



**HAZARD IDENTIFICATION AND RISK ASSESSMENT (HIRA)
FOR SMALL MINES IN WESTERN US**

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ANNUAL REPORT 2005 - 2010

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SPECIFIC AIMS

The project had two purposes: (1) to identify critical mine hazards, assess risk, and outline procedures to reduce accident/incident rates in small mines in the Western United States; and (2) train mine workers and supervisors on hazard identification and risk assessment (HIRA) in each participating mine, develop training modules and document findings. The main objective of this project was to train staff and hourly workers of small mines on how to implement HIRA programs in their mines.

The plan started with five small mines the first year and continued with other 20 mines the following five years. The experience gained during these inspections was used to develop training modules and deliver to mine workers and supervisors in safety meetings. This allowed the small mine operators to gain expertise in identifying their critical hazards and to develop corrective measures without requiring the help of outside experts.

The project outcomes included written surveys on health and safety issues, field inspections and observations conducted by the HIRA team, and feedback from mine workers and supervisors. The collected information was evaluated and compared with pre-established standards and the critical hazards determined based on their likelihood and consequence rates. The program elements, summarized in site specific training modules, were discussed with interested parties, examined by experts for tolerance levels, and presented to mine operators for implementation. The safety intervention results were monitored through follow-up visits and evaluated periodically.

STUDIES AND RESULTS

The following activities have been completed during the six year plan:

1. Health and Safety Survey of Small Mines in the Western US. Survey forms have been developed to determine the size of the mine, the sources of energy involved, and the health and safety programs followed (Appendix A). The forms have been sent to over 50 additional small mine operators located in Utah, Idaho, New Mexico, Colorado, California and Nevada.

The objective of this survey was to reach as many small mine operators as possible, determine their needs and seek for their involvement with this program.

2. Risk Assessment Chart. A five-level, consequence-likelihood risk assessment chart for small mines was developed (Appendix B). The levels of this chart have been determined in consultation with small mine operators, considering their limitations, activities carried out and resources involved. The consequence levels were initially expressed in dollar figures. Following the External Advisory Committee’s recommendations, these were changed to hours or days of production lost. The chart was used to evaluate the survey data and to determine the critical hazards.
3. Report Format for HIRA Inspections and Observations. A standard report format was developed for this program. Each report included a summary of inspections and observations, critical hazards, procedures to reduce or eliminate these hazards, and recommendations to management to improve work place conditions and practices. Following each mine visit, the main findings were summarized in a PowerPoint presentation, a description of critical hazards, applicable check lists, and short audio-video clips highlighting good work practices and potential hazards. Each report also included a summary of the HIRA team intervention results determined through site inspections and follow-up visits.
4. Small Mine Contractor Safety Booklet. This booklet was designed for the education and training of contract workers and those who employ them. It is an intervention booklet based on work practices observed in existing small mines. It highlights the common hazards to which contract workers are exposed to and the work practices utilized. It is designed to be used in conjunction with an experienced trainer. Although several suggestions are made in it, none are to be regarded as ruling policies, unless as quoted from a regulatory agency.
5. Field Inspections and Observations. In the last six years (2005-2010), 25 small mines have been visited: 16 surface operations and 9 underground mines. A total of 189 workers were reached: 46 supervisors and 143 hourly workers (Table 1). During this period, the HIRA team also conducted 28 follow-up visits (Appendix C).

Table 1. Summary of Workers Involved in HIRA Project, 2005-010

Year	New Mines	Follow-up Visits	Personnel Trained		
			Sub-total	Supervisors	Miners
2010	0	3	16	12	4
2009	5	6	28	18	10
2008	5	5	30	23	7
2007	5	4	38	31	7
2006	5	5	45	34	11

2005	5	5	32	25	7
Total	25	28	189	143	46

The highlights of the last three field inspections and observations are presented below.

- a. **IMV Nevada.** The mine is located in Amargosa Valley, NV. It includes three quarries and a processing plant. The final products are bentonite, saponite, and sepiolite. The mining activities involve scraping, dozing, and hauling. At the processing plant, the activities include milling, screening, packaging, and loading.

This mine has been visited twice, one in June 2009 and another in January 2010. Three critical hazards were identified in this mine: (1) working in elevated areas, (2) stacking and storing practice, and (3) noise. A summary of these unsafe conditions is as follows:

- Working in elevated areas. A truck driver (client operated truck) was spotted performing his job improperly. This worker was handling materials on top of his truck without wearing any fall-arrest system. He was exposed to unsafe conditions. The event was spotted and stopped by the safety supervisor in time. The HIRA team recommended that any worker, company employee or contractor, whose job requires working in elevated areas (greater than 5 ft) must be equipped with fall-arrest devices and trained on how to wear them. In small mines, truck drivers perform various activities on and around trucks. These include: opening and closing hatches of storage tanks, securing tarps, and checking the load distribution on the truck. All these activities if not staffed adequately and performed correctly, can result in slip and fall accidents.
- Stacking and storing practice. Unstable loads were observed at the plant. Loads must be stable and tied down. Our team recommended that maximum stacking height is 3 times the shortest distance at the base. Workers must be trained in applying correct stacking and storing procedures.
- Noise. High levels of noise were observed around fans and compressors. The noise level in a shop (near a roller mill) varied between 92 and 96 dB (above TLV). The HIRA team recommends management to reduce noise level and provide workers with ear muffs or other hearing protection devices. Following the MSHA hearing conservation program, workers who are exposed to high levels of noise at their working areas (> 90 dB) must wear double ear protection devices.

During the second visit, it was found that most of the recommendations have been implemented except those related to working in elevated areas. This issue was discussed with the mine personnel and the final recommendation submitted again to management for implementation.

- b. **Shamrock Mining Associates, LLC.** It is a surface onyx mine near Hanna, UT. The mining process includes: drilling, block slicing by chain saws, cutting, and hauling at the quarry, and cutting, slabbing, and forming at the processing plant. The mine was visited

twice. During the first inspection the following unsafe conditions and practices were identified: (1) electrical hazards, (2) fire hazards, and (3) housekeeping.

- Electrical hazards. During the inspection, the HIRA team found unprotected electrical control boards. These should be labeled and protected against accidental operation. To avoid unwanted events, HIRA team recommended management to label switches and protect them from poor weather conditions.
- Fire Hazards. The number of fire extinguishers was not adequate at the quarry area. This condition may result in hazardous fire emergency situations. To facilitate an emergency response, fire extinguishers should be stored in sufficient number at places that can be recognized and reached by workers easily. All fire extinguishers should be secured adequately and kept free from obstructions. Management should provide each work area with fire extinguishers and other fire control devices. A best practice is to have one fire extinguisher for every 200 square-meter area.
- Housekeeping. Improper storage of unused materials, tools, and food containers were observed at the shop. Our team recommended management to establish and implement procedures to keep work area clean and tidy and store materials in the proper place.

During the second visit, workers were still exposed to the first two hazards. This issue was discussed with the mine operator and a set of recommendations submitted to management for implementation.

- c. **Yule Marble Quarry.** Colorado Stone Quarries, Inc., operates the Yule Marble Quarry, in Marble, CO, about 20 miles south of Glenwood Springs, using a fully-mechanized room-and-pillar mining method. The final product is cut by sawing machines, broken hydraulically, and removed by diesel powered front-end-loader. This mine was visited three times. During the last inspection positive changes such as good illumination near the working, improved ventilation and good housekeeping were observed at the mine. However, two unsafe conditions were identified: (1) poor acetylene storage practice at the mine and (2) improper materials handling at the product delivery yard.
- Acetylene storage. Acetylene cylinders were stored inadequately in the mine shop. Cylinder should be kept in up-right position and chained with the control valve kept tightly closed. Care should always be taken to avoid leaks and ruptures. These conditions were discussed with the safety supervisor and a final recommendation submitted to management for implementation.
 - Contractor Safety. Because the mine produces large marble blocks, heavy pieces of equipment are used at the delivery yard. These are commonly operated by contract workers. Unsafe work practices while loading marble blocks onto a truck were observed during the visit. The truck tires were not chocked properly and the driver was not equipped with proper PPE while working in elevated areas. Our team

recommended management to provide contract workers with proper PPE and train them to apply safe operating procedures when handling heavy blocks of marble.

