Intrepid Potash
Major Hazard Risk Assessment

Application of risk assessment techniques
to review natural gas and oil ingress risks

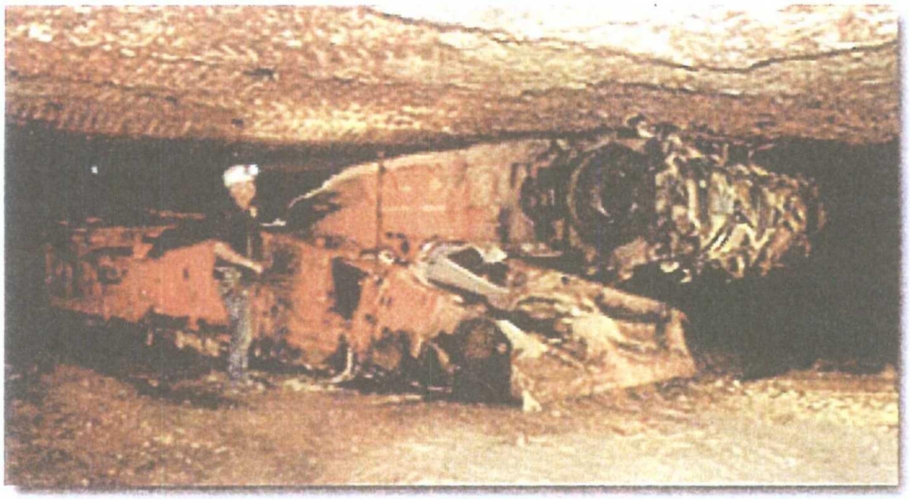

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EXHIBIT
Intrepid 20

This exercise and the development of this document were funded by a NIOSH research project on the "Application of Major Hazard Management and Risk Analysis Methods" to US mining situations. As such the report has been developed to communicate specific results to the subject mine while providing context to NIOSH for the evaluation of methods and processes to assess and manage risk in US mines.

Using This Report

This report is designed to document a specific risk assessment exercise that was done at Intrepid Potash Mine. As such it is not intended to be a procedural document for the mine or mining company

To optimally apply the results of the exercise and the information in this report the following 3 activities should be subsequently undertaken

1. Use the information "Priority Existing Controls" in the Results Section of this report to define a list of controls that should be monitored and audited regularly at Intrepid Potash to ensure they are in place and effective.

2. Complete the draft "Action Plan of Potential New Controls" in the Appendices. This Action Plan lists all the new potential controls identified by the team. As such each idea should be used to derive specific actions or an alternative approach established.

3. Review the content of this report at least annually to ensure the risks have not changed over the previous period. Changes can include a change in the nature or magnitude of the hazard, changes in control status, changes to key personnel, etc.

This report should also be retained in the mine's document control system.

Definitions

The following definitions of terms used in this report have been extracted from the Australian Minerals Industry Risk Assessment Guideline www.mishc.uq.edu.au .

Barrier (or Controls)
Anything used to control, prevent, or impede energy flows Types of barriers include physical, equipment design, warning devices, procedures and work processes, knowledge and skills, and supervision. Barriers may be control or safety barriers or act as both.

Consequence
The outcome of an event expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain. There may be a range of possible outcomes associated with an event.

Event
An incident or situation, which occurs in a particular place during a particular interval of time

Hazard
A source of potential for harm or a situation with a potential to cause loss, an uncontrolled exchange of energy

Likelihood
Used as a qualitative description of probability or frequency

Loss
Any negative consequence, financial or otherwise.

Monitor
To check, supervise, observe critically, or record the progress of an activity, action or system on a regular basis in order to identify change.

Probability
The likelihood of a specific event or, outcome measured by the ratio of specific events or outcomes to the number of possible events or outcomes Probability is expressed as a number between 0 and 1, with 0 indicating an impossible event or outcome and 1 indicating an event or outcome is certain.

Residual risk
The remaining level of risk after risk treatment measures have been taken

Risk
The chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood.

Risk acceptance
An informed decision to accept the consequences and the likelihood of a particular risk.

Risk analysis
A systematic use of available information to determine how often specified events may occur and the magnitude of their consequences.

Risk assessment
The overall process of risk identification, risk analysis and risk evaluation

Risk identification
The process of determining what can happen, why and how.

Risk management
The culture, processes and structures that are directed towards the effective management of potential opportunities and adverse effects.

Risk management process
The systematic application of management policies, procedures and practices to the tasks of establishing the context, identifying, analysing, evaluating, treating, monitoring and communicating risk.

Background

Twenty-nine coal miners went underground at International Coal Group's Sago Mine near Buckhannon in Upshur County, West Virginia, on the morning of 2 January 2006. At 6:26 am 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.

(This information was extracted from "The Sago Mine Disaster: A preliminary report to Governor Joe Manchin III" published in July 2006)

The impact of this event on the US mining industry has been both swift and extensive. One aspect involves government supported investigation of mine safety approaches used across the global mining industry

A recent report by the US Mine Safety Technology and Training Commission titled "Improving Mine Safety Technology and Training: Establishing US Global Leadership" stated the following in the Preface.

