Focus on setting the world record	Leadership and Administration	Inadequate Leadership or Supervision	Fire and Explosion Hazards
No secondary escapeway due to the roof fall	Leadership and Administration	Inadequate Leadership or Supervision	Removing Safety Devices
Deliberate disabling of the electrical protective relays	Leadership and Administration	Inadequate Leadership or Supervision	Removing Safety Devices
Ventilation dogleg	Engineering Controls	Inadequate Engineering	Inadequate Guards or Barriers
Improperly installed fire-fighting equipment	Emergency Preparedness	Inadequate Tools, Equipment, Materials	Inadequate or Improper Protective Equipment
Failure to evacuate everyone at the first sign of trouble	Emergency Preparedness; Employee Training Leadership and Administration;	Inadequate Leadership or Supervision	Inadequate Warning System
Improper donning of self-rescuers	Emergency Preparedness; Employee Training	Lack of Knowledge	Failure to Use PPE Properly
Blocked tailgate	Leadership and Administration; Engineering Control	Lack of Knowledge; Inadequate Engineering	Inadequate or Improper Protective Equipment

Loveridge No. 22 Mine Disaster

Marion County, WV; 1986

On February 6, 1986, a coal pile collapsed at the Loveridge No. 22 mine in Marion County, West Virginia. According to the United States Mine Rescue Association, seven company and contractor officials walked to the top of a raw coal pile to inspect the damage in the rails of a tripper belt structure discovered the day before. Five minutes into the inspection, a section of the coal pile that was four to six feet in diameter suddenly collapsed, suffocating five individuals and injuring two others. MSHA investigators attributed the development of the crater to the normal operation of a feeder beneath the coal pile that was designed to move coal from the pile to a processing plant, and attributed the accident to management's failure to prevent the development of such craters and to detect their existence. MSHA also determined that management contributed to the disaster by permitting people to walk and stand on the coal pile while reclaiming operations proceeded.

Situation	**Loss-Control Failures**		
	Domino 1	**Domino 2**	**Domino 3**
Permitting people to walk on coal piles when cavities can give way	Management Training	Inadequate Leadership or Supervision	Improper Position for Task

William Station No. 9 Mine Disaster

Sullivan, KY; 1989

On September 13, 1989, an explosion occurred on Longwall Panel "O" at the William Station Mine, No. 9 Slope, located in Sullivan, Kentucky. According to the United States Mine Rescue Association, fourteen miners were present in the longwall recovery area at the time of the explosion. Ten died as a result of the explosion; four escaped despite being exposed to high concentrations of carbon monoxide and smoke. MSHA investigators concluded that the primary cause of the explosion was the failure of management to maintain a sufficient volume and velocity of air in the proper direction in the 4th West entries and longwall face to dilute, render harmless, and carry away methane accumulations in that area.

Situation	**Loss-Control Failures**		
	Domino 1	**Domino 2**	**Domino 3**
Failure to maintain adequate airflow	Engineering Controls	Inadequate Engineering	Inadequate Ventilation
Failure to maintain the bleeder system	Engineering Controls	Inadequate Engineering	Inadequate Ventilation
Failure to maintain curtains in the recovery room	Engineering Controls	Inadequate Leadership or Supervision	Inadequate Ventilation
Failure to conduct a preshift examination	Planned Inspections	Improper Motivation; Inadequate Leadership or Supervision	Failure to Warn

Southmountain No. 3 Mine Disaster

Norton, VA; 1992

On December 7, 1992, an explosion occurred on the 1 Left section of Southmountain Coal Co. Inc's No. 3 Mine at Norton, Virginia. According to the United States Mine Rescue Association, eight miners were killed and another miner working in an outby area was injured. The methane explosion resulted in sufficient forces and flames to suspend and ignite coal dust in 1 Left. The coal dust explosion continued to propagate the entire distance of the No. 1 West Main entries to the surface area of the mine. MSHA investigators concluded that an open flame from a cigarette lighter found on the mine floor was the ignition source. Persons were smoking in the mine, and the operator's smoking search program was not effective. One cigarette pack containing nine unsmoked cigarettes was found on a victim located at the point of origin, and ten smoked cigarettes were found in his pockets. In addition, the bleeder system was not examined or maintained to continuously move methane-air mixtures away from the active faces, and ventilation controls, both permanent and temporary, on the active working section had been removed or unmaintained.

Situation	**Loss-Control Failures**		
	Domino 1	**Domino 2**	**Domino 3**
Smoking underground	Leadership & Administration	Improper Motivation; Inadequate Leadership or Supervision	Fire and Explosion Hazards
The bleeder system was not examined for methane	Planned Inspections	Improper Motivation; Inadequate Leadership or Supervision	Fire and Explosion Hazards
Ventilation controls were either removed or not maintained	Leadership & Administration; Engineering Controls	Improper Motivation; Inadequate Leadership or Supervision; Inadequate Engineering	Making Safety Devices Inoperable; Removing Safety Devices; Fire and Explosion Hazards; Inadequate Ventilation
Failure to maintain the proper incombustible content of rock dust	Leadership & Administration; Engineering Controls	Improper Motivation; Inadequate Leadership or Supervision; Inadequate Engineering	Inadequate Guards or Barriers; Fire and Explosion Hazards; Poor Housekeeping

Jim Walter Resources No. 5 Mine Disaster

Brookwood, AL; 2001

On September 13, 2001, two separate mine explosions occurred at the Jim Walter Resources No. 5 Mine in Brookwood, Alabama, killing 13 miners. According to a NIOSH report on underground coal mine disasters, the first explosion occurred after roof fall at a scoop battery charging station. The fall damaged a scoop battery and ventilation controls, and an arc flash from the damaged scoop battery ignited methane. The explosion damaged critical ventilation controls and injured four miners who were working in the affected section. Three of the miners escaped while the fourth was left behind because of the seriousness of his injuries. The second explosion occurred as 12 miners made their way to rescue the miner left behind. This explosion was most likely caused when a signal light system ignited methane in the track entry. At least 12 miners were killed by the second explosion, and the miner left behind from the initial explosion did not survive. MSHA admonished the mine owner, Jim Walter Resources, for having "no responsible person who took control of the situation" during the accident. The agency also declared the mine's firefighting plan inadequate.

Situation	**Loss-Control Failures**		
	Domino 1	**Domino 2**	**Domino 3**
Placing an electrical installation where the roof and ribs are showing signs of movement.	Task Observations	Lack of Knowledge; Inadequate Leadership or Supervision; Inadequate Engineering	Inadequate Guards or Barriers
Mine rescue procedures must be followed and practiced to avoid harm coming to rescuers.	Emergency Preparedness	Lack of Knowledge; Inadequate Leadership or Supervision	Failure to Secure

Sago Mine Disaster

Tallmansville, WV; 2006

On January 2, 2006, an explosion occurred at the Sago Mine in Tallmansville, West Virginia, killing 12 miners. According to the United States Mine Rescue Association, a methane ignition in a recently sealed area of the mine triggered an explosion that blew out the seals and propelled smoke, dust, debris and lethal carbon monoxide into the working sections of the mine. One miner was killed by the blast. Sixteen escaped. Twelve were unable to escape and retreated to await rescue behind a curtain at the face of the Two Left section. Mine rescuers found the trapped miners approximately 41 hours later. By that time all but one had succumbed from carbon monoxide asphyxiation. MSHA identified root causes as: 1) The 2 North Main seals were not capable of withstanding the forces generated by the explosion, 2) The atmosphere within the sealed area was not monitored and it contained explosive methane/air mixtures, 3) Lightning was the most likely ignition source for this explosion with the energy transferring onto an abandoned pump cable in the sealed area and providing an ignition source for the explosion.

Following the disaster, the UMWA emphasized a need for better regulation in: requirements for seals, mine rescue teams, emergency shelters, communications, MSHA responsibilities as a watchdog, tracking devices, oxygen, and mine operator responsibilities.

Situation	**Loss-Control Failures**		
	Domino 1	**Domino 2**	**Domino 3**
Management met only minimum standards for seal construction	Engineering Controls	Inadequate Engineering	Inadequate Guards or Barriers
Management met only minimum standards for SCSR availability	Emergency Preparedness	Inadequate Purchasing	Inadequate or Improper Protective Equipment
Atmospheres within sealed areas must be closely monitored	Planned Inspections	Inadequate Engineering	Fire and Explosion Hazards
Cables and conductors should be removed from areas to be sealed	Management Training	Lack of Knowledge	Poor Housekeeping

Darby No. 1 Mine Disaster

Harlan County, KY; 2006

On May, 20 2006, an explosion occurred at Darby No. 1 Mine in Harlan County, Kentucky killing 5 miners and injuring another. A NIOSH report on underground coal mine disasters describes the incident: after the afternoon shift ended, two miners stayed behind to cut roof straps near a ventilation seal in the return airway. At the same time, the midnight shift crew was entering the mine. Shortly after the afternoon shift crew reached the outside, an explosion occurred in the mine. The two miners performing the cutting work died in the explosion, and three miners from the entering midnight shift crew died while trying to escape. One miner survived and was able to travel part of the way towards the mine entrance wearing his self-contained self-rescuer (SCSR); he was later rescued. According to the United States Mine Rescue Association, the accident occurred because the operator did not observe basic mine safety practices and because critical safety standards were violated. Mine management failed to ensure that proper seal construction procedures were utilized in the building of the seals at the A Left Section. Mine management also failed to ensure that safe work procedures were used while employees attempted to make corrections to an improperly constructed seal. Furthermore, mine management failed to adequately train miners in escapeway routes and proper SCSR usage.

Situation	**Loss-Control Failures**		
	Domino 1	**Domino 2**	**Domino 3**
The operator did not observe basic mine safety practices and standards	Management Training	Inadequate Leadership or Supervision	Failure to Secure
Mine management did not ensure proper seal construction	Leadership & Administration	Inadequate Engineering	Inadequate Guards or Barriers
Mine management did not ensure that safe work procedures were followed during corrections to the seals	Leadership & Administration	Improper Motivation	Inadequate Guards or Barriers
Miners were not properly trained for escapeway routes and proper SCSR usage	Employee Training	Lack of Knowledge; Lack of Skill	Failure to Use PPE Properly

Crandall Canyon Mine Disaster

Carbon County, UT; 2007

On August 6, 2007, a major coal bump or bounce occurred on the Main West pillar section at Crandall Canyon Mine in Carbon County, Utah. According to MSHA, six miners were killed in a catastrophic coal outburst when roof-supporting pillars failed and violently ejected coal over a half-mile area. Ten days later, two mine employees and an MSHA inspector perished in a coal outburst during rescue efforts. MSHA attributed the disaster to inadequate mine design, flawed engineering analysis, inadequate engineering management review, and withholding of information and failure to revise mining plan following prior coal bursts.

Situation	Loss-Control Failures		
	Domino 1	**Domino 2**	**Domino 3**
Inadequate Mine design	Engineering Controls	Inadequate Engineering	Inadequate Guards or Barriers
Flawed engineering analysis	Engineering Controls	Inadequate Engineering	Inadequate Guards or Barriers
Failed to revise mining plan following coal outbursts	Engineering Controls	Inadequate Engineering	Inadequate Guards or Barriers
Withholding of recent coal outburst information	Organizational Rules	Inadequate Leadership or Supervision	Failure to Warn
Mining coal in a prohibited area	Organizational Rules	Inadequate Leadership or Supervision	Failure to Warn

Upper Big Branch Mine Disaster

Montcoal, WV; 2010

On April 5, 2010, a massive coal dust explosion occurred at the Upper Big Branch Mine-South in Montcoal, West Virginia. According to the MSHA Fatal Accident Report, the explosion was the largest coal mine disaster in the United States in 40 years, killing 29 miners and injuring two. MSHA identified the source of the explosion as a small amount of methane, likely liberated from the mine floor, accumulated in the longwall area due to poor ventilation and roof control practices. The physical conditions that led to the explosion were the result of a series of basic safety violations. While violations of particular safety standards led to the conditions that caused the explosion, the unlawful policies and practices implemented by PCC/Massey were the root cause of this tragedy. The evidence accumulated during the MSHA investigation demonstrates that PCC/Massey promoted and enforced a workplace culture that valued production over safety, including practices calculated to allow it to conduct mining operations in violation of the law. MSHA identified specific management practices of the mine operator that led to the explosion as: failure to perform required examination adequately and remedy known hazards and violation of law; maintaining two sets of books to conceal hazardous conditions; intimidating miners to prevent MSHA from receiving evidence of safety and health violation and hazards; failure to provide adequate training to workers; and establishing a regular practice of giving advance notice of inspections to hide violation and hazards from enforcement personnel.

Situation	**Loss-Control Failures**		
	Domino 1	**Domino 2**	**Domino 3**
Illegally providing advance notice to miners of MSHA inspections	Leadership & Administration	Inadequate Leadership or Supervision	Failure to Secure
Failing to properly conduct required examinations and to identify, record, and correct hazards	Leadership & Administration	Improper Motivation; Inadequate Leadership or Supervision	Failure to Secure
Allowing hazardous levels of loose coal, coal dust, and float coal dust to accumulate	Leadership & Administration	Improper Motivation; Inadequate Leadership or Supervision	Fire and Explosion Hazards
Failing to adequately apply rock dust to the mine	Leadership & Administration	Improper Motivation; Inadequate Leadership or Supervision	Fire and Explosion Hazards
Failing to comply with the approved	Leadership & Administration	Improper Motivation; Inadequate	Using Defective Equipment; Servicing

ventilation plan by operating the shearer with missing and clogged water sprays		Maintenance; Inadequate Leadership or Supervision	Equipment in Operation; Inadequate or Improper Protective Equipment; Fire and Explosion Hazards
Failing to maintain the longwall shearer (worn bits) in safe operating condition	Leadership & Administration	Improper Motivation; Inadequate Maintenance; Inadequate Leadership or Supervision	Using Defective Equipment; Servicing Equipment in Operation; Fire and Explosion Hazards
Failing to comply with its approved roof control plan in the 1 North Panel tailgate entry, as required by the approved roof control plan	Leadership & Administration	Improper Motivation; Inadequate Leadership or Supervision	Fire and Explosion Hazards
Failing to maintain the volume and velocity of the air current in the areas where persons work or travel at a sufficient volume and velocity to dilute, render harmless, and carry away flammable, explosive, noxious, and harmful gases, dusts, smoke, and fumes	Leadership & Administration	Improper Motivation; Inadequate Leadership or Supervision	Fire and Explosion Hazards; Inadequate Ventilation

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Appendix B – Underground Coal Mine Risk and Readiness Workshop Invitation

MSHA invites you to represent your colleagues and your industry at the

Underground Coal Mine Risk and Readiness Assessment Workshop

MSHA is working with ABS Consulting to develop risk and readiness assessment models for the coal mining industry to use to prevent major mine emergencies. We are seeking input from mine operators and emergency responders to help develop these models.

Where: National Mine Health and Safety Academy, Beaver, West Virginia
When: April 3-5, 2013

This workshop will be held at the National Mine Health and Safety Academy the same week of the 2013 Coal Mine Rescue, First Aid, Bench and Preshift Rules Training. Industry representatives are asked to attend sessions from both events. Session dates and times for the Underground Coal Mine Risk and Readiness Assessment Workshop are shown below and session details are provided on the following page.

Wednesday, April 3, 2013	1:00 p.m – 5:00 p.m	Risk Assessment
Thursday, April 4, 2013	1:00 p.m – 5:00 p.m	Emergency Preparedness
Friday, April 5, 2013	9:00 a.m – 1:00 p.m.	Mine Rescue Teams & Responsible Persons Readiness

The number of participants in each session is limited. To sign up for one or more sessions, email Jeff Kravitz at Kravitz.Jeffery@dol.gov and include your name, title, email, phone, and the name of each session you plan to attend. ABS Consulting will reach out to confirm your attendance and provide read-ahead material prior to the workshop.

You may contact Kimberly Spencer at spencer.kimberly@dol.gov or Natasha Cordle at cordle.natasha@dol.gov or 304-256-3252 to inquire about availability of housing at the National Mine Academy. Attached is a listing of motels in the area surrounding the Academy.

Session 1: RISK ASSESSMENT

Wednesday, April 3, 2013; 1pm – 5pm

Seeking – coal mine operators familiar with common risk factors which could lead to a major mine emergency and hands-on miners with actual experience in emergency situations.

Session Details: Individuals with experience in underground coal mines (large and small) or expertise in mining emergencies will work together to identify and prioritize underground coal mine hazards to support the development of a quantitative risk

assessment tool to prevent major mine emergencies. Participants should be prepared to brainstorm, use group voting tools, and support discussions to reach a consensus on hazards which could lead to a major mine emergency and the prioritization and weighting of those hazards for incorporation into the risk assessment tool.

Session 2: EMERGENCY PREPAREDNESS

Thursday, April 4, 2013; 1pm – 5pm

Seeking – participants from the entire community including mine management, first response, and mine rescue teams, etc.

Session Details: Individuals with experience in underground coal mine (large and small) and other emergency planning, preparedness and response management will work together to identify and validate emergency preparedness factors and prescribed regulations that are critical to a successful emergency response. This session will support the development of a quantitative tool to assess the scope and level of preparedness of the entire emergency response system to respond to an underground coal mine emergency.

Session 3: MINE RESCUE TEAMS & RESPONSIBLE PERSONS READINESS

Friday, April 5, 2013; 9am – 1pm

Seeking – participants with advanced training in underground coal mine (large and small) rescue and emergency management.

Session Details: This session will support the development of a mine rescue team readiness assessment tool and a responsible person readiness assessment tool. Individuals will work together to identify and validate critical success factors and prescribed regulations for mine rescue and managing mine emergencies. These readiness assessment tools will provide a snapshot of the level of preparedness at the time of assessment, and sufficient data to determine trends in readiness over time.

Appendix C – Underground Coal Mine Risk and Readiness Workshop Read-Ahead Materials

UNDERGROUND COAL MINE

RISK ASSESSMENT WORKSHOP

WEDNESDAY, APRIL 3, 2013

1 P.M. – 5 P.M.

CLASSROOM C-106

THE WORKSHOP

MSHA is working with ABS Consulting to develop a risk assessment model for the underground coal mining industry to use to assess risk at mines to help prevent major mine emergencies. This Risk Assessment Workshop, to be held Wednesday April 3rd, will support the development of the risk assessment model. Individuals with experience in underground coal mines or expertise in mine emergencies will work together to identify and prioritize underground coal mine hazards to support the development of a quantitative risk assessment tool to prevent major mine emergencies.

HOW CAN I HELP?

MSHA is seeking individuals to attend this workshop with experience in emergency mine situations, mine workers, coal mine operators, and other stakeholders who are familiar with common risk factors which could lead to a major mine emergency. Participants will be asked to brainstorm, use group voting tools and discussion support tools to identify hazards which could lead to a major mine emergency. Participants will also help with prioritization and weighting of those hazards for incorporation into the model.

HOW CAN I PREPARE?

Think about an underground coal mine that you've worked in, managed, or visited before. If you were asked to assess whether the mine is a safe place to work, what factors would you assess to determine your answer? Think only of factors which could lead to a major mine emergency. This exercise should not include the emergency response which occurs after the initiating event. *Use the back of this sheet to record your responses and bring your list to the workshop.*

Operating an underground coal mine requires not only mining equipment, but individuals who are trained, procedures for them to use, and so on. Get a jump start on an exercise we will be performing during this workshop by weighting or ranking the list of major categories listed on the back of this page. *Use the back of this sheet to record your responses and bring your list to the workshop.*

ABS Consulting

BRAINSTORMING EXERCISE

Brainstorm a list of key factors which would indicate to you that a mine is unsafe and could result in a major mine emergency.

IMPORTANCE WEIGHTING EXERCISE

There are 11 categories listed below. Assign a percentage to each area listed below to show its importance in operating a mine safely to prevent a major mine emergency. All of your percentages should add up to 100%. Alternatively, if you'd prefer, just rank the areas in order of importance (ties are acceptable).

Weighting or Rank	Category	Definition/Examples
	Design	Design of the mine, design input
	Equipment Reliability Program	Overall mine maintenance program
	Documentation and Records	Equipment records and manuals, training records
	Material/Parts and Product	Equipment provided from vendor
	Hazard/Defect Identification and Analysis	Methods used to identify and analyze mine hazards and defects
	Procedures	Available, complete and correct procedures
	Workplace Conditions/Human Factors	Housekeeping, workplace layout, workload
	Training/Personnel Qualification	On-the-job training, annual training
	Supervision	Job preparation, on-the-job supervision, teamwork
	Verbal and Informal Written Communication	Timely communication, available communications systems, standard terminology
	Personal Performance	Hiring, incentives program, no horseplay

UNDERGROUND COAL MINE

EMERGENCY PREPAREDNESS WORKSHOP

FRIDAY, APRIL 5, 2013

9 A.M. – 1 P.M.

CLASSROOM C-106

THE WORKSHOP

MSHA is working with ABS Consulting to develop risk and readiness assessment models for the underground coal mining industry to use to help prevent major mine emergencies and improve emergency response. This session will support the development of a model that individual mines can use to assess how prepared they are to respond to an underground mine emergency.

HOW CAN I HELP?

MSHA is seeking individuals from the entire community including mine management, first responders, mine rescue teams, etc., with experience in underground coal mines and other emergency planning, preparedness and response management. Participants will be asked to brainstorm, support discussion, and work together to identify and validate emergency preparedness factors and capabilities that are critical to a successful emergency response for incorporation into the model.

HOW CAN I PREPARE?

Imagine you are on the wrong end of an emergency in an underground coal mine (e.g. fire, roof fall). What would you like to know has been done in preparation to ensure that you get out safely?

Brainstorm a list of critical success factors necessary to be prepared for a successful emergency response. While developing your list of key preparedness factors, consider people, equipment and processes. Use the back of this sheet to record your responses and bring your list to the workshop.

ABS Consulting

BRAINSTORMING EXERCISE

Brainstorm a list of critical success factors necessary to be prepared for a successful emergency response.

Category	Preparedness Factors
PEOPLE	
• Local Coordination – Command & Control • Knowledgeable Party • Training: 40 hours new miner • Training: other • Training: 8 hours refresher training • Training: reassignment • Training: exercises	*Examples: identification of command center personnel, self-rescue device training, map reading*
EQUIPMENT	
• Firefighting • Maps • Emergency shelters • Communications • Equipment and supplies	*Examples: maps in fireproof containers, two-way wireless communications, first aid*
PROCESS	
• Preparedness & response plan • Local coordination – command & control • Rescue teams • Firefighting • Other	*Examples: compliant emergency response plan, mutual aid agreements with outside resources*

UNDERGROUND COAL MINE

MINE RESCUE TEAMS READINESS WORKSHOP

THURSDAY, APRIL 4, 2013

1 P.M. – 3 P.M.

CLASSROOM C-106

THE WORKSHOP

MSHA is working with ABS Consulting to develop risk and readiness assessment models for the underground coal mining industry to use to help prevent major mine emergencies and improve emergency response. This session will support the development of a readiness assessment tool for mine rescue teams. This tool will review the state of the rescue teams and their organization. Data gathered over time will help mine operators to determine trends in readiness.

ROLE of MINE RESCUE TEAMS

Throughout history, miners have traveled underground secure in the knowledge that if disaster strikes and they become trapped in the mine, other miners will make every possible attempt to rescue them. This is the mine rescue tradition. Underground mines need fully-trained and equipped professional mine rescue teams available in the event of a mine emergency.

-MSHA

HOW CAN I HELP?

MSHA is seeking individuals with advanced training in underground coal mines, mine rescue and emergency management. Participants will be asked to brainstorm, support discussion, and work together to identify and validate critical success factors and prescribed regulations for mine rescue and managing mine emergencies.

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HOW CAN I PREPARE?

Imagine you are trapped in a mine and help is on the way. What would you like to know that you can count on with respect to the rescue teams? Similarly, if you are part of a mine rescue team, what would you like to know about your colleagues to ensure that they are prepared?

Brainstorm a list of critical success factors necessary to ensure that mine rescue teams are ready to execute a successful mission. Consider staffing, equipment, training and exercises.

Category	Preparedness Factors
PEOPLE	
• Competencies • Training • Leadership • Organization	*Examples: team captain/ co-captain competence, communications training, capable superintendent*
EQUIPMENT	
• Rescue Team Resources	*Examples: available maps, personal safety equipment, knowledge of equipment needed*
PROCESS	
• Procedures	*Examples: protocols for communications and logistics, methods for planning exploration*

UNDERGROUND COAL MINE

RESPONSIBLE PERSONS READINESS WORKSHOP

THURSDAY, APRIL 4, 2013

3 P.M. – 5 P.M.

CLASSROOM C-106

THE WORKSHOP

MSHA is working with ABS Consulting to develop risk and readiness assessment models for the underground coal mining industry to use to help prevent major mine emergencies and improve emergency response. This session will support the development of a readiness assessment tool to determine the ability of the designated responsible person to lead and coordinate all the various stakeholders involved in a mine emergency and rescue. This tool will provide a snapshot of the level of preparedness at the time of assessment, and sufficient data to determine trends in readiness over time.

ROLE of RESPONSIBLE PERSONS

For each shift that miners work underground, there shall be in attendance a responsible person designated by the mine operator to take charge during mine emergencies involving a fire, explosion, or gas or water inundation.

> The responsible person shall have current knowledge of the assigned location and expected movements of miners underground, the operation of the mine ventilation system, the location of the mine escapeways, the mine communications system, any mine monitoring system if used, locations of firefighting equipment, the mine's Emergency Response Plan, the Mine Rescue Notification Plan, and the Mine Emergency Evacuation and Firefighting Program of Instruction.
>
> **-30 CFR Part 75.1501**

HOW CAN I HELP?

MSHA is seeking individuals with responsible persons training in underground coal mines, mine rescue and emergency management. Participants will be asked to brainstorm, support discussion, and work together to identify and validate critical success factors and prescribed regulations for managing mine emergencies.

ABS Consulting

HOW CAN I PREPARE?

A mine emergency has just occurred (e.g. roof fall, fire) and you are counting on the responsible person in charge to manage the situation and lead you to safety. What would you like to know that you can count on with respect to the responsible person on duty?

Brainstorm a list of critical success factors necessary to ensure a responsible person is ready to respond to an emergency and successfully execute an emergency preparedness plan. Consider capabilities, training, and knowledge of the response plan.