The positive changes of this mine were mainly the new manager's approach to safety who provided the required resources to improve the work conditions at the mine.

Appendix D shows a summary of critical hazards and recommendations for 22 other mines. In each case, the potential risks were discussed with the mine manager or safety coordinator and the results compiled in a safety report. This was then presented to supervisors and workers in safety meetings. In addition to recommendations, each report included illustrations on safe and unsafe conditions, video clips on common work practices, and check lists. Most of these mines have been visited twice.

SIGNIFICANT EVENTS AND OBSERVATIONS

- **SponCom Hazard.** Data from the Bear Canyon Mine was evaluated using the spontaneous combustion (SponCom) program from the USBM, and the Mine Climate Simulator (CLIMSIM) from MVS Inc. The results showed that the Bear Canyon coal has medium-high spontaneous combustion potential and that the heat load can be controlled using ventilation alone. To this purpose however, the existing ventilation system should be upgraded and the leakage quantity reduced. The SponCom issue was confirmed by MSHA inspectors. For safety reasons, the susceptible section was sealed off and the workings directed to other work areas.
- **Safety Glasses for Forge Operators.** During the visit to the Bonanza Gilsonite Mine, Dave Cook, the Maintenance Superintendent, asked a specific question about eye protection for employees operating the forge that is used for re-conditioning of mining tools. Mr. Cook said he had been unable to determine whether eye protection devices other than standard safety glasses were required for these employees. HIRA project personnel researched this question and determined that employees required safety glasses that provide protection from ultraviolet radiation. This is an excellent example of how an assessment visit by HIRA personnel provided a specific answer to an important safety question.

Small Mine Contractor Safety. Small mine operators strongly depend on independent contractors for full operation of their mines. A sample survey conducted by the HIRA team showed that 13 out of 15 operators were employing contract workers to perform multiple tasks. Table 2 shows the highlights of the results for each mine, including the type of operation, minerals produced, and the personnel reached with the program. It also highlights the dependency of this industry on independent contractors. In most cases, contractors are employed to perform two major tasks: (1) haul the ore from the mine to the processing plant, and (2) transport final products to refining and distribution centers. Each task involves the operation of several pieces of equipment from fork lifts and loaders to overhead cranes. In most cases, the contract workers were not fully trained in the operation of all the equipment used in completion of their tasks.

Table 2. List of Western Small Mines Visited by HIRA Team

Mine	Mining Type	Mineral	Personnel Reached	Contractor Activity (Hauling)	
				Raw Material	Final Product
1	U	Coal	10		
2	U	Gilsonite	4		X
3	S	Gypsum	4	X	X
4	S	Marble	6	*	X
5	S	Bentonite	8		X
6	U	Marble	13		X
7	U	Gold	10		X
8	U	Gold	10	X	X
9	U	Gold	4		
10	U	Gold	8		X
11	U	Gilsonite	12		X
12	U	Moly	8	X	X
13	S	Salt	5		X
14	S	Perlite	3	X	X
15	S	Barite	14		X

S = Surface; U = Underground; D & B = Drilling and Blasting; * = occasional drilling and blasting

To assist mine operators in overcoming part of this problem, the HIRA personnel prepared a booklet using Brush Resources' beryllium mine as a hypothetical location. The booklet is for people who will be on the plant site only for short periods of time (less than 3 days per week). It includes three sections: (1) safety requirements and policies, (2) specific safety instructions, and (3) an evaluation form. The safety requirements include health and safety regulations administered by MSHA and company policies on contractor safety. The specific instructions include training materials on the use of personal protective equipment, roadway safety, and safe work practices for activities such as moving equipment, loading and unloading, and handling hazardous materials. An evaluation form is added at the end of the booklet to certify that a contractor has completed this specific training.

This booklet was reviewed by our industry consultant, George Kenzy, formerly Chief Engineer at Skyline Coal, UT, who made the following comments:

- Some companies may wish to add a section about the use of drugs and alcohol on site, and requirements on drug testing
- Truck drivers frequently carry handguns. A policy regarding guns and ammunitions should be clearly stated
- Most truck drivers have CB radio. It might be useful to designate a monitored channel to enable quick communication with them.

The suggested changes were made, and the booklet is now used by our team to assess each mine operator's safety program for independent contractors, and also as a reference material.

- Risk Assessment Matrix.** During the presentation to Mount Royale Ventures, LLC, the mine manager, Matt Collins, inquired about the utilization of the risk assessment matrix for small mines. He asked to the HIRA team for assistance in developing and presenting such a matrix to each of the participating mines. The risk assessment matrix is a very useful tool which can be used to determine the critical hazards and to formulate the corrective measures to prevent or eliminate risks. The HIRA team presented a summary of findings on this issue in a safety meeting at the mine.
- Safe Production Model for Small Mines.** This is the subject of an M.S. thesis that was developed and completed by Sony Suryanto in summer, 2008. It is based on the safety records of 17 small mines located in the western U.S. that were inspected between 2005 and 2007. The study identified eight key safe production elements: (1) Management commitment to safety, (2) Hiring process, (3) Training and evaluation, (4) Hazard identification and risk assessment, (5) Accident investigation, (6) Safety policies and procedures, (7) Safety accountability, and (8) Communication and participation. These elements were used as working tools to build the Safe Production Model for Small Mines. This model involves three major activities: developing human resources, adding safety as a value to the production process, and practicing safe operations. These activities are bound by a control system: safety accountability (Figure 1).

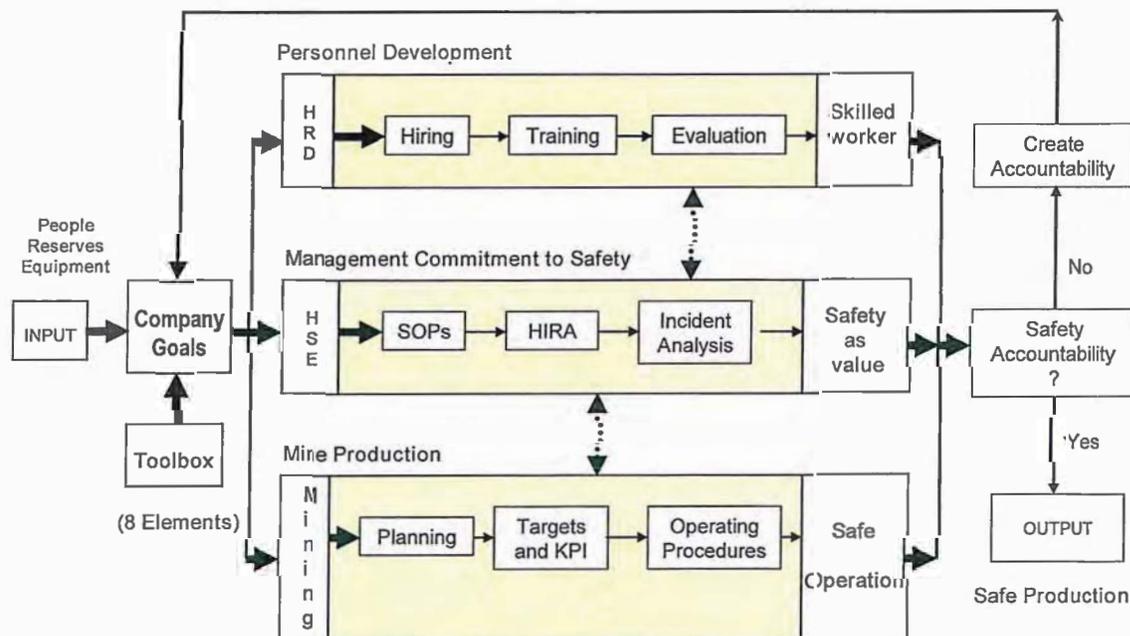


Figure 1. Schematic of the Safe Production Model for Small Mines

The model was validated using field data collected through two survey forms: Form-1 (for expert judges) and Form-2 (for mine managers and supervisors). Appendix E shows the elements and attributes of each form. The information collected through Form-1 was

evaluated using an Analytic Hierarchy Process (AHP) to determine the relative importance of each element. The evaluation yielded the following weights: management commitment and leadership: 16%, hazard identification and risk assessment: 16%, training and evaluation: 15%, safety accountability: 14%, communication and participation: 13%, safety policies and procedures: 13%, accident investigation: 9%, and hiring process: 4%.