"The report that follows rings a clarion call for a new paradigm for ensuring safety in underground coal mines, one that focuses on systematic and comprehensive risk management as the foundation from which all life-safety efforts emanate."
(full report available at http://www.coalminingsafety.org/default.asp)

NIOSH is working in many related areas including an investigation of Australian minerals industry risk management methods specific to major hazard management. As part of this project, mining companies have been invited to seminars and involved in discussions about providing an opportunity to apply related methods as part of the investigation. Intrepid Potash, among other companies, stated interest in participating and provided an issue at their mines for examination using the risk assessment methods.

Introduction to the Project

The Intrepid Potash website provides the following description of their Carlsbad area mining operations

"Potash is mined from subterranean salt deposits containing a mixture of potassium chloride (KCl) and sodium chloride (NaCl) and other impurities The Carlsbad deposits are located 800 to 1,500 feet below the surface. Potash is recovered in a refining process by which the potassium chloride is separated from the sodium chloride and other impurities

Facilities are located near Carlsbad, New Mexico, and referred to as the "West Facility" and the "East Facility " The Company also operates a granular compaction plant near the East and West Facilities which is referred to as the "North Facility."

West Facility

The West Facility comprises a mine and refinery, originally built by U S Potash in 1929

All refined product produced at the West Facility is transported to the North Facility compaction plant where the vast majority is converted to granular form and sold to agricultural fertilizer dealers and distributors

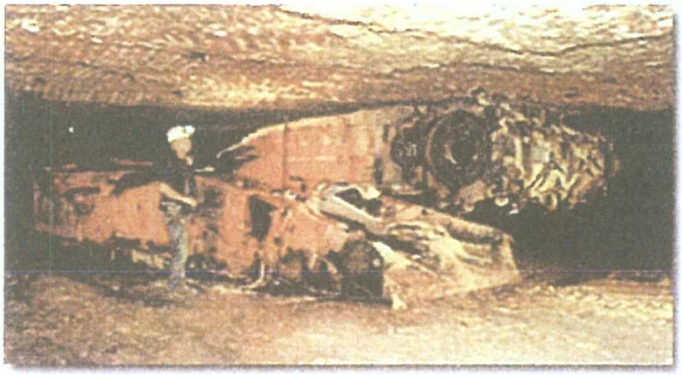
The main ore body at the West mine is located 800-1100 feet below the surface After initial crushing, the mined ore is moved to a shaft by conveyor and hoisted to the surface

East Facility

All of the refined potash products produced at this facility are a standard form of white potash, which is of high purity A significant part the production is converted to granular grade at the on-site compaction plant and sold as an agricultural fertilizer

The East facility produces 62%, white Muriate of Potash (MOP) products

The product is mined, upgraded and screen into the various grades The product is then loaded and shipped in railcars and trucks for delivery to industrial and agricultural customers.



Potash mining is similar to underground coal mining and uses similar continuous mining equipment. It is relatively safe mining due to the high strength and stability of the geological strata

Intrepid Potash – Carlsbad, NM LLC has an outstanding safety record "

At about 10,000 feet below the surface in this area there is also a natural gas and oil deposit in a Permian Basin This deposit has been drilling and recovered for many decades with considerable drilling activity in proximity to the Intrepid Mines.

Intrepid Potash is aware of the current and past drilling. Significant precautions have been undertaken to reduce the likelihood that gas or oil from the reservoir below the mines does not enter the mine workings However, because the consequences could be so large, they have decided to review the issue using a systematic risk assessment method

Objective

The objective of this risk assessment was to,

1. Review hazards associated with the potential for a natural gas inundation of the active mining area,
2. Evaluate strategies and techniques for management of the hazard, and
3. Provide information to help develop an inundation risk management plan for this mine

Method

The risk assessment project was designed (or scoped) in early 2007 based on discussion between Intrepid management personnel and Mr. Floyd Varley of NIOSH.

The Risk Assessment involved facilitation of a team of personnel through a structured process involving the following steps.

1. Hazard description
2. Pathways identification
3. Potential unwanted event identification
4. Bow Tie Analysis method introduction
5. Causes and prevention controls discussion
6. Consequences and loss reduction controls discussion
7. Repeat of Steps 5 and 6 for all the unwanted events identified in Step 3.

Risk Assessment Team

The team was made up of persons familiar with the mine's operation, as well as an external facilitator and two observers.

The team members were as follows.

