Asia-Pacific Partnership Coal Mine Task Force Steering Committee Meeting

Objective: To identify priority challenges and address steps to move forward

Improvements in U.S. Mine Safety
Fatality Rates

- Dramatic since 1977 Act

- Underground Coal: 1977-2004
  - ✓ Fatal IR down 47.8% to 0.036
  - ✓ Fatalities dropped from 112 to 14*

- Underground Metal/Nonmetal: 1977-2004
  - ✓ Fatal IR down 83.7%
  - ✓ Fatalities dropped from 35 to 1* (2003)

* Record low

Improvements in U.S. Mine Safety
Lost-Time Injury Rates

- Underground Coal: 1977-2004
  - ✓ NFDL IR: 10.87 to 6.24
  - ✓ Down 42.6%

- Underground Metal/Nonmetal: 1977-2004
  - ✓ NFDL IR: 10.54 to 3.50
  - ✓ Down 66.8%

U.S. Experience
Significant Hazards: 1996-2005
(MSHA reportable accidents)

- Annual average of 5.5 fires
- Annual average of 69.4 ignitions and explosions
- Annual average of 19.7 inundations
- Thus significant risk of loss exists, even when major emergency events do not occur

U.S. Experience in 2006

- All coal mine fatalities reach 46 (thus far)
- Two explosions and a fire => 19 fatalities
- The tragedies revealed vulnerabilities at some underground coal mines
- Challenge: Protect miners by addressing vulnerabilities and persistent problems

Improving Mine Safety Technology and Training: Establishing U.S. Global Leadership

Report of the Mine Safety Technology & Training Commission

Commissioners

Dr. R. Larry Grayson, *Chairman*
University of Missouri-Rolla

Mark Beauchamp
Twentymile coal Company

Anthony Bumbico
Arch Coal, Inc.

Stanley I. Cohn
Concepts to Operations, Inc.

Dr. Amy Donahue
University of Connecticut

J. Brett Harvey
CONSOL Energy, Inc.

Dr. Jeffrey Kohler
NIOSH

Dr. Thomas Novak
Virginia Tech

Cecil Roberts, Jr.
UMWA

Buddy Webb
Waste Isolation Pilot Plant

Process

- ✓ Created March 2006
- ✓ Process, charter and outline done at March meeting
- ✓ Additional meetings in April, May, July
- ✓ Preliminary draft report in July
- ✓ Final draft report in September
- ✓ Expert review: September-October
- ✓ Final report: Released today

Charter

- Study existing and new technologies, including in other industries
- Determine which can improve protection of underground coal miners
- Consider dynamic aspects of mining, and need for new perspectives and approaches
- Particularly look at new technologies and procedures ***potential impact*** in ***significantly increasing odds of survival for miners in emergency situations***

Fire & Explosion Fatalities 25 Years

- 1984-1992 (9 years) — 6.11/yr
  - ✓ 5 explosions – 28 fatalities
  - ✓ 1 fire – 27 fatalities
- 1993-1999 (7 years) — Remarkable!!!
  - ✓ No fatalities
- 2000-2006 (6 years, to early 2006) — 6.17/yr
  - ✓ 5 explosions – 35 fatalities
  - ✓ 1 fire – 2 fatalities

40% of fatalities

Why the recent problems?

Why the recent problems?

- Evolution of how threats of abandoned areas are controlled
- Fire suppression technology has not kept pace with equipment evolution
- Influx of new miners coupled with mentoring void concerning handling of infrequent emergency situations
- Design of mines changed over time
- Based on record safety performances, some level of complacency cannot be ruled out

Fire & Explosion Fatalities Weaknesses & Gaps

- 1984-1992 (9 years – 55 fatalities)
  - ✓ Inadequate ventilation of bleeders and active workings – 5 of 6 incidents
  - ✓ Air flows to bleeders disrupted by roof falls, rising water, construction or removal of controls, missing controls, liberation of methane from rider seam
  - ✓ Repercussions of air changes not understood