The information collected through Form-2 was interpreted using the Likert's approach to define each company's position in a safety scale. For simplicity, the following safety scale was used: excellent ($\geq 95\%$), good (75-94 %), average (45-74 %), poor (25-44 %), and unacceptable ($\leq 24\%$). A total of 18 forms was sent out to small mine operators and supervisors. Of these, eight completed and returned the forms. A preliminary evaluation of these survey forms showed that only one of the eight mines was rated as "good", six were rated as "average", and one as "poor". The model can be used by a mine operator for self-evaluation, to determine a list of elements and attributes that need to be corrected.

The above results show how the safe production model can be used to rate small mines based on their efforts to achieve zero harm and to indicate those that need to improve their existing work conditions and practices

- **Safety Mini-conference for Small Mines.** The HIRA team organized a mini-conference for small-mine operators and workers in Blackhawk, CO, in 2007. The meeting was attended by 16 mine operators and workers. The covered topics included: emergency rescue team, task training, and safety culture.
 - Because small mines do not have their own mine rescue teams, they must depend on the nearest large mine when a rescue team is needed. In this location, the nearest large mine is the Henderson Mine in Empire, CO. This requires a good coordination with the large mine, so that the team is available within 2 hours of the incident start time. Gold Cash has trained several of its workers in mine rescue techniques, in cooperation with the Henderson Mine.
 - Small mine operators often employ experienced workers to carry out multiple tasks. Site specific training programs at these mines are needed urgently.
 - Workers should be instructed and evaluated periodically. This will allow the workers to develop safe work attitudes to accomplish their jobs safely.

This meeting was fruitful for all participants. It allowed them to learn about the common problems and resources that are available to them. The managers of American Gilsonite, Hess Pumice Products, Treasure Canyon Calcite, and Allen Rocks have shown interested in participating in future events.

- **Pit Bench Design.** During the visit to the Shamrock Mining, Doug Giles, the Site Manager, asked us a specific question about bench design. Mr. Giles wanted to know the correct bench dimension for his mine. HIRA team came up with the bench design parameters for the pit

including safe bench dimensions. These were discussed in the field and a recommendation submitted to management.

- **Electrical and Mechanical Pocket Cards.** This is the subject of an M.S. thesis that has been developed by Syafril Hernendi. It is based on safety inspections that were carried out in 25 small mines located in the western U.S. These inspections have shown that workers in these mines are frequently exposed to electrical and mechanical hazards. A review of MSHA statistics has shown that in this sector mine workers experience higher incident rates than electricians and mechanics, thus requiring an effective intervention. Electrical and mechanical pocket cards are developed to mitigate this problem. These are divided into two groups: electrical and mechanical.

Electrical Pocket Cards: These address the following issues:

- Handling Cables
- Transformer Installation, and
- Lock-Out Tag-Out

Mechanical Pocket Cards: These address the following issues:

- Machine Guarding
- Moving Equipment Operation, and
- Working in Elevated Areas.

These cards were developed using both practical and theoretical approaches to each hazard. Practical approaches include the results of mine inspections and work practices observed in large mine operations. The theoretical approaches include a review of current literature and heuristic models developed to improve workplace conditions and safe behavior. Figure 2 shows a screen view of a sample electrical pocket card for small mines.

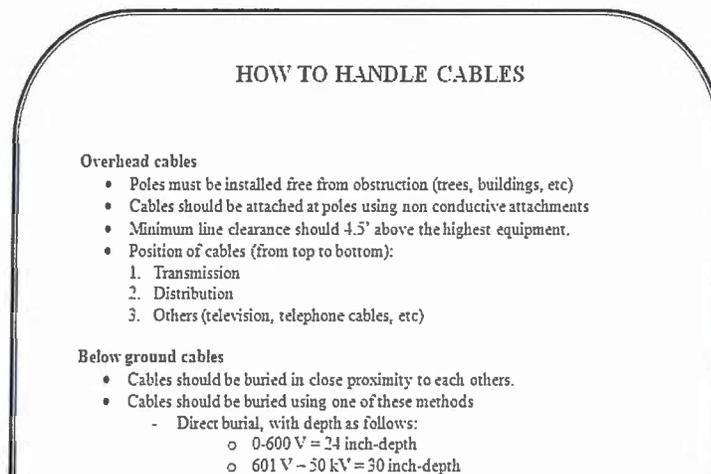


Figure 2. Sample Pocket Cards for Small Mines

In the next step the pocket cards were validated using field data collected through safety inspections and survey forms developed specifically to this purpose. Appendix F shows the survey form using to validate these cards. The questions were developed to measure

respondent's opinion about the usefulness of these cards. The forms were sent to experts and mine supervisors. Experts are people who have knowledge and experience in mining but are not involved in the day-to-day activities. The supervisors are the leaders in charge of a mining process. Syafril defended his thesis in 2010 successfully. Currently, he is working on editorial corrections of his work. This will be submitted electronically to the University of Utah graduate school. A copy of this will be sent to NIOSH.

- **Hazard Identification Video Clips (DVD's).** The HIRA team developed a set of video clips for different work conditions and practices. Each clip illustrates factual cases of safe and unsafe practices observed in existing mines, potential hazards to which workers are exposed to and highlighting the control measures that can be used to mitigate the problem.
- **Safety Training Modules.** The HIRA team developed a site specific training module for each participating mine. Each module included the results of safety inspections and observations, a list of safe and unsafe practices and conditions, the critical hazards for each mine, and recommendations to reduce the impact of these hazards. The module also included PowerPoint presentations, applicable safe operating procedures and check lists, and video clips highlighting safe and unsafe work practices (Appendix G).
- **HIRA for Small Mines Webpage**

This webpage was created to disseminate the information collected through inspections and observations carried out in several small mines located in the western U.S. It includes: the objectives of the program, progress reports, video clips on safe and unsafe work practices, suggestions for overcoming potential problems, publications, survey forms and check lists, and useful links. Figure 3 shows the cover page of this program (see: www.hiraproject.org). This page is updated periodically.

 **Hazard Identification and Risk Assessment (HIRA)
for Small Mines in Western United States**

HOME
HIRA TEAM
ANNUAL REPORTS
VIDEO CLIPS
SAFE WORK PRACTICES
CONTRACTOR'S SAFETY
PUBLICATIONS
USEFUL LINKS
Contact Us

HIRA-Team Members

Professors:

Dr. Felipe Calizaya

Dr. Michael G. Nelson



Figure 3. HIRA for Small Mines Web Page

PUBLICATIONS

- Calizaya F., and S. Suryanto, 2008. Safe Production Model for Small Mines. *Journal of Coal Science & Engineering (China)*. Vol. 14, No. 3: 436-442.
- Calizaya, F., M.G. Nelson, and S. Suryanto. 2008. Small Mine Contractor Safety – A Case Study. Paper presented at the 2008 SME meeting and submitted to *SME Transactions* for peer review. 8 pp.
- Calizaya, F., and M.G. Nelson. 2007. Contractor Safety in the Mining Environment. HIRA Project, University of Utah. Salt Lake City, UT. 21 pp.
- Hernendi, S., 2010. Electrical and Mechanical Pocket Cards for Small Mines. M.S. Thesis. Mining Engineering Department, University of Utah. Salt Lake City, UT. Work in progress.
- Suryanto, S., 2008. Safe Production Model for Small Mines. M.S. Thesis. Mining Engineering Department, University of Utah. Salt Lake City, UT.

Appendix A

Health and Safety Survey

1. **Prevention** (Please circle one number for each statement)

	Disagree <u>Strongly</u>	Disagree <u>Somewhat</u>	<u>Neutral</u>	Agree <u>Somewhat</u>	Agree <u>Strongly</u>
Employee safety is a top concern of company management.....	1.....	2.....	3.....	4.....	5.....
Safety at this company is more important than profits	1.....	2.....	3.....	4.....	5.....
Dangerous equipment is properly marked	1.....	2.....	3.....	4.....	5.....
Unsafe conditions are properly fixed in a timely manner.....	1.....	2.....	3.....	4.....	5.....
The restrooms, showers, and shops are kept clean and tidy.....	1.....	2.....	3.....	4.....	5.....