- Intrepid Potash
  - Robert Baldridge, Manager of Mines
  - Tom McGuire, Chief Mine Engineer
  - Andrew Schissier, Manager of Engineering
  - Randy Logsdon, Manager of Safety
  - Dick Heinen, Manager of Operations
  - Dennis Hill, Relief Electrical Supervisor

- NIOSH Observers
  - Tom Camm, Mining Engineer
  - Tom Brady, Mining Engineer

- University of Queensland / MISHC
  - Jim Joy, Director / Facilitator

The work was carried out at offices on the Intrepid Potash facilities on Monday, March 11th and Tuesday March 12th, 2007

Hazards

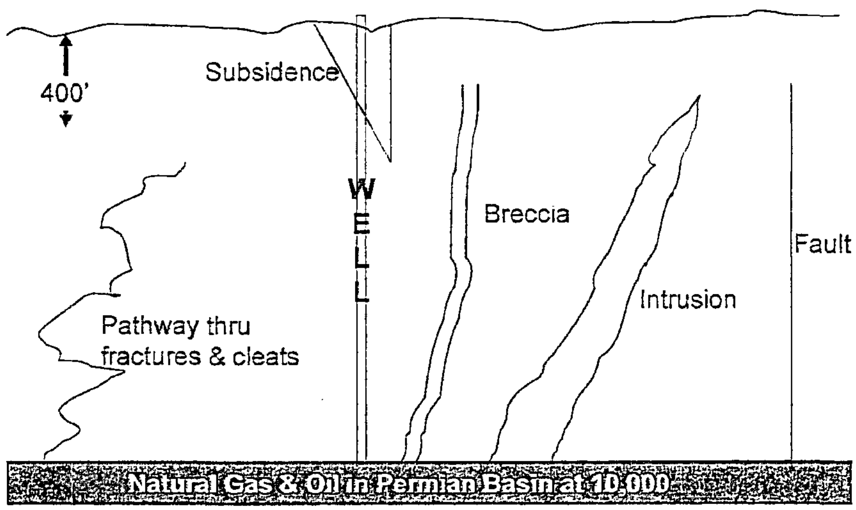
The first step in the risk assessment involved identifying and understanding the hazard related to natural gas and oil around the current and planned Intrepid Potash mining operations.

The primary inundation hazard was seen to be the natural gas located in the Permian Basin approximately 10,000 below the surface, as well as the gas in any natural or man made conduits from below There was also a hazard related to gas being piped on the surface on or in proximity to the mines.

Pathways from Basin/Gas Well into Mine were also identified by the team as follows.

- Up the inside of the drill pipe
- Up the drill hole but outside the casing
- Up faults
- Up/along igneous intrusions such as dikes
- Up through permeable ground along fractures or cleats
- Up to mine from collapsed breccia pipes
- Down to mine workings from wells damaged by subsidence

Natural Gas Hazard Schematic



The risk assessment team created the above schematic to illustrate the hazards and pathways related to the Intrepid Potash mining operations.

Consequences of an Unwanted Event

The team noted that ground material at Intrepid East is so hard that sparks are produced from use of cutting machines during production. Also, there is no intrinsically safe mining equipment at either mine. The mines are currently classified by MSHA as class IV

Therefore, should natural gas enter the mine, heat sources could be readily available to cause an ignition

The mine has protocols for different gas methane levels detected by hand held units

At 0.5% ventilate and retest; requires notification of supervisor
At 1 0% ventilate, shit down equipment, notify supervisor, power off in the panel
At 2.0% ventilate, shit down equipment, remove personnel and notify supervisor

The monitors are intended for methane but will respond to natural gas, though it was not clear whether the monitors have been calibrated to the natural gas.

If an explosion occurred, the pressure would probably destroy all stoppings as stoppings are made of brattice cloth. The ventilation could be totally disrupted and egress could also be severely compromised by the event. The mine has series ventilation leading to one panel's exhaust becoming another panel's intake. In an area where gas ingress event occurs escape involves getting to fresh air but, for downstream ventilated areas, egress may be compromised and made more complicated.

Barricading may not work for this type of event; miners will need to get out of the mine

The team identified that an ingress of natural gas into the mine workings could have all or some of the following consequences.

- Oxygen displacement
- 2 – 15% hydrocarbon (methane mostly) explosive range atmospheres
- Large prolonged ignition
- Multiple fatalities
- Major mine damage
- Classification of mine to an MSHA gassy mine that would cause Mine to shutdown because there are no current mining equipment that are permissible for the new higher class

In summary, the team identified that any ingress event could be catastrophic to the mine and, potentially, mine personnel.

System Boundaries

The team analyzed possible natural gas ingress hazards in relation to the overall mine plan for Intrepid Potash, considering both current and future operations.