Fire & Explosion Fatalities Weaknesses & Gaps

- 1984-1992 (9 years – 55 fatalities)
  - ✓ Monitoring of methane inadequate in 2 cases
  - ✓ Low barometric pressure enhanced migration of methane
  - ✓ Serious/blatant violations of regulations in four cases

Fire & Explosion Fatalities Weaknesses & Gaps

- 1984-1992 (9 years – 55 fatalities)
  - ✓ Inattention to good mining practices (fire protection, delayed response to escape, trying to help other miners)
  - ✓ Lack of familiarity with alternate escape route
  - ✓ SCSR/FSR not used properly

Fire & Explosion Fatalities Weaknesses & Gaps

- 2000-2006 (6 years – 37 fatalities)
  - ✓ Inadequate ventilation in 2 of 6 cases
  - ✓ Only one bleeder system inadequately ventilation
  - ✓ Sealed gob areas involved in 2 cases (Sago and Darby mines)
  - ✓ Delayed response to escape (2 cases)

Fire & Explosion Fatalities Weaknesses & Gaps

- 2000-2006 (6 years – 37 fatalities)
  - ✓ Communication systems destroyed
  - ✓ Knowing location of miners problematic
  - ✓ SCSRs not fully used; difficulty in using them reported

Summary of Persistent Issues and New Complexities

- Worked-out areas of mines a critical issue, including detecting methane levels in and near sealed areas
- Not delaying escape is a paramount issue
- Maintaining communications with escaping and trapped mines is critical
- Reliability and meeting intended purpose of SCSRs is critical

Summary of Persistent Issues and New Complexities

- Improving state of preparedness for escape and emergency response is imperative
- Slow response in reporting emergency needs addressed (done now)
- Need better means for protecting trapped miners
- Complex and dynamic change occurring; more hazards likely in future

Recommendations (75) by Content Area

- Risk-Based Design and Management
- Communications Technology
- Emergency Response and Mine Rescue Procedures
- Training for Preparedness
- Escape and Protection Strategies

Risk-Based Design and Management

- Risk assessment and management is a well-established process used by high-performing industries, which have reduced accidents in high-hazard situations
- Exemplars include:
  - ✓ U.S. Navy Submarine Flooding Prevention and Recovery Program
  - ✓ Naval Nuclear Propulsion Program
  - ✓ Aerospace Corporation's Launch Verification Process

Risk-Based Design and Management

- Columbia Accident Investigation Board:

  "The safety cultures and organizational structure of all three [exemplar organizations] make them highly adept in dealing with inordinately high risk by designing hardware and management systems that prevent seemingly inconsequential failures from leading to major accidents."

Recommendation #1
Risk-Based Design and Management

- … a comprehensive approach, founded on the establishment of a culture of prevention, be used to focus all employees on the prevention of all accidents and injuries.

Recommendation #2
Risk-Based Design and Management

- … every mine should employ a sound risk-analysis process, should conduct a risk analysis, and should develop a management plan to address the significant hazards identified by the analysis; simple regulatory compliance alone may not be sufficient to mitigate significant risks.

Risk-Based Design and Management

Minerals Council of Australia through the Minerals Industry Health and Safety Centre, University of Queensland, adopted risk assessment guidelines (Joy and Griffiths, 2005), stating:

"The Minerals Council of Australia as the initiator of this project is seeking to take risk assessment in the Australian minerals industry to the next level. … This on-line resource is structured to help individuals design and undertake formal and informal risk assessments. … The Council believes this Guideline will make an important contribution in ensuring the Australian minerals industry continues to provide leadership in improving the safety performance of the minerals sector."

Recommendation #3
Risk-Based Design and Management

- … NIOSH develop a series of case studies that mines could use as templates for guidance on conducting risk analysis and developing a risk management plan, and that it conduct workshops and seminars to diffuse this throughout the industry.