2. **Reporting and Monitoring** (Please circle one number for each statement)

	Disagree <u>Strongly</u>	Disagree <u>Somewhat</u>	<u>Neutral</u>	Agree <u>Somewhat</u>	Agree <u>Strongly</u>
There are procedures in place to detect unsafe conditions.....	1.....	2.....	3.....	4.....	5.....
MSHA regulations are posted in a prominent location.....	1.....	2.....	3.....	4.....	5.....
I believe management has a high regard for MSHA regulations	1.....	2.....	3.....	4.....	5.....
If I reported an unsafe condition or unsafe act to management, I would not get into trouble.....	1.....	2.....	3.....	4.....	5.....

3. **General Working Conditions** (Please circle one number for each statement)

	Disagree <u>Strongly</u>	Disagree <u>Somewhat</u>	<u>Neutral</u>	Agree <u>Somewhat</u>	Agree <u>Strongly</u>
My work area is examined every day for health and safety conditions.....	1.....	2.....	3.....	4.....	5.....
Roads, berms and traffic lights are kept in good working order.....	1.....	2.....	3.....	4.....	5.....
The equipment I work with is in safe working condition	1.....	2.....	3.....	4.....	5.....
There are no electrical hazards in my immediate work area.....	1.....	2.....	3.....	4.....	5.....
There is adequate fire detection/prevention where I work.....	1.....	2.....	3.....	4.....	5.....
Noise, dust and gas levels are not excessive.....	1.....	2.....	3.....	4.....	5.....
I have access to PPE and wear it when needed at work	1.....	2.....	3.....	4.....	5.....
Proper medical treatment is readily available to treat injuries.....	1.....	2.....	3.....	4.....	5.....

4. **Training** (Please circle one number for each statement)

	Disagree <u>Strongly</u>	Disagree <u>Somewhat</u>	<u>Neutral</u>	Agree <u>Somewhat</u>	Agree <u>Strongly</u>
I have received the proper safety training for my job.....	1.....	2.....	3.....	4.....	5.....
All employees are well trained on safe operating procedures.....	1.....	2.....	3.....	4.....	5.....
I have been trained in proper lifting techniques.....	1.....	2.....	3.....	4.....	5.....
I have received training with HAZCOM	1.....	2.....	3.....	4.....	5.....
Other employees around me always act in a safe manner	1.....	2.....	3.....	4.....	5.....

Appendix A (continued)

What things this company do to increase safety at the workplace?

6. Mine Operation Details

<u>Surface Mine</u>	<u>Underground Mine</u>	<u>Sand and Gravel</u>	<u>Other</u>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Are diesel powered machines used? Yes No

Number of Employees:

7. Job Satisfaction

How satisfied are you with your employer?

<u>Very dissatisfied</u>	<u>Dissatisfied</u>	<u>Neutral</u>	<u>Satisfied</u>	<u>Very Satisfied</u>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How long do you plan to continue your career with this company?

<u>Less than a year</u>	<u>One to two years</u>	<u>Two to five years</u>	<u>More than five years</u>	<u>Don't Know</u>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Would you recommend employment at this company to a friend?

<u>Definitely not</u>	<u>Probably not</u>	<u>Maybe</u>	<u>Probably would</u>	<u>Definitely would</u>
<input type="radio"/>				

8. Which of the following best describes your role in the organization?

- First-level supervisor.....
- Manager/supervisor higher than first level
(including senior management positions)
- Not a manager or supervisor

9. Hazard Identification and Risk Assessment (HIRA) Program

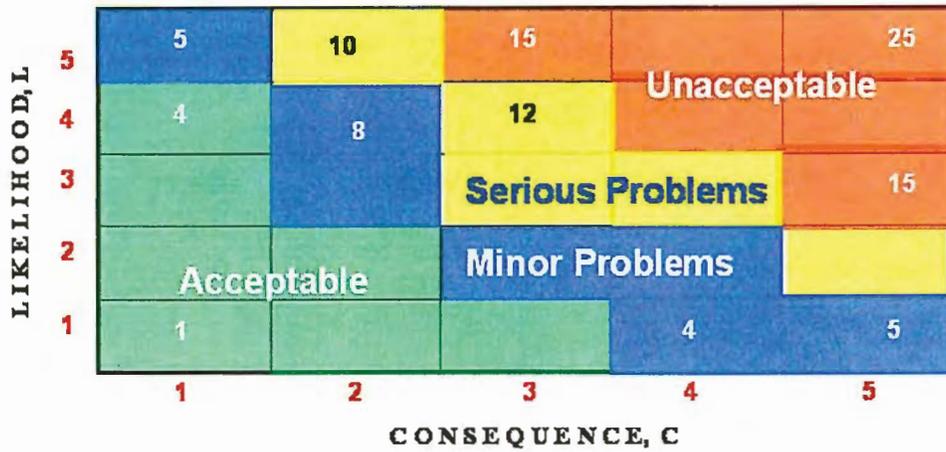
HIRA is a mine hazard reduction program sponsored by the National Institute for Occupational Safety and Health (NIOSH). One of the objectives of this program is to determine the critical health and safety risk areas, and outline methods to reduce the accident and incident rates in small mines in the Western United States. Another objective is to train mine personnel on how to use HIRA in three small mines each year.

Would your company be interested in participating in this program?

Yes If yes, please state contact information

Appendix B

Risk Assessment Matrix



Severity Level (Consequence)

1. **First Aid Case.** (1-hour of production loss)
2. **Temporary injury.** (1-hr to 1-day of prod. loss)
3. **LTA Case.** (1 to 3 days of production loss)
4. **Critical.** (3 to 7 days of production loss)
5. **Catastrophic.** More than 7-days of prod loss)

Frequency Level (Likelihood)

1. **Very Unlikely.** Error occurs rarely
2. **Remote.** One unlikely to commit this error
3. **Occasional.** Several times in lifetime
4. **Probable.** Several times a year
5. **Frequent.** One often will commit this error

Appendix C

HIRA for Small Mines – List of Mining Companies

Table 1. Workers Involved in HIRA Project (New Mines), 2005-10

No	Operator Name	S/U	Personnel Trained	Miners	Supervisors
2004 - 05					
1	Bear Canyon Mine, UT	U	10	8	2
2	Bonanza Gilsonite Mine, UT	U	4	3	1
3	Western Clay Co., UT	S	8	7	1
4	Indian Queen Marble LLC., UT	S	6	4	2
5	Diamond K Gypsum Inc., UT	S	4	3	1
Sub-total			32	25	7
2005 - 06					
1	Colorado Stone Quarries, Inc., CO	U	13	11	2
2	Original Sixteen to One Mine, CA	U	8	6	2
3	Mount Royale Ventures, LLC., CO	U	10	6	4
4	Hunter Gold Mining Corp., CO	U	10	8	2
5	Hidee Gold Mine, CO	U	4	3	1
Sub-total			45	34	11
2006 - 07					
1	Huck & Sons Salt Co., NV	S	5	4	1
2	Ziegler Chemical & Mineral Co. UT	U	12	11	1
3	Ashdown Project LLC, NV	U	5	3	2
4	Tenacity Perlite Mine, NV	S	2	1	1
5	Baker Hughes Drilling Fluids, NV	S	14	12	2
Sub-total			38	31	7
2007 - 08					
1	Point of Mountain East Quarry, UT	S	5	3	2
2	Keigley Quarry, UT	S	3	2	1
3	Treasure Canyon Calcium, ID	S	10	9	1
4	Hess Pumice Products Inc., ID	S	8	6	2
5	Allen Rock Quarry, UT	S	4	3	1
Sub-total			30	23	7

Table 1 (Continued)

No	Operator Name	S/U	Personnel Trained	Miners	Supervisors
2008 - 10					
1	McGuire Pit	S	2	0	2
2	Weber City Pit	S	2	1	1
3	Brigham City Pit	S	5	3	2
4	IMV Mine, NV	S	14	11	3
5	Shamrock Mining, UT	S	5	3	2
Sub-total			28	18	10
Total			173	131	42