Category	Preparedness Factors
PEOPLE	
• Demonstrated Competencies • Training • Knowledge and Information	*Examples: organizing, multitasking, firefighting coordination, knowledge of layout and escapeways*
EQUIPMENT	
• Responsible Person Resources	*Examples: Emergency response plan, emergency evacuation and firefighting plan, checklists*
PROCESS	
• Emergency Response Plan • Systems	*Examples: access control and management plan, logs for all key functions, check in/ check out*

Appendix D – Underground Coal Mine Risk and Readiness Workshop Presentation Materials

Workshops to Support the Development of Risk and Readiness Assessment Models

Models for MSHA and Industry

ABS Consulting
AN ABS GROUP COMPANY

- Logistic
- Introductions
- Overarching Goal
- Workshop
- Wrap-up

- Schedule
  - break

- Facilities
  - phones

  - restrooms

ABSG Consulting Inc.

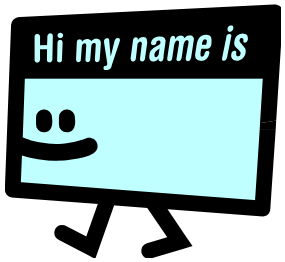
- Safety
  - exits
  - assembly points

- Sign-in Sheet

- Voting Tool

ABSG Consulting Inc.

- Name
- Mine or Mine Entity you represent
- Mining Area of Expertise



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ABS Consulting is a global

- safety, risk and integrity management company
- serving the Oil and Gas, Energy, Pipeline, Marine, Financial, Corporate and Public Sectors.

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The Mining Risk and Readiness Assessment Models Charter

To supply the mining industry with a pro-active toolset for underground coal mine operators to self-assess:

the risks associated with your mine and methods to prevent major mine emergencies,

your preparedness to respond to an emergency,

the readiness of your rescue teams, and

the readiness of responsible persons to execute your emergency plan.

~ Jeff Kravitz

MSHA Chief of Scientific Development

MSHA Technical Support

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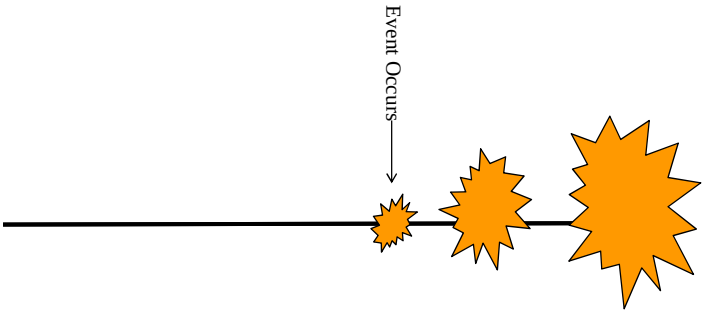
Risk Assessment Model for Preventing Major Mine Emergencies

Preparedness and Readiness Models for Responding to Major Mine Emergencies



Planning, People, Training, and Equipment to respond

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Risk Assessment Workshop

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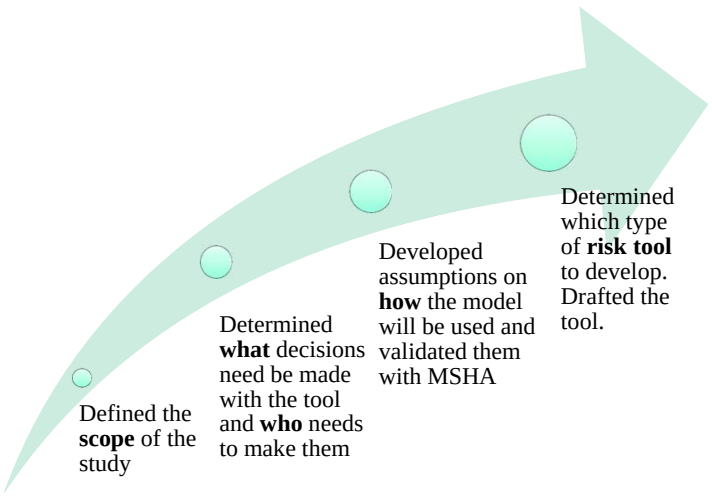

ABSG Consulting Inc. Mining Risk Assessment Workshop

- Charter
  - to supply the mining industry with a pro-active toolset for underground coal mine operators to self-assess the risks associated with their mine and methods to prevent major mine emergencies
- Industry
  - underground coal mines, including large and small operations
    - Large = More than 36 underground employees
    - Small = 36 or less underground employees

- Team's Composition
- Level of Difficulty
- Model Format
- Frequency of Use
- Amount of Time to Devote
- Education Level and Tech-Savviness of User
- Physical Location of Model's Use
- Use of Results

Details

- Where in the spectrum of risk does my mining operation stand?
- How is the risk profile at my mine changing over time?
- What corrective action, would improve my mine's risk profile?

Step 1: Establish base risk (day-to-day) of the mine

Step 2: Alter the base risk depending on the activities the mine will be performing within the next three months

Step 3: Calculate and evaluate the mine's score

Step 4: Determine areas which need improvement, assess recommendations, take action to determine/implement corrective actions

Questions? Issues?

ABSG Consulting Inc. Mining Risk Assessment Workshop

Test Audience Response Remotes

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- Part 1:
  - You just finished visiting a mine and you tell your colleague, “I’ve just visited what must be the safest mine in the US, because…” (list two reasons).
- Part 2:
  - You just finished visiting a mine and you tell your colleague, “I won’t be going back in that mine for a while. I could tell it was unsafe because…” (list two reasons).

Write Answers on the Back of Your Packet

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1. Design
2. Equipment Reliability and Mine Maintenance
3. Documentation and Records
4. Material/Parts
5. Hazard/Defect Identification and Analysis
6. Procedures
7. Workplace Conditions/Human Factors
8. Training/Personnel Qualification
9. Supervision
10. Verbal and Informal Communication
11. Personal Performance

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- Mine's Base Risk Model Worksheet
  - Review each sub-category (2 minutes)
  - Voting on each sub-category
    - Is this sub-category understandable?
    - Are the terminology appropriate for the mining industry?
    - Are "the questions to help frame your thoughts" sufficient?
  - Write down your comments
- Recommendations Worksheet (4 minutes)
  - STAAR

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1. Design
2. Equipment Reliability and Mine Maintenance
3. Documentation and Records
4. Material/Parts
5. Hazard/Defect Identification and Analysis
6. Procedures
7. Workplace Conditions/Human Factors
8. Training/Personnel Qualification
9. Supervision
10. Verbal and Informal Communication
11. Personal Performance

ABSG Consulting Inc.

1. Designs/Plans
2. Equipment Maintenance
3. Mine Maintenance/Housekeeping
4. Documentation and Records
5. Material/Parts
6. Hazard/Defect Identification and Analysis
7. Procedures
8. Workplace Conditions/Human Factors
9. Training/Personnel Qualification
10. Supervision
11. Verbal and Informal Communication
12. Personal Performance

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- Existing Items:
  - Review each question to access whether it should affect the overall risk score.
  - Are the "questions to help frame your selection" appropriate?
- Additional Items:
  - Are there any other activities that can occur at a mine which would increase the risk of a mine?

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- Evaluate the affect that each activity should have on the overall evaluation of the mine's risk.
  - Significantly
  - Moderately
  - Slightly

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- Develop a list of layers of protection which should be in place to prevent an accident from occurring because of this activity
  - Write each layer of protection on a different sticky note

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- Session Feedback
  - What went well?
  - What could we have done differently?

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THANK YOU

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Readiness Assessment – Mine Rescue Teams

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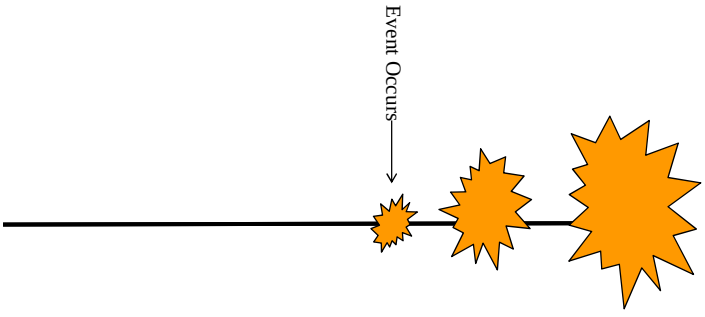
Risk Assessment Model for Preventing Major Mine Emergencies

Preparedness and Readiness Models for Responding to Major Mine Emergencies



Planning, People, Training, and Equipment to respond

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DEFINITION: Readiness is the *ability* of persons, systems or organizations *to successfully execute planned activities* when responding to a major mine emergency.

READINESS ASSESSMENT METHODOLOGY; We are building readiness assessment models that will *assess the adequacy* of people and organizations *[mine rescue teams and responsible persons]* to execute the planned activities.

ABSG Consulting Inc.

- To develop an easy-to-use means of self-assessing the capabilities and competencies of a mine's rescue teams to respond to an emergency
- To provide mine operators with indicators of critical success factors to address in order to improve overall readiness
- Potentially to provide mine operators with insights into areas for continuous improvement through best practices and benchmarking.

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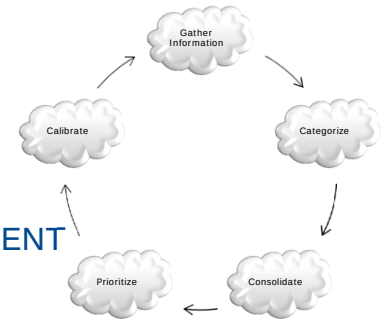
- Literature Review
  - Miners Act 2006 (merged)
  - Regulations (MSHA)
  - Training Programs
  - Best Practices
- Organize by PEOPLE / EQUIPMENT (Resources) & PROCESS
- Identify Subcategories
- Brainstorm & List Critical Success Factors
- Rank Factors and Weight Sub-Categories
- Follow up with 2-4 person team



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- Step 1: Select the top five most important **factors** using 1 -5 where 1 is the least important and 5 is the most important.
- Step 2: Weight the importance of the **subcategories** (the bold highlighted sections). To do this, distribute $100 preparedness dollars across each of the subcategories to indicate the relative importance of each subcategory.

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Readiness Assessment – Responsible Persons

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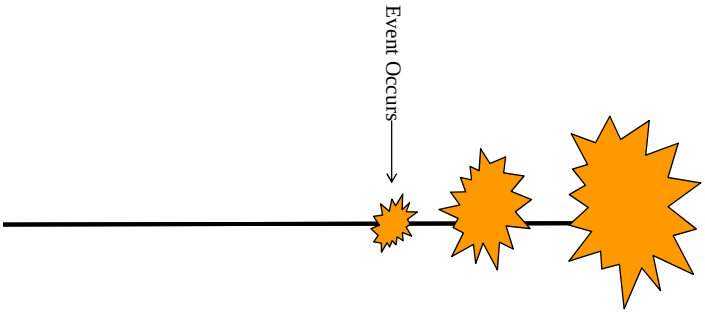
Risk Assessment Model for Preventing Major Mine Emergencies

Preparedness and Readiness Models for Responding to Major Mine Emergencies



Planning, People, Training, and Equipment to respond

ABSG Consulting Inc.

DEFINITION: Readiness is the *ability* of persons, systems or organizations *to successfully execute planned activities* when responding to a major mine emergency.

READINESS ASSESSMENT METHODOLOGY; We are building readiness assessment models that will *assess the adequacy* of people and organizations *[mine rescue teams and responsible persons]* to execute the planned activities.

ABSG Consulting Inc.

- To develop an easy-to-use means of self-assessing the capabilities and competencies of responsible person(s) to respond to and manage an emergency
- To provide mine operators with indicators of critical success factors to address in order to improve responsible person readiness
- Potentially to provide mine operators with insights into areas for continuous improvement through best practices and benchmarking.

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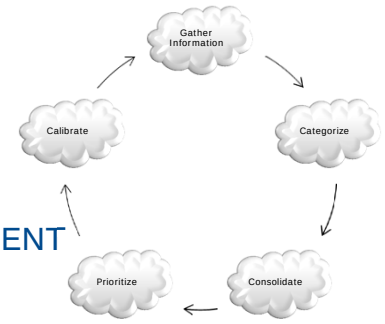
- Literature Review
  - Miners Act 2006 (merged)
  - Regulations (MSHA)
  - Training Programs
  - Best Practices
- Organize by PEOPLE / EQUIPMENT (Resources) & PROCESS
- Identify SubCategories
- Brainstorm & List Critical Success Factors
- Rank Factors and Weight Sub-Categories
- Follow up with 2-4 person team



ABSG Consulting Inc.

- Step 1: Select the top five most important **factors** using 1 -5 where 1 is the least important and 5 is the most important.
- Step 2: Weight the importance of the **subcategories** (the bold highlighted sections). To do this, distribute $100 preparedness dollars across each of the subcategories to indicate the relative importance of each subcategory.

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Preparedness Workshop

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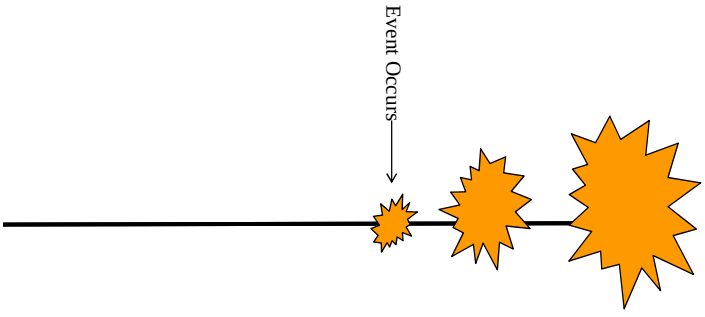
Risk Assessment Model for Preventing Major Mine Emergencies

Preparedness and Readiness Models for Responding to Major Mine Emergencies



Planning, People, Training, and Equipment to respond

ABSG Consulting Inc.

DEFINITION: Preparedness is the integration of activities such as *planning*, *training*, *exercises*, *personnel qualification and certification standards*, *equipment acquisition and maintenance to certified standards*, and the *publication of processes and activities* to ensure that a mine operator can successfully respond to a major mine emergency.

PREPAREDNESS ASSESSMENT METHODOLOGY; We are building a model that will *assess the thoroughness* of the mine operator's preparedness activities.

ABSG Consulting Inc.

- To develop an easy-to-use means of self-assessing the overall state of a mine to respond to an emergency
- To provide mine operators with indicators of critical success factors to address in order to improve overall preparedness
- Potentially to provide mine operators with insights into areas for continuous improvement through best practices and benchmarking.

ABSG Consulting Inc.

- Literature Review
  - Miners Act 2006 (merged)
  - Regulations (MSHA)
  - Training Programs
  - Best Practices
- Organize by PEOPLE / EQUIPMENT (Resources) & PROCESS
- Identify SubCategories
- Brainstorm & List Critical Success Factors
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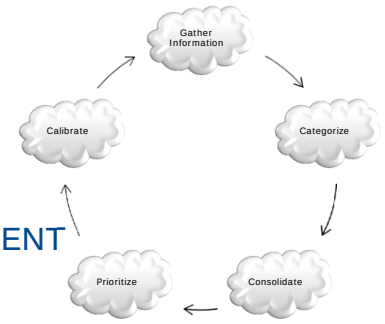
- Follow up with 2-4 person team



ABSG Consulting Inc.

- Step 1: Select the top five most important **factors** using 1 -5 where 1 is the least important and 5 is the most important.
- Step 2: Weight the importance of the **subcategories** (the bold highlighted sections). To do this, distribute $100 preparedness dollars across each of the subcategories to indicate the relative importance of each subcategory.

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Appendix E – Risk Assessment Model and Methodology

Underground Coal Mine Risk Assessment Model Directions

Purpose of This Model: The purpose of this model is to supply the mining industry with a proactive toolset for underground coal mine operators to use to self-assess the risks associated with their mine and develop methods to prevent major mine emergencies.
Recommended Use: It is recommended that each mine perform this risk assessment every three months. It is expected that the first time a mine completes this assessment, it will take slightly longer than subsequent assessments.
Assessment Results: While the models are being validated and calibrated, access to the results will be limited to individual mines. The primary audience is the mine's management for decision-making purposes.
How to Use This Model:

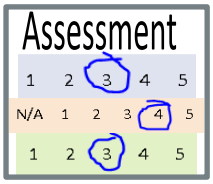
Step 1: Go to the following website **www.msha.gov/riskmodel**

Step 2: For this assessment, you *only* need to print the **Risk Model** file which includes (1) Directions (2) Scoring Criteria and (3) The Model.

Step 3: Save the **Risk Results** file to your computer, but do not print.
Note: Only the final step of this model (calculating your results) requires a computer.

Step 4: Gather a team of individuals from the mine to perform this assessment. The team might include the Mine Foreman, a Shift Supervisor, a Mine Examiner (Shift Inspector), a Mine Engineer, and the designated responsible person(s).
Recommendation: Select an individual to lead this effort for this mine. If possible, select someone who can lead the first assessment and subsequent assessments (every three months) to provide consistency.

Step 5: Briefly review the material you have printed to help ensure that the team has a basic understanding of how this process will work.



Step 6: Meet with the team to make a series of judgments in Sections A, B, and C of the model. Each judgment will involve circling your selection, a number 1 through 5 or Not Applicable (N/A).
Reminder: Each section of the model has its own scoring criteria, shown on the Scoring Criteria page. For ease of use, the scoring criteria is color coded to the section.

Step 7: After the team has completed making all the assessments in Sections A, B, and C, use a computer to open the **Risk Results** file. Transfer the numbers from the paper-based **Risk Model,** used by the group, to the computer file.

Step 8: If desired, print the results. Then, review the risk score of the mine.

Step 9: As a team, review areas where the score was less than ideal and develop recommendations to address them. To support your development of recommendations, sample recommendations have been provided within the **Risk Results** file on another tab.
To access the tab: Look to the bottom of the computer-based **Risk Results** file for the tab labeled "Recommendations." Click on the tab.

Underground Coal Mine Risk Assessment Model Scoring Criteria

SCORING CRITERIA for Section A - Assess the Mine's Base Risk				
To score a 1, the factor must meet these criteria:	**To score a 2, the factor must meet these criteria:**	**To score a 3, the factor must meet these criteria:**	**To score a 4, the factor must meet these criteria:**	**To score a 5, the factor must meet these criteria:**
For this factor, the mine is frequently worse than industry standards	For this factor, the mine occasionally does not meet industry standards	For this factor, the mine meets industry standards	For this factor, the mine is frequently better than industry standards	For this factor, the mine is exemplary, almost always exceeding industry standards
Serious injuries have been known to occur with this factor as an intermediate cause	No serious injury within six months with this factor as an intermediate cause	No serious injury within one year with this factor as an intermediate cause	No serious injury within two years with this factor as an intermediate cause	No serious injury within five years with this factor as an intermediate cause

Definition of Serious Injury - An injury which had a reasonable potential to cause death. For additional detail on those specific kinds of accidents see MSHA Code Section 50.10 of Part 50.

Definition of Intermediate Cause - An underlying reason why an equipment performance gap or front-line personnel performance gap caused an incident to occur, or allowed the consequences of the incident to be worse than they might have been.

SCORING CRITERIA for Section B - Assess the Mine's Activity Risk				
To score a 1:	**To score a 2:**	**To score a 3:**	**To score a 4:**	**To score a 5:**
I believe the layers of protection are very questionable, and I had to make numerous assumptions	I believe the layers of protection are questionable, and I had to make many assumptions	I believe the layers of protection are in place, and I had to make several assumptions	I can demonstrate that the layers of protection are in place and established, and I only had to make a few assumptions	I can demonstrate that the layers of protection are in place and well established, and I had to make very few assumptions

Definition of Layers of Protection - any measure (people, equipment, system/process, training, and infrastructure, etc.) that the mine has taken to help ensure that performing this activity does not increase the risk of working at this mine.

SCORING CRITERIA for Section C - Assess the Mine's Safety Culture				
To score of 1:	**To score a 2:**	**To score a 3:**	**To score a 4:**	**To score a 5:**
Strongly disagree with the safety culture criteria.	Disagree with the safety culture criteria.	Neither agree nor disagree with the safety culture criteria.	Agree with the safety culture criteria.	Strongly agree with the safety culture criteria.

Definition of Safety Culture - A safety culture are the shared norms, values, assumptions and relative importance about safety that exist within the mine and shape the relevant attitudes and behaviors of people working at the mine.

Section A - Assess the Mine's Base Risk

Directions: Use the **BLUE** scoring criteria on page 2 to complete this section. Score the mine, as it is today, in each of the factors below on a scale of 1 to 5. To select a score, the factor must meet both criteria (see page 2). If you struggle to select an appropriate score, make a conservative selection by choosing the lower score.

A. Design and Planning

A.1. Mine Location, Minewide Design, and Minewide Plans: Score the mine on its overall location, the minewide design, and the minewide plans. + Questions to Help Frame Your Thoughts: Is the mine layout conducive to safe operation? Has a diligent search for old mines and gas wells near the mine been conducted? Have all questions related to the proximity of old mines and gas wells been addressed? Are the minewide design output drawings and specifications complete, correct, consistent, and clear? Do you have high confidence that the maps of nearby mines and gas wells are up to date and accurate? Do you know the condition of nearby mines (e.g., inundated with CO2, CH4, or water)? Are plans in place to reduce the risks associated with nearby old mines and gas wells? Is there a mine-wide design and plan which considers emergency shelters throughout the mine in areas accessible to workers but out of the way of potential damage?	1 2 3 4 5
A.2. Engineered Mine Design of Mine Infrastructure: Score the mine on the design of the major infrastructure systems, including the mine layout, mine ventilation system, ground control system (stability), main haulage system, mine power system, and pumping and drainage system. + Questions to Help Frame Your Thoughts: Are the design output drawings and specifications complete, correct, consistent, and clear? Are you satisfied with the amount of ventilation that is designed to make it to your operating sections? Does your roof control plan adequately address safety issues dealing with ground stability? Is your haulage system designed to adequately address safety concerns? Is your mine power system designed for safety? Is the pumping and drainage system designed to minimize inundation? Does your mine perform design review/verification, which can detect problems in the design? Are all operating conditions (normal, startup, shutdown, emergency) considered in the mine infrastructure designs?	1 2 3 4 5
A.3. Monitoring Systems Design: Score the mine on the design of its monitoring systems, including handheld and integrated detectors (e.g., CO, CH4, O2, NOX, electrical system monitoring and control [overcurrent, temperature, overvoltage, and short-circuit], CH4 detectors on continuous miners and shearers.) + Questions to Help Frame Your Thoughts: Are your monitoring systems designed to be compatible with the overall system you want to protect? Were your monitoring systems designed to detect abnormal conditions with speed and sensitivity?	1 2 3 4 5

A.4. Equipment Components Design: Score the mine on the design of the equipment used at and in the mine (e.g., continuous miners, longwall equipment, conveyer belts, track, shuttle cars, battery powered scoops, battery powered forklifts, and mantrips). + Questions to Help Frame Your Thoughts: When you send out pieces of mine equipment to be overhauled, do you upgrade to current state of the art design? When you purchased this equipment, did you specify the requirements for the design correctly? If you altered the design of the equipment to satisfy your mine's needs, did the design take into consideration all of the necessary safety precautions and was it built to your design? Does the design of the operating equipment used in the mine take into account the range of operating conditions?	1 2 3 4 5

B. Equipment Maintenance and Reliability

B.1. Equipment Reliability Program Design: Score the mine's equipment reliability program. (Note: This item should only evaluate the reliability program. The next item, B.2, evaluates the maintenance program.) + Questions to Help Frame Your Thoughts: Is the correct maintenance specified for equipment? Is an analysis process used to determine whether maintenance requirements are adequate? Does the repair activity cover the required scope? Is the maintenance program designed appropriately? Has all critical equipment that should be included in the maintenance program been identified? Have the appropriate maintenance methods been specified for the mine's critical equipment? Are the high-priority maintenance tasks being specified over low-priority maintenance? Do the miners avoid a "we'll fix it when it breaks" mentality for equipment, which could have high consequences of failure?	1 2 3 4 5
B.2. Maintenance of Mine Equipment: Score the mine's maintenance program, including periodic maintenance, event-based maintenance, condition-based maintenance, fault-finding maintenance, preventive maintenance, and corrective maintenance. + Questions to Help Frame Your Thoughts: Is the frequency of the scheduled maintenance appropriate? Is the maintenance correctly performed? Is the maintenance performed when it should be performed (e.g., following a shutdown, before a startup, at the beginning of winter)? Does the mine practice preventative/predictive maintenance rather than reactive maintenance? Are maintenance personnel notified when a triggering event (which should lead to event-based maintenance) occurs? Does the mine follow manufacturing specifications and/or recommendations in the maintenance program?	1 2 3 4 5
B.3. Routine Inspection and Servicing of Mine Equipment: Score the mine operators (not maintenance staff) on their ability to perform routine inspection and servicing maintenance on mine equipment, appropriately and in a timely manner. + Questions to Help Frame Your Thoughts: Do the mine operators follow approved recommendations (e.g., MSHA recommendations) for inspection? Is the scope of the routine servicing and inspection (rounds) appropriate (i.e., too broad or too narrow)? Do the routine rounds cover all necessary portions of the mine?	1 2 3 4 5

C. Upkeep of Mine Infrastructure/Housekeeping

C.1. Rockdusting: Score the mine on its rockdusting schedule and implementation. + Questions to Help Frame Your Thoughts: Does the mine have a minewide rockdusting schedule? Is the rockdusting schedule adequate to maintain proper coating of the roof, ribs, and floor in the entire mine? Is the rockdusting applied to the mine per the schedule (never skipping a scheduled dusting)? Do the rockdusting levels meet or exceed levels specified by state and federal agencies?	1	2	3	4	5
C.2. Routine Inspection and Servicing of Mine Infrastructure: Score the mine foreman and other mining personnel on their ability to perform routine inspection and servicing of the mine infrastructure, including the mine layout, mine ventilation system, ground control system (stability), main haulage system, mine power system, and pumping and drainage system. + Questions to Help Frame Your Thoughts: Are all sources of ignition being protected/shielded? Are your seals, stoppings, overcasts, and regulators in good repair? Is there an inspection and servicing schedule for the mine infrastructure? Does the mine foreman strictly adhere to the inspection and servicing schedule for the mine infrastructure?	1	2	3	4	5