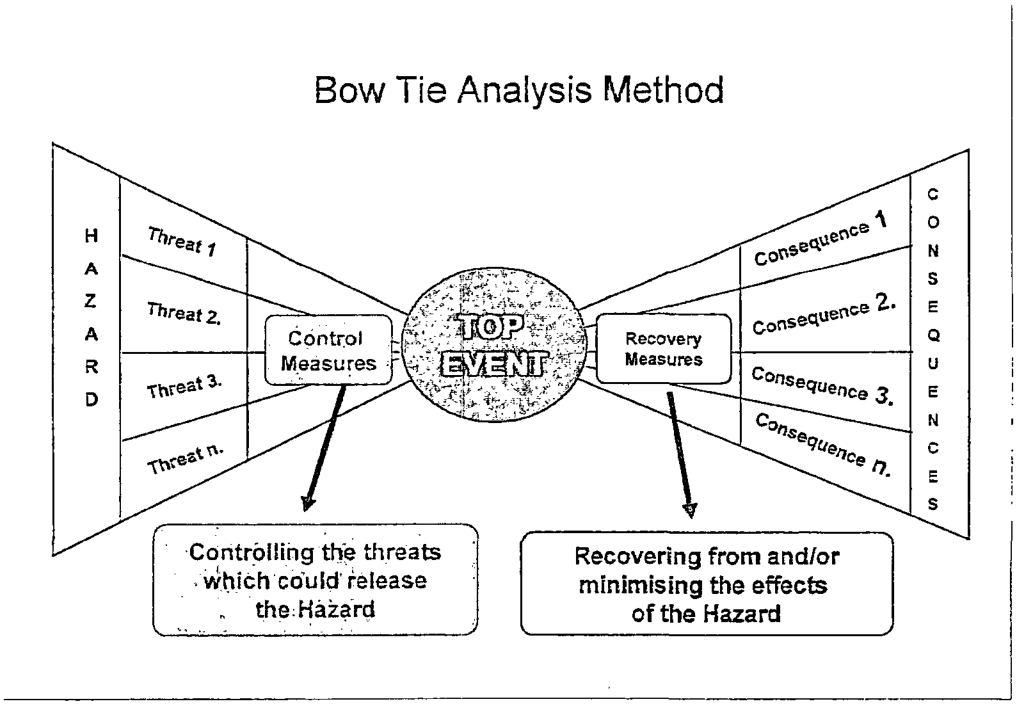
Risk Assessment Methods Outline

Bow Tie Analysis Method

The *Bow Tie Analysis* (BTA) tool was selected for examining the threats at the specific locations and the controls used to mitigate the gas ingress risk. Once a list of priority unwanted events was identified, they were examined in more detail using the BTA method

Bow Tie Analysis was developed by Shell Oil in the 1980's as part of their Tripod package of concepts and tools for managing occupational health and safety in their business.

The illustration below suggests the logic of BTA. The tool requires that specific causes (called "threats" in BTA) are identified for a specific event. It is important to note that the "Top Event" in the BTA is not the full event and consequence considered in the BBRA but rather a statement about the initiating event that might lead to the major consequence. Following that step control measures intended to prevent the unwanted initiating event. The team discusses the nature and quality of the prevention controls as part of the BTA. The right side of the BTA requires that all consequences to the unwanted initiating event are all identified. Consequences can involve impact areas (persons hurt, systems damaged, etc.). Of course these may vary with location of the unwanted event, as well as the phase of the mining. Therefore the BTA must be done considering these dimensions.



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The left side of the Bow Tie, and first step, looks at all causes of that event and the prevention controls. The right side, and second step, of the BTA examines all the potential consequences of the event followed by identification of all recovery measure controls intended to reduce or minimise the loss.

The Bow Tie Analysis method was used by the Intrepid Risk Assessment Team to review and discuss the current controls in place to reduce risks related to a series of hypothetical ingress events.

Results

As a result of the discussion the team identified a list of hypothetical, potential unwanted events for further consideration. Natural gas ingress due to:

1. Mining into an existing oil/gas well
2. Mining into old workings that have gas from pathways or another source
3. Mining into fault / dike / breccia pipe which contains gas
4. A sudden collapse in an old mined area leading to puff or blast of gas into mine workings
5. Gas leaks into mine workings from an oil/gas well through strata
6. Gas leaks into mine workings from faults or dikes
7. Gas leaks into mine workings from breccia pipes
8. Gas leaks into mine workings through permeable ground
9. Gas leaks into mine workings from subsidence around well area.
10. Drillers accidentally fracing a well in a way that creates a pathway for gas into mine workings
11. A gas line on surface rupturing and the gas being sucked into mine surface ventilation intake (note that the fans are underground)

The Bow Tie Analysis approach was used to consider each of the above events. Based on the analysis that was done by the team, following are the key existing controls for these risks that should be in place throughout relevant phases of the mining operations. As such they should be reinforced, monitored and audited with priority. Full information from the BTA is located in Tables in Appendix B

Priority existing controls for event prevention

1. Physically checking surface well location i.e. topographic, aerial, recon, etc.
2. Checking well locations against well locations supplied by state of New Mexico
3. Monitoring for new Applications for Drilling (APD)
4. Checking on the ground for old well location by locating old bricks, oil seeps, etc

