

# Mine emergency risk preparedness and readiness self-assessment; A proactive approach

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**M**ining is an inherently risky business. Over the years, major mine disasters have resulted in the deaths and injuries of thousands of miners in the United States. These disasters also resulted in innovations in approaches to mine design, operations and the training of miners and mine rescue teams. The U.S. Congress responded to these disasters with new laws designed to create 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 in 2012, the U.S. Mine Safety and Health Administration (MSHA) identified the need for the development of risk and readiness assessment models for MSHA and the mining industry. MSHA's objective was to evolve existing theoretical concepts for risk and readiness assessment into simplified tools that can be applied by the mining industry for use at operational levels. In 2012, MSHA hired ABS Group, a recognized industry leader in safety risk management and a wholly owned subsidiary of the American Bureau of Shipping, to develop self-assessment models to help meet this objective.

In September 2012, MSHA chartered a project to supply the coal mining industry with a pro-active toolset for mine operators to:

1. Self-assess the risks associated with underground coal mining operations in order to prevent major mine emergencies.
2. Assess the preparedness of mine operators to respond to an emergency.
3. Measure the readiness of mine rescue teams and responsible persons to execute emergency plans.

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## The models

MSHA called for the development of four separate models. The first was a risk assessment

model for coal mine operators to use to prevent major mine emergencies. The second was a model to assess the preparedness of coal mines to respond to emergencies. The remaining two models would assess the readiness of mine rescue teams and responsible persons. ABS Group assembled a team of consultants with experience in developing risk and preparedness assessment tools for other government agencies and industries to support this effort. The specialized team also included the late Dr. Christopher Bise, who had more than 40 years of experience in planning, engineering, operation, management, teaching and research aspects of mining, occupational and environmental health and safety.

## Literature review

ABS Group conducted a thorough literature review of historical mine disasters, common hazards and emergency response best practices to support development of the models. Data were examined from 1900-2006 to understand the loss-control failures that led to the incidents, provide a clear picture of the most common causal factors and help gain a better understanding of where to focus emergency planning and response improvement efforts, such as through training exercises and stakeholder outreach and engagement. Best practices for risk, readiness and preparedness assessments from other countries and industries, specifically Australia, South Africa and the aviation industry, were also surveyed.

## Industry workshop

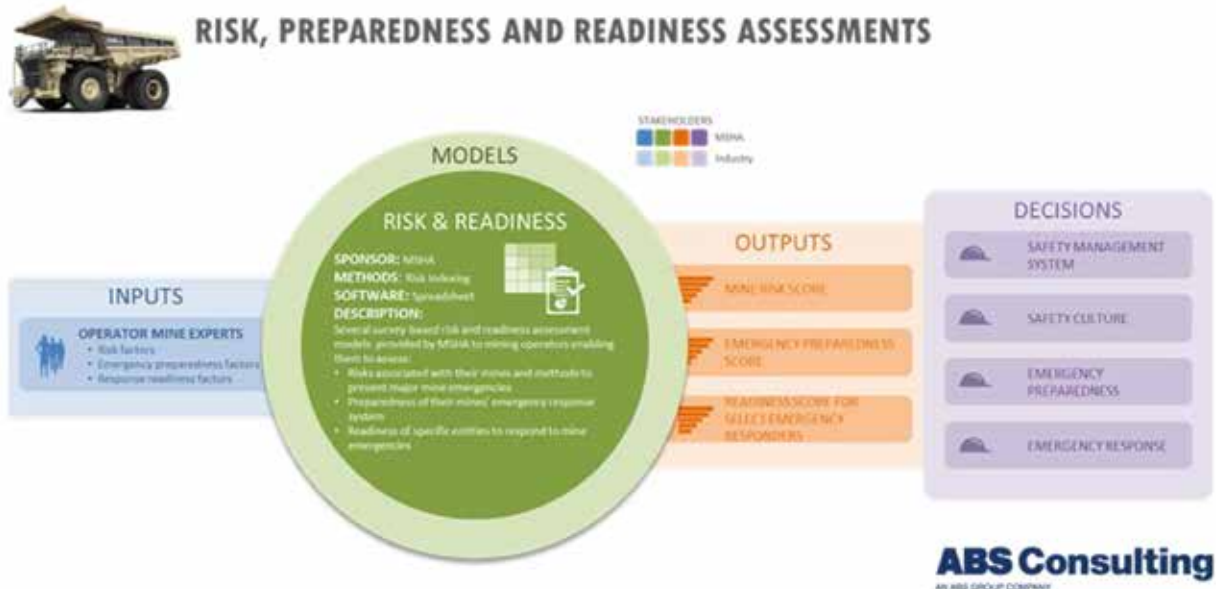
Following development of assumptions and frameworks for each model, a series of workshops with subject matter experts from the mining industry was organized to provide input on critical success factors, validate assessment criteria and assist in building out the models. The Underground Coal Mine Risk and Readiness Assessment Workshop was held at the National Mine Health and Safety Academy in Beaver, WV, on April 3-5, 2013. Industry representatives, including mine operators and emergency responders, reviewed the models and