D. Documentation and Records

D.1. Infrastructure and Equipment Records/Manuals: Score the mine's equipment records and manuals (e.g., rebuild manuals). + Questions to Help Frame Your Thoughts: Are the following documents accessible and correct: original equipment manufacturers' manuals, material requirements, and drawings? Are the appropriate versions of the equipment manuals available? Are the manuals up to date?	1	2	3	4	5
D.2. Operational and Maintenance History: Score the mine's operational and maintenance history (e.g., weekly equipment permissibility books, daily inspection logs). + Questions to Help Frame Your Thoughts: Is the history of the mining equipment complete? Is the history of the equipment available, up to date, and convenient to obtain? Are the work orders or other formal documentation up to date and complete (no omissions), and do they contain sufficient detail?	1	2	3	4	5
D.3. Risk Assessment Records: Score the mine's risk assessment recordkeeping (e.g., job safety assessment [JSA], root cause analysis [RCA], inspection analysis, management of change [MOC], and readiness reviews.) + Questions to Help Frame Your Thoughts: If the mine has completed risk assessments, are the records accurate, complete, available, and up to date? NOTE: If the mine does not have risk assessment records because the mine does not complete risk assessments, then select 5.	1	2	3	4	5
D.4. Personnel Records: Score the mine's personnel recordkeeping (e.g., hiring records, training records, qualification records). + Questions to Help Frame Your Thoughts: Is the mine's training record system complete and up to date? Are the documents available and convenient to obtain? Does the mine's training record system accurately reflect the employee's training and qualifications? Do the documents show qualifications that have expired? Are only up-to-date official training/qualifications documents used at the mine?	1	2	3	4	5
D.5. Other Documents and Records: Score the mine's documents and recordkeeping for items not covered in other sections of D. This section includes items such as preshift books, weekly exam books, bulkhead/seal books, fan chart, and fireboss books. + Questions to Help Frame Your Thoughts: Are these documents accurate, complete (no omissions), available, and up to date?	1	2	3	4	5

E. Material/Parts/Equipment

E.1. Material/Parts/Equipment: Score the mine's purchasing specifications, acceptance criteria, acceptance testing, handling and storage, and inventory for raw materials, parts, and equipment received from outside the facility and materials/parts made within the company. + Questions to Help Frame Your Thoughts: Are combustible fuels being protected/shielded? When equipment/material/parts arrive from external vendors, are the orders reviewed before acceptance to ensure that they meet specifications? Are material/parts/equipment stored and handled properly (no heat, cold, acid, fumes, etc.)? Does the mine keep an appropriate amount of inventory on hand, and is it organized to help ensure that it is available when needed? When possible, does the mine use industry-made material/parts that have been through a rigorous design and quality control testing instead of making its own material/parts?	1	2	3	4	5

F. Hazard/Defect Identification and Analysis

F.1. Startup Review: Score the mine on the quality of its start-up reviews of new processes, processes that have been shut down for modification, and processes that have been administratively shut down for another reason. + Questions to Help Frame Your Thoughts: Do all readiness reviews consist of workplace observations and verification that all appropriate equipment is ready for operation; procedures, documents, and assessments are updated; and training is completed?	1	2	3	4	5
F.2. Management of Change: Score the mine on its management of change (MOC) process, including how miners ask for changes, how change requests are considered (not all approved or denied), and how the mine implements changes. + Questions to Help Frame Your Thoughts: Do the miners know when a change assessment is required and for what type of change? Do the miners get authorization signatures from key personnel before design/field changes are implemented? Do the change assessment scopes include appropriate items and considerations (risks and hazards)? Are change assessments performed in a timely manner? Are the corrective actions identified in the change review implemented? Are the risk acceptance criteria appropriately applied?	1	2	3	4	5
F.3. Proactive Risk/Safety/Reliability/Quality/Security Analysis: Score the mine's ability to proactively (before it occurs) identify a hazard, complete an analysis of the hazard, provide recommendations, and implement recommendations. + Questions to Help Frame Your Thoughts: Are the hazard reviews of the mine's systems adequate? Are risk assessments proactively performed? During the proactive analysis are safety, reliability, quality, and security hazards identified?	1	2	3	4	5
F.4. Reactive Risk/Safety/Reliability/Quality/Security Analysis: Score the mine's ability to reactively assess hazards (i.e., a hazard has been identified but a major mine event has not occurred) to analyze which correct step to take first, report the hazard, and provide recommendations. + Questions to Help Frame Your Thoughts: Are recommendations for known deficiencies, despite funding and project delays, implemented before recurrence of the deficiency or before it gets worse?	1	2	3	4	5
F.5. Inspection/Audit/Measurement: Score the mine's ability to perform an adequate number of audits of the system and to act upon the results. + Questions to Help Frame Your Thoughts: Does the mine have audits of safety, reliability, and quality performed at regular appropriate intervals? Are recommendations successful in preventing recurrence of the issues? Are quality issues tracked?	1	2	3	4	5

G. Procedures

G.1. Procedure Use: Score the miners on using the current procedure correctly when completing tasks (e.g., job safety analysis [JSAs], safe job procedures [SJPs], standard operating procedures [SOPs]). + Questions to Help Frame Your Thoughts: Is using procedures encouraged? Do miners use the correct versions of the procedures to perform their actions versus using an outdated procedure that is easier to access? Do the miners use the procedure correctly?	1 2 3 4 5
G.2. Procedure Correct/Complete/Readily Available: Score mine management on providing readily available procedures to miners that are correct and complete. + Questions to Help Frame Your Thoughts: Do tasks that need procedures have them? Are procedures in place to reduce the risks associated with any nearby mines and gas wells? Are the procedures in their designated locations and are the master copies of the procedures available for reproduction? Are the procedures designed for the inexperienced miner? Are the steps in the mine's procedures sequenced correctly (e.g., warnings appropriately placed within each step instead of at the end of the document)? Do they contain consistent requirements, all of the steps/content, and the correct facts? Do the procedures contain information only for the task at hand (no overlaps or gaps between other procedures that you'll have to look up)? Are the procedures written in a language that is familiar to the miners? Are the mine's procedures formatted appropriately and easy to use? Do they contain just one action per step, adequate checklists, and graphics and diagrams as needed? Do they have complete wording, sufficient references, and an appropriate amount of detail?	1 2 3 4 5

H. Workplace Conditions/Human Factors

H.1. Tools/Equipment: Score the mine on its employees having appropriate, and sufficient-quality, functioning tools that allow them to complete their work. + Questions to Help Frame Your Thoughts: Are the correct tools supplied for the job? Are the tools durable and made to last under the rough conditions of the mine? Are tools in poor condition replaced or repaired in a timely manner? Are the tools and instruments calibrated properly? Do the miners rarely have to improvise with tools?	1	2	3	4	5
H.2. Workplace Layout: Score the mine on the layout of its systems and tools. + Questions to Help Frame Your Thoughts: Are the controls and displays adequate? Do the controls provide an adequate range of control for the function the equipment performs? Do the displays provide all the information needed about system status and parameter values to meet task requirements? Are the locations of controls and displays appropriate? Are they used in an approved and consistent configuration with general use of the equipment in industry? Does the configuration of the display make information easy to see and interpret? Are the proper tools easy to access? Are the controls, displays, and other equipment appropriately and clearly labeled? Is similar equipment in various sections of the mine laid out similarly? Are the PPE and emergency response equipment in an easily retrievable location?	1	2	3	4	5
H.3. Workload and Environment: Score the mine on matching the physical and mental demands of tasks with the capabilities of its personnel. + Questions to Help Frame Your Thoughts: Are the tasks requested of the miners within an appropriate physical workload with no risk of repetitive stress injuries or excessive strength requirements? Are the workers encouraged to take their time to get the job done (instead of being rushed)? Are the monitoring methods and equipment easy enough for the personnel to follow and operate (not too complex)? Are the miners who monitor for gases (e.g., O, CH4, O2, NOX) only asked to monitor for appropriate lengths of time? Do the miners have enough ambient lighting to maintain situational awareness?	1	2	3	4	5
H.4. Error Mitigation: Score the miners on their ability to detect issues (by way of alarms or instrument readings) that could lead to a major mine emergency such that they may recover from an error before a failure occurs. + Questions to Help Frame Your Thoughts: Does the mine provide effective means for individuals to monitor system status and detect issues? Does the mine have redundancies in critical alarm systems in case a miner makes a mistake in the reading or the detector fails?	1	2	3	4	5

I. Training/Personnel Qualification

I.1. Decision When to Train: Score the mine's enforcement of the standard mining mentality that "experience is never a substitute for training." + Questions to Help Frame Your Thoughts: Does your mine operate with the understanding that experience does not replace training? When a highly experienced miner changes jobs, location, or equipment, do you train him/her fully before allowing him to switch positions?	1	2	3	4	5
I.2. Training Identification: Score the mine on its ability to identify training needs by individuals, groups, all mine personnel, and contracted third-parties. This includes identifying supplemental or annual refresher training courses based on topics related to the mine's changing conditions (e.g., training needs to be given minewide because we've had a lot of near misses this year related to rib rolls).	1	2	3	4	5
I.3. Training Requirements Completed: Score the mine's ability to follow through on ensuring that individuals meet training requirements and that required training courses are completed.	1	2	3	4	5
I.4. Training Program Design/Development/Implementation: Score the mine on its training program design, development, and implementation (e.g., quality/effectiveness/thoroughness of classroom training, laboratory/practical training, on-the-job training, self-study and computer-based training, continuing training, cross-training, and training resources). + Questions to Help Frame Your Thoughts: The law generally mandates how much time must be spent on training, but does your mine take the extra step to ensure that the training is also of high quality? Is the training program effective in producing miners who can perform work correctly? Is the training thorough, in that it covers all aspects of the training that are important? Have the miners been cross-trained in other areas so that if there is absenteeism they can safely support/work in an area that is not the miner's primary workplace?	1	2	3	4	5
I.5. Qualification: Score the mine on verifying that personnel filling positions that require a certification or qualification have a current and valid certification or qualification. + Questions to Help Frame Your Thoughts: Does the mine verify that certificates and qualifications are current and legitimate, especially when hiring?	1	2	3	4	5

J. Supervision

J.1. Preparation: Score the minewide supervisors and front-line supervisors on the quality of their job plans, instructions to workers, and walkthroughs, and their ability to demonstrate tasks using proper procedures, schedule jobs, select and assign personnel, use authority, and match work tasks to qualified personnel. + Questions to Help Frame Your Thoughts: Does the supervisor always ensure that the following tasks are assigned to a qualified person: electrical work, repair of energized surface high-voltage lines, air flow tests, and tests for methane and oxygen deficiency? Are the supervisors consistent in their daily work preparation activities with various miners? Do the supervisors lead by example? Do the supervisors describe potential safety concerns when demonstrating tasks?	1	2	3	4	5
J.2. Supervision During Work: Score the minewide supervisors and front-line supervisors on their ability to provide supervision, including ensuring compliance with regulations, enforcing pre-op checks, correcting improper performance, facilitating coordination, and balancing their supervision style (i.e., instead of using less effective management techniques like micromanaging or laissez-faire managing). + Questions to Help Frame Your Thoughts: Are your supervisors successful in providing adequate support, coverage, oversight, and supervision during job performance? Is there adequate coordination among the miners? Do supervisors correct improper performance when they observe it or learn about it? Do supervisors avoid letting improper performance slip past "just this once"? Are there sufficient methods for supervisors to detect improper performance? Do supervisors have an appropriate amount of contact with workers (not too infrequent)?	1	2	3	4	5

K. Verbal and Informal Written Communication

K.1. Communication Method: Score the adequacy of the mine's real-time communication system (e.g., mine phones, face-to-face, radios, written). + Questions to Help Frame Your Thoughts: Does a method or system exist for communicating efficiently and effectively among groups or individuals?	1	2	3	4	5
K.2. Communication Performed: Score the effectiveness of the communication, including face-to-face and written, among the miners to successfully complete day-to-day activities. + Questions to Help Frame Your Thoughts: Is there adequate communication between section and shift foremen (e.g., pre-and post-shift meetings)? Is there adequate communication between miner to miner to complete task work?	1	2	3	4	5
K.3. Timely Communication: Score the timeliness of communication among the miners within the mine and with outside mine entities. + Questions to Help Frame Your Thoughts: Is the communication timely (not too late)?	1	2	3	4	5
K.4. Communication Understanding: Score the mine's communication techniques, the miners' ability to be understood within the mine, and the miners' ability to communicate with contracted third-parties. + Questions to Help Frame Your Thoughts: Does the mine use standard terminology and the verification/repeat-back technique? Are verbal instructions complete and correct? Can the miners communicate effectively (e.g., no translation/language issues)? When management provides instruction, are they understood?	1	2	3	4	5

L. Personal Performance

L.1. Personnel Hiring: Score the mine's performance in hiring personnel from outside the current organization. + Questions to Help Frame Your Thoughts: Are appropriate personnel hired to perform the work? Is the employee hiring program effective in correctly identifying requirements for particular jobs and screening potential employees against those requirements?	1	2	3	4	5
L.2. Resource/Staffing: Score the mine's performance in establishing resourcing/staffing. + Questions to Help Frame Your Thoughts: When existing personnel are moved into new positions, are they suitable for the new role (e.g., miner moving into a supervisor position). Are there sufficient personnel available to perform the task? Are staffing levels revised as efforts within the mine change? Are there sufficient personnel resources to perform scheduled tasks? Does the mine ensure that an appropriate mix of miners are available to perform the work?	1	2	3	4	5
L.3. Rewards/Incentives: Score the mine's performance in establishing rewards and incentives. + Questions to Help Frame Your Thoughts: Are personnel rewarded for only good behavior? Are personnel disciplined for bad behavior? Does the rewards system avoid incentivizing workers who take shortcuts, which may be a safety concern? Do you have a safety incentives program?	1	2	3	4	5
L.4. Detection of Individual Performance Problems: Score the mine's performance in detecting individual performance problems. + Questions to Help Frame Your Thoughts: Is the mine able to identify performance issues that may lead to a safety concern? Does the mine have programs to assist employees with these problems, allowing them to identify themselves as being in need and receive help? Does the mine have a drug abuse policy that is enforced?	1	2	3	4	5
L.5. Individual Performance: Score the performance of the miners in regard to their sensory/perceptual abilities; mental/physical capabilities; personal problems affecting work; adherence to company procedures/policies; and issues with horseplay, off-the-job rest/sleep (fatigue), prescribed-drug interactions, drug/alcohol abuse, internal sabotage, and criminal activity (all of which affect the workplace). + Questions to Help Frame Your Thoughts: Does the mine have personnel with no issues related to substance abuse? Are the mine personnel alert and not sleep deprived? Does the mine have personnel who do not sabotage the mine or participate in horseplay?	1	2	3	4	5

Section B - Assess the Mine's Activity Risk

Directions: Use the **BROWN** scoring criteria on page 2 to complete this section. Evaluate each of the following activities listed below and determine whether the mine will be involved in this activity within the next three months. **Not Involved** - If the mine will not be involved in this activity, select "not applicable" (N/A). **Involved** - If the mine will be involved in this activity within the next three months, then evaluate your confidence that the mine has the appropriate layers of protection in place. A handful of layers of protection are listed below, but others may exist. Select a number on a scale of 1 to 5 that best represents your team's confidence that all appropriate layers of protection are in place. If you struggle to select an appropriate level, make a conservative selection by choosing the lower score.

M. Equipment/Infrastructure

M.1. Equipment Replacement/Overhaul: During the next three months, do you expect the mine's equipment to be replaced or overhauled? + Questions to Help Frame Your Selection: Do you expect to purchase new equipment? Do you plan to overhaul equipment your mine already utilizes then put it back into service? **No**, select N/A. **Yes,** score your confidence that the following items (as appropriate) and any other layers of protection you can think of have been addressed in preparation for this activity: classroom training on new/updated/changed equipment, on-the-job training, testing of the equipment, and job task analysis.	N/A 1 2 3 4 5
M.2. Equipment Transfer: During the next three months, do you expect to transfer equipment from a mined-out section to a new section? + Questions to Help Frame Your Selection: Do you expect to complete mining in one section of the mine then transfer the equipment to another section of the mine? Do you expect a major move? **No,** select N/A. **Yes,** score your confidence that the following items (as appropriate) and any other layers of protection you can think of have been addressed in preparation for this activity: individuals have been trained in moving equipment (the move crew) to facilitate the move, and the individual in charge of the transfer is aware of the requirement to clear people inby.	N/A 1 2 3 4 5
M.3. Mine Infrastructure Change: During the next three months, do you expect to change your mine infrastructure? + Questions to Help Frame Your Selection: Do you expect to modify, replace, or overhaul infrastructure, for example: coal transportation - main belt lines, roof support - roof bolts, electrical - main load center, ventilation - air shafts, ventilation - overcasts, water system - main dam room, water system - pump. **No,** select N/A. **Yes,** score your confidence that the following item (as appropriate) and any other layers of protection you can think of have been addressed in preparation for this activity: all miners are aware that the only people allowed underground during the change are the personnel responsible for the change.	N/A 1 2 3 4 5

N. Personnel

N.1. Transfer Key Personnel: During the next three months, do you expect to transfer key personnel to a different position within your company's workforce? + Questions to Help Frame Your Selection: Do you expect to change the role (promote/demote/transfer) of key individuals to a different position within your mine? Do you expect to move key individuals to another mine? **No**, select N/A. **Yes**, score your confidence that the following items (as appropriate) and any other layers of protection you can think of have been addressed in preparation for this activity: cross-training among staff so that they know various positions in case there is a need, and replacement personnel are fully trained.	N/A 1 2 3 4 5
N.2. Turnover: During the next three months, do you expect turnover among key personnel or a substantial percentage of your workforce? + Questions to Help Frame Your Selection: Do you expect an individual in a key position to retire, be fired, or be hired? Do you expect a higher than normal amount of your workforce to leave the company or be hired? **No**, select N/A. **Yes**, score your confidence that the following items (as appropriate) and any other layers of protection you can think of have been addressed in preparation for this activity: cross-training among staff so that they know various positions in case there is a need, the mine's personnel (HR) department is aware of the need and is working to find suitable replacements, and replacement personnel are fully trained before they can begin work at the mine.	N/A 1 2 3 4 5
N.3. Absenteeism: During the next three months, do you expect to experience significant absenteeism? + Questions to Help Frame Your Selection: Do you expect a key individual to be absent due to scheduled or unscheduled leave? Do you expect a significant portion of your staff to be absent? **No,** select N/A. **Yes,** score your confidence that any layers of protection you can think of have been addressed in preparation for this activity.	N/A 1 2 3 4 5

O. Mining Condition

O.1. Change in Geological Setting: During the next three months, from your exploration or other sources, do you expect a change in the depositional characteristics of the mine in which you will be working that might increase the risk of an incident occurring? + Questions to Help Frame Your Selection: Do you expect a significant shift in your mine's geological setting: seam thickness, quality of the floor, hardness of the coal seam, quality of the immediate roof, depth of cover, and/or water migration? **No**, select N/A. **Yes**, score your confidence that any layers of protection you can think of have been addressed in preparation for this activity.	N/A 1 2 3 4 5
O.2. Change in Roof Conditions: During the next three months, do you expect to be mining in an area where the roof conditions are significantly different than your miners are used to? **No**, select N/A. **Yes**, score your confidence that the following item (as appropriate) and any other layers of protection you can think of have been addressed in preparation for this activity: the tension on the roof bolts is installed correctly.	N/A 1 2 3 4 5
O.3. Methane Liberation: During the next three months, will the methane liberation for this mine or seasonal effects of methane (from October to March) be an issue? **+ Note 1:** Some mines naturally have more methane liberation than other mines, and despite extreme layers of protection these gaseous mines may still feel it appropriate to rate themselves lower in this area because the layers of protection still cannot compensate for the extra risk of being a gaseous mine. **+ Note 2:** Winter is dangerous for underground coal mines because of the changing weather (e.g., more methane seeps from the coal into the mine atmosphere, creating a greater explosion risk). Some of the worst mining disasters have occurred between October and March. **No**, select N/A. **Yes**, score your confidence that the following items (as appropriate) and any other layers of protection you can think of have been addressed in preparation for this activity: adequate quantities of fresh air, thorough rock dusting on the ribs and other mine surfaces, supplemental rock dusting (e.g., podduster) during nonproduction shifts, diligent search for ignition sources, etc.	N/A 1 2 3 4 5

P. Mining Location

P.1. Mine Proximity: During the next three months, do you expect to be working in a mine area that puts you at increased proximity to another mine, another infrastructure, or a high concentration of people (nonminers) who could be harmed by your mine (a large explosion, cave-in, etc.)? **No**, select N/A. **Yes**, score your confidence that any layers of protection you can think of have been addressed in preparation for this activity.	N/A 1 2 3 4 5

Section C - Assess the Mine's Safety Culture

A safety culture is the shared norms, values, assumptions and relative importance of safety that exist within the mine and shape the relevant attitudes and behaviors of people working at the mine.

Directions: Use the **GREEN** scoring criteria on page 2 to complete this section. Read the safety culture factors below and assess the mine as it is today. Select a score from page 2 that represents the consensus view of the safety culture. If you struggle to select an appropriate score, make a conservative selection by choosing the lower score.

Note: The score that you select here will most likely not change within a short time frame (e.g., the safety culture score should not change every three months). The reasoning for this is that changing the safety culture of a mine is usually very difficult and time consuming. Even if there is a known issue within the safety culture of a mine, developing and implementing effective recommendations at the organizational culture level is difficult. The fastest shifts in organizational culture are usually attributed to a mine (or industry) encountering a significant near miss or accident.

Q. Safety Culture

Q.1. Organizational Values include Safety: Safety is a clearly recognized value in the organization in comparison to other organizational priorities.	1 2 3 4 5
Q.2. Importance of Safety: There is a high level of agreement about the importance of safety within and between work groups from the top to the bottom of the organization.	1 2 3 4 5
Q.3. Proactive Actions: Proactive actions and investments are made, before some type of adverse event, to ensure safety. Safety is a value, not a cost.	1 2 3 4 5
Q.4. Performance and Accountability: Safety performance is closely monitored and accountability for safety within the mine is clear.	1 2 3 4 5
Q.5. Communications: Communications about safety matters are open and candid within and between work groups from the top to the bottom of the organization.	1 2 3 4 5

Underground Coal Mine Risk Assessment Model Input (Page 1)

Assessment Date: 08/30/2013

Category	Input Score	Scoring Criteria with Color Indicator
Section A - The Mine's Base Risk		
A. Design and Planning		
A.1. Mine Location, Mide-wide Design, and Mine-wide Plans	5	Almost always exceeds industry standards
A.2. Engineered Mine Design of Mine Infrastructure	4	Frequently better than industry standards
A.3. Monitoring System Design	4	Frequently better than industry standards
A.4. Equipment Components Design	4	Frequently better than industry standards
B. Equipment Maintenance and Reliability		
B.1. Equipment Reliability Program Design	4	Frequently better than industry standards
B.2. Maintenance of Mine Equipment	3	Meets industry standards
B.3. Routine Inspection and Servicing of Mine Equipment	3	Meets industry standards
C. Upkeep of Mine Infrastructure/Housekeeping		
C.1. Rockdusting	3	Meets industry standards
C.2. Routine Inspection and Servicing of Mine Infrastructure	3	Meets industry standards
D. Documentation and Records		
D.1. Infrastructure and Equipment Records/Manuals	4	Frequently better than industry standards
D.2. Operational and Maintenance History	4	Frequently better than industry standards
D.3. Risk Assessment Records	3	Meets industry standards
D.4. Personnel Records	4	Frequently better than industry standards
D.5. Other Documents and Records	3	Meets industry standards
E. Material/Parts/Equipment		
E.1. Material/Parts/Equipment	3	Meets industry standards
F. Hazard/Defect Identification and Analysis		
F.1. Startup Review	3	Meets industry standards
F.2. Management of Change	3	Meets industry standards
F.3. Proactive Risk/Safety/Reliability/Quality/Security Analysis	3	Meets industry standards
F.4. Reactive Risk/Safety/Reliability/Quality/Security Analysis	3	Meets industry standards
F.5. Inspection/Audit/Measurement	3	Meets industry standards
G. Procedures		
G.1. Procedure Use	4	Frequently better than industry standards
G.2. Procedure Correct/Complete/Readily Available	3	Meets industry standards

Underground Coal Mine Risk Assessment Model Input (Page 2)

Assessment Date: 08/30/2013

Category	Input Score	Scoring Criteria with Color Indicator
H. Workplace Conditions/Human Factors		
H.1. Tools/Equipment	3	Meets industry standards
H.2. Workplace Layout	3	Meets industry standards
H.3. Workload and Environment	3	Meets industry standards
H.4. Error Mitigation	3	Meets industry standards
I. Training/Personnel Qualification		
I.1. Decision When to Train	3	Meets industry standards
I.2. Training Identification	3	Meets industry standards
I.3. Training Requirements Completed	4	Frequently better than industry standards
I.4. Training Program Design/Development/Implementation	4	Frequently better than industry standards
I.5. Qualification	4	Frequently better than industry standards
J. Supervision		
J.1. Preparation	3	Meets industry standards
J.2. Supervision During Work	4	Frequently better than industry standards
K. Verbal and Informal Written Communication		
K.1. Communication Method	3	Meets industry standards
K.2. Communication Performed	4	Frequently better than industry standards
K.3. Timely Communication	4	Frequently better than industry standards
K.4. Communication Understanding	3	Meets industry standards
L. Personal Performance		
L.1. Personnel Hiring	3	Meets industry standards
L.2. Resource/Staffing	2	Occasionally does not meet industry standards
L.3. Rewards/Incentives	3	Meets industry standards
L.4. Detection of Individual Performance Problems	4	Frequently better than industry standards
L.5. Individual Performance	3	Meets industry standards

Underground Coal Mine Risk Assessment Model Input (Page 3)

Assessment Date: 08/30/2013

Category	Input Score	Scoring Criteria with Color Indicator
Section B - The Mine's Activity Risk		
M. Equipment/Infrastructure		
M.1. Equipment Replacement/Overhaul	N/A	Not Applicable
M.2. Equipment Transfer	5	Layers of protection in place and well established
M.3. Mine Infrastructure Change	N/A	Not Applicable
N. Personnel		
N.1. Transfer Key Personnel	N/A	Not Applicable
N.2. Turnover	3	Layers of protection in place
N.3. Absenteeism	3	Layers of protection in place
O. Mining Conditions		
O.1. Change in Geological Setting	2	Layers of protection questionable
O.2. Change in Roof Conditions	3	Layers of protection in place
O.3. Methane Liberation	3	Layers of protection in place
P. Mining Location		
P.1. Mine Proximity	N/A	Not Applicable
Section C - The Mine's Safety Culture		
Q. Safety Culture		
Q.1. Organizational Values include Safety	3	Safety culture is strong
Q.2. Importance of Safety	3	Safety culture is strong
Q.3. Proactive Actions	3	Safety culture is strong
Q.4. Performance and Accountability	3	Safety culture is strong
Q.5. Communications	3	Safety culture is strong

Underground Coal Mine Risk Assessment Results

Assessment Date: 08/30/2013

The average score for a mine is set to 70 points.