S = Surface Operations (16); U = Underground Mines (9)

Table 2. Workers Involved in HIRA Project (Re-visits), 2005-10

No	Operator Name	S/U	Personnel Trained	Miners	Supervisors
2004 – 05					
1	Bear Canyon Mine, UT	U	10	8	2
2	Bonanza Gilsonite Mine, UT	U	4	3	1
Sub-total			14	11	3
2005 - 06					
1	Colorado Stone Quarries, CO	U	13	11	2
2	Hidee Gold Mine, CO	U	4	3	1
3	Mount Royale Ventures, CO	U	10	6	4
4	Original Sixteen to One Mine, CA	U	8	6	2
Sub-total			35	26	9
2006 - 07					
1	Western Clay Co.	S	2	0	2
2	American Gilsonite Co.	U	5	2	3
3	Mount Royale Ventures, LLC	U	6	3	3
4	Indian Queen Marble, LLC	S	2	0	2
5	Ziegler Chemical & Mineral	S*	12	11	1
Sub-total			28	17	11
2007 - 08					
1	Baker Hughes Drilling Co., NV	S	14	12	2
2	Ashdown Project LLC, NV	S*	5	1	4
3	Treasure Canyon Calcium, ID	S	10	9	1
4	Hess Pumice Products Inc., ID	S	8	6	2
5	Colorado Stone Quarries, CO	U	13	11	2
Sub-total			50	39	11
2008 - 09					
1	Treasure Canyon Calcium, ID	S	10	9	1
2	Yule Marble, CO	S	13	11	2
3	Western Clay, UT	S	7	6	1
4	American Gilsonite	U	4	2	2
5	Hess Pumice	S	9	7	2
Sub-total			43	35	8
2009 - 10					
1	Huck Salt & Sons, NV	S	4	2	2
2	Allen Rock Quarry, UT	S	12	6	6
3	Treasure Canyon, ID	S	10	9	1
4	Yule Marble, CO	S	13	11	2
5	Ashdown Project, NV	U	8	6	2
Sub-total			47	34	13
Total			174	127	47

S = Surface Operations (5); S* = Processing Plant; U = Underground Mines (9)

Appendix D

Field Inspections and Observations Summary of Findings – 2005-10

- 1. Bear Canyon Mine.** Bear Canyon Mine is located on the eastern edge of the Wasatch Plateau Coal Field, approximately 15 miles southwest of Price, UT. The mine has a unique problem: excessively high coal temperature in one of its headings. In Mine 3 (6-Right) the coal temperature reached 183 °F. In addition to heat stress, high temperatures in coal mines pose the threat of coal dust flashing. Based on field data and numerical simulators it was concluded that the heat at the Bear Canyon Mine is likely to be residual heat which can be controlled using ventilation alone, by upgrading the main fan system and reducing leakage. In consultation with experts, guidelines for working in a hot environment have been developed and presented to the mine operator.
- 2. American Gilsonite Bonanza Mine.** The mine is located approximately 35 miles southeast of Vernal, UT. It is one of the two mines in the western U.S. that produces gilsonite ore. The mine employs multi-task workers. The ore is broken in underground stopes using pneumatic chipping hammers, extracted by an exhaust fan system, transported by trucks to a processing center, and converted to final products in a gilsonite resin plant. Our inspectors covered both surface and underground facilities. In the processing plant two “problem” areas were identified: palletizing and forging. In the underground section three problems were identified: transportation cage, machine guarding, and working in elevated areas. A “punch list” highlighting these issues was prepared and sent to the mine operator for feedback. Once the field data were evaluated and the critical hazards identified, guidelines to correct these problems were developed, compiled in a manual, and presented to the mine operator. The manual includes video clips of safe and unsafe acts and conditions and still pictures tailored for group discussions and safety meetings. Improved work conditions practices were observed during the second visit.
- 3. Western Clay Quarry.** Western Clay Co. operates a bentonite and swell clay quarry near Redmond and a size reduction plant in Aurora, UT. At the quarry two critical hazards were identified: Highwall stability and contractors’ health and safety. Bench angles greater than 70 degrees, in poorly consolidated materials, were spotted at more than one working place. Independent contractors are regularly employed at this mine to haul the raw material from the quarry to the plant and also to distribute the final products. In spite of the training provided by the mine operator, some of the contractors still required additional training. A contractor’s hazard training check list was developed and discussed with the quarry supervisor. At the site reduction plant three critical hazards were identified: housekeeping, accumulation of dust, and mechanical hazards. Poor materials storage practices and damaged stairs with no foot protection were found at the plant. Furthermore, considerable amounts of dust were allowed to settle on walkways, roof tiles and floor. Finally, circuit breakers and other electrical control panels were found at various gathering places with no high voltage signs. A health

and safety training module highlighting these hazards was developed and presented to the mine operator.

The mine was revisited in 2007. a few improvements were observed at the processing plant, but dust is still a major concern. Another potential problem was spotted at this mine: inadequate number of fire extinguishers. The HIRA team recommended management to install additional number of extinguishers, and train workers on emergency procedures.

4. **Indian Queen Quarry.** Indian Queen Marble, LLC operates a quarry and a size reduction plant near Milford, UT. The mine produces crushed stone for various applications. The mining activities involve drilling and blasting, crushing, loading and hauling. Contractors are regularly employed to haul the ore from the quarry to the plant. At the quarry three critical hazards were identified: housekeeping, machine guarding, and human factor. Most workers are trained to performed several activities. However, certain activities such as drilling and blasting are carried out at the pit only a few times per year. Non-repetitive activities such as these require more training, especially when explosives are involved. This issue was discussed with the quarry supervisor and some basic guidelines added to the training manual. At the plant two critical hazards were identified: housekeeping at the shop and fire protection system. Although the plant had only a few work areas, the escape ways were not clearly demarcated and fire warning signs were not posted at visible sites. Based on the above findings a training manual was assembled and presented to management for implementation.

5. **Diamond K Gypsum Quarry.** Diamond K Gypsum Inc. operates a processing plant in Richfield, UT and a gypsum quarry 82 miles east of this town. At the plant, where most of the workers are employed, the company operates a gypsum processing plant, an automated bagging system, and a loading and distribution center. All work areas are kept clean and tidy. Materials handling and ore processing tasks are carried out by trained employees using the correct tools. The health and safety program of this mine is well managed and goes beyond the regulatory requirements. At the quarry however, two critical hazards were spotted: workers did not wear proper PPE, and contractors' safety. Although the company provides its workers with the required PPE, the utilization of these devices is not enforced. Though gypsum is a soft material, heavy equipment is used to remove the overburden and to load out the raw products, so PPE is needed. In addition, gypsum is found in snow white beds, resulting in high-glare conditions at times during the work day. To protect workers from injuries it was recommended to management that all workers, including contractors, be required to wear hard hats, steel-toed boots, and shielded dark glasses. Another issue of interest is the contractors' health and safety. To prevent unwanted incidents, it was recommended that these workers be integrated into the company's health and safety training program. The training module for this mine includes video clips on the company's safe production practice and the steps needed to overcome potential problems.

Mine ventilation was another concern in this mine. Diesel-powered machines are used throughout the mining process. Ventilation measurements showed that air velocity near the face was less than 50 fpm, with carbon monoxide concentrations of 30-35 ppm. Though two

portable fans were in use, these did not provide clean air to the faces, but just recirculated the contaminated air. Base on the machine horsepower and the normal work sequence, the HIRA team recommended improving the ventilation system by installation of a 100-horsepower fan with vent tubes, to provide at least 70,000 cfm of clean air to the working areas. This recommendation together with a system layout was presented to the mine personnel. A follow-up visit to the mine is schedule for this fall.