5. Developing and updating the oil and gas map database
6. Applying a circle radius for oil wells of 1320 feet and for gas wells of 2640 feet. (Intrepid standards not MSHA)
7 Resurveying all locations on mine property (GPS survey) and comparing them to the mine survey to reduce likelihood of wrong location on map.
8 Using quality Software (CAD and Geographic) to check and compare each mapped well location
9 Third party checking of data and map location
10. Ongoing checking of the surveys
11. Keeping the elevation of all mine workings in mine panels
12. Using the best technology and taking every survey shot with triple flop of scope
13. Locating escape maps in dinner hole that plot oil and gas locations in critical mining areas
14. Providing regular work area maps for foremen which plot lease boundaries and the location of oil and gas wells
15. Surveying panels every 125 feet to fix locations
16. Maps are given every work day to foremen and operators at west Intrepid Mine
17. Discussing and clarifying work expectations everyday
18. Shift bosses being able to open up maps underground
19. Foremen giving each operator his personal map on surface at start of shift (West Intrepid)
20. Operator error would be identified by shift foremen monitoring mine work to ensure well location is known and operator is following mine plan and matches survey location
21. Operator error (depending on the nature of the deviant behavior) would be dealt with by known disciplinary procedure (verbal, written communication, days off, fired)

Priority existing controls to reduce consequences should an ingress occur

1. If major in rush of gas occurs the expectation is that all equipment power would be shut off (miner can trip power to transformer from mining machine), supervisors would be notified and all other equipment would be shut down
2. At West Intrepid, power would be shut off to rest of mine except hoist by call to Lubbock, TX, the electrical power supplier
3. At East Intrepid, mine power would be shut down by surface personnel.
4. Current evacuation plans call for mine workers to utilize diesel & battery equipment to get to shaft which are intake but is the auxiliary escape route.
5. Escape and emergency egress is practiced every six months.
6. Other U/G personnel not in the immediate vicinity of gas inrush would be notified by one of three ways. page phone system, word of mouth or flashing lights on belts.
7. The hoistman is the key communication person
8. Workers when they call in would be directed to which egress pathway to take.

9. The person would call his supervisor who may or may not know which way to escape. Supervisor may or may not be in communication with hoistman.
10. At both mines power of hoist is totally isolated from mine power
11. Ventilation fans are underground and can be shut off or reversed
12. There are refuge chambers at each mine fed by compressed air from surface with enough food, water and air for 80 people.
13. There are caches of SCSR breathing apparatuses located at each mine. These are the one hour units.
14. Miners carry the ten minute Ocenco oxygen in addition the W65 CO unit. Mine has petitioned to MSHA to eliminate the W65 units.

Potential New Controls

The following are new ideas identified by the team during that risk assessment to further reduce the ingress risks at the mine. These ideas for new potential controls should be addressed through the development of an Action Plan. A blank Action Plan with the ideas inserted and space left for derivation of specific actions, timing and resourcing has been included in the Appendix A.

The new potential controls identified by the team were as follows.

1. Consider the role of the initial event communicator, his capability, and decision making that is critical and include in the Emergency Response Plan. At East Intrepid Mine, there is an additional need because there is no cager just a hoistman.
2. Consider methods for automatically dropping power in the section where gas in rush occurs.
3. Consider all the factors and develop understanding of all tradeoffs of egress options for series ventilation and the inexperience of the new mine workers. At the present time, even though both mines are connected, the company has not practiced egress from one mine to another
4. Examine the use of blast doors or isolation doors underground to reduce ignition consequences and isolate any event to that section of the mine.
5. Use new communication system to add selected gas monitoring locations at various places in the mine.
6. Check the mine survey every 2000 – 3000 feet of advance
7. Reinforce the need to turn on the AutoCAD layers to show well locations
8. Identify well locations before any new panel is planned or mined
9. Reinforce best practices at East Intrepid.
10. Consider drilling from either surface or underground to classify, locate and determine gas pressure of old mines suspected to be in the area of active mining. There is a possibility that some existing extracted panels ventilated by Intrepid

might have some accumulation of gas that may be deliberately holed. The critical panels are the panels which are 20 to 30 years old.

11. Consider drilling and investigating existing extracted panels which are greater than some value in time (to be established by Intrepid determined by mine personnel based upon experience).
12. Investigate the use of sampling pump technology to test atmosphere closer to face than the current continuous miner operator by placing sensor technology on CM cutter head. Same preset values are present for triggering action items for the gas values at 0.5%, 1% and 2% gas.
13. Seal old mine workings to keep any accumulated gas in the old workings area even if a fall of ground occurred in the old workings.
14. Increase efforts to eliminate drilling from surface mine property in close proximity of mine and get drillers to utilize directional drilling.
15. Influence the drillers or third parties to get drillers to utilize better drilling methodologies.
16. Increase mine awareness of any drilling problems by either a cooperative effort with drilling companies, OCD, BLM or combination of all the above. This needs to include gathering and communicating vital information on drill location, well type and all other relevant data.
17. Add new monitoring sensor to new communication system at all intake shafts or all shafts to shut down fans if gas leak detected. (Mine personnel will determine gas trips applying experience, consequences, and all possibilities to determine trigger values on all gas monitors at the location that must be monitored. Trigger values may be different depending on location and impact to and possible consequence.)

Assuming that the information provided in the risk assessment was accurate, completion if the Action Plan and an increased focus on monitoring and auditing of the key identified controls would appear to provide an opportunity to effectively reduce the risk of fatalities related to gas ingress at Intrepid Potash Mines.