Section A - The Mine's Base Risk		This mine meets the industry standards and has standard processes for the organization and is proactive.
A. Design and Planning		Frequently better than industry standards
B. Equipment Maintenance and Reliability		Meets industry standards
C. Upkeep of Mine Infrastructure/Housekeeping		Meets industry standards
D. Documentation and Records		Frequently better than industry standards
E. Material/Parts/Equipment		Meets industry standards
F. Hazard/Defect Identification and Analysis		Meets industry standards
G. Procedures		Frequently better than industry standards
H. Workplace Conditions/Human Factors		Meets industry standards
I. Training/Personnel Qualification		Frequently better than industry standards
J. Supervision		Frequently better than industry standards
K. Verbal and Informal Written Communication		Frequently better than industry standards
L. Personal Performance		Meets industry standards
Section B - The Mine's Activity Risk		Additional steps should be taken or existing layers of protection should be reinforced for activities occurring within the next three months to prevent the risk of an event occurring.
M. Equipment/Infrastructure		Activities are expected in the next three months, but layers of protection are in place to prevent the risk of an event occurring.
N. Personnel		Additional layers of protection should be evaluated for activities occurring within the next three months.
O. Mining Conditions		Additional layers of protection should be evaluated for activities occurring within the next three months.
P. Mining Location		Activities are not expected within the next three months.
Section C - The Mine's Safety Culture		The safety culture at the mine is strong. It is recommended that the mine evaluate methods to help ensure that the safety culture becomes even stronger.
Overall Risk Score	**70**	The expected risk for this mine within the next three months is higher than typical underground coal mines.

This tool is meant to assist the user in identifying risks and to provide recommendations to help the user in establishing a safety conscious work environment. This tool is not intended to eliminate all risks and in no way assures or guarantees against the occurrence of any accident or incident. Uncertainty exists in key analysis parameters that can only be estimated. Particularly, uncertainties exist in (but are not limited to) local site conditions, condition of construction, etc. which can result in estimates of risk being significantly different than losses sustained in specific actual events. The analysis is additionally constrained by the quality of the input data provided by the user. If the input data is not accurate or is incomplete, this may adversely affect the usefulness and/or accuracy of results from this tool.

Underground Coal Mine Risk Assessment Model Recommendations

Category	Sample Recommendations
Section A - The Mine's Base Risk	
A. Design and Planning	**• Consider emergency requirements during design.** **• Account for all equipment and process interactions in designs.** **• Ensure specifications include all design requirements.**
A.1. Mine Location, Mine-wide Design, and Mine-wide Plans	• Maintain clear and legible designs. • Invest money to upgrade the mine design for increased safety. • Conduct check surveys regularly to verify accuracy of mine maps. • Ensure mine-wide design and plans consider emergency shelters throughout the mine in areas accessible to workers but out of the way of potential damage.
A.2. Engineered Mine Design of Mine Infrastructure	• Invest money to enhance mine layout/infrastructure for increased safety. • Verify that your mine infrastructure designs take into account all operating conditions: normal, startup, shutdown, and emergency.
A.3. Monitoring System Design	• Survey personnel who regularly use mine monitoring systems to re-evaluate its design, including: accuracy, compatibility with the overall system, sensitivity, etc.
A.4. Equipment Components Design	• Invest money to streamline equipment design to prevent ad-hock redesign by the miners of equipment to fit their needs. • Allow miners to provide input into the design specifications of equipment. • Implement a mine exploration program to check if the equipment (as designed) works in the operating conditions. If it does not work then reevaluate design.
B. Equipment Maintenance and Reliability	**• Identify critical equipment.** **• Ensure functional monitoring systems.** **• Select appropriate maintenance type such as planned/predictive rather than corrective maintenance.**
B.1. Equipment Reliability Program Design	• Develop tiered equipment list and evaluate maintenance based on criticality. • Implement preventative maintenance program. • Follow manufacturers specification recommendations when developing maintenance schedules. • Document equipment failures to include reason, corrective action, and future recommendations.

Category	Sample Recommendations
B.2. Maintenance of Mine Equipment	• Follow manufacturers specification recommendations when performing maintenance. • Develop relationships with manufacturers to assure maintainability of equipment. • Regularly check monitoring systems for how quickly the mine repairs/replaces those that aren't working properly [such as those along conveyor belt lines].
B.3. Routine Inspection and Servicing of Mine Equipment	• Evaluate the scope of routine inspections to ensure appropriate workload. • Evaluate routine inspection schedules and encourage regular changes to inspection routes to ensure all equipment is inspected.
C. Upkeep of Mine Infrastructure/Housekeeping	**• Identify critical infrastructure components.** **• Ensure good mine housekeeping.** **• Encourage pride in the miners for a well-kempt mine.**
C.1. Rockdusting	• Invest money for additional rockdust quantities and staff/man-hours to decrease risk associated with inadequate rockdusting. • Schedule thorough mine-wide rockdusting during non-production shifts.
C.2. Routine Inspection and Servicing of Mine Infrastructure	• Conduct weekly maintenance/ supervisor meetings to review inspections and equipment servicing needs. • Regularly check installed systems such as roof bolts. • Regularly check water lines to ensure that the systems as installed are ready for any potential risk. • Evaluate the effectiveness of the routine inspections to identify servicing needs.
D. Documentation and Records	**• Establish a plan for distributing original equipment manufacturers' manuals.** **• Ensure accurate and accessible information is documented on rounds.** **• Ensure inspection records are easily accessible for federal and state inspectors.**
D.1. Infrastructure and Equipment Records/Manuals	• Task an individual(s) to identify and maintain equipment records and manuals within the mine and ensure they are up to date and readily available. • Implement a cataloguing system to describe whereabouts and number of copies available.
D.2. Operational and Maintenance History	• Employ a work order system including description of work to be done, tools and procedures required, and documentation of work completion. • Document scheduled equipment checks. • Document scheduled infrastructure checks.

Category	Sample Recommendations
D.3. Risk Assessment Records	• Task an individual(s) (maintenance planner/master mechanic) to maintain a list potential hazards for each task/function. • Integrate risk assessment records into work order system.
D.4. Personnel Records	• Collect personnel records above and beyond federal/state training records requirements to include education, certifications, general and job specific training, past employment, etc. • Conduct regular reviews of personnel records to verify that all information is up to date.
D.5. Other Documents and Records	• Document recordkeeping requirements (e.g. details, frequency) for management and maintenance personnel. • Develop a recordkeeping tracker to catalogue who is responsible for maintaining specific books and logs.
E. Material/Parts/Equipment	**• Confirm that product acceptance requirements match design requirements.** **• Provide proper environmental conditions for new equipment/materials.**
E.1. Material/Parts/Equipment	• Implement original equipment manufacturers (OEM) policy. • Consider function, quality, durability, cost, and expected life in purchasing decisions. • Specify particular material/parts/equipment to purchasing rather than a generic category.
F. Hazard/Defect Identification and Analysis	**• Require authorization signatures for all field changes in the mine.** **• Provide a safety/hazard/risk review procedure.**
F.1. Startup Review	• Conduct permissibility checks. • Develop comprehensive checklist to aid in conducting readiness review. • Define the startup review system roles and responsibilities and require maintenance personnel training in startup areas - permissibility, availability etc.
F.2. Management of Change	• Document and communicate procedures for suggesting, authorizing, communicating, and implementing change. • Encourage suggestions for change through change request forms and suggestion boxes. • Develop a formal change assessment process.
F.3. Proactive Risk /Safety /Reliability /Quality /Security Analysis	• Develop detailed guidelines for various levels of risk assessment - safety, quality, security etc. • Schedule regular hazard assessments.
F.4. Reactive Risk /Safety /Reliability /Quality /Security Analysis	• Provide hazard recognition training. • Develop procedures for communicating potential hazards and responding in a timely manner.

Category	Sample Recommendations
F.5. Inspection/Audit/Measurement	• Develop a formal process for recognizing and evaluating areas of change. • Use computer simulation to evaluate and improve systems, such as production or ventilation.
G. Procedures	**• Ensure copies of procedures are available at all times.** **• Address specific roles and responsibilities in a written policy.**
G.1. Procedure Use	• Provide procedural guidance that includes step-by-step instructions and examples of how to use the procedure in different
G.2. Procedure Correct/Complete/Readily Available	• Allow miners, the people who do the job, to provide input to ensure procedures are correct and complete. • Evaluate procedures as applied in the workplace. Is the procedure adequate for the task being performed? Does the procedure help avoid or reduce hazards? • Compare procedures to documented job safety analyses. • Designate an individual(s) responsible for reviewing existing procedures to ensure they are up to date and new procedures for accuracy, clarity, and completion. • Develop cataloguing system to ensure procedures are organized and accessible.
H. Workplace Conditions/Human Factors	**• Provide employees with adequate personal protective equipment.** **• Provide employees a feedback mechanism to bring to light any workplace conditions or human factor issues.**
H.1. Tools/Equipment	• Provide guidelines/training on proper use of tools and equipment. • Conduct regular evaluations of tools and equipment being used. Ensure they are correct for the job. • Store emergency response equipment in a retrievable location. • Provide proper PPE to all miners. • Use MSHA approved tools whenever possible. • Conduct tests to determine if adequate protection is provided by safety glasses and other PPE. • Require examination of tools prior to performing tasks. • Routinely exchange tools for newer/upgraded versions. • Stock section or mine maintenance facilities with the proper tools to do the job, and update inventory regularly. • Evaluate design/use of tools and equipment on ability to reduce hazards resulting from human error. • Designate an individual(s) to keep up with technological improvements on tool design. • Implement proximity detection systems.

Category	Sample Recommendations
H.2. Workplace Layout	• Establish relationship with manufacturers to help evaluate the adequacy of controls and displays. • Ensure uniformity across displays. • Locate related controls together. • Provide bilingual displays where necessary. • Ensure displays are visible especially in remote controlled equipment. • Mount lighting on equipment. • Design for clarity of operation and reduction/mitigation of human error.
H.3. Workload and Environment	• Train supervisor to recognize physical, mental or emotional limitations of workforce.
H.4. Error Mitigation	• Ensure that important safety and quality related equipment is adequately equipped with error-detection systems. • Modify equipment to go to a safe state or mode when problems are detected. • Provide training on recognition and proper response when an alarm is deployed. • Review all workplace observation concerns with mine personnel. • Provide and review post accident citation information. • Provide feedback to operators to help improve performance and reduce errors. • Communicate impacts (cost and performance) of equipment or system failures where possible. • Build in redundancies, both system and personnel.
I. Training/Personnel Qualification	**• Provide job hazards training.** **• Develop and implement a formal training policy with written procedures and specific roles and responsibilities.** **• Provide new miner, refresher, and reassignment training.**
I.1. Decision When to Train	• Develop a formal training policy. • Provide a written description of the training requirement associated with a specific job title. • Provide training in the hazards of the process and job tasks associated with normal operations, nonroutine operations, and emergency operations. • Provide training for maintenance tasks such as inspection, testing, calibration, preventive maintenance, repair, replacement and installation. • Require training on all new systems and procedures. • Reassess safety procedures and training when the operating environment changes. • Specify additional training above safety requirements.

Category	Sample Recommendations
I.2. Training Identification	• Use workplace observations, workforce capabilities and experience, downtime and production statistics to conduct needs assessment. • Reference incident rates, violations per inspection day, and other issues/accidents in assessing training needs. • Identify all of the specific duties associated with each job title. Include important topics associated with these duties within the corresponding training module. • Take advantage of additional training provided by equipment manufacturer. • Collect and compile information regarding safety issues at the mine and communicate to the workforce. • Adapt training based on changing in mining conditions. • Ensure that contractor personnel receive comparable training.
I.3. Training Requirements Completed	• Employee and supervisor should develop an individual development plan together. • Document past and future training schedules. • Review training record of new personnel against requirements to determine what training/retraining needs exist. • Develop policies that prohibit individuals from performing specific job tasks without associated training/qualifications.
I.4. Training Program Design/Development/Implementation	• Establish training mechanisms to maximize retention of information (e.g. 1-2 hour sessions vs. 1 eight hour session). • Employ multiple forms of training including classroom, on-the-job, simulation, computer-based, etc. • Provide cross training and up-to-date documentation of job/task duties to reduce the negative impacts of absenteeism. • Use training evaluation forms and other means of assessing knowledge gained through training. • Design training programs to facilitate feedback from attendees throughout the session. • Ensure that the lesson content of each training module addresses learning objectives to ensure complete understanding of required tasks. • Periodically evaluate work practices in the field to verify that they are consistent with training. • Categorize training requirements for knowledge-based, rule-based, and skill-based tasks. • Identify what training must be completed before a worker or visitor can enter the facility and what training must be completed before a worker can begin on-the-job training.

Category	Sample Recommendations
I.5. Qualification	• Periodically review certificates/qualifications of personnel to ensure that they are current. • Evaluate the quality of background checks. • Develop methods for testing qualifications prior to hire. • Identify remedial training requirements for those who fail or lose their initial qualification. • Identify skills and abilities that require periodic testing to assure performance.
J. Supervision	**• Designate responsible persons and clearly define roles** **• Ensure that supervisors correct improper performance.** **• Ensure supervisors conduct frequent walkthroughs and provide job oversight and support.**
J.1. Preparation	• Ensure that supervisors understand that it is their responsibility to provide workers with instruction and to conduct walkthroughs
J.2. Supervision During Work	• Make supervisors available for questions about job tasks. • Encourage supervisors to give their supervisory role priority over assisting others in actually performing the job task. • For nonroutine jobs or jobs that require specific safety precautions, encourage supervisors to oversee the job and provide job support as necessary. • Encourage supervisors to provide more supervision to less experienced workers. • Develop an employee observation checklist for supervisor use. • Encourage supervisors to constantly monitor employee performance and make suggestions for improvement. Do not wait until their mid-year performance appraisal; acknowledge problems immediately. • Foster a sense of mutual trust between workers. • Evaluate supervisor training, support, and tools for supervising the workforce. • Encourage supervisors to stress safety throughout the workplace - PPE, roof and rib control, ventilation practices etc.

Category	Sample Recommendations
K. Verbal and Informal Written Communication	**• Provide a backup means of communication. • Establish standard terminology for equipment and operations • Conduct shift-change meetings to alert oncoming shifts of special tasks or safety issues.**
K.1. Communication Method	• Ensure that some method of communication is functional at all times. • Evaluate communication system design and the various methods of communication and their effectiveness (verbal/face-to-face vs. notes, or pre-shift or on-shift vs. post-shift). • Exercise multiple forms of communication such as digital, text, verbal. • Provide continuous audio-visual presentations to update miners on business related topics. • Use written accounts to detail communication. • Assess adequacy of pre-mining safety talks. • Foster climate of open communication between employees and supervisors, especially if problems arise. • Communicate company safety statistics.
K.2. Communication Performed	• Develop detailed communication procedures and examples to include standard questions like who, what, where, when, how. • Evaluate the effectiveness of pre and post shift meetings. • Provide guidance on the content of shift turnovers (equipment location, workplace conditions etc.) • Require mine foreman to monitor the quality of between shift communications. • Provide training for mine-wide communication in an emergency situation. • Evaluate the effectiveness of company communicating to individual miners such as newsletters, videos, etc.
K.3. Timely Communication	• Communicate deadlines. • Provide a backup means of communication when required. • Communicate post-accident, post-significant citation information to the miners as soon as the facts are in. • Identify and address issues (safety and personnel) as soon as possible to avoid bigger problems later. • Develop detailed communication procedures and examples that include *when* to communicate. • Emphasize the importance of timely communication especially of potential hazards.

Category	Sample Recommendations
K.4. Communication Understanding	• Solicit feedback to ensure that the communication was understood. • Establish standard terminology for equipment and operations. • Make sure the language used in communication is at the level of understanding of the person you are communicating with. • Use the repeat-back method of communication. • Provide written instructions when necessary.
L. Personal Performance	**• Ensure that staffing levels are appropriate.** **• Develop performance metrics and rewards that are consistent with company goals and objectives.** **• Give supervisors the authority to remove workers from hazardous assignments when personal problems are detected.**
L.1. Personnel Hiring	• Periodically review job advertisement, interview, and selection processes. • If contract workers are used, evaluate the contracting firms hiring practices. • Evaluate knowledge of upper level managers in important aspects of mine management and staffing and provide training where necessary. • Ensure job requirements are met at time of hiring.
L.2. Resource/Staffing	• Assess staffing levels at least annually. • Evaluate whether staffing and resource issues stem from lack of personnel, training, skill/ability, tools etc. • For new hires, require a 90-day trial period for evaluation prior to final employment status. • Assess appropriate resource allocation as work tasks are revised. • Provide sufficient levels of staffing to support organizational safety, reliability, quality, security, and other goals.

Category	Sample Recommendations
L.3. Rewards/Incentives	• Rewards programs should not be limited to production. These programs should include safety, reliability, quality, etc. • Rewards and incentives should include more than monetary/gift payments. Consider various forms of employee recognition or "time off". • Develop rewards that are consistent with company goals and objectives. • Ensure that rewards systems do not encourage undesirable behaviors. • Continuously monitor rewards/incentives programs to help ensure they are encouraging appropriate and safe behavior.
L.4. Detection of Individual Performance Problems	• Provide supervisors with training on the detection of personal problems. • Provide supervisors with training on the detection of drug and alcohol abuse. • Give supervisors the authority to remove workers from hazardous assignments when personal problems are detected. • Provide a means for personnel to self-report problems. • Encourage coworkers to help identify personnel performance problems.
L.5. Individual Performance	• Determine if the cause of the problem is administrative such as shift length, physical demands, etc. so that you may address the underlying cause of the individual's performance. • Conduct regular on the job performance evaluations and provide feedback for improvement. • Inform and encourage workers to take advantage of employee assistance programs. • Encourage individuals to have an appropriate work-life-balance.

Category	Sample Recommendations
Section B - The Mine's Activity Risk	
M. Equipment/Infrastructure	
M.1. Equipment Replacement/Overhaul	• Seek guidance from manufacturers and other operators on steps to replace or overhaul the equipment in a safe and controlled manner.
M.2. Equipment Transfer	• Seek guidance from other mine operators for steps to transfer this type of equipment.
M.3. Mine Infrastructure Change	• Seek guidance from other mine operators for steps to change infrastructure.
N. Personnel	
N.1. Transfer Key Personnel	• Take steps to have replacements for key personnel well-trained to assume the role with as much advance as possible.
N.2. Turnover	• Emphasize development of backup capability within workforce. • Ensure processes are well documented and transparent to support turnover between personnel.
N.3. Absenteeism	• Management should be realistic in determining the amount of work they should strive to produce with the staff they have on hand.
O. Mining Conditions	
O.1. Change in Geological Setting	• Constantly evaluate if there are changes in the geological setting, such as seam thickness. If changes in the geological setting are anticipated then take steps to address the issues.
O.2. Change in Roof Conditions	• Constantly evaluate roof conditions. If changes in the roof conditions are anticipated then take steps to address the issues.
O.3. Methane Liberation	• Constantly evaluate methane liberation. If changes in methane liberation are anticipated take steps to address the issues.
P. Mining Location	
P.1. Mine Proximity	• Take steps to proactively address potential hazards associated with the mine's proximity to another mine, another infrastructure, or a high concentration of people who could be harmed by your mine or who could harm your miners.

Category	Sample Recommendations
Section C - The Mine's Safety Culture	
Q. Safety Culture	
Q.1. Safety Culture	• Utilize audio visual aids, posters and other written displays to promote safety in the workplace. • Host frequent safety talks between management and workers. • Management should provide open and obvious support for safety programs. • To facilitate recommendations and comments about safety concerns by workers, the use of anonymous comment boxes should be considered.

Appendix F – Emergency Preparedness Assessment Model and Methodology

Underground Coal Mine Emergency Preparedness Assessment Model Directions

Purpose of This Model: The purpose of this model is to supply the mining industry with a proactive toolset for underground coal mine operators to use to self-assess the emergency preparedness of the mine.
Recommended Use: It is recommended that each mine perform this assessment every three months. It is expected that the first time a mine completes this assessment, it will take slightly longer than subsequent assessments.
Assessment Results: While the models are being validated and calibrated, access to the results will be limited to individual mines. The primary audience is the mine's management for decision-making purposes.
How to Use This Model:

Step 1: Go to the following website **www.msha.gov/readinessmodel**

Step 2: For this assessment, you *only* need to print the **Emergency Preparedness Model** file which includes (1) Directions and (2) The Model.

Step 3: Save the **Emergency Prepardness Results** file to your computer, but do not print.
Note: Only the final step of this model (calculating your results) requires a computer.

Step 4: Gather a team of individuals from the mine to perform this assessment. The team might include the Mine Foreman, a Shift Supervisor, a Mine Examiner (Shift Inspector), a Mine Engineer, and the designated responsible person(s).
Recommendation: Select an individual to lead this effort for your mine. If possible, select someone who can lead the first assessment and subsequent assessments (every three months) to provide consistency.

Step 5: Briefly review the material you have printed to help ensure that the team has a basic understanding of how this process will work.

Step 6: Meet with the team to make a series of judgments in Sections A (People), B (Equipment and Resources), and C (Process) of the model. Each judgment will involve filling in your selection, a number 1 through 5.

Step 7: After the team has completed making all the assessments in Sections A, B, and C, use a computer to open the **Emergency Preparedness Results** file and transfer the numbers from the paper-based **Emergency Preparedness Model,** used by the group, to the computer file. All fields, including the date, must be populated to view the results.

Step 8: If desired, print the results. Then, review your score on the Preparedness Scorecard.

Step 9: As a team, review areas where the score was less than ideal and develop recommendations to address them.

Underground Coal Mine Emergency Preparedness Assessment

Directions: Score each category based on a scale of one to five. Use the criterion provided within each score (1, 3, and 5) to guide your selections. If you struggle to select an appropriate score, make a conservative selection by choosing the lower score.

Insert Date of Assessment (MM/DD/YYYY): **8/30/2013**

A.1. Local Coordination - Command and Control

	1	2	3	4	5	Score
A.1.1. MERD exercises	Key mine officials/personnel do not participate in any Mine Emergency Response Development (MERD) exercises.		Key mine officials/personnel participate in one Mine Emergency Response Development (MERD) exercise annually		Key mine officials/personnel participate in at least one Mine Emergency Response Development (MERD) exercise annually and participate in at least one other mine rescue training session annually.	5
A.1.2. Identification of command center personnel in emergency response plan	Key mine officials/personnel have not been identified in the event of a mine emergency.		Key mine officials/personnel have been identified in the ERP plan but the emergency response plan does not formally declare their roles.		The Emergency Response Plan provides delegation of authority and task lists for all functions. This includes key mine officials, MSHA representatives, representatives of the state agency, and labor organization representatives.	5

Section A - People

A.1. Local Coordination - Command and Control

	1	2	3	4	5	Score
A.1.3. Maintenance of the emergency response plan	The emergency preparedness plan was developed years ago and has not been updated since. There is no review process in place.		The emergency response plan is reviewed approximately every two to three years.		The emergency response plan is reviewed annually. If changes to the plan are necessary, the plan is modified to reflect the needed changes in a timely manner.	5
A.1.4. Command center training	Command center training does not exist for teaching key mine officials/personnel how to communicate and function during an emergency.		Key mine officials/personnel receive annual classroom training		Key mine officials/personnel receive annual classroom training and participate in at least one mine emergency response drill (MERD) annually.	5
A.1.5. Command center support groups (scheduling and rotation modules, transportation modules, plan development modules)	Command center support groups have not been designated.		Specific support groups for the most critical functions have been designated and other functions are allocated according to availability of personnel.		There are designated command center support groups with documented roles and responsibilities. These support groups participate in two mine emergency response drills annually.	5
A.1.6. Familiarity with local first responders	Key mine officials/personnel are unfamiliar with local first responders. Command center training does not incorporate local first responders.		Key mine officials/ personnel know some of the first responders and have worked with each other to a limited extent on MERD exercises, but never an actual mine emergency.		Key mine officials/ personnel know most of the local first responders very well. They are well aware of the formal agreements in place and communicate with first responder management quarterly to ensure plans and contacts are up to date. Command center personnel participate in mine emergency response drills annually and exercise communications with local first responders.	5

Section A - People

A.2. Knowledge of Emergency Responders

	1	2	3	4	5	Score
A.2.1. Knowledge of the emergency response plan	Emergency responders are unfamiliar with the mine emergency response plan and have not used it as an operating document.		Emergency responders have limited familiarity with the emergency response plan from class room training but have never done more than simulated training exercise.		Emergency responders have demonstrated knowledge in understanding the emergency response plan, including communication procedures, designation of responsible persons, designation of authorities, access control, and management plan. Emergency responders know how to access the emergency response plan.	5
A.2.2. Knowledge of mine ventilation system	Emergency responders are unfamiliar with the mine ventilation system and do not have experience identifying ventilation issues or conducting readings.		Emergency responders have limited familiarity of the mine ventilation system from classroom training but do not have experience identifying short circuits or inadequacies to ventilation system.		Emergency responders have demonstrated knowledge in understanding principles of ventilation and identifying failures of the ventilation system. Emergency responders have access to guides for interpreting monitoring system readings and are familiar with all protocols if any failures to the ventilation system are detected.	1
A.2.3. Organization of the emergency	Emergency responders have no expertise handling emergency situations and have never participated in mine emergency response drills.		Emergency responders have some familiarity with handling emergency situations from attending mine emergency response training but have not participated in an actual mine emergency.		Key mine officials/personnel have extensive expertise handling emergency situations and have participated in a least one realistic simulation mine emergency response drill annually for at least two years and have firefighting, rescue team and/ or EMT-P experience and certifications.	2

Section A - People

A.2. Knowledge of Emergency Responders

	1	2	3	4	5	Score
A.2.4. Knowledge of tracking and communications systems	Emergency responders are unfamiliar with the communications systems and devices and do not have the skills to be able to use the devices.		Emergency responders have some knowledge of the communications systems from mine emergency response training but have not assisted in an actual mine emergency situation.		Emergency responders have extensive expertise and knowledge to operate the miner tracking systems and state-of-the-art devices.	4
A.2.5. Knowledge of gas properties and interpretation of readings	Emergency responders are unfamiliar or need additional training in the use of air measurement devices.		There is at least one emergency responder who has experience using the air monitoring equipment that the mine utilizes.		At least two of the Emergency responders have expertise in the use of all gas monitoring and sampling equipment that the mine has available. Many of the emergency responders have received training in gas sampling and analysis techniques. Emergency responders are tested for proficiency in the use of these sampling/monitoring devices semi-annually.	2
A.2.6. Knowledge of mine monitoring system	Emergency responders have not received training in the mine ventilation and monitoring systems (e.g. CO monitoring). Emergency responders have no experience identifying ventilation issues or conducting readings.		Emergency responders have received class room training on mine monitoring systems but have limited experience conducting readings and identifying inadequacies or failures to the ventilation system.		Emergency responders demonstrate knowledge in understanding ventilation systems and identifying inadequacies or failures to the ventilation system by taking proctored tests. Emergency responders have access to guides for interpreting monitoring system readings and are familiar with all protocols if any ventilation inadequacies or failures are detected.	1
A.2.7. Knowledge of resources available (outside services, supplies)	Emergency responders have not received any training or resources on outside services or supplies.		Emergency responders have access to a list of available outside resources but have limited experience working with these resources.		Emergency responders have immediate access to a list of available outside resources, services, and supplies. Emergency responders regularly receive updates regarding changes to existing resources or the introduction of new resources.	4