6. **Hidee Gold Mine.** The Hidee Mine, located near Central City, CO, is one of the 20 tourist mines operated in Colorado. It produces crushed samples of marcasite and covellite rich in gold and silver. Between 10 and 50 gold collectors visit the mine each week. In general, the mine is well managed. The critical hazard identified during the inspection was electrical. The HIRA team found an electrical plug that was regularly used to turn off and on an underground illumination network. This is an unsafe practice. Instead of using an ordinary plug, which was also worn out, the installation of a switch control board was recommended. This will reduce the workers' exposure to electrical hazards.
7. **Bates Hunter Mine.** This is a gold mine located in Central City, CO. It was the second ore body discovered by John Gregory in 1859, triggering the Colorado gold rush. The ore is primarily gold in quartz with trace amounts of copper and silver. After being abandoned for years, the mine was reopened by Hunter Gold Mining Corporation. Presently, the ore is broken in underground stopes using manual chipping hammers and extracted by a skip. The critical hazards were inadequate shaft guarding and chemical hazards. The shaft is used as the main entry and escapeway for the workers. It is equipped with a hoisting system, vent bags, and ladders for escape. The skip is used to transport ore and materials from different levels. During the inspection, it was found that the shaft was not isolated or guarded on various levels, and the landing platforms were not well maintained, thus exposing workers to trip and fall hazards. Our team recommended that management protect the shaft by providing barriers on each level and securing the timber planks. Improper storage of chemical containers was another concern at this mine. Based on HazCom standards, all chemical substances should be labeled and stored according to their applicable MSDS. Refresh training for all workers on HazCom standards and procedures was recommended.
8. **Original Sixteen to One Mine.** This is a gold mine located in Alleghany, CA. The mine was started by Tom Bradbury, the first owner, in 1896. After various changes in name and ownership over many years, the current mine owner resumed operations using the first name, the Original Sixteen to One. The mine uses the room-and-pillar method with conventional drilling and blasting for ore recovery, and a mill to produce concentrates of gold. Due to abundant mine water, ground support is a major issue on all levels. Rotten timber sets and rusted split-set bolts are two common problems. These generate loose and hanging rocks in drifts, especially in the main haulage drift, which is also used as the main access to the mine. Based on field inspections, the HIRA team recommended that management consider the following changes: (1) inspect timber sets regularly and replace the rotten ones; (2) scale down all loose and hanging rocks from drift backs, (3) consider other types of ground support

such as a combination of rock bolts, steel straps, and chain link, especially for the weak ground along the haulage drift. Another hazard found during the inspection was inadequately protected electrical boxes. Since the mine is wet, the HIRA team recommended that the boxes be either waterproof or provided with roofs to divert water, thus minimizing the risk of shorts and electrical shocks to the workers.

9. Huck & Sons Salt Mine. The mine is located near Fallon, NV. It includes a surface mine and a processing plant. The mining activities include: dozing, crushing, screening, and hauling, and sizing, and packing at the processing plant. During the inspection the following critical hazards were identified: (1) electrical hazards, and (2) multitasking. Three electrical hazards were observed. These are divided into three categories: (1) power cables, (2) electrical installations, and (3) cable storage. A summary of recommendations is presented below.

Power cables. Cables for pulley motors were laid down on the floor. Based on safe operating procedures, all cables must be installed adequately and treated as though they were powered. Our team recommended the operator to use cable-hangers as much as possible.

Cable color coding. Cables at the processing plant were difficult to identify. To avoid incorrect connections, our team recommended the use of cable identification labels.

Storage. Used cables were not stored properly. Under these conditions, workers are exposed to electrical hazards. Always disconnect and roll up extension cables after use.

Multitasking. Due to the limited number of personnel, workers at this mine perform many different tasks during a shift. Multi-tasking is a routine job for most of them. This was observed at the mine site, where one worker performed several tasks from operating a dozer to driving a haul truck. To prevent accidents due to multi-tasking, it is recommended that: (1) workers be trained for each different task, and (2) work conditions be fully assessed before starting each new task.

10. Ziegler Gilsonite Mine. This mine is located approximately 30 miles southeast of Vernal, UT. The mine has two work areas: an underground mine and a surface ore processing plant. The ore is broken in underground stopes using pneumatic chipping hammers, extracted by an exhaust fan system, and transported by trucks to the processing plant where it is converted to final products. At the mine two critical hazards were identified: (1) working in elevated areas, and (2) inadequate illumination. At the processing plant three hazards were identified: (1) dust and noise, (2) inadequate illumination, and (3) poor housekeeping. A summary of recommendations for these hazards is presented below.

Working in Elevated Areas. The mine uses a sublevel method to extract the ore. The roof and floor at various working places were not covered adequately. In more than one case, workers were exposed to falling rock from upper levels. In addition, the ladders and ropes used to access the stopes were not installed properly. Installation of additional planks and ropes to protect workers from trip-and-fall hazards was recommended.

Inadequate Illumination. The ore storage building is used to store materials and as a work area. During the inspection, the illumination in the building was inadequate. Workers were exposed to trip-and-fall type hazards. Adequate lighting should be provided. In addition, all work areas where machines are operated should have proper illumination so that all moving parts are seen clearly. To overcome these hazards, it was recommended that: (1) additional lights be installed, (2) windows be opened, (3) plastic curtains be used on building doors, and (4) a transparent roof be installed. Since Gilsonite dust can be ignited by radiant heat, installation of compact fluorescent lamps in the warehouse was recommended.

Dust and Noise. Workers were exposed to dust and noise and were not equipped with proper PPE at the processing plant. Dust should be controlled at the source by an auxiliary vent system. If this is not possible, workers should be provided with respirators. Another problem was the “float dust,” which can cause eye injuries. Full-face goggles may be needed in some areas. Workers at the plant were also exposed to high levels of noise (> 95 dB) from screens and other moving equipment. The permissible noise level for an 8-hour work period is 90 dB. It was recommended that workers be provided with proper PPE against high levels of noise.

11. Tenacity Perlite Mine and Mill. The mine is located in Caliente, NV. Mining operations include drilling and blasting, hauling, crushing, roasting, and packing. The mining activities at the pit are sporadic (once every 2 weeks), and carried out by contractors. The activities at the processing plant include crushing, screening, roasting, and bagging, and are carried out by company workers. During the inspection, the following unsafe conditions were spotted: dust and noise at work places, electrical hazards, fire hazards, and poor housekeeping. The crusher and conveyor transfer points were the major sources of dust. Power cables were not installed adequately; some were laid down on the floor. To improve workplace conditions, our team recommended that the vent system be equipped with collection hoods, and workers be provided with proper PPE.

12. Point of Mountain East Quarry. The mine, located in Draper, UT, consists of a sand and gravel quarry and a processing plant. The mining activities include: ripping, dozing, loading, and hauling. At the processing plant the activities include: crushing, screening, and hauling. Most of these activities are carried out in a safe manner. During the inspection the following hazards were identified: (1) electrical and mechanical, (2) inadequate use of PPE, and (3) poor housekeeping.

Electrical and Mechanical Hazards. At the processing plant, sagging power cables mixed with hydraulic hoses were found. Some of these were buried under muck piles. In one area, the access to a control room was blocked by rubbish and unused materials. Broken screens and rotating pinch points were also spotted in this area. To improve these conditions, the HIRA team recommended management to use cable hangers as much as possible, and clean up liquid and solid spills. The team also recommended repairing broken screens, guards, and handrails.

Inadequate Use of PPE. Another safety concern identified during the inspection was the reduced number of safety goggles at the work place. Workers did not wear glasses when performing their jobs. The HIRA team advised management to provide workers with adequate safety glasses and implement a policy to enforce their use.

Housekeeping. At the processing plant, the main hazards were created by improper stacking practices and poor housekeeping. Several walkways and working platforms were covered by dust and ice. To avoid slip-and-fall hazards, it was recommended that the floor and sidewalks be cleaned up before starting any new task. The utilization of the 5-minute, Neil George safety reminder was recommended to remind workers to remember to keep work areas clean and tidy.

- 13. Keigley Quarry.** The mine, operated by J. B. Parsons Companies, is located in Genola, UT. The mine consists of a sand and gravel quarry and a processing/bagging plant. The mining activities include: drilling, blasting, dozing, crushing, and screening. At the processing plant, the activities include drying and bagging. In general, the safety program at the mine is well managed. However, the following hazards were identified during the inspection: (1) improper material storage, (2) electrical hazards, and (3) failure to wear fall arrest devices.

Improper Material Storage. Bags of final products were stacked too high. In more than one case the pallets were broken and the stacks tilted. This is a poor materials stacking practice. A good stacking practice calls for a maximum height of three times the shortest distance at the base. This was illustrated with diagrams in the training module.