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# Risk Preparedness

Figure 1

Mine risk, preparedness and readiness assessment model framework.



provided feedback on the factors contained in each model. Following the workshop, the ABS Group project team incorporated input from the discussions into the risk and readiness models.

MSHA and representatives from the industry groups, including National Mining Association, United Mine Workers of America, the Bituminous Coal Operators Association and the J.A. Holmes Association, also provided input for the final versions of the models that were completed in August 2013.

## The framework

These models help mine operators make safety-related decisions. The inputs to the models in Fig. 1 include risk, preparedness and readiness factors. The models themselves use a series of worksheets and a risk-indexing method to enable mine operators to assess their own operations. Outputs include a mine's risk score, emergency preparedness score and readiness scores that provide immediate information for the mine operator to make decisions related to safety management systems, safety culture, emergency preparedness and the readiness of first responders.

Inherent in the design of the models is the self-assessment approach. In an inspection environment in which an external entity conducts a review or audit, everyone hopes that the inspector doesn't find problems. In a self-assessment environment, in which the mine's management team conducts the review, everyone should be looking to uncover unaddressed problems to highlight and correct. Therefore, it is

vital that an environment of candor, courage and commitment be established by the mine's top management.

Used as a self-assessment tool, mine operators can use the results to quickly develop action plans to address areas for improvement thereby reducing risks and improving preparedness and readiness of their operations.

Figure 2 provides an illustration of the output from the assessment models. Simple color coding of the results enable coal mine operators to quickly see their areas of strengths, which are represented by green scores and the areas needing improvement, which are color coded yellow and red.

Another important feature of the models is that mine operators can use the results of these assessments for comparison among different mines within their company. Figure 3, for example, illustrates the results of the risk model among six different mines. Operators can use these comparative results to identify strengths and areas for improvement in particular risk factors among all of their mines. Associations, such as SME and the Joseph A. Holmes Safety Association, could use assessment results (anonymously) among different mining companies to look for trends across the entire industry.

## Site assessments

During 2014 and 2015, several mining companies volunteered to assist the project by assessing operations at their mine sites using the models. This field calibration phase of the project

**Figure 2**

Sample assessment output.