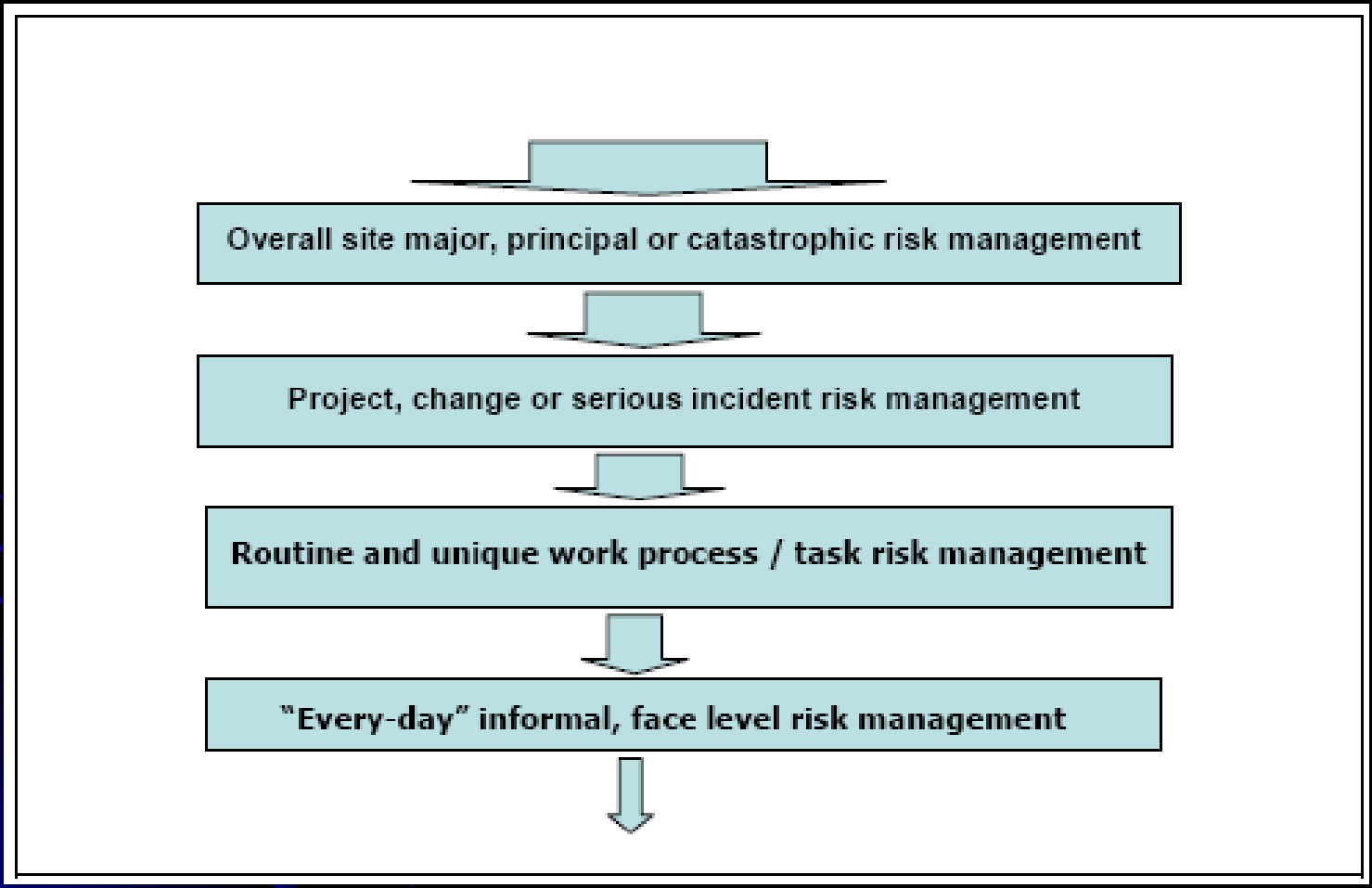
Risk-Based Design and Management

- It is important to understand how to manage the implementation of risk analysis, and introduce the concept in a planned, methodical manner.