Section A - People

A.2. Knowledge of Emergency Responders

	1	2	3	4	5	Score
A.2.8. Knowledge of how to communicate with media and families. This factor is not generally performed by emergency responders	The key mine officials/personnel are unfamiliar with public or emergency communications protocols, or electronic communication equipment used at this mine.		The key mine officials/personnel have had some training in communications protocols but have never been tested or demonstrated any proficiency in a crisis situation.		Key mine officials/personnel receive extensive training in corporate and crisis media communications and the designated official(s) participate in MERD exercise twice annually.	4
A.2.9. Knowledge of electrical system	Emergency responders are unfamiliar with the mine's electrical system. A training program for helping emergency responders gain experience identifying electrical issues does not exist.		Emergency responders receive training on the mine's electrical system and how to identify electrical issues.		Emergency responders undergo annual electrical system training annually so that they gain experience in identifying electrical issues. Emergency responders undergo additional training whenever electrical system elements are adjusted or updated.	2
A.2.10. Knowledge of gas sampling techniques	Emergency responders do not receive training on gas sampling techniques.		Emergency responders receive gas sampling training but are not asked to demonstrate their knowledge.		Emergency responders receive field-based gas sampling training and are regularly tested on their ability to identify potential gas hazards.	4

Section A - People

A.3. Mine Emergency Preparedness Training

	1	2	3	4	5	Score
A.3.1. Self-rescuer training	A training program does not exist for training employees how to don a self-rescuer.		A training program for training employees how to don the self-rescuer exists. All employees receive training on a regular basis.		In addition to their original and refresher training sessions, employees undergo semiannual tests in simulated conditions on how to use the self-rescue device.	5
A.3.2. Designated escape ways	An escape ways training program does not exist.		Employees receive annual classroom training and semiannual mine conditions updates. Employees are starting to be tested on escape way locations and protocols.		All employees receive annual classroom training. Once a month the supervisor briefs employees on mine conditions, changes and emergency escape way requirements specific to this mine.	4
A.3.3. Basic ventilation training	A training program does not exist for teaching employees how to find and use a respiratory device.		All employees have been trained once on how to find and use the respiratory device and know where the user manuals are.		In addition to their original refresher training sessions, employees undergo semiannual tests on how to use the respiratory device in simulated smoky conditions.	4
A.3.4. Map reading	A training program has not been developed for map reading.		A basic classroom map training program exists and new mine maps are printed semiannually.		All employees receive map training at least every year and up-to-date mine maps.	5
A.3.5. Gas analysis	A training program in gas analysis, monitoring and response, does not exist.		Employees receive desk training in gas analysis monitoring and response but are not tested on their knowledge.		Employees receive annual training with certification in gas analysis monitoring and response. All of the underground staff is familiar with the procedures to be followed if a hazardous gas is detected.	3

Section A - People

A.3. Mine Emergency Preparedness Training

	1	2	3	4	5	Score
A.3.6. Cross-training among response personnel	A cross-training program does not exist. Response personnel are trained in their specific role and would be unable to perform other response roles if requested.		Response personnel receive some cross-training amongst their roles but are never tested beyond their specific roles during emergency drills.		Response personnel receive cross-training amongst their roles. They receive semiannual tests on the roles and responsibilities of other personnel and participate in two mine emergency drills annually where they must demonstrate their ability to multi-task and to perform other roles.	3
A.3.7. Certification of refresher training	No refresher course is taught at this mine.		Refresher training is given semi-annually. Safety briefing updates are also distributed semi-annually.		An 8-hour classroom refresher course and 8-hour practical training occur semi-annually. Monthly briefing updates are also distributed.	3
A.3.8. Hazard training for visitors (communication, transportation, escape ways, rescue caches, etc.)	A training program does not exist for teaching employees how to recognize hazards.		A hazard recognition training program exists and employees are starting to be tested.		A hazard recognition training program exists. All miners are tested at least once a year on hazard recognition.	3
A.3.9. Seismic activity	A training program in seismic activity monitoring and protocols does not exist.		An annual seismic activity monitoring and protocol training program is given to employees as well as semiannual updates on seismic activity and vulnerabilities in the area.		Employees receive annual training with certification in seismic activity monitoring and response. All of the underground staff is familiar with the procedures to be followed in the case of seismic activity.	3
A.3.10. Task-specific training including medical	Employees are not trained when they are reassigned.		A classroom training and on-the-job experience is given to reassigned employees.		In addition to classroom training and above ground simulation, miners have to pass simulated above ground competency tests before reassignment can be completed.	5

Section A - People

A.4. Exercises and Drills

	1	2	3	4	5	Score
A.4.1. Underground evacuation drills (map reading)	Underground evacuation drills have not been developed for this mine.		Desktop evacuation drills are given to miners at least once a year.		Underground evacuation drills and procedures are conducted every 6 months.	4
A.4.2. Demonstration of self-rescue device use	A training program does not exist for teaching employees how to find and use a self-rescue device.		A training program for teaching employees how to use the self-rescue device exists. All employees have taken the training once. Every employee knows where the user manuals are.		In addition to their original and refresher training sessions, employees undergo semiannual tests in simulated conditions on how to use the self-rescue device.	5
A.4.3. Individual firefighting capability (equipment and methods)	A firefighting training program does not exist at this mine.		Annual classroom training on firefighting is given to employees.		In addition to annual firefighting training, miners must complete semiannual competency tests.	1
A.4.4. Smoke training for miners and rescue teams	A smoke training program does not exist at this mine.		Miners and rescue teams receive desk smoke training but are not tested for comprehension.		Miners train in smoke at least once every six months	1
A.4.5. Demonstrating skills in simulated emergencies (Lights out drills)	No simulated emergency drills exist. Miners conduct training and exercises in a classroom setting or a non-emergency environment.		Miners participate in simulated emergencies but are not debriefed or critiqued post-simulation.		Miners participate in two simulated mine emergency drills annually.	2

Section A - People

A.4. Exercises and Drills

	1	2	3	4	5	Score
A.4.6. Response time drills for emergency response system (mine, mine rescue teams, local response)	A response time training program does not exist at this mine.		A table-top response time training program exists and mine, mine rescue, and local response personnel receive this training.		The entire mine emergency response system participates in two mine emergency drills annually and each entity (mine, mine rescue teams, local response) their ability to rapidly respond to a mine emergency.	3
A.4.7. All individuals participate in drills	Individuals volunteer to participate in drills at their own will.		All employees on shift at the time of the drill participate.		All employees at the mine participate in at least two mine emergency drills annually.	3
A.4.8. First-aid (basic and advanced) skills	A first-aid training program does not exist at this mine.		Annual classroom first-aid training is given to employees. Employees semiannual updates on first aid protocols and equipment.		An annual first-aid training and certification program is given to employees. Once a month the supervisor briefs employees on changes and updates to first-aid protocols and equipment specific to this mine.	2
A.4.9. MERD Exercises	Mine rescue personnel do not participate in any Mine Emergency Response Development (MERD) exercises or other mine rescue contests.		Mine rescue personnel conduct MERD exercises, but on an infrequent basis.		Mine rescue personnel participate in two Mine Emergency Response Development (MERD) exercises or other mine rescue contests annually.	3

Section B - Equipment and Resources

B.1. Communications

	1	2	3	4	5	Score
B.1.1. Redundant two-way wireless communications	The mine is equipped with an older telephone communication system that has not been updated recently.		The mine is equipped with older communications equipment, however as the mine develops or advances the old system is updated.		The mine is equipped with state-of-the-art communication equipment, maintained regularly and accessible at all times.	5
B.1.2. Secure hard-line phone. Consider deleting this factor-	A secure hard-line phone does not exist or is nonoperational.		A secure hard-line phone is present to all working sections.		A secure hard-line phone exists and is maintained regularly in case wireless communications fail. The hard line is accessible at all times.	4
B.1.3. Closed circuit communications	The mine does not own or have access to a closed circuit communication system.		The mine has a closed circuit communications system.		The mine has its own state-of-the-art closed circuit communication system that is maintained regularly and is accessible wherever crews might need it.	4
B.1.4. Cell phone towers	There is no cell phone service anywhere on mine property.		There are cell phone towers in the area but cell phone service comes and goes at different locations on the mine property.		The mine has excellent cell phone reception and maintains a cell phone tower to ensure reliability.	5
B.1.5. Satellite phones	The mine does not own or have access to satellite phones.		The mine has access to satellite phones but they are of an old model or have been heavily used.		The mine owns satellite phones and they are easily accessible to the necessary parties. Spare batteries accompany the phones.	2

Section B - Equipment and Resources

B.2. Firefighting

	1	2	3	4	5	Score
B.2.1. Fire brigade teams with Self Contained Breathing Apparatus and turnout gear	Fire brigade teams do not have access to SCBAs or turnout gear.		Fire brigade teams have SCBAs and turnout gear.		Fire brigade teams have an adequate supply of SCBAs and full turnout gear. Spare gear is easily accessible.	2
B.2.2. Emergency Fire Fighting Equipment, fire boxes with hoses and clips and fire emergency carts	Emergency Fire Fighting Equipment are absent from the mine and/or they do not contain an adequate supply of additional equipment. .		There is adequate fire fighting equipment positioned in the mine but they are not routinely inspected.		Fire fighting equipment is positioned throughout the mine and are easily accessible. Fire boxes are routinely inspected and maintained.	5
B.2.3. Foam equipment (generators, pro-packs, inductors)	There is no foam equipment available.		There is foam equipment located on mine property but it is old or has not been inspected regularly.		Foam equipment is readily accessible and located throughout the mine. This equipment is regularly maintained.	5
B.2.4. Fire lances, wall of water	The mine does not have fire lance technology or the proper capabilities to run fire lances in the mine.		There is fire lance equipment onsite, but no one knows of its condition.		Fire lance equipment is stored onsite, inspected regularly and accessible.	4
B.2.5. Thermal imagers	The mine does not own portable thermal imaging equipment.		The mine owns old or heavily used thermal imaging equipment.		The mine maintains several thermal imagers and has them accessible in the case of an emergency.	2

Section B - Equipment and Resources

B.3. Facilities

	1	2	3	4	5	Score
B.3.1. Security personnel - fences, gates	Perimeter security such as fences and gates are absent from the mine property.		The mine has fences, gates, as well as security personnel. The perimeter fences and gates are infrequently inspected for wear.		The mine has sufficient security, including adequate fences and gates that are regularly maintained and inspected.	4
B.3.2. Cleaning facility for mine rescue team equipment (bench area)	The mine does not have a station/location where mine rescue equipment can be cleaned and maintained.		The mine has designated a station/location where mine rescue equipment can be cleaned and maintained.		The mine has a cleaning facility for mine rescue equipment that is capable of processing all necessary equipment.	5
B.3.3. Defined staging areas, housing, food, sanitary facilities, etc.	Defined staging areas do not exist.		The mine has an area that could be used as a temporary staging area.		The mine has staging areas, such as housing, food, and sanitary facilities designated for mine emergencies.	4
B.3.4. Family centers	The mine does not have a family center or an area that could host families temporarily.		The mine has an area that could be converted into a family center in an emergency.		The mine has a family center or prearranged area for families.	5
B.3.5. Media center	The mine does not have a designated media center.		The mine has an area that could be converted into a media center in an emergency.		The mine has at least one media center containing state-of-the-art technology.	3
B.3.6. Clergy	The mine does not have clergy designated or access to clergy.		The mine has limited or distant access to outside or local clergy.		The mine has its own clergy designated or at least quick access to clergy.	3
B.3.7. Landing pads for air transportation	The mine does not contain landing pads for air transportation or an area that could be converted into a landing pad if need be.		The mine has an area on mine property that could be converted into a landing pad in an emergency situation.		The mine contains a landing pad sufficient for all necessary air transportation. The location of the landing pad is easily accessible. Longitude and latitude available.	5
B.3.8. Temporary Morgue	The mine does not have the capabilities to house a temporary morgue.		The mine has available space to house a temporary morgue but outside resources are required.		The mine has a temporary morgue designated or easy access to a temporary morgue.	3

Section B - Equipment and Resources

B.4. Mine Equipment

	1	2	3	4	5	Score
B.4.1. Gas equipment (detectors, pumps, chromatographs (GC))	The mine has not updated gas detection and abatement equipment recently.		The mine has gas detection and monitoring equipment but a regular schedule for testing and inspection has not been developed.		The mine has gas detection equipment, pumps, and chromatographs that are easily accessible, up-to-date and well-maintained.	3
B.4.2. Transportation for personnel and equipment	The mine does not have transportation that is designated for emergencies.		The mine has several forms of transportation for personnel and equipment but nothing specific to the needs of a specific scenario, geography, or type of equipment.		The mine has a variety of state-of-the-art transportation options for personnel and equipment that meet the needs of all scenarios.	4
B.4.3 Map printing capability	The mine does not have a printer that is sufficient for printing maps on-site.		The mine has the equipment to print maps on-site, but the technology is old or heavily used.		The mine has modern map printing equipment onsite with back-up equipment in case the primary equipment fails.	5
B.4.4. Refuge Chambers	The mine does not possess refuge chambers or possesses out-of-date, malfunctioning refuge chambers.		There are several refuge chambers but no one knows when they were last inspected or their capacity.		The mine has multiple refuge chambers that are positioned in suitable locations throughout the mine to which persons may go in case of an emergency. Refuge chambers contain adequate supplies of air, SCBA equipment, communication systems, and accommodations for up to 15 people.	4
B.4.5. Good lifelines (reflectors, cones, reachable)	The mine does not contain lifeline equipment.		The mine has lifelines but no one knows when they were last inspected or their condition.		The mine has lifelines such as reflectors and cones that are easily accessible.	5
B.4.6. Maintenance for underground transportation (charging stations)	The mine does not have underground charging stations for underground transportation.		The mine has several intermittent underground charging stations.		The mine has charging stations for underground transportation positioned at pre-determined locations throughout the mine to ensure no vehicles are stranded and can be adequately charged.	4

Section B - Equipment and Resources

B.4. Mine Equipment

	1	2	3	4	5	Score
B.4.7. Surface generators	The mine does not have surface generators.		The mine has several surface generators but a regular schedule for testing and inspection has not been developed. .		The mine has multiple state-of-the-art surface generators and a regular schedule for testing and inspection is followed.	5
B.4.8. Maps in fireproof containers	The mine does not provide fireproof containers for mine maps.		The mine provides fireproof containers for maps in the main office only.		The mine has mine maps that are frequently updated. The mine maps are kept underground in fireproof containers and in the mine office at the surface of the mine.	4
B.4.9. Non-sparking tools	The mine does not maintain non-sparking tools on-site.		The mine maintains a variety of non-sparking tools but they are heavily used and show visible wear.		The mine maintains a wide variety of non-sparking tools that are available and easily accessible.	3
B.4.10. Alternate underground transportation to escape ways	The mine does not provide alternative underground transportation to escape ways.		The mine provides alternate underground transportation to escape ways.		The mine provides multiple and regularly maintained alternate underground transportation options to escape ways.	4
B.4.11. Water pumps	The mine does not store additional portable water pumps on-site.		The mine has multiple water pumps on-site but the pumps are heavily worn or inefficient.		The mine has multiple water pumps on-site that are frequently inspected and are stored in an easily accessible location.	3

Section B - Equipment and Resources

B.5. Outside Suppliers

	1	2	3	4	5	Score
B.5.1. Outside resources - drilling, pumps, and other supplies	The mine has no agreements with outside drilling, pump, or other suppliers to hire their services in an emergency.		The mine has tentative agreements with outside drilling, pump, or other suppliers to hire their services in an emergency.		The mine has formal agreements in place for outside vendors who have state-of-the-art drills and pumps to supply resources to the mine in an emergency.	3
B.5.2. Mine supply arrangements (curtains, lines, ventilation, timbers)	The mine has no arrangements with mine suppliers to provide curtains, lines, ventilation, or timbers during an emergency.		There are only The mine has informal arrangements with mine suppliers to provide curtains, lines, ventilation, and timbers in the event of an emergency. Individual companies have not been isolated to supply specific goods or services.		The mine has formal arrangements with outside suppliers to provide curtains, lines, ventilation resources, and timbers in the event of an emergency.	5
B.5.3. MOUs with vendors (e.g. Verizon)	The mine has no existing MOUs with venders or only informal responsibilities have been assigned.		The mine has informal arrangements of MOUs developed with vendors to provide goods and services in an emergency.		The mine has formal MOUs with vendors to provide resources and services. Formal responsibilities have been assigned.	3
B.5.4. Additional housing, food, clothing sanitary facilities, etc.	The mine has no existing arrangements with outside suppliers of additional housing, food, clothing, or sanitation facilities.		The mine has outside suppliers who have the ability to supply limited housing, food, clothing, and sanitation facilities in an emergency but it is unknown which companies would supply specific goods and services.		The mine has formal arrangements with outside suppliers to provide additional housing, food, clothing, and sanitation facilities.	4
B.5.5. Ambulance services	The mine has no arrangements established with local emergency response centers to aid in a mine emergency.		The mine has informal arrangements established with local emergency response centers to aid in a mine emergency.		The mine has formal arrangements established with local emergency response centers to aid in a mine emergency and the emergency response centers have the necessary ambulance services aid a mine emergency.	4

Section B - Equipment and Resources

B.5. Outside Suppliers

	1	2	3	4	5	Score
B.5.6. Suppliers' emergency plan and equipment	Mine suppliers have an incomplete emergency plan and insufficient equipment.		Mine suppliers have a one- to two-year-old emergency plan and heavily used equipment to support the plan.		Mine suppliers have a clear emergency plan and the equipment to support the plan.	5
B.5.7. Availability of specialty tools	Local vendors do not carry the necessary specialty tools that would be used in the case of an emergency.		Local vendors carry a limited number of specialty tools that would be used in case of an emergency.		Local vendors carry a wide range of specialty tools, including backup devices, in the event of an emergency.	5
B.5.8. Surveyors	There are no surveyors nearby who could respond quickly in the event of an emergency.		There are several surveyors in the local community who have been identified as potential aids to the mine in the event of an emergency.		The mine has formal arrangements established with surveyors to provide support to the mine in the event of an emergency.	5
B.5.9. Decontamination	Decontamination services are not offered by local vendors.		Local vendors offer limited decontamination services.		The mine has established formal agreements for decontamination services from local vendors and responsibilities have been assigned in order to ensure responsiveness to an emergency.	4
B.5.10. Surface light plants (trailered in)	No local vendors can provide surface light plants.		Outside vendors have old, heavily used, or limited surface light plants that could be ordered in an emergency.		The mine has formal arrangements established for vendor(s) to supply the surface light plants in the event of an emergency.	4
B.5.11. Heavy equipment (dozers, drillers)	The mine has no arrangements with outside venders to supply heavy equipment.		Outside vendors have limited numbers of heavy equipment. In many cases, this equipment shows a lot of wear and is untrustworthy.		The mine has formal arrangement established with outside vendors, who possess state-of-the-art and well-maintained heavy equipment, in the event of an emergency.	5

Section B - Equipment and Resources

B.6. Rescue Equipment

	1	2	3	4	5	Score
B.6.1. Cleaning facility for equipment (bench area)	The mine does not provide a cleaning facility for mine rescue equipment.		The mine has a cleaning facility designated for rescue equipment in the event of an emergency.		The mine provides a modern cleaning facility for rescue equipment that is easily accessible in the event of an emergency.	5
B.6.2. Spare parts for maintenance of mine rescue equipment	The mine rescue station does not have an adequate supply of spare parts for the maintenance of mine rescue equipment.		The mine rescue station has an adequate supply of spare parts for the maintenance of mine rescue equipment.		The mine rescue station has an adequate supply of spare parts for the maintenance of mine rescue equipment. The stations also maintains spare parts, sensors, electrical components for gas detection devices, radios and other related mine rescue equipment.	5
B.6.3. Self-rescue devices	Self-rescue equipment hasn't been updated in at least ten years.		We buy some new self-rescue equipment every few years and replace the old and worn out units.		We have state-of-the-art self-rescue equipment that is maintained regularly and accessible wherever crews might need it.	3
B.6.4. First aid	The mine rescue station does not have an adequate supply of first-aid equipment and supplies in the event of a mine emergency.		The mine rescue station has an adequate supply of first-aid equipment and supplies in the event of a mine emergency.		The mine rescue station has an adequate supply of first-aid equipment and supplies in the event of a mine emergency and the station is equipped with state-of-the-art first aid equipment that is regularly inspected, tested and accessible.	3
B.6.5. Spare breathing apparatus	The mine rescue station does not store spare/additional breathing apparatuses.		The mine rescue station has spare/additional breathing apparatuses; however the spare/additional apparatuses are not maintained, inspected regularly and stored in a state of readiness.		The mine rescue station has spare/additional breathing apparatuses that are maintained, inspected regularly and stored in a state of readiness.	5

Section C - Process

C.1. Planning

	1	2	3	4	5	Score
C.1.1. Individual roles and responsibilities designated within the plan	The mine does not designate formalized roles and responsibilities in the event of a mine emergency.		The Emergency Response Plan (ERP) outlines individual roles and responsibilities.		The Emergency Response Plan provides detailed workflow, roles and responsibilities, delegation of authority and task lists for all functions.	3
C.1.2. Briefing/ Debriefing protocols	The mine has not developed a protocol for the informal exchanges when rotating mine rescue teams.		The mine has developed a protocol for exchanging information between personnel but the protocol has not been used during either a MERD or an actual mine emergency.		The mine has developed a defined protocol for communicating tasks/commands, communicating conditions encountered, and sharing specific information that has to be captured and collected by the mine rescue teams.	2
C.1.3. Response times for rescue personnel	The mine has not determined the response times for rescue personnel.		The mine has determined the response times for rescue personnel but the times have not been adjusted for road conditions or traffic.		The mine has determined the response times for rescue personnel through a series of tests/drills set up to evaluate the amount of time that rescue/emergency personnel will require to respond to a mine emergency.	3
C.1.4. Family relations (clergy, housing, food, communications, and designated liaison)	The mine has not developed a protocol to accommodate families in the event of an emergency.		The mine has developed a protocol to accommodate families in the event of an emergency, but training has not been conducted on protocol.		The mine has conducted extensive training on the protocol for providing families a liaison, housing, food, clergy, and communication services in the event of an emergency.	5

Section C - Process

C.1. Planning

	1	2	3	4	5	Score
C.1.5. Resupply responsibilities and logistics	The mine does not have a procedure for designation of responsibility for assessing supplies and resupplying goods.		The mine does have a procedure for designation of responsibility for assessing supplies and resupplying goods.		The mine has a designated person or team in charge of resupplying logistics and support. . The designated person/team is required to assess supplies and to re-supply as needed.	5
C.1.6. Media relations	The mine does not have a protocol established for communicating with the media.		The mine has a documented protocol for communicating with the media.		The mine has a protocol for communicating with the media that well-known and publicized to key mine personnel. All contact with the media is through a designated spokesperson that has been extensively trained for communicating with the media.	4
C.1.7. Designated plan owner	The mine has not developed a protocol for designation of key mine officials/personnel's duties and responsibilities in the event of a mine emergency		The mine has developed a protocol for designation of key mine officials/personnel's duties and responsibilities in the event of a mine emergency		The mine has developed a protocol for designation of key mine officials/personnel's duties and responsibilities in the event of a mine emergency. Duty/responsibility training of these key mine officials/personnel is accomplished through MERD training which is conducted at least annually.	5

Section C - Process

C.2. Outside Resource Coordination

	1	2	3	4	5	Score
C.2.1. Mine rescue teams	The mine does not provide any employees to train as rescue team members.		The mine provides a minimum of two employees to train as rescue team members.		The mine provides a minimum of six (6) employees to train as rescue team members.	5
C.2.2. Arrangements with suppliers for response and contingency efforts (e.g. fast-tracking purchase orders)	The mine has not established agreements with outsiders for response and contingency efforts from vendors in the event of a mine emergency.		The mine has established agreements with outsiders for response and contingency efforts from vendors in the event of a mine emergency.		The mine has established agreements with outsiders for response and contingency efforts from vendors in the event of a mine emergency and all agreements are validated & updated regularly with contact details and annually for service level agreement.	4
C.2.3. State and local homeland security plan responsibility	The mine has not established agreements with the local communities in the event of a mine emergency.		The mine has established agreements with the local communities in the event of a mine emergency.		The mine has established agreements with the local communities in the event of a mine emergency and all agreements are validated & updated every six months.	5
C.2.4. Emergency medical	The mine has not established agreements with outsiders or any formal medical services in the event of a mine emergency.		The mine has established agreements with outsiders or any formal medical services in the event of a mine emergency.		The mine has established agreements with outsiders or any formal medical services in the event of a mine emergency and all agreements are validated & updated every six months with contact details and annually for service level agreement. Longitude and Latitude available.	4
C.2.5. Firefighting	The mine has not established agreements with outsiders for firefighting services in the event of a mine emergency.		The mine has established agreements with outsiders for firefighting services in the event of a mine emergency.		The mine has established agreements with outsiders for firefighting services in the event of a mine emergency and all agreements are validated & updated every six months with details and annually for service level agreement.	4

Section C - Process

C.2. Outside Resource Coordination

	1	2	3	4	5	Score
C.2.6. Local law enforcement	The mine has not established agreements with local law enforcement for coverage in the event of a mine emergency.		The mine has established agreements with local law enforcement for coverage in the event of a mine emergency.		The mine has established agreements with local law enforcement for coverage in the event of a mine emergency and all agreements are validated & updated every six months.	4
C.2.7. Critical stress debriefing	The mine has not established agreements with outsiders for critical stress debriefing in the event of a mine emergency.		The mine has established agreements with outsiders for critical stress debriefing in the event of a mine emergency.		The mine has established agreements with outsiders for critical stress debriefing in the event of a mine emergency and all agreements are validated & updated every six months with contact details and annually for service level agreement.	5
C.2.8. Grief counseling	The mine has not established agreements with outsiders for grief counseling in the event of a mine emergency.		The mine has established agreements with outsiders for grief counseling in the event of a mine emergency.		The mine has established agreements with outsiders for grief counseling in the event of a mine emergency and all agreements are validated & updated every six months with contact details and annually for service level agreement.	4

Section C - Process

C.2. Outside Resource Coordination

	1	2	3	4	5	Score
C.2.9. Federal resources	The mine has not established agreements for federal resources in the event of a mine emergency.		The mine has established agreements for federal resources in the event of a mine emergency.		The mine has established agreements for federal resources in the event of a mine emergency and the agreement is validated every six months.	4
C.2.10. Air transportation	The mine has not established protocols regarding air transportation in the event of a mine emergency.		The mine has established protocols regarding air transportation in the event of a mine emergency.		The mine has established protocols regarding air transportation in the event of a mine emergency and any agreements are validated & updated every six months with contact details and annually for service level agreement.	5
C.2.11. Telecom providers	The mine has not established agreements with a telecom provider in the event of a mine emergency.		The mine has established an agreement with a telecom provider in the event of a mine emergency.		The mine has established an agreement with a telecom provider in the event of a mine emergency and the agreement is validated & updated every six months with contact details and annually for any service level agreement.	4

Underground Coal Mine Emergency Preparedness Assessment Results

5	Highest likelihood that the mine is prepared to respond to a major mine emergency.
4	High likelihood that the mine is prepared to respond to a major mine emergency.
3	Moderate likelihood that the mine is prepared to respond to a major mine emergency.
2	Low likelihood that the mine is prepared to respond to a major mine emergency.
1	No likelihood that the mine is prepared to respond to a major mine emergency.