MODEL 1: RISK ASSESSMENT		MODEL 2: EMER PREPAREDNESS		MODEL 3: MINE RESCUE TEAMS	
Risk Criteria	Rating	Risk Criteria	Rating	Risk Criteria	Rating
<b>SECTION A – BASE RISK</b>		<b>SECTION A - PEOPLE</b>		<b>SECTION A – PEOPLE</b>	
A. Design and Planning		A. Local Coordination		A. Competencies	
B. Equip, Maintenance/Reliability		B. Knowledge		B. Training Drills And Exercises	
C. Upkeep of Infrastructure		C. Training and Exercises		C. Leadership/Organization	
D. Documentation/Records		<b>SECTION B – EQUIPMENT</b>		<b>SECTION B – EQUIPMENT</b>	
E. Equipment/Parts/Material		D. Communications		D. Rescue Team Equipment	
F. Hazardous Material		E. Firefighting		E. Mine Infrastructure Equipment	
G. Procedures		F. Facilities		F. Contracted Team Resources	
H. Workplace Conditions		G. Mine Equipment		<b>SECTION C – PROCESS</b>	
I. Training/Personnel Qualifications		H. Rescue Equipment		G. Communications	
J. Supervision		I. Outside Suppliers		H. Emergency Procedures	
K. Communication		<b>SECTION C – PLANNING</b>			
L. Personnel Performance		J. Planning			
<b>MODEL 4: RESPONSIBLE PERSONS</b>					
<b>SECTION B – ACTIVITY RISK</b>		<b>SECTION A – PEOPLE</b>		<b>SECTION C – PROCESS</b>	
M. Equipment/Infrastructure		A. Competencies		G. Communication	
N. Personnel		B. Training		H. Emergency Procedures	
O. Mining Conditions		C. Knowledge			
P. Mining Location		<b>SECTION B – EQUIPMENT</b>			
<b>SECTION C – SAFETY CULTURE</b>		D. Equipment			
Q. Safety Culture		E. Infrastructure			
		F. Contracted Resources			

provided valuable insights into the interpretation of the factors included in the models, as well as insights into improvements with the self-assessment methodology. In 2016 and 2017, ABS Group, in partnership with the Colorado Division of Reclamation Mining & Safety (CDRMS) and MSHA’s Technical Support Directorate, visited a number of underground coal and metal and nonmetal mines to conduct assessment using the models. Several mining companies with operations in Colorado, West Virginia, Louisiana and other states participated in the site assessments.

The key benefit of the self-assessment approach is for the mining company to review its own operations with a critical eye toward identifying problems. Participants also developed action plans to correct the issues found, with the aim to prevent a major mine disaster and to look for gaps in their own preparedness and readiness to respond, should an event occur. The self-assessment approach enables a mine operator to:

1. Identify problems that are often overlooked.
2. Bring together those who know the most about the mine.
3. Rely on the judgment and experience of the management team to develop action plans.
4. Provide a track record of continuous improvement.
5. Discover industry best practices and common problems.
6. Increase confidence of mine managers in

preparedness.

7. Reinforce the belief that you have done “all you can do” to prevent a mine disaster.

Feedback from the mining companies that participated in the self-assessments in 2014-2017 thought the models were helpful in improving the safety in their mining operations. Below are some of the comments from participating companies:

- “Impressed by the dialog inspired among the workforce.”
- “Made us think about things that have been taken for granted.”
- “The ‘focus group’ environment fully engaged our mine management and staff throughout assessment.”
- “Produced new understanding and insights about our preparedness to further reduce risk.”
- “We were able to engage on substance with each other.”
- “This workshop was geared toward real issues within mines.”
- “This workshop allowed for everyone’s input, which was really useful.”
- “Allowed to both provide the rating as well as fully explain it.”
- “The models can be used as a checklist for critical issues within the mine.”
- “This can be adapted to several other areas throughout the mine.”
- “This workshop increased our overall

# Risk Preparedness

**Figure 3**

Comparison of risk assessment results among different mines.