Appendices

Appendix A: The Action Plan of Potential New Controls

Identified Potential New Controls	Specific Required Actions	Respons-ability	Due date
1. Consider the role of the initial event communicator, his capability, and decision making that is critical and include in ERP. At East Intrepid Mine, there is an additional need because there is no cager just a hoistman.			
2. Consider methods for automatically dropping power in the section where gas in rush occurs.			
3. Consider all the factors and develop understanding of all tradeoffs of egress options for series ventilation and the inexperience of the new mine workers. At the present time, even though both mines are connected, the company has not practiced egress from one mine to another but only has discussed.			

Identified Potential New Controls	Specific Required Actions	Respons-ability	Due date
4. Examine the use of blast doors or isolation doors underground to reduce ignition consequences and isolate any event to that section of the mine.			
5. Use new communication system to add selected gas monitoring locations at various places in the mine.	.		
6. The mine survey should be checked every 2000 – 3000 feet of advance.			
7. Reinforce that AutoCAD layers are turned on to show well locations.			
8. Identify well locations before any new panel is planned or mined			
9. Reinforce best practices at East Intrepid.			

Identified Potential New Controls	Specific Required Actions	Respons-ability	Due date
10. Consider drilling from either surface or underground to classify, locate and determine gas pressure of old mines suspected to be in the area of active mining. There is a possibility that some existing extracted panels ventilated by Intrepid might have some accumulation of gas that may be deliberately holed. The critical panels are the panels which are 20 to 30 years old.			
11. Consider drilling and investigating existing extracted panels which are greater than some value in time. This is to be determined by mine personnel based upon experience.			
12. Investigate Use of Sampling pump technology to test atmosphere closer to face than the current Continuous miner operator by placing sensor technology on CM cutter head. Same preset values are present for triggering action items for the gas values at 0.5%, 1% and 2% gas.			

Identified Potential New Controls	Specific Required Actions	Respons-ability	Due date
13. Seal old mine working to keep any accumulated gas in the old workings area even if a fall of ground occurred in the old workings.			
14. Increase efforts to eliminate drilling from surface mine property in close proximity of mine and get drillers to utilize directional drilling.			
15. Influence the drillers or third parties to get drillers to utilize better methodologies.			
16. Increase mine awareness of any drilling problems by either a cooperative effort with drilling companies, OCD, BLM or combination of all the above. This needs to include gathering and communicating vital information on drill location, well type and all other relevant data.			

Identified Potential New Controls	Specific Required Actions	Respons-ability	Due date
17. Add new monitoring sensor to new communication system at all intake shafts or all shafts to shut down fans if gas leak detected. (Mine personnel will determine gas trips applying experience, consequences, and all possibilities to determine trigger values on all gas monitors at the location that must be monitored. Trigger values may be different depending on location and impact to and possible consequence.)			

Appendices B – Bow Tie Information

The ingress risks identified by the team and analysed further were as follows.

1. Mining into an existing oil/gas well
2. Mining into old workings that have gas from pathways or another source
3. Mining into fault / dike / breccia pipe which contains gas
4. A sudden collapse in an old mined area leading to puff or blast of gas into mine workings
5. Gas leaks into mine workings from an oil/gas well through strata
6. Gas leaks into mine workings from faults or dikes
7. Gas leaks into mine workings from breccia pipes
8. Gas leaks into mine workings through permeable ground
9. Gas leaks into mine workings from subsidence around well area.
10. Drillers accidentally fracing a well in a way that creates a pathway for gas into mine workings
11. A gas line on surface rupturing and the gas being sucked into mine surface ventilation intake (note that the fans are underground)

Identified causes of 1. Mining into an existing oil/gas well

Mapping Error

A. unmapped well
B. well mapped but location wrong on map well hole deviation
C. well mapped but location wrong with respect to mine survey
D. well mapped but plotted wrong

Operator Error

E. known well location but operator error from communication mistake
F. operator told well location but forgets/lapses
G. operator told well location but ignores

Bow Tie Analysis Results – Event #1 – Mining into an existing oil/gas well

Top Event: ->	Mining into an existing oil/gas well
Cause	**Existing controls to prevent the unwanted event**
A. Unmapped well	• Physically checks surface well location i.e. topographic, aerial, recon, etc.
	• Check well location against well location supplied by state of New Mexico
	• Monitor for new Application for Drilling (APD)
	• Check on the ground for old well location by locating old bricks, oil seeps, etc
	• Develop and update oil and gas map database
	Ideas for new controls to prevent the unwanted event
	•
Consequences of the event	**Existing controls to reduce the consequences of an unwanted event**
	• If major in rush of gas occurs the expectation is that all equipment power will be shut off (miner can trip power to transformer from mining machine), supervisors are notified and all other equipment would be shut down.
	• At West Intrepid, power can be shut off to rest of mine except hoist by call to Lubbock, TX, the electrical power supplier
	• At East Intrepid, mine power can be shut down by surface personnel.
	• Current evacuation plans call for mine workers to utilize diesel equipment to get to shaft which are intake but is the auxiliary escape route
	• Escape and emergency egress is practiced every six months.
	• Other U/G personnel not in the immediate vicinity of gas inrush would be notified by one of three ways. page phone system, word of mouth or flashing lights on belts.
	• The hoistman is the key communication person.
	• Workers when they call in are directed to which egress pathway to take.
	• The person calls his supervisor who may or may not know which way to escape Supervisor may or may not be in communication with hoistman
	• At both mines power of hoist is totally isolated from mine power
	• Ventilation fans are underground and can be shut off or reversed