Date of Assessment: 8/30/2013

Section A - PEOPLE	**4**
A.1. Local Coordination - Command & Control	5
A.2. Knowledge of Emergency Responders	3
A.3. Mine Emergency Preparedness Training	4
A.4. Exercises and Drills	3
Section B - Equipment and Resources	**4**
B.1. Communications	4
B.2. Firefighting	4
B.3. Facilities	4
B.4. Mine Equipment	4
B.5. Outside Suppliers	4
B.6. Rescue Equipment	4
Section C - Process	**4**
C.1. Planning	3
C.2. Outside Resource Coordination	4
OVERALL SCORE	**4**

This tool is meant to assist the user in assessing the extent to which a mine or mine operator is prepared to deal with a major mine emergency. This tool is not intended to account for all eventualities and in no way assures or guarantees that the user will be prepared for all or any specific accident or incident. Uncertainty exists in key analysis parameters that can only be estimated. The analysis is additionally constrained by the quality of the input data provided by the user. If the input data is not accurate or is incomplete, this may adversely affect the usefulness and/or accuracy of improvement actions indicated by the tool.

Appendix G – Readiness Assessment Model and Methodology for Mine Rescue Teams

Underground Coal Mine Rescue Team Readiness Assessment Directions

Purpose of This Model: The purpose of this model is to supply the mining industry with a proactive toolset for underground coal mine operators to use to self-assess the Readiness of the Rescue Teams for their mine.

Recommended Use: It is recommended that each mine perform this Readiness assessment every three months. It is expected that the first time a mine completes this assessment, it will take slightly longer than subsequent assessments.

Assessment Results: While the models are being validated and calibrated, access to the results will be limited to individual mines. The primary audience is the mine's management for decision-making purposes.

How to Use This Model:

Step 1: Go to the following website **www.msha.gov/readinessmodel**

Step 2: For this assessment,you *only* need to print the **Rescue Team Readiness Model** file which includes (1) Directions and (2) The Model.

Step 3: Save the **Rescue Team Readiness Results** file to your computer, but do not print.
Note: Only the final step of this model (calculating your results) requires a computer.

Step 4: Gather a team of individuals from the mine to perform this assessment. The team might include the Mine Foreman, a Shift Supervisor, a Mine Examiner (Shift Inspector), a Mine Engineer, and the designated responsible person(s).
Recommendation: Select an individual to lead this effort for your mine. If possible, select someone who can lead the first assessment and subsequent assessments (every three months) to provide consistency.

Step 5: Briefly review the material you have printed to help ensure that the team has a basic understanding of how this process will work.

Step 6: Meet with the team to make a series of judgments in Sections A (People), B (Equipment and Resources), and C (Process) of the model. Each judgment will involve filling in your selection, a number 1 through 5.

Step 7: After the team has completed making all the assessments in Sections A, B, and C, use a computer to open the **Rescue Team Readiness Results** file and transfer the numbers from the paper-based **Rescue Team Readiness Model,** used by the group, to the computer file. All fields, including the date, must be populated to view the results.

Step 8: If desired, print the results. Then, review your score in the Rescue Team Scorecard.

Step 9: As a team, review areas where the score was less than ideal and develop recommendations to address them.

Underground Coal Mine Rescue Team Readiness Assessment

Directions: Score each category based on a scale of one to five. Use the criterion provided within each score 1, 3, and 5 to guide your selections. If you struggle to select an appropriate score, make a conservative selection by choosing the lower score.

Insert date of Assessment	**8/30/2013**

Section A - People

A.1. Competencies

	1	2	3	4	5	Score
A.1.1. Competent team members	Team members are selected based on their mining experience, convenience and availability at the mining operation.		Team members have extensive, proven and demonstrated expertise in emergency situations but the teams haven't been together long enough for members to develop complete trust and confidence in each other yet.		Team members have extensive, proven and demonstrated expertise in emergency situations. Members are confident in their teammates' ability to execute their mission effectively.	5
A.1.2. Mine emergency experience	No team members have responded to an actual mining emergency. The member's only training has been during drills or contests.		Approximately one half of the team members have worked together in an actual rescue or recovery operations		We ensure that our rescue teams have all worked together on at least three occasions and they train together at least twice annually.	4
A.1.3. Physically capable	Team members do not discuss each other's physical fitness. Team members have expressed concerns about the lack of physical fitness within the team.		Approximately one half of the members are very conscious of their physical condition and fitness.		Team members know and understand each other's physical condition. Team members regularly train together and push each other to the peak of physical exertion. When asked privately, each team member expressed confidence in his/her team members' physical fitness.	3

Section A - People

A.1. Competencies

	1	2	3	4	5	Score
A.1.4. Ability to remain composed in stressful situations	Team members have not trained together in a stressful environment. Team members are unable to gauge each other's emotional state or reliability.		Some team members have responded to a mine rescue or recovery operation together and understand how each other react under stress.		Team members have experienced many stressful situations and environments together and understand each other's emotional reactions and stability. Each team member has proven their emotional stability to the rest of the team in a variety of rescue scenarios. When asked privately, each team member expressed confidence in his/her team members' emotional reliability.	5
A.1.5. Ability to work together as a team	The team(s) has never practiced/trained as a team before.		The teams still have a number of new members and are working towards building a cohesive unit.		Team members express full confidence in their collective ability to complete any mine rescue mission.	4
A.1.6. Well-balanced team (qualifications)	Team members are selected by which employee(s) are available at the mine site. We simply don't have enough people available to ensure a balance of various skills and expertise.		We encourage members to be cross-trained but either because we have many new members or through existing members' choices, only about half the teams can fulfill multiple requirements.		Our teams have worked together for a few years and average turnover is less than one member per year. Each member has been cross-trained and the team composition ensures multiple redundancies.	3
A.1.7. Ability to lead	Team leaders/captains are chosen based on the number of years of mining experience.		Team leaders/captains are chosen based on the number of rescue or recovery operations they have experienced. .		We administer leadership training to all team leaders, captains, and co-leads. We carefully monitor these authorities and organization skills in drills throughout the year.	4

Section A - People

A.1. Competencies

	1	2	3	4	5	Score
A.1.8. Mental capability, strong willed, authoritative Team Leaders	Team leaders/captains are chosen based on their mining experience. We assume that mining experience correlates to authoritativeness and mental capabilities.		Team leaders /captains undergo leadership training exercises but they do not have to demonstrate their authority or mental strength.		We put team leaders through a series of training exercises and both written and field-based tests to ensure that they have the mental strength and capabilities to lead in stressful environments.	5
A.1.9. Confidence in equipment	Teams must use, train and maintain what is provided for a mine emergency at the operation. We don't have the resources to keep a full inventory of state of the art equipment.		We ensure that our equipment is well maintained and kept in good condition.		All of our equipment is state of the art, maintained on regular schedules and rescue teams are required to train using our equipment at least twice a year.	4
A.1.10 Confidence in teammates	When asked, team members are wary of and indecisive about their team's ability to execute a mine rescue or recovery operation.		Team members express support for one another and confidence in specific individuals but not in the team as a whole.		Team members express full confidence in their collective ability to complete any mine rescue or recovery operation..	3
A.1.11. Multi-tasking	Team members have specific skills and capabilities to deal with one particular problem at a time.		Team members have demonstrated their ability to manage a variety of problems/situations simultaneously, but their effectiveness changes from task to task.		During a rescue or recovery operation, the team is able to manage a wide variety of problems simultaneously and effectively.	4
A.1.12. Group skills practice	Our team spends the minimum amount of time training together.,		The team spends most of each training session together and practices both table-top and field-based drills.		We place our teams through extensive, stressful drills not only to check their individual skills, but to evaluate the group dynamic as well.	2
A.1.13. Product technology (service knowledge)	Much of the equipment that the teams have available is new and the teams have not yet tried to use it.		Rescue teams field test the equipment but are not asked to demonstrate their knowledge of each device.		Each piece of equipment is field tested by the teams until each team member masters how to use/operate each piece of equipment.	5

Section A - People

A.2. Training

	1	2	3	4	5	Score
A.2.1. Ventilation systems	Team members have not demonstrated proficiency in identifying ventilation problems. Team members do not have experience constructing ventilation controls, reading mine maps, or - been exposed system of map markings.		Team members practice building ventilation controls periodically but are not regularly tested on the quality of their work.		Team members have demonstrated their proficiency in identifying ventilation issues.. Team members regularly practice in timed scenarios the building and repositioning of ventilation controls.	3
A.2.2. Apparatus	The team is unfamiliar with what equipment is available for a rescue or recovery operation.		Team members keep a list of the equipment they need, but do not have this list memorized.		The team has been trained in an equipment check protocol. The team regularly conducts equipment inventories and organizes their equipment by use and team member. They immediately recall what equipment is needed when asked.	4
A.2.3. Communications	The team has not trained without the aid of communication devices. The team does not practice alternative communication techniques.		The team trains in communication and rescue and recovery operation logistics every month. Team members understand each other easily in a variety of scenarios,		The team rehearses rescue and recovery operation logistics and protocols monthly. The team's communication with and without proper equipment is well-practiced and test-proven each week. Team members only need to say something once for the entire team to understand them, Team members take turns speaking.	2
A.2.4. Instrumentation (Gas protection)	Team members have not adequately demonstrated proficiency in the use of gas detecting instruments.		There is at least one team member who has used most of the equipment that we use. Many of the team members have had training in gas sampling and analysis techniques.		Teams have at least two members proficient in the use of all gas monitoring and sampling equipment that we have available and demonstrate this proficiency every six months.	4

Section A - People

A.2. Training

	1	2	3	4	5	Score
A.2.5. Types of gases and their limits	Team members do not have adequate training in the various mine/fire gases that they would encounter or how to perform adequate sampling procedures.		Team members have been educated in the various mine/fire gases in classroom settings.		All members of the team have had extensive training in the detection and identification of the various mine/fire gases and responses and management techniques for each of them.	5
A.2.6. General procedures	Teams are provided emergency response logistics, procedures and training; however the training is not comprehensive.		The team trains in communication and rescue and recovery logistics annually. Team members understand each other easily in a variety of scenarios, but they often have to repeat themselves.		The team rehearses rescue and recovery logistics and protocols every six months. The team's communication with and without proper equipment is well-practiced and test-proven each week. All aspects have been tested and "playbooks" exist for various conditions that they might encounter	3
A.2.7. Firefighting - foam, water, extinguisher, fire behavior	The team is unfamiliar with what equipment is necessary for the rescue or recovery operation. The team has not received formal training on equipment or firefighting techniques.		Team members maintain their equipment and have had practical training individually within the past year.		All equipment is checked regularly and the team practices firefighting drills every six months.	2
A.2.8. Working in smoke	The team has no smoke training.		Team members have had no more than two smoke drills, and not as a team.		The team practices in smoke every six months.	1

Section A - People

A.2. Training

	1	2	3	4	5	Score
A.2.9. First-aid	Rescue team members are not proficient or comfortable giving emergency medical treatment.		Some team members have different medical and first aid emergency training, but no two have the same training. At least one member is EMT-B or EMT-P certified.		All team members are proficient in emergency medical response. Team members have trained together on responding to an emergency medical situation and know what to do. At least two team members consider themselves specialists in emergency medical treatment. One an EMT-B and one an EMT P.	3
A.2.10. Certifications, qualifications	Team members do not have underground - certifications.		Each team has at least at least two members who have certifications in one of the following: Gas detecting instruments, MET, EMT, mine foreman, electrical.		There are at least three members on teams with certifications in gas detecting instruments, MET, EMT (EMT-B and EMT-P), mine foreman, electrical. (A team member may have more than one certification/qualification).	4
A.2.11 Mine Map Reading	Team members have not been exposed to our system of map markings.		At least half of the team has training in map reading.		Team members work at or visit the mine once every three months and "walk the mine" using our maps as guides and references.	5
A.2.12. Lifeline Communications Training	Team members have had lifeline communications training in a classroom setting only.		Team members have been trained in both table top and field-based settings in lifeline communication. Team members are not tested on their proficiency.		Team members regularly practice their lifeline communications skills and demonstrate their proficiency through a series of simulated tests.	2
A.2.13. Cross Training	Team members stick to their specific roles. Team members do not practice/train other roles than their own.		Team members are trained in all aspects of emergency rescue response; however they do not regularly practice all roles of the job.		Team members regularly practice each other's specializations in order to master all aspects of the job.	1

Section A - People

A.3. Leadership

	1	2	3	4	5	Score
A.3.1 Organized	Rescue teams are typically assembled based on availability of personnel. The captain is selected based on seniority.		We have started developing protocols and manuals for our rescue teams, but we are in the early stages and nothing has been tested yet.		Every team member has a defined role or set of roles and the captain receives additional training on managing his crew under unpredictable conditions.	2
A.3.2. Communicate	We do not review communications tools and techniques.		We conduct informal spot checks to ensure that team leaders /captains are clearly understood in their various forms of communications		We evaluate the behavior of our team leaders/captains and the reactions and responses of the teams to their instructions and communications to ensure clarity and intent is achieved	3
A.3.3. Mine Rescue	Rescue teams are typically assembled based on availability of personnel. The captain is selected based on seniority.		Team leaders/captains have typically been involved in at least one real life rescue or recovery operation.		Team leaders/captains are well trained, but more importantly have extensive real experience that is respected by all members of their teams.	5
A.3.4. Capable mine management	Mine management has received emergency management training but has no experience leading emergency operations.		Mine management has 5-10 years of mine emergency training.		Mine management has 5-10 years of experience leading teams during mine emergencies. He/she is familiar with the management of our mine and has demonstrated proficiency in logistical strategies and emergency management.	4
A.3.5. Mobilize	Team leaders/captains and mine management have no formal process to get the teams up and running in the event of an emergency.		We have a protocol for mobilizing teams. Mine management knows where to find this and follow it in an emergency.		Mine management and all team leaders/captains and members practice according to an agreed and tested protocol. We have random calls to check on the ability of the team to react, respond and assemble.	3
A.3.6. Open-minded	Mine management has developed a process to address emergencies and managers and team captains are discouraged/ punished for deviating from policy in extreme emergencies.		In general, our mine management, team leaders/captains and the surface supervisors feel they must keep control over situations and while they will listen to other opinions and ideas, will likely stay on plan.		Mine leadership and team captains are encouraged to think "out of the box" and receive training in how to explore new ideas in response to volatile situations.	4

Section A - People

A.4. Organization

	1	2	3	4	5	Score
A.4.1. Quick response	Mine management is reluctant to make decisions on available data collected or so rigid in their compliance with processes and policies that it takes forever to get task accomplished.		We have developed protocols and systems but we still only get response times or personnel availability at about half of what the standards require.		We have put emergency procedures in place to be able to activate the emergency system within minutes of an event occurring and we test the availability of response teams regularly.	5
A.4.2. Availability of resources	Our rescue teams are quite spread out geographically. Most teams take quite a while to meet or gather at the respective mine rescue stations.		We generally have one person and a backup available above ground at all times.		We always have at least two to four people above ground, carrying radios and cell phones and able to mobilize various parts of the organization in the event of an emergency.	5
A.4.3. Who is in charge	Mine management has developed a line chart and determined who to contact in case of an emergency however the line chart is not posted.		We have identified who is in charge during emergencies, but we still have to establish training, operating procedures and organization.		We have practice drills and weekly briefings on mine status, locations being worked and who is in charge if there is an emergency	5

Section A - People

A.4. Organization

	1	2	3	4	5	Score
A.4.4. Communication	Our rescue team members work at different locations or may be from different mining identities. They frequently have to repeat themselves or clarify orders or tasks - due to a difference in mining terminology.		Each team employs its own jargon and terminology.		We have established specific vocabulary and communications protocols so that members of rescue teams can ensure clarity of communication.	4
A.4.5. Supplies and equipment	No one is really responsible for maintaining our rescue equipment in a state of readiness status. We assume that rescue team members will clean, test and maintain the equipment after an exercise or an incident.		At the end of each drill or emergency, teams submit "repair orders" which are used to refill or repair equipment. Once completed, the equipment or supplies are not checked again until required.		We have a specific office and individual responsible for maintaining all equipment for the rescue team. He/she follows a process that regularly: a. Checks what the teams need; b. checks where it is, orders more and ensures that all equipment is ready based on a specific schedule.	3
A.4.6. Delegation	We don't really have enough folks or structure to spread the work effort. No single employee is initially delegated for areas of responsibility in case of an emergency		Each person with a responsibility and authority over another (team or individual) is required to determine who takes on what responsibility.		Through design and practice we have developed detailed plans for activities to be performed during an emergency, including who is responsible for each.	2

Section B - Equipment and Resources

B.1. Mine Rescue Resources

	1	2	3	4	5	Score
B.1.1. Apparatus and backup equipment	We have someone to test and maintain mine rescue apparatuses and backup breathing equipment once a year and they decide whether to order more of anything		Inventory is conducted twice each year. The designated employee follows a check list and organizes the equipment by use. Faulty or expired equipment/supplies are purchased.		Inventory is conducted monthly. The designated employee regularly checks the condition of the apparatus and the additional backup needed.	3
B.1.2. Available Maps	Maps are hidden from view and are created annually.		Maps are accessible to rescue team members quarterly.		New maps are given directly to rescue teams and miners as changes to the mine occur. The maps are fully updated and thoroughly distributed.	4
B.1.3. Knowledge of Equipment	The team is unfamiliar with our mine emergency equipment.		Team members train once a month to familiarize themselves with the above and belowground equipment. They spend time operating this equipment.		The team visits our mine at least quarterly/semi-annually to ensure that team members are familiar with the equipment above and belowground. They make special visits whenever we receive new equipment.	5
B.1.4. Gas Detection	Mine management has provided some older devices which we maintain in working order.		Team members train once a month to familiarize themselves with the above and belowground devices. They spend time operating this equipment.		Our devices are pretty much state-of-the-art. We ensure that they are constantly in working order and include this in assigned personnel responsibilities.	5

Section B - Equipment and Resources

B.1. Mine Rescue Resources

	1	2	3	4	5	Score
B.1.5. Radios	Mine management has provided some older devices which we try to keep in working order. It takes some experience and skill to be able to use it and interpret results.		Team members train once a month to familiarize themselves with the above and belowground devices. They spend time operating this equipment.		Our devices are pretty much state-of-the-art. We ensure that they are constantly in working order and include this in assigned personnel responsibilities.	5
B.1.6. Availability of Equipment	Inventory is estimated every year by a designated employee who does a quick look-over of the equipment. He/she could provide access to the supplies in an emergency.		Inventory is conducted twice each year. The designated employee follows a check list and organizes the equipment by use. Faulty or expired equipment is purchased.		Inventory is conducted monthly. The designated employee regularly checks the condition of the equipment as well as the number of tools/supplies. Each set of tools/supplies are grouped for easy access and distribution.	4
B.1.7. Durability and reliability of equipment	Most of our equipment is older and we struggle to keep it all working. We generally manage only about 50% availability/ reliability.		About half of our equipment is less than three years old. We have a somewhat active maintenance program and manage to maintain about 75% reliability.		We have only state-of-the-art equipment, a policy of sufficient backup unit redundancy, and all equipment is either under service contracts or supported by internal formal maintenance cycles.	3
B.1.8. First-aid equipment	We have basic first-aid equipment and a few people trained in the use		We have a well-stocked first-aid station and certain advanced equipment. Some of our rescue team members have received basic first aid training.		We have a fully stacked advanced medical services facility for emergencies and can meet almost all the capabilities of trained EMTs.	4

Section B - Equipment and Resources

B.1. Mine Rescue Resources

	1	2	3	4	5	Score
B.1.9. Underground transportation	We have no underground transportation for rescue teams		We have underground transportation designated for use by rescue teams.		We keep fully maintained and charged personnel carriers throughout the mine to ensure that rescue teams don't want energy, air and power getting to the site of an incident.	5
B.1.10. Service and support logistics	We have enough supplies to operate day to day. Any demand on our systems beyond the ordinary exceeds our ability to supply		We check our inventories and supplies every three to six months and repair or replace faulty or expired equipment and supplies.		We have formal action plans to mobilize vendors and crews in an emergency. All vendors have signed Service Level Agreements to ensure repairs and supplies are always at required levels. Key suppliers have developed emergency procedures to respond outside of normal hours. We test these systems response annually.	3
B.1.11. Lifelines	There are lifelines available that are inspected once upon arrival or purchase.		Lifelines are inspected upon arrival or purchase and then taken out of service after noticeable wear and use.		There are lifelines for each rescue team that are rigorously tested and inspected upon arrival or purchase. Each lifeline is inspected after each use thereafter.	2
B.1.12. Tested equipment	Equipment is inspected once when it is first received or purchased.		Equipment is regularly inspected for wear and general quality and replaced at the first sign of wear or failure to operate adequately.		Equipment is regularly inspected for wear and general quality. Each type of equipment goes through a rigorous annual field test.	4

Section C - Process

C.1. Procedures

	1	2	3	4	5	Score
C.1.1. Accurate team briefings / debriefings	These are informal exchanges during team rotation.		We have printed check lists that briefings are based on.		There is a defined protocol for handing over, determining specific information that has to be captured and shared. This system has been developed over the years and tested many times. We use the information to continually improve the protocol.	5
C.1.2. Flexible exploration	There is minimal or no preplanning done for rescue or recovery operations and we leave it up to the team captain to direct the actions of the teams.		We develop rescue and recovery plans based on information collected by the team and communicated to a command center.		We use a formal protocol for rescue and recovery planning, which also includes signaling protocols so that deviation decisions made by the team captain can be communicated to the surface. We test this in simulated environments and encourage problem solving.	2
C.1.3. Exchange of critical information before entry	These are informal exchanges when rotating teams.		We have printed check lists that briefings are based on.		There is a defined protocol for handing over, determining specific information that has to be captured and shared. This system has been developed over the years and tested many times	4
C.1.4. Call out procedures/ notification procedures	There are informal exchanges when rotating teams.		We have printed check lists that briefings are based on.		There is a defined protocol for handing over, determining specific information that has to be captured and shared. This system has been developed over the years and tested many times	3
C.1.5. Understanding of action plans	Our rescue teams do not see our overall action plans.		Teams see and contribute to the rescue team section of our plans.		When writing our plan, we ensure that rescue teams, their leaders/captains and their crew all provide input and commentary, and all receive a copy (or at least their section).	2

Section C - Process

C.1. Procedures

	1	2	3	4	5	Score
C.1.6. Documented protocols for communication and logistics	There is no documentation or control for communications process.		There are documented expectations for communications but we haven't developed or documented formal procedures.		There is a defined protocol for communicating between FAB, C2 and crews, determining specific information that has to be shared and schedule of communiques. This system has been developed over the years and tested many times.	4
C.1.7. Review mine maps	Mine maps get updated approximately every six to twelve months.		Mine maps get updated approximately every three to six months.		Maps are reviewed on a monthly scheduled cycle and sooner if any change in mine conditions or areas occurs. Map updating is part of the operational checklist for any of these conditions and a signature is required to indicate that this was done.	3
C.1.8. Firefighting	We have one or two crew members who have been trained a while ago.		We require that one third of the members of each team be trained on the latest firefighting techniques and equipment and on equipment at our mine at least once a year.		We require that two thirds of the members of each team be trained on latest firefighting techniques and equipment and on equipment at our mine at least once a year.	3
C.1.9. Equipment change outs	We have no procedures for these beyond manufacturer's recommendations.		Every team's designee is responsible for filling in a work ticket for replacement equipment or supplies.		Our system tracks equipment usage details, comprehensive checking after return, and tracks the equipment until a confirmation of maintenance completion is indicated and the item placed back into inventory. Detailed service history is available for each piece of equipment.	2

Section C - Process

C.1. Procedures

	1	2	3	4	5	Score
C.1.10. Team rotation schedules	We rotate teams on an as needed or availability basis.		We try to ensure that teams spend a limited amount of time in the mine but we are subject to the size and complexity of the problem.		We have strict guidelines about the amount of time rescue teams spend underground according to conditions and stresses they are subjected to and we have a medical examiner present for all rotations.	3
C.1.11. Equipment checks	Team members are responsible for their own equipment.		Maintenance signs all equipment out after checking it. After that it's up to the team member.		Each person's equipment is checked by themselves and at least one other team member before being used.	2
C.1.12. Re-ventilation procedures	We don't have any re-ventilation procedures.		Teams are required to communicate what they plan to do and give the command center specific information about the ventilation.		We have specific "playbooks" for re-ventilation for defecting scenarios and playbooks are located at various places underground.	1

Underground Coal Mine Rescue Team Readiness Assessment Results

5	Highest likelihood that the rescue team is ready to respond to a major mine emergency.
4	High likelihood that the rescue team is ready to respond to a major mine emergency.
3	Moderate likelihood that the rescue team is ready to respond to a major mine emergency.
2	Low likelihood that the rescue team is ready to respond to a major mine emergency.
1	No likelihood that the rescue team is ready to respond to a major mine emergency.

Date of Assessment:	8/30/2013
Section A - People	4
A.1 Competencies	4
A.2 Training	3
A.3 Leadership	3
A.4 Organization	4
Section B - Equipment and Resources	4
B.1 Mine Rescue Resources	4
Section C - Process	3
C.1 Procedures	3
OVERALL SCORE	4

This tool is meant to assist the user in assessing the extent to which a mine's Rescue Team or Teams are ready to deal with a major mine emergency where people may be trapped underground. This tool is not intended to account for all eventualities and in no way assures or guarantees that the user or the Teams or every member of every team will be ready for all or any specific accident or incident. Uncertainty exists in key analysis parameters that can only be estimated. The analysis is additionally constrained by the quality of the input data provided by the user. If the input data is not accurate or is incomplete, this may adversely affect the usefulness and/or accuracy of improvement actions indicated by the tool.