Electrical Hazards. The HIRA team found power cables laying on ground or covered by dirt. In one work area, an electrical outlet was covered by snow. Our team advised management to always treat cables as though they are powered, install power cables properly, and use a color coding system.

Working in Elevated Areas. Another safety concern was the failure to wear fall arrest devices while working in elevated areas. At the plant, two workers were found fixing a screen from a muck pile about 10 feet above ground level. They were not wearing any fall arrest devices. The HIRA team advised the plant supervisor to clean up the working platforms prior to starting a new task, and to remind workers to wear fall-arrest device when working at height.

- 14. Hess Pumice Quarry.** The mine is located in Malad, ID. It consists of a quarry and a processing plant. The activities at the mine included: ripping, dozing, screening, and hauling. At the processing plant, the activities included milling, screening, drying, classifying, and bagging. Most of these activities are carried out in a safe manner. The haul roads, shops, and other work facilities were kept in safe conditions. However, during the inspection, the following unsafe conditions and practices were observed: fire hazards, electrical hazards, and failure to wear proper PPE when working in elevated areas.

Fire Hazards. The quarry was not equipped with the right number of fire extinguishers, especially where combustible materials are stored. To facilitate a correct emergency

response, fire extinguishers should be stored at places that can be recognized and reached by workers easily. All fire extinguishers should be secured adequately and kept free from obstructions. Management should provide each area with a fire protection and prevention system. In addition, the quarry supervisor should assign specific responsibilities to ensure that each worker knows how to respond to emergency situations. A best practice on the number of fire extinguishers is one unit for every 200 square-meter area.

Electrical Hazards. At the quarry, an electric outlet was placed behind a rotating chair in the control room. In addition, cables from a power generator were found lying on the ground. The HIRA team recommended management to correct the problem and treat cables as they were powered. The use of cable-hangers, and color coding to distinguish power cables was also recommended.

Working in Elevated Areas. At the processing plant, two portable ladders were found in unstable positions. This condition may result in slip and fall injuries when workers attempt to use them. All ladders should be checked and marked; if any faults are found, the ladder should be repaired or taken out. During the inspection, our team also found a worker (crusher operator) who was not wearing any fall protection device while checking a vibrating screen (more than 10 feet above ground). The HIRA team recommended that management train workers on the use of fall arrest devices when working in elevated areas.

- 15. Treasure Canyon Calcite Quarry.** The mine is located near Preston, ID. At the quarry, the mining activities include drilling and blasting, dozing, secondary breaking, crushing, and hauling the raw materials to the processing plant. At the mill the activities include: crushing, screening, drying, classifying, and bagging. The final products, fine-sized, bagged calcite, are trucked to distribution centers. Most of these activities are carried out in a safe manner, except for dust emission at the quarry. This issue was discussed in safety meetings and possible solutions recommended.

During the inspections, the following hazards were identified: dust and highwall safety at the quarry, and electrical and materials storage hazards at the processing plant.

Float Dust. Workers were exposed to high levels of respirable and float dust around the crusher and conveyor transfer points. These particles can cause eye injuries and other health problems. Workers were not equipped with respirators. Dust should not be allowed to pass through the workers' breathing zone. Engineering solutions should be sought first, then administrative measures considered. Of the three possible dust control methods—enclosure, exhaust system, and water sprays—the latter was recommended.

Highwall Safety. Workers were exposed to falling rock hazards from a highwall. To overcome this condition, the HIRA team recommended that management (1) construct adequate catch berms in front of highwall toe, (2) inform workers not to step out of equipment cabin unless required, and (3) post adequate warning signs.

Electrical Hazards. In the bagging room, a power cable was found lying on the floor. Some switches were not labeled properly. The HIRA team recommended management to always treat cables as they were powered, use cable-hangers for permanent installations, and employ a color coding system.

Improper Material Storage. Poor stacking practices were observed at the repair shop. Truck tires, cables, and hoses were not stored to standards. These conditions expose workers to struck-by type hazards. Workers must be trained on good stacking and storing practices. Loads must be stable and tied down. A good stacking practice calls for a maximum height of 3 times the shortest distance at the base.

16. Allen Rock Quarry. The mine is located in Cove, UT. It produces sand and gravel for construction and road maintenance. At the quarry, activities include ripping, mucking, and hauling; and crushing and screening at the processing plant. The haul roads, shops, and other working areas were kept in safe conditions. The critical hazards included inadequate berms at the quarry, and electrical and fire hazards at the processing plant.

Inadequate berms. The berms at the ore dumping point and water pond perimeter were not adequate for the equipment utilized. Our team recommended that the supervisor reinforce the berms, especially those near the dumping point, to keep the equipment in track. Another berm around the water pond was also recommended, to eliminate submersion and flooding hazards. The berms should be at least mid-axle height for the largest equipment used.

Electrical hazards. At the processing plant, the access to the control room was blocked by a pile of unused materials. These obstructions would delay workers to shutdown the moving parts in case of an emergency. To avoid unnecessary delays, the HIRA team recommended that management clean up the access to the control room and to keep walkways clean and tidy.

Fire Hazard. Combustible materials were found close to flammable products and stored improperly. This represents a serious fire hazard. The best practice is to identify all chemical substances using their MSDS and store them properly. All combustible materials and ignition sources should be stored separately.

For each mine, recommendations were summarized in a report, discussed with the supervisors, presented to workers in safety meeting and submitted to management for implementation.

17. Mount Royale Ventures, LLC. This company operates the Cash Mine and Gold Hill Mill, near Boulder, CO. This is an underground gold mine, employing 15 fulltime and 3 part time workers. The mining activities involve enlarging old workings for current machinery, developing new headings, and mining ore from existing stopes. At the mill, the activities include crushing, screening, and producing gold and silver concentrates in a gravity circuit.

The mine was inspected twice. Four unsafe conditions and two unsafe acts were identified during the first visit, including working on uneven surfaces and poor materials storage practices. These issues were discussed with the mine personnel and the final recommendation submitted to management for implementation. In the second visit, it was seen that every recommendation had been implemented to achieve compliance with the applicable MSHA standards. A working platform was installed on top of a grizzly to eliminate slip and trip hazards, and special tool racks were built and installed in mine drifts to store drill rods and tools. At this mine, management takes a full advantage of any outside resources available to improve the workplace conditions and practices.

- 18. Baker Hughes Drilling Fluids.** The mine, located near Battle Mountain, NV, consists of various small pits and a processing plant. It employs 15 workers, most of them of Hispanic background. The mining activities include down-hole drilling and blasting, loading and hauling, and stockpiling of ore. At the mill, ore transportation, crushing, and jigging are the main activities. The final product is fine barite, which is bagged for shipment. The mine was visited three times. During the first inspection the following unsafe conditions and practices were identified: (1) trip-and-fall hazards, (2) inadequate machine guarding, and (3) high levels of dust and noise.

Trip-and-Fall Hazards. Unorganized tools on working platforms, loose handrails and fences, and platforms without toe-boards were found at the processing plant. These conditions expose workers to trip-and-fall type hazards. The HIRA team recommended that management install adequate handrails for fixed ladders and stairs, install a hose wrapping machine at the packing plant, and provide workers with fall protection devices where there is a danger of falling.

Machine Guarding. Broken screens and guards were found at the processing plant. Defective walkways and unguarded rotating shafts (pinch points) were also found. In the conveyor belt section, the emergency stop buttons and pull switches were covered by dust and looked like they were not getting the required attention from the supervisors. Our team recommended to repair or replace the broken screens, guards and handrails, and to inspect the conveyor emergency switches regularly.

Dust and Noise. Workers were exposed to high levels of dust and noise near the crusher area. Most were not equipped with proper PPE. Engineering solutions, including the installation of dust enclosures and water sprays near transfer points, were recommended. The utilization of a full face protection device by the crusher operator was recommended.

Significant improvements to the company's safety program were observed in the following two visits. All workplaces were clean and tidy, worn out guards had been replaced, a new water spraying system had been installed, and task training sessions were conducted at the work place. A strong commitment to safety from management made the difference. We produced a training module and video clips highlighting the critical hazards, alternate solutions to problems, and recommendations to solve these. These were presented in English and Spanish. Our efforts in identifying their critical hazards and developing site specific training modules for them were well received.