- Learning how to use practical approaches to address major risks is the important first step of a “multi-layered” risk management approach.

Risk-Based Design and Management

Multi-layered approach to risk management.*



* Phelps Dodge Study (Joy, 2006)

Risk-Based Design and Management

- It is important to recognize that the change to a “culture of prevention” via “systematic and comprehensive risk management” involves a journey with each step taking several years.

Recommendation #4
Risk-Based Design and Management

- … **an industry stakeholder working group investigate and suggest optimal approaches to managing the change to a minerals industry risk management paradigm.**

Recommendation #5
Communications Technology

- … mines utilize hardened mine pager phone or leaky feeder systems, as an interim measure, to meet the immediate need for post-incident emergency voice communications.

Recommendation #6
Communications Technology

- … the development of guidelines to address the network architectures, the mechanical strengthening of components, altered installation practices, and modifications to the hard-wired network be completed as soon as possible.

This will require substantial engineering design and testing, but is doable over twelve to eighteen months.

Recommendation #7
Communications Technology

- … a hybrid communication system be developed to allow reliable wireless communication enhanced by the leaky feeder backbone or other metallic infrastructure, such as wire-core life lines, haulage track, and pipes, and that such a system be deployed in mines as soon as possible.

Recommendation #8
Communications Technology

- … work be done to adapt “breadcrumb” technology for use by mine rescue teams.

Breadcrumb nodes are portable and can be battery powered. Several nodes combine to create an ad-hoc mesh network. The network can be deployed as a stand-alone wireless network as the rescue team advances into the mine.

Recommendation #9
Communications Technology

- … work be conducted to develop an RFID-based tracking system that will function with the emergency communication systems that are under development, such as the software defined radio, and that the system be demonstrated as soon as the emergency communication systems are developed.

Recommendations #10 & #11

Communications Technology

- … NIOSH lead the development of standards for wireless communications in underground mines.

- … alternative and promising emergency communications and tracking systems be developed and commercialized for the long-term enhancement of mine safety.

Recommendations #12-51

Emergency Response & Mine Rescue Procedures

- Training quality (8)
- Collaboration (4)
- Standardization (4)
- Team expertise and sustainability (6)
- Response time (1 - 4 parts)
- Team deployment (3)
- Incident Command and Decision-Making (9)
- Equipment and Technology (5)

Essence of Emergency Response and Mine Rescue Procedures Recommendations

- Broader and deeper professionalization of the mine rescue function needed
- Certification and training of teams are critical aspects as well as the skill-composition of teams and standardization of procedures
- Facilities, organizations, and structure to facilitate the development of professionalization are needed

Training for Preparedness
Key Skill/Knowledge Areas

- Knowledge of Escape/Rescue Technologies
- Mine-Specific Knowledge
- Escape/Rescue Conceptual Knowledge – greatest potential for improving successful escape

Training for Preparedness

Training for Preparedness Survey

- Training issues addressed by the Survey include:
  - ✓ The escape/rescue competency levels of miners
  - ✓ Methods of evaluating competency levels
  - ✓ The need to develop new/better training materials

Training for Preparedness

Training for Preparedness Survey

- In the commission's view, the results of the Survey confirm the findings of the NIOSH research with regard to improving the ability of miners to escape (or be rescued) during a mine disaster.

Recommendation #52

Training for Preparedness

Regulatory Training

- … the following priority training needs be addressed in MINER Act training:

  - ✓ SCSR training, including
    - o Donning an SCSR
    - o Transferring from one SCSR unit to another SCSR
    - o Expectations training (breathing through an SCSR)
    - o Location of SCSR caches

Recommendation #52 (cont'd)

Training for Preparedness

Regulatory Training

- ✓ Escape ways, including
  - o Location of escape ways
  - o Walking key portions of escape ways
  - o Location and use of lifelines (and/or other directional devices)
  - o Way-finding (utilizing alternate escape routes)

Recommendation #52 (cont'd)