Appendix H – Readiness Assessment Model and Methodology for Responsible Persons

Underground Coal Mine Responsible Person Readiness Assessment Directions

Purpose of This Model: The purpose of this model is to supply the mining industry with a proactive toolset for underground coal mine operators to use to self-assess the Readiness of the "Responsible Person" who will take charge in the event of a major mine emergencies.
Recommended Use: It is recommended that each mine perform this assessment every three months. It is expected that the first time a mine completes this assessment, it will take slightly longer than subsequent assessments.
Assessment Results: While the models are being validated and calibrated, access to the results will be limited to individual mines. The primary audience is the mine's management for decision-making purposes.
How to Use This Model:

Step 1: Go to the following website **www.msha.gov/readinessmodel**

Step 2: For this assessment, you *only* need to print the **Responsible Person Readiness Model** file which includes (1) Directions and (2) The Model.

Step 3: Save the **Responsible Person Readiness Results** file to your computer, but do not print. **Note:** Only the final step of this model (calculating your results) requires a computer.

Step 4: Gather a team of individuals from the mine to perform this assessment. The team might include the Mine Foreman, a Shift Supervisor, a Mine Examiner (Shift Inspector), a Mine Engineer, and the designated responsible person(s).
Recommendation: Select an individual to lead this effort for your mine. If possible, select someone who can lead the first assessment and subsequent assessments (every three months) to provide consistency.

Step 5: Briefly review the material you have printed to help ensure that the team has a basic understanding of how this process will work.

Step 6: Meet with the team to make a series of judgments in Sections A (People), B (Equipment and Resources), and C (Process) of the model. Each judgment will involve filling in your selection, a number 1 through 5.

Step 7: After the team has completed making all the assessments in Sections A, B, and C, use a computer to open the **Responsible Person Readiness Results** file and transfer the numbers from the paper-based **Responsible Person Readiness Model,** used by the group, to the computer file. All fields, including the date, must be populated to view the results.

Step 8: If desired, print the results. Then, review your score on the Responsible Person Scorecard.

Step 9: As a team, review areas where the score was less than ideal and develop recommendations to address them.

Underground Coal Mine Responsible Person Readiness Assessment

Directions: Score each category based on a scale of one to five. Use the criterion provided within each score (1, 3, and 5) to guide your selections. If you struggle to select an appropriate score, make a conservative selection by choosing the lower score.

Insert date of Assessment	**8/30/2013**

Section A - People

A.1. Demonstrated Competencies (Ability)

	1	2	3	4	5	Score
A.1.1. Responsible Person	The Responsible Person(s) was selected on the basis of his/ her expertise and experience as a miner.		The Responsible Person(s) has experience under emergency situations and have participated in two realistic simulation drills for at least two years and have current knowledge of mine and have completed annual training in mine emergency response.		The Responsible Person(s) has extensive, proven and demonstrated expertise under emergency situations and has participated in two realistic simulation drills for at least two years and have current knowledge of mine and have completed annual training in mine emergency response.	5
A.1.2. Organize and delegate	The Responsible Person(s) was selected on the basis of his/ her expertise and experience as a miner.		The Responsible Person(s) has experience under emergency situations and has participated in two realistic simulation drills for at least two years. He/she has current knowledge of the mine and has completed annual training in mine emergency response.		The Responsible Person(s) has extensive, proven and demonstrated expertise under emergency situations and has participated in two realistic simulation drills for at least two years and will take charge during mine emergencies involving a fire, explosion or gas/water inundations.	4

Section A - People

A.1. Demonstrated Competencies (Ability)

	1	2	3	4	5	Score
A.1.3. Clarity in communication	The Responsible Person(s) was selected on the basis of his/ her expertise and experience as a miner.		The Responsible Person(s) has experience under emergency situations and has participated in two realistic simulation drills for at least two years and have current knowledge of the mine's emergency response plan.		The Responsible Person(s) has extensive, proven and demonstrated expertise under emergency situations and has participated in two realistic simulation drills for at least two years and have knowledge of the mine emergency evacuation and firefighting plan. The responsible person only needs to say something once and is understood.	3
A.1.4. Coordination/Multi-tasking	The Responsible Person(s) was selected on the basis of his/ her expertise and experience as a miner.		The Responsible Person(s) has experience under emergency situations and have participated in two realistic simulation drills for at least two years and has completed training annually in a course of instruction in mine emergency response.		The Responsible Person(s) has extensive, proven and demonstrated expertise under emergency situations and has current knowledge of the assigned location and expected movements of miners underground; the operation of the mine ventilation system; the location of mine escapeways and refuge alternatives; the communication system; locations of firefighting equipment; and the mine rescue notification plan.	4
A.1.5. Ability to use communications tools	The Responsible Person(s) was selected on the basis of his/ her expertise & experience as a miner.		The Responsible Person(s) has training on communication equipment and systems but have not demonstrated proficiency in their use.		Responsible Person(s) has been trained on all available communication equipment and has demonstrated their proficiency with the mine's communications systems and has completed training in communicating appropriate information relating to the emergency.	5

Section A - People

A.1. Demonstrated Competencies (Ability)

	1	2	3	4	5	Score
A.1.6. Communication	The Responsible Person(s) has not completed training in public or emergency communications, protocols, or electronic communication equipment used at this mine.		The Responsible Person(s) has completed training in communications protocols but have never been tested or demonstrated any proficiency in a crisis situation.		The Responsible Person(s) has received extensive training in corporate and crisis media communications, as well as tactical and operational communications to manage the rescue or recovery operations.	2
A.1.7. People skills	The Responsible Person(s) was selected on the basis of his/ her expertise and experience as a miner.		The Responsible Person(s) has experience under emergency situations and has participated in two realistic simulation drills for at least two years. He/she has firefighting, Rescue Team and/ or EMT experience and certifications.		The Responsible Person(s) has extensive, proven and demonstrated expertise under emergency situations and has participated in two realistic simulation drills for at least two years. He/she has firefighting, Rescue Team and/ or EMT experience and certifications.	3

Section A - People

A.2. Training (Skill)

	1	2	3	4	5	Score
A.2.1. Mine emergency procedures	The Responsible Person(s) has had minimal training in mine emergency response.		The Responsible Person(s) is familiar with our emergency procedures involving fires, explosions and gas/water inundations but has never practiced them.		The Responsible Person(s) has completed the annual training course prescribed by MSHA's office of educational policy and development for responsible person(s) training and has extensive, proven and demonstrated expertise regarding emergency situations.	4
A.2.2. Evacuation procedures	The Responsible Person(s) has completed mine emergency evacuation procedures.		The Responsible Person(s) has completed training and are familiar with our evacuation procedures but has never practiced them or had to coordinate in a simulated environment with information flowing between multiple parties simultaneously.		The Responsible Person(s) has completed extensive training on the mine emergency evacuation plan; has participated in evacuation drill exercises; and is competent to assess the information being communicated by evacuating miners.	5
A.2.3. Disaster response	The Responsible Person(s) has limited Disaster Response training or experience.		The Responsible Person(s) has completed training in disaster response procedures but has never practiced in a simulated environment or coordinated a disaster response.		The Responsible Person(s) has extensive experience in disaster response and is engaged as First Responders for a number of teams on their own time.	1
A.2.4. Rescue Personnel Coordination	The Responsible Person(s) has limited training in Mine Rescue Team protocols.		The Responsible Person(s) has been trained in the procedure of deployment of the Mine Rescue Teams but has never coordinated a mine rescue or recovery operation.		The Responsible Person(s) has completed training relating to the mine rescue notification plan and has extensive experience coordinating mine rescue personnel and rescue or recovery operations.	2

Section A - People

A.3. Knowledge and Information (Knowledge)

	1	2	3	4	5	Score
A.3.1. Knowledge of the mine infrastructure (and equipment)	The Responsible Person(s) has completed training relating to the mine infrastructure.		The Responsible Person(s) has current knowledge of the locations of the mine escapeways, refuge alternatives, and firefighting equipment.		The Responsible Person(s) has extensive, proven and demonstrated knowledge of the mine infrastructure (e.g. the operation of the mine ventilation system; locations of the mine escapeways; refuge alternatives; mine communications system; mine monitoring system and locations of firefighting equipment The Responsible Person(s) receives briefings on new equipment and/or infrastructure changes.	3
A.3.2. Knowledge of the location of people	The Responsible Person(s) is unfamiliar with the location of people, both in daily operations and/or in the event of an emergency.		The Responsible Person(s) is familiar with the mine emergency plans and procedures. He/she has experience dealing with data on miner and rescue team locations. He/she has knowledge of the assigned location and expected movements of miners underground.		The Responsible Person(s) is intimately familiar with the mine emergency plans and procedures, particularly the roles and expected location of people during an emergency. He/she has experience dealing with incoming data on miner and rescue team locations and has demonstrated the ability to interpret the data and direct operations using the information.	5
A.3.3. Familiarity with plans	The Responsible Person(s) is unfamiliar with mine emergency plans and procedures.		The Responsible Person(s) is familiar with mine's emergency response plan; the mine rescue notification plan; and the mine emergency evacuation and firefighting plan. He/she does not participate in reviewing or updating procedures and is not tested on his/her knowledge of the plan.		The Responsible Person(s) has demonstrated extensive knowledge of mine emergency plans and procedures. He/she participates in reviewing and/or updating emergency plans and procedures.	4

Section A - People

A.3. Knowledge and Information (Knowledge)

	1	2	3	4	5	Score
A.3.4. Layout and escape ways	The Responsible Person(s) is unfamiliar with the mine's layout and escape ways.		The Responsible Person(s) is familiar with the mine's layout and escape ways by studying current maps and completing required mandatory training.		The Responsible Person(s) is intimately familiar with the mine's layout; refuge alternatives, mine communication systems; pools of water; dewatering pumps; direction of air; travelways and escapeways. He/she always has current maps on hand. In the event of an emergency, the Responsible Person(s) has access to up-to-date information on the mine's status and available escape ways.	3
A.3.5. Knowledge of CO monitoring systems	The Responsible Person(s) is unfamiliar with the mine ventilation and monitoring systems (e.g. CO monitoring).		The Responsible Person(s) is familiar with the mine ventilation and monitoring system (e.g. CO monitoring system). He/she has limited experience identifying ventilation issues.		The Responsible Person(s) has completed training and demonstrated knowledge in understanding ventilation systems and identifying ventilation issues. He/she has access to the - monitoring system readings and is familiar with all protocols if any ventilation issues are detected.	4
A.3.6. Knowledge of the location of emergency equipment	The Responsible Person(s) has not demonstrated awareness of the location of emergency equipment.		The Responsible Person(s) is familiar with the mine's layout and the expected location of all firefighting equipment. He/she has access to equipment listing containing all equipment owned by the mine and its location.		The Responsible Person(s) is intimately familiar with the mine's layout and the expected location and condition of all firefighting equipment. The mine maintains an equipment listing of all equipment and its location and condition.	5

Section A - People

A.3. Knowledge and Information (Knowledge)

	1	2	3	4	5	Score
A.3.7. Knowledge of the delegation of authority	The Responsible Person(s) is unfamiliar with designated roles and responsibilities during a mine emergency.		The Responsible Person(s) is familiar with the implantation of the emergency response plan; and the contacting all persons identified in the mine emergency evacuation and firefighting plans.		The Responsible Person(s) is intimately familiar with designated roles and responsibilities during a mine emergency. He/she has input in assigning roles and has access to the Emergency Response Plan which provides detailed workflow, roles and responsibilities, delegation of authority and task lists for all functions.	5
A.3.8. Knowledge of the location of firefighting equipment	The Responsible Person(s) have completed training on deploying firefighting equipment and personnel.		The Responsible Person(s) is familiar with the location of firefighting equipment since he/she keeps a logbook of all of the firefighting equipment in the mine.		The Responsible Person(s) is intimately familiar with the mine's layout; the location of firefighting equipment; the condition of all firefighting equipment: firefighting personnel; and direction of air currents.	4

Section B - Equipment and Resources

B.1. Responsible Person Resources

	1	2	3	4	5	Score
B.1.1. Emergency Response Plan	A formal Emergency Response Plan in a form that can be used as an operating document does not currently exist.		The mine has an Emergency Response Plan in place and publicizes the plan by making it accessible to employees in hard copy to those employees who request it.		The mine has a formal Emergency Response Plan in place. The Responsible Person(s) is intimately familiar with details and how to utilize the plan. Plans are instantly accessible and are available in print at all times in two copies on the surface and one below ground.	3
B.1.2. Tracking system and location of miners	The miner tracking system has a limited range and takes some experience and skill to be able to use.		The miner tracking system and devices are in good working order but are heavily used. The mine does not have sufficient backup unit redundancy.		The miner tracking systems and devices are state-of-the-art. We have sufficient backup unit redundancy and all equipment is either under service contracts or supported by internal formal maintenance cycles.	2
B.1.3. Emergency Notification Plan (contact info)	A formal Emergency Notification Plan in a form that can be used as an operating document does not currently exist.		The mine has a formal Emergency Notification Plan in electronic form that can be printed upon request; a hard copy is posted at various locations at the mine site and is updated regularly.		The mine has a formal Emergency Notification Plan in place. The Responsible Person(s) is intimately familiar with details and how to utilize. Plans are instantly accessible and are available in print at all times in two copies on the surface and one below ground.	3

Section B - Equipment and Resources

B.1. Responsible Person Resources

	1	2	3	4	5	Score
B.1.4. Emergency Response Manual (should include delegation of authority)	A formal Emergency Response Manual in a form that can be used as an operating document does not currently exist.		A formal Emergency Response Manual is in place and includes delegation of authority. The manual is available in electronic or print form and can be printed upon request.		The mine has a formal Emergency Response Manual in place. The Responsible Person(s) is intimately familiar with details and how to utilize. Plans are instantly accessible and are available in print at all times in two copies on the surface and one below ground.	4
B.1.5. Communications equipment (multi-media)	The mine's communication equipment takes some experience and skill to be able to use it and interpret results.		The mine's communication equipment is in good working order; however the mine does not have backup unit redundancy.		The communications systems and devices are state-of-the-art and have sufficient backup unit redundancy. All communication equipment is either under service contracts or supported by internal formal maintenance cycles. Assigned personnel responsibilities include ensuring that equipment is in working order.	5
B.1.6. Communications plan	A formal Communications Plan in a form that can be used as an operating document does not currently exist.		The mine has a formal Communications Plan that can be used as an operating document. Plans are accessible in electronic or print form.		The mine has a formal Communications Plan in place. The Responsible Person(s) is intimately familiar with details and how to utilize. Plans are instantly accessible and are available in print at all times in two copies on the surface and one below ground.	2

Section C - PROCESS

C.1. Emergency Response Plan

	1	2	3	4	5	Score
C.1.1. Communication procedures (multi-party)	There is no documentation or control for communications process.		The Emergency Response Plan provides communication protocols for emergency situations. Communication procedures prescribe communication tools and a uniform language and determine what information should be shared.		The Emergency Response Plan provides defined communication protocols for emergency situations. Communication protocols prescribe specific communication tools and a uniform language, determine what information should be shared and provide guidance on when to schedule communiques.	3
C.1.2. Designation of responsible persons	There is no formal designation of the "Responsible Person(s)." We assign responsibilities as situations arise.		For each shift that miners work underground, there is a responsible person designated.		The responsible person(s) is identified to all miners for their work shift. Any change in the identity of the responsible person(s) will be communicated to the miners. The designated responsible person(s) will take charge during a mine emergency involving a fire, explosion or gas/water inundation.	5

Section C - PROCESS

C.1. Emergency Response Plan

	1	2	3	4	5	Score
C.1.3. Designation of authorities	There are no formalized roles or powers. Responsibilities are designated as situations arise.		The Emergency Response Plan designates authorities but does not elaborate on task lists, workflow, or responsibilities.		The Emergency Response Plan provides detailed workflow, roles and responsibilities, delegation of authority and task lists for all functions.	3
C.1.4. Access control and management plan	There is no formal management plan in place for coordinating authorities and managing access control during an emergency.		The mine has a management plan outlined that provides procedures for managing access control during a mine emergency. This plan is updated annually.		The mine has a formal management plan in place that provides procedures for coordinating authorities and managing access control during a mine emergency. This plan includes designation of authorities and first-responder contact information, check-in/check-out procedures, and location tracking protocols. The management plan and first-responder contact information is reviewed and updated quarterly.	4
C.1.5. Debrief/data collection plan	There is no formalized debriefing process. We deal with these as conditions require.		There is a debriefing/data collection outline for Responsible Persons but no formal process for debriefing/data collection in place.		The Operator's Manual for Responsible Persons contains a debriefing checklist to ensure all information is gathered consistently.	5

Section C - PROCESS

C.2. Systems

	1	2	3	4	5	Score
C.2.1. Underground tracking systems	There is no formal system of procedures for tracking underground miners. We expect miners to be in a designated area and use the mine's day-to-day communication tools in the event of an emergency.		A tracking system for tracking underground miners is in place and functional.		Our tracking systems are state-of-the-art. We have multiple mechanisms and sufficient backup unit redundancy. There are documented procedures and best practices for both trapped miners and those on the surface. All equipment is either under service contracts or supported by internal formal maintenance cycles.	3
C.2.2. Underground communication systems	The communication system takes some experience and skill to be able to use it and interpret results.		The underground communication systems are inspected and tested annually to ensure they are in good working order.		Our underground communications systems and devices are state-of-the-art. We have sufficient backup unit redundancy and all equipment is either under service contracts or supported by internal formal maintenance cycles. Assigned personnel responsibilities include ensuring that equipment is in working order.	2

Section C - PROCESS

C.2. Systems

	1	2	3	4	5	Score
C.2.3. Method of getting mine status information	We don't have a formal system or procedures for obtaining mine status information.		The basic procedure for obtaining mine status information is outlined in the Emergency Response Plan.		The Emergency Response Plan outlines protocols for obtaining updated mine status information. We have an electronic/ manual system for ensuring that the Rescue Team Coordinator, the Fresh Air Base and the Control/Command Room have current and synchronized information on the status of the mine and all first responders.	3
C.2.4. Search and Rescue status	We don't have a formal system or procedures for obtaining search and rescue information.		The procedures for obtaining information on search and rescue information are outlined in the Emergency Response Plan.		The Emergency Response Plan outlines protocols for obtaining updated search and rescue information. We have an electronic/ manual system for ensuring that the Rescue Team Coordinator, the Fresh Air Base and the Control/Command Room have current/synchronized information on the status of the mine and all first responders.	4
C.2.5. Check in/ Check out	We don't have a formal system or procedures for obtaining check in/check out information.		Procedures for obtaining information on check in/ check out information are outlined in the Emergency Response Plan.		The Emergency Response Plan outlines protocols for obtaining updated check in/ check out information. We have an electronic/ manual system for ensuring that the Rescue Team Coordinator, the Fresh Air Base and the Control/Command Room have current/synchronized information on the status of the mine and all first responders.	5

Section C - PROCESS

C.2. Systems

	1	2	3	4	5	Score
C.2.6. Surface communication systems	The surface communication system takes some experience and skill to be able to use it and interpret results.		The surface communication systems is fully functional, however it does not have backup unit redundancy.		Our communications systems and devices are state-of-the-art. We have sufficient backup unit redundancy and all equipment is either under service contracts or supported by internal formal maintenance cycles. Assigned personnel responsibilities include ensuring that equipment is in working order.	3
C.2.7. Method of getting location knowledge	We don't have a formal system or procedures for obtaining location knowledge.		We have procedures for obtaining location knowledge outlined in the Emergency Response Plan.		The Emergency Response Plan outlines protocols for obtaining updated mine status information. We have an electronic/ manual system for ensuring that the Rescue Team Coordinator, the Fresh Air Base and the Control/Command Room have current/synchronized information on the status of the mine and all first responders.	4

Underground Coal Mine Responsible Person Readiness Assessment Results

5	Highest likelihood that the responsible person is ready to respond to a major mine emergency.
4	High likelihood that the responsible person is ready to respond to a major mine emergency.
3	Moderate likelihood that the responsible person is ready to respond to a major mine emergency.
2	Low likelihood that the responsible person is ready to respond to a major mine emergency.
1	No likelihood that the responsible person is ready to respond to a major mine emergency.

Date of Assessment: **8/30/2013**

Section A - People	4
A.1 Demonstrated Competencies (Ability)	4
A.2 Training (Skill)	3
A.3 Knowledge and Information (Knowledge)	4
Section B - Equipment and Resources	3
B.1 Responsible Person Resources	3
Section C - Process	3
C.1 Emergency Response Plan	4
C.2 Systems	3
OVERALL SCORE	3

This tool is meant to assist the user in assessing the extent to which a mine or mine operator's appointed Responsible Person is ready to manage a major mine emergency. This tool is not intended to account for all eventualities and in no way assures or guarantees that the Responsible Person will be ready for all or any specific accident or incident. Uncertainty exists in key analysis parameters that can only be estimated. The analysis is additionally constrained by the quality of the input data provided by the user. If the input data is not accurate or is incomplete, this may adversely affect the usefulness and/or accuracy of improvement actions indicated by the tool.

Appendix I – Readiness Assessment Model and Methodology for Government and Industry

Underground Coal Mine Government and Industry Readiness Assessment Directions

Purpose of This Model: The purpose of this model is to supply the Mine Safety and Health Administration (MSHA) with a proactive toolset to use to self-assess government and industry readiness to respond to a major mine emergency.

Recommended Use: It is recommended that MSHA perform the full assessment annually. This includes individual assessments of the a) Coal Safety and Health Districts, b) Coal Safety and Health Headquarters, c) Mine Emergency Response Coordinator (MERC), and d) MSHA assessment of Industry. It is expected that the first time MSHA completes these assessments, it will take slightly longer than subsequent assessments.

Assessment Results: Districts, Coal Headquarters, MERC, and Industry readiness assessment results will roll up to provide a summary of overall government and industry readiness. The primary audience of the results is MSHA management for decision-making purposes.

How to Use This Model:

Step 1: Go to the following website **www.msha.gov/readiness model**

Step 2: Print the **Government Readiness Model** file for the group that you have been asked to assess - Districts, Headquarters, MERC, or Industry. This file includes (1) Directions and (2) The Model.

Step 3: Save the **Government Readiness Results** file to your computer, but do not print.
Note: Only the final step of this model (calculating your results) requires a computer.

Step 4: Verify that you are the appropriate individual to lead this assessment and assemble a team of individuals from your division to assist in performing the assessment. Recommended individuals to lead each assessment:

- For the Coal Safety and Health District Assessments: District Manager
- For the Coal Safety and Health Headquarters Assessment: Chief of Division of Safety
- For the Mine Emergency Response Coordinator Assessment: MERC
- For the MSHA Assessment of Industry: **MERC**

Initial Review

Step 5: Briefly review the material you have printed to help ensure that the team has a basic understanding of how this process will work.

Assessment

Step 6: Meet with the team to conduct the assessment by making a series of judgments for each emergency response event. Each judgment will involve assigning a score, a number 1 (weak) through 5 (strong). The model provides criterion to help guide your score.

Input Results

Step 7: After the team has completed making all of the assessments use a computer to open the **Government Readiness Results** file, select the appropriate tab (Districts, Coal Headquarters, MERC, Industry) and transfer the numbers from the paper-based **Government Readiness Model,** used by the group, to the computer file. All fields, including the date, must be populated to view the results.

Review Results

Step 8: If desired, print the results. Then, review your score by selecting the "Scorecard" Tab.

Step 9: Send the completed assessment to the assigned person in MSHA. They will consolidate all of the assessments from other groups to determine the overall government and industry readiness.

Recommendations

Step 10: As a team, review areas where the score you assessed was less than ideal and develop recommendations to address them.

Government and Industry Readiness Assessment - Coal Mine Safety and Health DISTRICTS

Coal District [#] - [District Name]

Directions: Score each category based on a scale of one to five. Use the criterion provided to guide your selection of 1, 2, 3, 4, or 5. If you struggle to select an appropriate score, make a conservative selection by choosing the lower score.