	• There are refuge chambers at each mine fed by compressed air from surface with enough food, water and air for 80 people.
	• There are caches of SCSR breathing apparatuses located at each mine. These are the one hour units.
	• Miners carry the ten minute Ocenco oxygen in addition the W65 CO unit. Mine has petitioned to MSHA to eliminate the W65 units.
	Ideas for new controls to reduce potential consequences of an unwanted event
	• Consider the role of the initial event communicator, his capability, and decision making that is critical and include in ERP At East Intrepid Mine, there is an additional need because there is no cager just a hoistman.
	• Consider methods for automatically dropping power in the section where gas in rush occurs.
	• Consider all the factors and develop understanding of all tradeoffs of egress options for series ventilation and the inexperience of the new mine workers. At the present time, even though both mines are connected, the company has not practiced egress from one mine to another but only has discussed
	• Examine the use of blast doors or isolation doors underground to reduce ignition consequences and isolate any event to that section of the mine.
	• Use new communication system to add selected gas monitoring locations at various places in the mine.

Top Event: ->	Mining into an existing oil/gas well
Cause	Existing controls to prevent the unwanted event
B./C Well mapped but location wrong	• Circle Radius for oil 1320 feet, for gas 2640 feet. Intrepid standards not MSHA
	• Resurvey all locations on mine property (GPS survey) and compare to mine survey to reduce likelihood of wrong location on map
	• Quality Software (CAD and Geographic) check to compare each answer
	• Third party check of data and map location
	Ideas for new controls to prevent the unwanted event
	•
Consequences of the event	**Controls to reduce the consequences**
	See previous event – A. Unmapped wells

Mine personnel will determine gas trips applying experience, consequences, and all possibilities to determine trigger values on all gas monitors at the location that must be monitored. Trigger values may be different depending on location and impact to and possible consequence.

Top Event: ->	Mining into an existing oil/gas well
Cause	Existing controls to prevent the unwanted event
D Mapped but plotted wrong	• Check survey ongoing
	• Keep elevation of all mine workings in mine panels
	• Use of best technology and every survey shot is taken with triple flop of scope
	Ideas for new controls to prevent the unwanted event
	• The mine survey should be checked every 2000 – 3000 feet of advance.
Consequences of the event	**Controls to reduce the consequences**
	See previous event – A. Unmapped wells

Top Event: ->	Mining into an existing oil/gas well
Cause	**Existing controls to prevent the unwanted event**
E., F & G. Operator error	• Circles of radius protection
	• Escape maps in dinner hole plots oil and gas locations in critical mining areas
	• Regular work area maps for foremen which plot lease boundaries and location of oil and gas wells
	• Panels are surveyed every 125 feet to fix locations
	• Maps are given every work day to foremen and operators at west Intrepid Mine
	• Work expectations are discussed and clarified everyday
	• Shift bosses can open up maps underground
	• Foreman gives each operator his personal map on surface at start of shift (West Intrepid)
	• Operator error would be identified by shift foremen monitoring mine work to ensure well location is known and operator is following mine plan and matches survey location
	• Operator error (depending on the nature of the deviant behavior) would be dealt with by known disciplinary procedure (verbal, written communication, days off, fired)
	•
	Ideas for new controls to prevent the unwanted event
	• Reinforce that AutoCAD layers are turned on to show well locations.
	• Identify well locations before any new panel is planned or mined
	• Reinforce best practices at East Intrepid.
Consequences of the event	**Controls to reduce the consequences**
	See previous event – A. Unmapped wells

Bow Tie Analysis Results – Event #2 – Mining into old workings

Top Event: ->	Mining into old workings
	Existing controls to prevent the unwanted event
	• Old Mines in area are naturally ventilated
	• Existing operations are unsealed
	• Intrepid uses the information from BLM data on closed mines, it actually owns some of them and has good data on its own captive old mines.
	• The mine uses a 100 foot buffer between old mine and new mines included in all plans.
	• The mine has ongoing gas detection for O_2 and CH_4 for operators and O_2, CO and CH_4 for all supervisors.
	• There is positive air pressure from ventilation for active mining area so unless old workings have a higher pressure, then gas will migrate towards old workings.
	Ideas for new controls to prevent the unwanted event
	• Consider drilling from either surface or underground to classify, locate and determine gas pressure of old mines suspected to be in the area of active mining There is a possibility that some existing extracted panels ventilated by Intrepid might have some accumulation of gas that may be deliberately holed The critical panels are the panels which are 20 to 30 years old
	• Consider drilling and investigating existing extracted panels which are greater than some value in time. This is to be determined by mine personnel based upon experience.
Consequences of the event	**Existing controls to reduce the consequences of an unwanted event**
	See previous event – A. Unmapped wells