Training for Preparedness

Regulatory Training

- ✓ Ventilation, including
  - o Mine ventilation systems
  - o Ventilation leakage
  - o Effects of carbon monoxide and other gases

Recommendation #52 (cont'd)

Training for Preparedness

Regulatory Training

- ✓ Barricading, including
  - o Barricading as a last resort
  - o How to erect an effective barricade

Recommendation #52 (cont'd)

Training for Preparedness

Regulatory Training

- ✓ Emergency response procedures, including
  - Training on mine emergency response plan
  - How to give/receive effective emergency warnings
  - Firefighting training

Recommendation #53

Training for Preparedness

Regulatory Training

- ✓ … MSHA use its existing authority to approve training plans to improve the quality of training provided to miners.

Recommendation #54

Training for Preparedness

Priority Needs

- ✓ … the industry, MSHA and NIOSH focus their "training for preparedness" efforts in the following critical areas:
  - o Emergency response decision-making training
  - o Leadership training for supervisors
  - o Team-building training
  - o Simulated smoke training

Recommendation #54 (cont'd)

Training for Preparedness

Priority Needs

- ✓ Also in:
  - o Dealing with stress during:
    - Emergency escape
    - Barricading
    - SCSR use
    - Command center protocol for mine managers

Recommendation #55

Training for Preparedness

Evaluation Methods

- … the industry, MSHA and NIOSH focus on developing and/or improving methods of evaluating the self-escape and aided-rescue competencies of underground miners (and other key emergency personnel) in the following areas:

  - ✓ Emergency/response decision-making

  - ✓ Coping with a smoke-filled environment

Recommendation #55 (cont'd)

Training for Preparedness
Evaluation Methods

- Also in:
  - ✓ Implementing emergency response procedures
  - ✓ Locating escape ways and lifelines
  - ✓ Way-finding (identifying alternative escape routes)

Recommendation #56

Training for Preparedness

New/Improved Training Materials

- … industry, MSHA and NIOSH focus resources on developing new/improved training materials in the following areas:
  - ✓ Simulated smoke training
  - ✓ Emergency/response decision-making
  - ✓ Team-building

Recommendation #56 (cont'd)

Training for Preparedness

New/Improved Training Materials

- Also in:
  - ✓ Leadership training for supervisors
  - ✓ SCSR expectations training
  - ✓ Constructing effective barricades
  - ✓ Mine rescue protocol training

Recommendation #57

Escape and Protection Strategies

- … mine-specific escape and rescue plans be required for each underground coal mine, and such plans must specify measures to be taken to address specific hazards at the mine that are responsive to the mine's characteristics.

Recommendation #58

Escape and Protection Strategies

- Because of the high priority of escape from the mine during an emergency, the following recommendations are aimed at increasing the probability of escape:

  - ✓ That improved technology for oxygen provision be pursued so that devices can be practically worn by miners.

Recommendation #59

Escape and Protection Strategies

- Also recommend:
  - ✓ That life lines, preferably with a metal core to facilitate emergency communications, or other direction-indicating devices be installed in all designated escape ways.

Recommendation #60

Escape and Protection Strategies

- Also recommend:
  - ✓ That tag lines be made available at strategic locations in a mine, including near the beginning of all designated escape ways.

Recommendation #61

Escape and Protection Strategies

- Also recommend:
  - ✓ That required oxygen-supply device caches may be located in substantially constructed areas between adjacent designated escape ways. This would require MSHA approval.

Recommendation #62

Escape and Protection Strategies

- Also recommend:
  - ✓ That MSHA-approved compressed air breathing apparatuses and refill stations, or other approved oxygen-supplying devices, may be substituted for SCSRs in a mine, provided devices are not mixed.

Recommendation #63

Escape and Protection Strategies

- Also recommend:

  - ✓ That 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 from a mine during an emergency.

Recommendation #64

Escape and Protection Strategies

- The commission recommends the following actions to protect miners during an emergency, even if they are not able to escape:

  - ✓ That research on and/or development of oxygen-supply devices be pursued such that the devices must provide adequate oxygen to effect escape, be capable of renewing the oxygen source without removing the face piece and be more practically wearable.