Enter your District Number

Insert date of Assessment

Event 1 - Your Coal District Office receives a call from the National Call Center

		1	2	3	4	5	Score
People	**Availability of District Manager**	The National Call Center has an emergency contact list for each district which includes phone numbers for each District Manager.		The National Call Center has an emergency contact list for each district which includes phone numbers for each District Manager and back-up.		The National Call Center has an emergency contact list for each district which includes phone numbers for the Emergency Phone, District Manager, Assistant District Managers, Staff Assistant, and Specialty Supervisor.	4
Equipment and Resources	**Call Tree and Emergency Action List are up-to-date and available**	The District Office updates their Call Tree for the National Call Center and Emergency Action List once annually.		The District Office updates their Call Tree for the National Call Center and Emergency Action List at least once every six months.		The District Office validates and updates their Call Tree for the National Call Center and Emergency Action List at least once a month.	5
Process	**Call Tree and Emergency Action List are formally maintained**	There is no formal protocol requiring regular review of the Call Tree and Emergency Action List.		The Call Tree and Emergency Action List are reviewed regularly as part of our quarterly management agenda.		The Call Tree and Emergency Action List are reviewed, updated and published monthly.	3

	Drills are conducted to exercise the notification process	There are no drills conducted to exercise the Call Tree and Emergency Action List.		The Call Tree and Emergency Action List are exercised only during actual emergency events.		The Call Tree and Emergency Action List procedures are exercised during regularly scheduled drills. Lessons learned are used to update notification processes.	3

Event 2 - District Manager calls the mine experiencing an emergency for information

		1	2	3	4	5	Score
People	**Ability of District Manager to contact mine for information**	The District Manager relies on transmitted information from the National Call Center to make contact with mine.		The District Manager has all mine information and POCs, updated quarterly.		The District Manager receives all of the information about the mine and the emergency, including updated contact information, from the National Call Center.	5
Equipment and Resources	**Call tree and reporting tool are up-to-date and readily available.**	Call trees for each local mine are updated once annually and the District Manager uses pen and paper to record emergency information.		Call list and incident report form are updated every six months.		Call list and incident report form are updated monthly and available electronically and hard copy.	5
Process	**Emergency Action List and reporting forms are formally maintained**	There is no formal protocol requiring regular review of the Emergency Action List and incident report form.		The Emergency Action List incident report form are reviewed regularly as part of our quarterly management agenda.		The Emergency Action List incident report form are reviewed, updated and published monthly.	5
	Drills are conducted to exercise the notification process	There are no drills conducted to exercise the notification process.		The notification process is exercised only during actual emergency events.		The notification process is exercised during regularly scheduled drills. Lessons learned are used to update notification processes.	3

Event 3 - District Manager dispatches District Response Team

		1	2	3	4	5	Score
People	**Formal District Response Team**	The District Response Team is selected based on who is available in the office.		We have a pool of trained and certified people who are able to act as the District Response Team.		We have a formal District Response Team with designated roles and responsibilities on a watch schedule ready to deploy at all times.	4
Equipment and Resources	**Emergency Response Kit**	The District Response Team assembles the Emergency Response Kit once notified of an emergency.		An Emergency Response Kit is available at all times, but the kit equipment needs to be tested once notified of an emergency.		A completely stocked Emergency Response Kit is available at all times and kit equipment is tested monthly.	5
Process	**Dispatch protocols in place**	There are no predefined protocols for dispatch actions, equipment, and transportation.		The District Response Team has predefined protocols for dispatch actions, equipment, and transportation, updated every six months.		The District Response Team has predefined protocols for dispatch actions, equipment, and transportation, updated monthly.	4
	Drills are conducted to exercise the dispatching process	There are no drills conducted to exercise the dispatching process.		The dispatching process is exercised only during actual emergency events.		The dispatching process is exercised during regularly scheduled drills. Lessons learned are used to update protocols. Lessons learned are used to update dispatch protocols.	3

Event 4 - District Manager calls the HQ Administrator for Coal Mine Safety and Health

		1	2	3	4	5	Score
People	**Ability of District Manager to contact the HQ Administrator for Coal Mine Safety and Health**	District Manager relies on the National Call Center or Headquarters to make contact with the Administrator.		The District Manager has POC information for the Administrator and alternate in smart device.		The District Manager and back-up have the Administrator and alternate on speed dial.	5
Equipment and Resources	**Coal Mine Safety and Health Administrator's contact details are up-to-date**	Administrator's contact details validated annually.		Administrator and alternate contact details validated quarterly.		Administrator and alternate contact details validated monthly.	4
Process	**Administrator has process to ensure updates of contact details and availability including alternate**	No formal process exists.		Administrator's staff updates roster of availability monthly.		Defined procedures are in place that require one specified position update availability roster weekly and distribute to all District Managers.	3
	Drills are conducted to exercise the notification process	There are no drills conducted to exercise the notification process.		The notification process is exercised only during actual emergency events.		The notification process is exercised during regularly scheduled drills. Lessons learned are used to update notification processes.	3

Event 5 - District Manager contacts backup District Managers per assigned schedule

		1	2	3	4	5	Score
People	**Availability of backup**	Name and contact details of backup validated and published annually.		Name and contact details of backup validated and published monthly.		Name and contact details of back-up roster validated and published weekly.	5
Equipment and Resources	**Back-up District Manager on duty has access to all resources**	Back-up District Manager validates contact details, emergency forms and procedures with District Manager periodically.		Back-up District Manager has access to contact details, emergency forms and procedures via the District Manager's computer.		Back-up District Manager has access to the same resources as the District Manager and updates contact details, emergency forms and procedures on his/her own smart device monthly.	4
Process	**Procedures to ensure formal Back-Up**	Backup District Managers are published in the Emergency Response Plan.		Protocol requires there be a roster of Back-Up District Managers, updated every six months.		Protocol requires there be a roster of Back-Up District Managers, updated and published monthly.	5
	Drills are conducted to exercise the notification process	There are no drills conducted to exercise the notification process.		The notification process is exercised only during actual emergency events.		The notification process is exercised during regularly scheduled drills. Lessons learned are used to update notification processes.	3

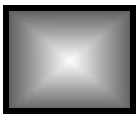
Event 6 - District Manager dispatches Family Liaison Coordinator (as needed)

		1	2	3	4	5	Score
People	**Availability of Family Liaison Coordinator**	The Family Liaison Coordinator is selected based on who is available in the office.		We have a pool of trained and certified people who are able to act as Family Liaison Coordinators.		A list of Family Liaison Coordinator scheduled for availability, along with their contact information, is provided to all District Managers.	5
Equipment and Resources	**Family Liaison Coordinator on duty has resources to support families**	It is left to Family Liaison Coordinator to determine what resources are needed to support the families.		The Family Liaison Coordinator has a general understanding of the resources provided by the mine to support the families.		The mine has provided the and Family Liaison Coordinator with a list of available resources to support the families.	5
Process	**Dispatch protocols in place**	There are no predefined protocols for dispatch actions and resources		The Family Liaison Coordinator has predefined protocols for dispatch actions and resources, updated every six months.		The Family Liaison Coordinator has predefined protocols for dispatch actions and resources, updated monthly.	4
	Family Liaison Coordinators participate in drills	There are no drills conducted to exercise the Family Liaison Coordinator Dispatch process.		The dispatch process is exercised only during actual emergency events.		The dispatch process is exercised during regularly scheduled drills. Lessons learned are used to update dispatch protocols.	3

Government and Industry Readiness Assessment - Coal Mine Safety and Health HEADQUARTERS

Directions: Score each category based on a scale of one to five. Use the criterion provided to guide your selection of 1, 2, 3, 4, or 5. If you struggle to select an appropriate score, make a conservative selection by choosing the lower score.

Insert date of Assessment



Event 1 - HQ Administrator for Coal Mine Safety and Health receives call from District

		1	2	3	4	5	Score
People	**Availability of the HQ Administrator for Coal Mine Safety and Health**	Regular and Emergency Contact number for Administrator published in HQ Emergency Response Plan.		Administrator updates POC details and availability schedule monthly.		Administrator updates POC details and availability schedule weekly and alternate POC details are published to all Districts.	4
Equipment and Resources	**Emergency Contact List and Action Checklist are up-to-date and available**	The Office of the Administrator updates their Emergency Contact List and Action Checklist once annually.		The Office of the Administrator updates their Emergency Contact List and Action Checklist at least once every six months.		The Office of the Administrator updates their Emergency Contact List and Action Checklist monthly.	2
Process	**Administrator has process to ensure updates of contact details and availability including alternate**	No formal process exists.		Administrator's staff identifies and publishes Administrator and Alternate POC details annually.		Defined procedures require one specified position update Administrator and Alternate POC details and publish monthly.	3
	Drills are conducted to exerticse the notification process	There are no drills conducted to exercise the notification process..		The notification process is exercised only during actual emergency events.		The notificaiton process is exercised during regularly scheduled drills. Lessons learned are used to update notification processes.	3

Event 2 - Administrator notifies the Assistant Secretary (as appropriate)

		1	2	3	4	5	Score
People	**Availability of Assistant Secretary**	No off-duty contact details available.		The Administrator has POC information for the Assistant Secretary and back-up in smart device.		The Administrator and alternate have the Assistant Secretary and back-up on speed dial.	5
Equipment and Resources	**Assistant Secretary's contact details are up-to-date**	Assistant Secretary contact details validated annually.		Assistant Secretary and back-up contact details validated quarterly.		Assistant Secretary and back-up contact details validated monthly.	3
	Templates are used to provide the required information to the Assistant Secretary	No templates are used.		Templates are used for some of the various types of emergency events.		Standard templates are used to ensure the right information is provided during the first notificaiton for ALL emergency events.	3
Process	**Assistant Secretary has process to ensure updates of contact details and availability including alternate**	No formal process exists.		Assistant Secretary's staff identifies and publishes Assistant Secretary and back-up POC details annually.		Defined procedures require one specified position update Assistant Secretary and back-up POC details and publish monthly	5

Event 3 - Administrator stands up Emergency Command Center at Headquarters (as appropriate)

People

	1	2	3	4	5	Score
Availability of Emergency Command Center Personnel	Emergency Command Center personnel are selected based on who is available at Headquarters at the time of the emergency.		We have a pool of people who are available to staff the Emergency Command Center.		Emergency Command Center personnel with designated roles and responsibilities are immediately available on a watch schedule.	5
Staffing of the Emergency Command Center	A sufficient number of people are available to staff the Emergency Command Center for an initial 8-hour shift.		A sufficient number of people are available to staff the Emergency Command Center for 2 8-hour shifts.		A sufficient number of people are available to staff three 8-hour shifts to ensure sustained operations of the Emergency Command Center on a 24-hour schedule.	5
Training of Emergency Command Center Personnel	Emergency Command Center personnel have not received formal training in their assigned duties.		Emergency Command Center personnel have been formally trained in their assigned duties.		Emergency Command Center personnel have been formally trained in their assigned duties and have proven demonstrated experience in command center operations during actual emergencies.	5

Equipment and Resources	**Emergency Command Center Equipment is Available and in Good Working Condition**	Equipment needed to operate the Emergency Command Center is assembled upon activication of the center.		All of the Emergency Command Center equipment, including additional phone lines, is immediately available.		All of the necessary equipment, including additional phone lines, is in place in a designated Emergency Commander Center and has been tested on a regular schedule to ensure it is in good working condition.	5
	Mine Mapping Tool System	The Mine Mapping Tool data is verified at least annually.		The Mine Mapping Tool hardware and software has been tested at least annually. The Mine and Mine Rescue Team data is verified at least annually.		The Mine Mapping Tool hardware and software has been tested on a regular schedule and is operating properly. The Mine and Mine Rescue Team data is accurate and up to date.	5
Process	**Emergency Command Center Standard Operating Procedures are in place**	Standard operating procedures outlining all of the positions, duties, responsibilities and protocols for the Emergency Commander Center are available and up to date.				Standard operating procedures outlining all of the positions, duties, responsibilities and protocols for the Emergency Commander Center are available and up to date.	4
	Emergency Command Center drills are conducted.	There are no drills conducted of the Emergency Command Center.		Emergency Command Center drills are not conducted. Lessons learned are evaluated following use of the center in an actual emergency event.		Emergency Command Center activation drills are conducted on a regular schedule and lessons learned are used to update the staffing, training and equipment.	3

Event 4 - Administrator notifies Mine Emergency Response Coordinator (as appropriate)

		1	2	3	4	5	Score
People	**Availability of Mine Emergency Response Coordinator**	No off-duty contact details available.		The Administrator has POC information for the Mine Emergency Response Coordinator and back-up in smart device.		The Administrator and alternate have the Mine Emergency Response Coordinator and back-up on speed dial.	5
Equipment and Resources	**Mine Emergency Response Coordinator contact details are up-to-date**	Mine Emergency Response Coordinator contact details validated annually.		Mine Emergency Response Coordinator and back-up contact details validated quarterly.		Mine Emergency Response Coordinator and back-up contact details validated monthly.	5
Process	**Mine Emergency Response Coordinator has process to ensure updates of contact details and availability including alternate**	No formal process exists.		Mine Emergency Response Coordinator's staff identifies and publishes MERC and back-up POC details annually.		Defined procedures require one specified position update MERC and back-up POC details and publish monthly	4
	Drills are conducted to exercise the notification process	There are no drills conducted to exercise the notification process..		The notification process is exercised only during actual emergency events.		The notification process is exercised during regularly scheduled drills. Lessons learned are used to update notification processes.	3

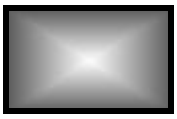
Event 5 - Administrator notifies other Program Administrators, Directors and Deputy Directors as appropriate

		1	2	3	4	5	Score
People	**Availability of Program Administrators, Directors & Associate Directors**	No off-duty contact details available.		The Administrator has POC information for all Program Administrators, Directors, and Deputy Directors, hard copy and electronically.		The Administrator has POC information for all Program Administrators, Directors, and Deputy Directors, hard copy, electronically and stored in mobile phone.	5
Equipment and Resources	**Program Administrators, Directors and Deputy Directors contact details are up-to-date**	All Program Administrators, Directors, and Deputy Directors contact details validated annually.		All Program Administrators, Directors, and Deputy Directors contact details validated quarterly.		All Program Administrators, Directors, and Deputy Directors contact details validated monthly.	5
Process	**Program Administrators, Directors and Deputy Directors have process to ensure updates of contact details and availability including alternate**	No formal process exists.		All Program Administrators, Directors, and Deputy Directors identify and publish POC and back-up POC details annually.		Defined procedures require one specified position update all Program Administrators, Directors and Deputy Directors, POC and back-up POC details and publish monthly.	4
	Drills are conducted to exercise the notification process	There are no drills conducted to exercise the notification process..		The notification process is exercised only during actual emergency events.		The notification process is exercised during regularly scheduled drills. Lessons learned are used to update notification processes.	3

Government and Industry Readiness Assessment - Mine Emergency Response Coordinator (MERC)

Directions: Score each category based on a scale of one to five. Use the criterion provided to guide your selection of 1, 2, 3, 4, or 5. If you struggle to select an appropriate score, make a conservative selection by choosing the lower score.

Insert date of Assessment



Event 1 - Mine Emergency Response Coordinator receives notification from Administrator

		1	2	3	4	5	Score
People	**Availability of Mine Emergency Response Coordinator**	Regular and Emergency Contact number for MERC published in Emergency Response Plan.		MERC updates POC details and availability schedule monthly.		MERC updates POC details and availability schedule weekly and alternate POC details are provided to Headquarters.	4
Equipment and Resources	**Emergency Contact List and Action Checklist are up-to-date and available**	The MERC updates Emergency Contact List and Action Checklist once annually.		The MERC updates Emergency Contact List and Action Checklist at least once every six months.		The MERC updates Emergency Contact List and Action Checklist at least monthly.	5
Process	**MERC has process to ensure updates of contact details and availability including alternate**	No formal process exists.		MERC's staff identify and publish MERC and Alternate POC details annually.		Defined procedures require one specified position update. MERC and Alternate POC details and publish monthly.	5
	Drills are conducted to exercise the notification process	There are no drills conducted to exercise the notification process..		The notification process is exercised only during actual emergency events.		The notification process is exercised during regularly scheduled drills. Lessons learned are used to update notification processes.	3

Event 2 - Mine Emergency Response Coordinator activates the Mine Emergency Unit

		1	2	3	4	5	Score
People	**Formal Mine Emergency Unit (MEU)**	The Mine Emergency Unit is selected based on who is available in the office.		We have a pool of trained and certified people who are able to act as the Mine Emergency Unit.		We have a formal Mine Emergency Unit with designated roles and responsibilities on a watch schedule ready to deploy at all times.	4
Equipment and Resources	**Emergency Response Equipment in each location**	The Mine Emergency Unit assembles the emergency response equipment once notified of an emergency.		Emergency response equipment is available at all times, but the equipment needs to be tested once notified of an emergency.		All of the emergency response equipment is available at all times and is tested and maintained monthly.	5
Process	**Dispatch protocols in place**	There are no predefined protocols for dispatch actions, equipment, and transportation.		The Mine Emergency Unit has predefined protocols for dispatch actions, equipment, and transportation, updated every six months.		The Mine Emergency Unit has predefined protocols for dispatch actions, equipment, and transportation, updated monthly.	5
	Drills are conducted to exercise the dispatching process	There are no drills conducted to exercise the dispatching process.		The dispatching process is exercised only during actual emergency events.		The dispatching process is exercised during regularly scheduled drills. Lessons learned are used to update dispatch protocols.	3

Event 3 - Mine Emergency Response Coordinator activates the Mine Emergency Operations (MEO) Division

		1	2	3	4	5	Score
People	**Mine Emergency Operation staff**	The selection of personnel in the Mine Emergency Operations Division to activate is based on who is available in the office at the time of the emergency.		We have a pool of trained and certified people who are able to activate.		We have a formal MEO personnel with designated roles and responsibilities on a watch schedule ready to deploy at all times.	5
Equipment and Resources	**Emergency Response Equipment**	The Mine Emergency Operations Division assembles response equipment once notified of an emergency.		Emergency response equipment is available at all times, but the equipment needs to be tested once notified of an emergency.		All of the emergency response equipment is available at all times and is tested and maintained monthly.	5
Process	**Activation protocols in place**	There are no predefined protocols for activating the MEO Division.		The MEO division has predefined protocols for dispatch actions, equipment, and transportation, updated every six months.		The MEO division has predefined protocols for activating during an emergency.	5
	Drills are conducted to exercise the activation process	There are no drills conducted to exercise the activation process.		The activation process is exercised only during actual emergency events.		The dispatching process is exercised during regularly scheduled drills. Lessons learned are used to update dispatch protocols	3

Event 4 - Mine Emergency Response Coordinator activates the Mine Emergency Technology Team (METT)

		1	2	3	4	5	Score
People	**Mine Emergency Technology Team**	The METT is selected based on who is available in the office.		We have a pool of trained and certified people who are able to act as the METT.		We have a formal METT with designated roles and responsibilities on a watch schedule ready to deploy at all times.	5
Equipment and Resources	**Emergency Response Equipment**	The METT assembles the emergency response equipment once notified of an emergency.		Emergency response equipment is available at all times, but the equipment needs to be tested once notified of an emergency.		All of the emergency response equipment is available at all times and is tested and maintained monthly.	5
Process	**Dispatch protocols in place**	There are no predefined protocols for dispatch actions, equipment, and transportation.		The METT has predefined protocols for dispatch actions, equipment, and transportation, updated every six months.		The METT has predefined protocols for dispatch actions, equipment, and transportation, updated monthly.	5
	Drills are conducted to exercise the dispatching process	There are no drills conducted to exercise the dispatching process.		The dispatching process is exercised only during actual emergency events.		The dispatching process is exercised during regularly scheduled drills. Lessons learned are used to update dispatch protocols	3

Event 5 -Mine Emergency Response Coordinator notifies Program Evaluation and Information Resources (PEIR)

		1	2	3	4	5	Score
People	**Availability of PEIR**	No off-duty contact details available.		The MERC has PEIR POC details in smart device.		The MERC and alternate have PEIR POC on speed dial.	3
Equipment and Resources	**PEIR contact details are up-to-date**	PEIR contact list is validated annually.		PEIR contact list is validated quarterly.		PEIR contact list is validated monthly.	5
	PEIR Emergency Comunications Equipment	The PEIR emergency communication equipment is assembled once notified of an emergency.		Emergency communications equipment is available at all times, but the equipment needs to be tested once notified of an emergency.		All of the emergency communications equipment is available at all times and is tested and maintained monthly.	5
Process	**MERC has process to ensure updates of contact details and availability including alternate**	No formal process exists.		PEIR staff identifies and publishes PEIR POC and back-up POC details annually.		Defined procedures require one specified position update PEIR POC and back-up POC details and publish monthly.	3
	Drills are conducted to exercise the notification process	There are no drills conducted to exercise the notification process.		The notification process is exercised only during actual emergency events.		The notification process is exercised during regularly scheduled drills. Lessons learned are used to update notification process.	3

Event 6 - Mine Emergency Response Teams (MEU, METT, MEO) mobilize as appropriate

		1	2	3	4	5	Score
People	**Team members are ready to respond**	All emergency response team members are available and can mobilize within four hours.		All emergency response team members are available and can mobilize within two hour.		All emergency response team members are available and can mobilize within one hour.	3
Equipment and Resources	**Equipment availability serviceability**	All emergency response equipment is readily available and can mobilize within one hour.		All emergency response equipment is readily available and can mobilize within two hour.		All emergency response equipment is readily available and can mobilize within one hour.	5
Process	**Procedures and protocols are used during mobilization.**	Team members are knowledgeable with mobilization procedures, which are learned from on-the-job training and experience.		Written mobilization procedures are in place and available to ensure all personnel and equipment are mobilized. Procedures are reviewed annually.		Written mobilization procedures are in place and available to ensure all personnel and equipment are mobilized. Procedures are reviewed quarterly and after every emergency mobilization.	4
	Drills are conducted to exercise the mobilization process	There are no drills conducted to exercise the mobilization process.		The mobilization process is exercised only during actual emergency events.		The mobilization process is exercised during regularly scheduled drills. Lessons learned are used to update mobilization procedures and protocols	3

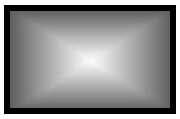
Event 7 -Technical Support notifies the Chief of the Pittsburgh Safety and Health Technology Center (PS&HTC) and the Chief of the Approval and Certification Center (A&CC)

		1	2	3	4	5	Score
People	**Availability of PS&HTC and A&CC**	No off-duty contact details available.		The MERC has PS&HTC and A&CC POC details in smart device.		The MERC and alternate have PS&HTC and A&CC POCs on speed dial.	3
Equipment and Resources	**PS&HTC and A&CC contact details are up-to-date**	PS&HTC and A&CC contact details validated annually.		PS&HTC and A&CC POC and back-up POC contact details validated quarterly.		PS&HTC and A&CC POC and back-up POC contact details validated monthly.	5
Process	**MERC has process to ensure updates of contact details and availability including alternate**	No formal process exists.		PS&HTC and A&CC staff identifies and publishes PS&HTC and A&CC POC and back-up POC details annually.		Defined procedures require one specified position update PS&HTC and A&CC POC and back-up POC details and publish monthly.	4
	Drills are conducted to exercise the notification process	There are no drills conducted to exercise the notification process..		The notification process is exercised only during actual emergency events.		The notification process is exercised during regularly scheduled drills. Lessons learned are used to update notification process.	3

Government and Industry Readiness Assessment - MSHA Assessment of Industry

Directions: Score each category based on a scale of one to five. Use the criterion provided to guide your selection of 1, 2, 3, 4, or 5. If you struggle to select an appropriate score, make a conservative selection by choosing the lower score.

Insert date of Assessment



Factor 1 - All underground coal mines are covered by at least two Mine Rescue Teams

	1	2	3	4	5	Score
Percentage of underground coal mines covered by at least two mine rescue teams within one hour.	Less than 50% of all underground coal mines have agreements with 2 or more mine rescue teams located within one hour of the mine.		75% of all underground coal mines have agreements with 2 or more mine rescue teams located within one hour of the mine.		100% of all underground coal mines have agreements with 2 or more mine rescue teams located within one hour of the mine.	4

Factor 2 - All Mine Rescue Teams meet annual training requirements

	1	2	3	4	5	Score
Percentage of certified mine rescue teams that have met annual training requirements.	Less than 50% of all certified mine rescue teams have met annual training requirements.		75% of all certified mine rescue teams have met annual training requirements.		100% of all certified mine rescue teams have met annual training requirements.	4

Factor 3 - All Mine Rescue Teams meet annual contest requirements

	1	2	3	4	5	Score
Percentage of certified mine rescue teams that have participated in at least two mine rescue contests annually.	Less than 50% of all certified mine rescue teams have met annual contest requirements.		75% of all certified mine rescue teams have met annual contest requirements.		100% of all certified mine rescue teams have met annual contest requirements.	5

Factor 4 - All Emergency Response Plans (ERPs) are accurate, up-to-date and approved

Percentage of Mine Emergency Response Plans for all mines are accurate, up-to-date (reviewed every six months by MSHA) and approved.

1	2	3	4	5	Score
Less than 50% of the ERPs required by mines are accurate, up-to-date and approved by MSHA.		75% of the ERPs required by mines are accurate, up-to-date and approved by MSHA.		100% of the ERPs required by mines are accurate, up-to-date and approved by MSHA.	3

Underground Coal Mine Government and Industry Assessment Model Results

5	Highest likelihood that the government is prepared to respond to a major mine emergency.
4	High likelihood that the government is prepared to respond to a major mine emergency.
3	Moderate likelihood that the government is prepared to respond to a major mine emergency.
2	Low likelihood that the government is prepared to respond to a major mine emergency.
1	No likelihood that the government is prepared to respond to a major mine emergency.

Date of Assessment:

	PEOPLE	EQUIPMENT	PROCESS	OVERALL READINESS
Coal Mine Safety and Health DISTRICTS	5	5	4	4
Event 1 - Your Coal District Office receives a call from the National Call Center	4	5	3	**4**
Event 2 - District Manager calls the mine experiencing an emergency for information	5	5	4	**5**
Event 3 - District Manager dispatches District Response Team	4	5	3	**4**
Event 4 - District Manager calls the HQ Administrator for Coal Mine Safety and Health	5	4	3	**4**
Event 5 - District Manager contacts backup District Managers per assigned schedule	5	4	4	**4**
Event 6 - District Manager dispatches Family Liaison Coordinator (as needed)	5	5	4	**4**
Coal Mine Safety and Health HEADQUARTERS	5	4	4	**4**
Event 1 - HQ Administrator for Coal Mine Safety and Health receives call from District	4	2	3	**3**
Event 2 - Administrator notifies the Assistant Secretary (as appropriate)	5	3	5	**4**
Event 3 - Administrator stands up Emergency Command Center at Headquarters (as appropriate)	5	5	4	**5**
Event 4 - Administrator notifies Mine Emergency Response Coordinator (as appropriate)	5	5	4	**5**
Event 5 - Administrator notifies other Program Administrators, Directors and Deputy Directors as appropriate	5	5	4	**5**
Mine Emergency Response Coordinator (MERC)	4	5	4	**4**
Event 1 - Mine Emergency Response Coordinator receives notification from Administrator	4	5	4	**4**
Event 2 - Mine Emergency Response Coordinator activates the Mine Emergency Unit	4	5	4	**4**
Event 3 - Mine Emergency Response Coordinator activates the Mine Emergency Operations (MEO) Division	5	5	4	**5**
Event 4 - Mine Emergency Response Coordinator activates the Mine Emergency Technology Team (METT)	5	5	4	**5**
Event 5 -Mine Emergency Response Coordinator notifies Program Evaluation and Information Resources (PEIR)	3	5	3	**4**

Event 6 - Mine Emergency Response Teams (MEU, METT, MEO) mobilize as appropriate	3	5	4	**4**
Event 7 -Technical Support notifies the Chief of the Pittsburgh Safety and Health Technology Center (PS&HTC) and the Chief of the Approval and Certification Center	3	5	4	**4**
OVERALL READINESS	**4**	**5**	**4**	**4**

MSHA Assessment of INDUSTRY

Factor 1 - All underground coal mines are covered by at least two Mine Rescue Teams	**4**
Factor 2 - All Mine Rescue Teams meet annual training requirements	**4**
Factor 3 - All Mine Rescue Teams meet annual contest requirements	**5**
Factor 4 - All Emergency Response Plans (ERPs) are accurate, up-to-date and approved	**3**
OVERALL READINESS	**4**

This tool is meant to assist the user in assessing the extent to which government and industry are prepared to deal with a major mine emergency. This tool is not intended to account for all eventualities and in no way assures or guarantees that the user will be prepared for all or any specific accident or incident. Uncertainty exists in key analysis parameters that can only be estimated. The analysis is additionally constrained by the quality of the input data provided by the user. If the input data is not accurate or is incomplete, this may adversely affect the usefulness and/or accuracy of improvement actions indicated by the tool.