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Bow Tie Analysis Results – Event #3 – Mining into a fault / dyke or breccia pipe

Top Event: ->	Mining into a fault / dyke or breccia pipe
	Existing controls to prevent the unwanted event
	• Breccias pipes and dikes have been mapped and located but all faults have not. The area is geologically stable so there are not too many faults. It is a large salt basin. The ore horizon is some twelve different horizons over a 400 foot of depth Some horizons are economic but some are not.
	• Gas inrush hazard would be considered to be a slow leak type of event and not a major inrush of gas.
	• The mine has past experience with mining into breccias area with an active oil seep.
	•
	Ideas for new controls to prevent the unwanted event
	• Investigate Use of Sampling pump technology to test atmosphere closer to face than the current Continuous miner operator by placing sensor technology on CM cutter head. Same preset values are present for triggering action items for the gas values at 0.5%, 1% and 2% gas.
Consequences of the event	**Existing controls to reduce the consequences of an unwanted event**
	See previous event – A. Unmapped wells

Bow Tie Analysis Results – Event #4 – A sudden collapse in an old mined area leading to puff or blast of gas into mine workings

Top Event: ->	A sudden collapse in an old mined area leading to puff or blast of gas into mine workings
	Existing controls to prevent the unwanted event
	•
	Ideas for new controls to prevent the unwanted event
	• Seal old mine working to keep any accumulated gas in the old workings area even if a fall of ground occurred in the old workings.
Consequences of the event	**Existing controls to reduce the consequences of an unwanted event**
	See previous event – A. Unmapped wells

Bow Tie Analysis Results – Event #5 to 8 – (Seen to be similar, a slow leak)

5. Gas leaks into mine workings from an oil/gas well through strata
6. Gas leaks into mine workings from faults or dikes
7. Gas leaks into mine workings from breccia pipes
8. Gas leaks into mine workings through permeable ground

Top Event: ->	Mining into a fault / dyke or breccia pipe
	Existing controls to prevent the unwanted event
	• See previous controls
	•
	•
	•
	Ideas for new controls to prevent the unwanted event
	•
Consequences of the event	**Existing controls to reduce the consequences of an unwanted event**
	See previous event – A. Unmapped wells

Bow Tie Analysis Results – Event #9 – Gas leaks into mine workings from subsidence around well area

Top Event: ->	Gas leaks into mine workings from subsidence around well area.
	Existing controls to prevent the unwanted event
	• See previous controls
	Ideas for new controls to prevent the unwanted event
	• Increase efforts to eliminate drilling from surface mine property in close proximity of mine and get drillers to utilize directional drilling
	• Influence the drillers or third parties to get drillers utilize better methodology.
Consequences of the event	**Existing controls to reduce the consequences of an unwanted event**
	See previous event – A. Unmapped wells

Bow Tie Analysis Results – Event #10 – Drillers accidentally fracing a well in a way that creates a pathway for gas into mine workings

Top Event: ->	Drillers accidentally fracing a well in a way that creates a pathway for gas into mine workings
	Existing controls to prevent the unwanted event
	• Some drillers notify proper authorities (Oil Conservation District State of New Mexico, OCD) and some companies even call Intrepid
	• Some events are mandated to be reported by the OCD but that requirement only affects ten percent of the land because it only affects state land. Most land is owned by BLM.
	• A permit to drill is required which allows the mine to publicly comment on the drilling application.
	Ideas for new controls to prevent the unwanted event
	• Increase mine awareness of any drilling problems by either a cooperative effort with drilling companies, OCD, BLM or combination of all the above. This needs to include gathering and communicating vital information on drill location, well type and all other relevant data.
Consequences of the event	**Existing controls to reduce the consequences of an unwanted event**
	See previous event – A. Unmapped wells

Bow Tie Analysis Results – Event #11 – A gas line on surface rupturing and the gas being sucked into mine surface ventilation intake (Example is pipeline travels thru one of the tailings piles into intake shaft area)

Top Event: ->	A gas line on surface rupturing and the gas being sucked into mine surface ventilation intake (Example is pipeline travels thru one of the tailings piles into intake shaft area.)
	Existing controls to prevent the unwanted event
	•
	Ideas for new controls to prevent the unwanted event
	• Add new monitoring sensor to new communication system at all intake shafts or all shafts to shut down fans if gas leak detected. (Mine personnel will determine gas trips applying experience, consequences, and all possibilities to determine trigger values on all gas monitors at the location that must be monitored Trigger values may be different depending on location and impact to and possible consequence.)
Consequences of the event	**Existing controls to reduce the consequences of an unwanted event**
	See previous event – A. Unmapped wells