Recommendation #65

Escape and Protection Strategies

- Also recommend:

  - ✓ That standards to govern specifications for a safe room be fully developed for future optional implementation.

Hardened, isolated “safe rooms” could be constructed along escape ways where escaping miners may take off their SCSRs, rest, get food and water, and through borehole service, call outside for a status update (both ways). Miners could then move on to the next “safe room.” The implementation of safe rooms should be based on risk analysis.

Recommendation #66

Escape and Protection Strategies

- Also recommend:
  - ✓ Specifications for fire-suppression systems, the flow quantity and pressure required for water lines, and other fire-protection measures be evaluated for compatibility with modern technology, and that a risk analysis form the basis for modifications.

Recommendation #67

Escape and Protection Strategies

- Also recommend:

  - ✓ Expand ability to control fires, and mitigate the risk of a major fire by developing "Fire Brigades," first responders, etc. and further recommends that every underground mine adopt the Fire Brigade, first responder, etc. concept. The commission also recommends that MSHA provide support for Fire Brigades, first responders, etc. by developing relevant, effective training materials.

Recommendation #68

Escape and Protection Strategies

- Also recommend:
  - ✓ A systems approach to mine ventilation be applied, utilizing mine personnel familiar with overall ventilation-system complexities, to analyze different possible modifications of the ventilation system for potential hazards and assure that risks are identified and addressed.

Recommendation #69

Escape and Protection Strategies

- Also recommend:

  - ✓ Research is needed to determine whether new science-based, practically achievable specifications for stopping construction along escape ways are needed to better preserve the escape routes for use in emergencies.

Recommendation #70

Escape and Protection Strategies

- Also recommend:
  - ✓ New criteria for the approval of seal designs and installation be determined through research, that seal installation be certified, and that mines conduct a risk-based assessment of all potential hazards related to sealed areas to determine how to manage the identified risks.

Recommendation #71

Escape and Protection Strategies

- Also recommend:
  - ✓ "Hardened" monitoring systems be developed and that methods for safely utilizing monitoring during emergencies be established.
  - ✓ Research and development be conducted to identify opportunities and practices for safety improvement through an expanded use of a mine monitoring system.

Recommendation #72 & 73

Escape and Protection Strategies

- Also recommend:
  - ✓ Research be conducted on strategies and technologies to maintain miners trapped underground and to facilitate their rescue.
  - ✓ Mines need to employ a range of strategies and technologies that are consistent with their risk analysis and management plan.

Recommendation #74

Escape and Protection Strategies

- Also recommend:
  - ✓ Require 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, various scenarios would be assessed for hazards and interventions taken to reduce the risks.

Recommendation #75

Escape and Protection Strategies

- Also recommend:
  - ✓ Congress study the level of funding that would be commensurate with the need to support research and development, cultivation of safety and technical professionals, addressing the serious shortage of miners and mine supervisors, and other issues for this high-risk industry

Conclusions

- Strong measures need to be adopted by all constituencies of the industry now to move the safety performance level forward to a leadership position globally.

Conclusions

- Report outlines a comprehensive, risk assessment-based approach toward prevention, which should significantly increase the odds of survival for miners in emergency situations, but also provides a guideline for pursuing zero accidents from all sources.

Conclusions

- Also, details included in following areas:
  - Communications technology,
  - Emergency response and mine rescue procedures,
  - Training for preparedness, and
  - Escape and protection strategies

Conclusions

- Broad issues framed by recommendations deserve serious attention, and should be used to fundamentally change the management approaches and work practices taken to fulfill basic safety requirements

Conclusions

- Companies which do not pursue the outlined approaches aimed at fulfilling fundamental safety requirements should not be permitted to operate underground coal mines.

Conclusions

- All major stakeholders should be involved in any process seeking to actuate various recommendations
- Many different options exist for implementation of specific recommendations
- We are hopeful that the details of the recommendations will be embraced and acted upon