Model 1: Base Risk Assessment	Mine 1	Mine 2	Mine 3	Mine 4	Mine 5	Mine 6
A. Design and Planning	GREEN	GREEN	GREEN	YELLOW	GREEN	YELLOW
B. Equipment Maintenance	GREEN	YELLOW	GREEN	YELLOW	YELLOW	RED
C. Upkeep of Infrastructure	GREEN	RED	GREEN	YELLOW	GREEN	GREEN
D. Documentation/Records	GREEN	RED	GREEN	YELLOW	GREEN	YELLOW
E. Material/Parts/Equipment	GREEN	YELLOW	GREEN	RED	GREEN	YELLOW
F. Hazard /Defect ID	GREEN	GREEN	GREEN	YELLOW	YELLOW	YELLOW
G. Procedures	GREEN	RED	GREEN	YELLOW	YELLOW	YELLOW
H. Workplace Conditions (Human Factors)	YELLOW	GREEN	GREEN	YELLOW	GREEN	GREEN
I. Training/Personnel Qualifications	YELLOW	GREEN	GREEN	YELLOW	YELLOW	YELLOW
J. Supervision	GREEN	YELLOW	GREEN	YELLOW	GREEN	YELLOW
K. Verbal and Informal Written Communication	YELLOW	RED	GREEN	YELLOW	GREEN	GREEN
L. Personnel Performance	GREEN	YELLOW	GREEN	YELLOW	GREEN	RED
M. Equipment/Infrastructure	GREEN	GREEN	GREEN	GREEN	GREEN	N/A
N. Personnel	GREEN	GREEN	GREEN	YELLOW	N/A	GREEN
O. Mining Conditions	GREEN	GREEN	GREEN	YELLOW	YELLOW	GREEN
P. Mining Location	GREEN	GREEN	GREEN	N/A	N/A	N/A
Q. Safety Culture	GREEN	GREEN	GREEN	YELLOW	GREEN	YELLOW
<b>OVERALL – BASE RISK</b>	<b>YELLOW</b>	<b>RED</b>	<b>GREEN</b>	<b>RED</b>	<b>YELLOW</b>	<b>RED</b>

and calibrate the models in a nonmetal mine. The assessment team met with the mine management team to assess the mine’s level of risk, state of preparedness and the readiness of their mine rescue teams and designated competent persons. As with the coal mines that participated in site assessments, the management team from the Louisiana salt mine concluded that the models were an invaluable tool at improving safety for the mine.

### Selected best practices

All of the mines that were visited were able to identify best practices that they had implemented. These best practices could be shared among the entire industry, through forums such as this, to improve safety across the industry.

- Implementation process for innovative changes is informal – approved and completed quickly.
- Workforce completes risk assessment cards every day — WRACs – Workplace Risk Assessment and Control evaluations - target low probability/high consequence events.
- Monitoring systems over and above requirements — lower alarm levels than required.
- Installing proximity detection on all CMs, scoops and trammers.
- Level of team training and equipment readiness exceeds industry standards.
- Acquiring latest wireless communication and tracking system for emergencies.
- Strong succession planning for company employees.

### Next steps

In 2018, the models were adapted for use in surface coal and metal/nonmetal mines. A train-the-trainer course was also developed. Future plans also include the development of an independent governance framework to assist the entire mining industry with the continued, consistent use of the models and the sharing sanitized results across the industry to highlight trends and address industry needs. Mine operators wanting to conduct a self assessment should contact David Stalfort at ABS Group ■

self-awareness. Tremendous asset to limit risk and reduce insurance costs.”

### Conversion for use in metal and nonmetal mines

In January 2016, ABS Group and the Colorado Division of Reclamation, Mining and Safety began to convert the models for use in underground metal and nonmetal mines. The initial efforts included research on disasters that have occurred in underground metal and nonmetal mines over the past 20 years. Researchers from ABS Group met with representatives at the National Mine Health and Safety Academy to gather data on major accidents and the associated rescue operations to identify causal factors and trends. The team used the research to validate the factors in the original models and developed an initial set of risk, preparedness and readiness models for underground metal and nonmetal mines.

The Colorado Division of Reclamation, Mining and Safety sponsored a workshop in May 2016 in Denver, CO to provide an opportunity for representatives from metal and nonmetal mines, equipment manufacturers and other experts to review and revise the models, aligning terminology with that used in metal and nonmetal mines. Updated versions of these models were sent to all of the workshop participants for final review. In June, 2016, final versions of the new underground metal and nonmetal risk, preparedness and readiness models were completed.

In December 2016, an assessment team from ABS Group and the Colorado Division of Reclamation, Mining and Safety visited an underground salt mine in Louisiana to test