19. Ashdown Project LLC. This is a molybdenum mine located in Humboldt County, NV. It consists of an underground mine and a processing plant and employs 30 workers, 15 per shift. It is classified by MSHA as remote and small mine. The mine has been visited twice. During the first inspection, the following unsafe practices and conditions were observed: (1) improper storage of explosives, (2) inadequate use of PPE, (3) inadequate illumination at the mill, and (4) failure to wear fall arrest devices.

Improper Storage of Explosives. An unattended cache of blasting accessories was found near a working stope during the first trip. These had been removed from a powder magazine before ensuring the blast holes were ready for loading. This issue was discussed with the mine manager. On the second trip, our team noted that an underground explosive magazine had been constructed and commissioned. The magazine, located in a dry area and away from active stopes, includes two separate storage rooms for blasting agents and detonators. It is well maintained and accessed only by authorized workers.

Inadequate Use of PPE at Mine Workings. During the first inspection, workers were exposed to high levels of noise at the working stopes. Noise levels of about 114 dB were measured at areas where jackleg drills were being used. The workers were not wearing double hearing protection as required by MSHA. During the second visit, this practice has not changed. The HIRA team recommended management to provide workers with proper PPE against high levels of noise. Properly maintained earmuffs and ear plugs can be used to reduce sound levels to the allowable limits. Another problem identified during the inspection was insufficient use of eye protection at the workings. Our team recommended management to provide workers with adequate safety glasses and reduce the dust level at the workings.

Inadequate Illumination. The illumination intensity near the flotation cells was below 4 foot-candles (FC). This intensity is considered inadequate for surface operations, especially in areas with moving machinery. It was recommended that lighting intensity be kept within 15 - 30 FC by installing additional lightings or windows.

Failure to Wear Fall Arrest Devices. The crusher operator was exposed to slip-and-fall hazards when operating a hopper feeder. His work area was not protected by any physical barrier, nor was he equipped with a fall arrest device. To avoid slip-and-fall accidents, the HIRA team recommended that management install adequate barriers, with toe boards. Providing a fall arrest device with a self-retracting lifeline for the operator would also be useful at this plant.

The plant was revisited in June 2008. This time, all areas with moving parts were well illuminated, the crusher protected by physical barriers, and the hopper feeder equipped with a fall arrest system. In general, the safety program of this mine is well established, and the workers are equipped and trained to perform multiple tasks safely.

20. Brigham City Pit. This mine is operated by J.B. Parsons Companies and is located in Brigham City, Utah. The mine consists of a sand gravel quarry and a processing plant. The mining and processing plant activities include: dozing, mucking, hauling, crushing and

screening. The following hazards were identified during the inspection: (1) fire hazard, (2) electrical hazard, and (3) dust and noise

Fire Hazards. The access to a fire extinguisher was blocked by a chair and unused materials in the control room. This may result in delays during an emergency situation. The best practice is to provide each area with the right number of fire extinguishers and keep their access ways free from obstructions. The location of these devices should be marked (except in offices) and identified by means of symbolic signs. In addition, sufficient quantities of the correct types of extinguishers and others fire fighting devices such as hoses, hydrants, sprinklers, etc should be provided to deal with various types of fire hazards at the plant.

Electrical hazards. In the crusher area, an electric box was not isolated properly. A good practice calls for all electrical units to be locked at the point of control or operation. To eliminate electrical hazards, all controls must be protected against accidental operation and inspected regularly (avoid deterioration of parts).

Dust and noise near the crusher. Workers were exposed to high levels of dust near the crusher area. In most areas, an excessive emission of “float dust” was the main problem. Dust should not be allowed to pass through the workers’ breathing zone. The HIRA team recommended that management install water spray at strategic locations along the belt lines, an exhaust ventilation system in confined areas, and provide workers with respirators (ensure they wear them when needed).

- 21. McGuire Pit.** This mine is located in Willard, Utah and is operated by J.B. Parsons Company. The final products are sand and gravel for road and building construction. The mining activities include dozing, mucking, and hauling. At the processing plant, the activities include crushing and screening. In general, the safety program is well managed. However the HIRA team identified the following hazards: (1) highwall safety, (2) electrical hazards, and (3) housekeeping.

Highwall safety. During the inspection, the HIRA team found workers were exposed to falling rock hazards from a highwall and load out stock piles. To overcome these conditions, our team recommended that management establish a safe mucking range from bench toe to work area and avoid undercutting. Our team also recommended constructing catch-berms to retain rolling boulders from bench top, and train workers on highwall safety.

Electrical hazards. In the pit area, an electric box was found unprotected. To eliminate electrical hazards, our team recommended installing adequate barriers to protect this box from moving equipment, and post safety signs to warn workers.

In the control room, the access to control breakers was blocked by unused materials. Our team recommended keeping all switches accessible and all circuit breakers free from obstructions (critical switches should be suitably identified).

Housekeeping. Unorganized tools and inadequate material stacking practices were found near the control room. General cleanup and proper materials storage are recommended. Good housekeeping will reduce or eliminate most of the unsafe conditions found in this work area. Since safe production is the main target, to keep work areas clean and tidy, special programs such as the 5-minute Neil George safety reminder could be of great help at this mine.

22. **South Weber Pit.** The mine, operated by J.B. Parsons Companies, is located in South Weber, Utah. At the South Weber Pit, mining activities include dozing, mucking, and hauling, and crushing and screening at the processing plant. The final products of this mine are sand and gravel for road and building constructions. Most of these activities are carried out in a safe manner. Workers are trained frequently, and potential problems discussed in safety meetings. A summary of our findings are presented below

Housekeeping. Housekeeping in the maintenance shop and lay-down yard needed some improvement. General cleanup and proper materials storage are recommended. A good staking practice calls for a maximum height of 3-times the shortest distance at the base. A good housekeeping will reduce or eliminate most of the unsafe conditions found at this shop. Since safe production is the main target, the implementation of special programs such as the 5-minute Neil George safety reminder is recommended for this mine.

Working in elevated area. During the inspection, the HIRA team found a platform that was not equipped with toe-boards. This exposes workers to slip and fall type hazards. To overcome this problem, the HIRA team recommended that management install adequate toe-boards, and wear safety harness when there is a danger of falling.

Fire hazards. In the maintenance shop, the HIRA team found several fire extinguishers that were blocked by unused materials. This may cause delays in an event of a fire. To eliminate or reduce fire hazards, our team recommended that management provide the plant with a sound fire protection and prevention system, and instruct workers on how to respond to emergency situations. Our team also recommended assigning specific responsibilities on fire prevention at each level of authority.

Appendix E

Survey Forms Used to Validate a Safe Production Model for Small Mines

FORM 1: EXPERT JUDGE'S QUESTIONNAIRE

Rank the following elements based on their importance to achieving safe production goals:			
	Less important	Important	Extremely important
Management Commitment and Leadership	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hiring Process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Training and Evaluation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hazard Identification and Risk Assessment (HIRA)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Accident Investigation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Safety Policies and Procedures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Safety Accountability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Communication and Participation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

FORM 2: MINE OPERATOR'S QUESTIONNAIRE

Rank the following elements based on their importance to achieving safe production goals:			
	Less important	Important	Extremely important
Management Commitment and Leadership			
Clearly stated and written objectives	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Focus on coaching and counseling rather than	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Established site-specific health & safety program	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hiring Process			
Minimum skills requirement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Specific treatment for unskilled workers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Established hiring procedure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Training and Evaluation			
Established site-specific training	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Method of delivery (multimedia, expert worker as	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Trainees' evaluation and assessment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hazard Identification and Risk Assessment (HIRA)			
Workers fully involved in process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HIRA used to establish Standard Operating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Revised SOP to account for new process, accident,	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Accident Investigation			
Workers involved in investigation team	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Root cause sought, not the fault	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Recommendations follow up	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Safety Policies and Procedures			
Clearly defined and achievable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Simple and cover all tasks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Set beyond the national standards	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Safety Accountability			
Well defined targets	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reward system in place for outstanding performance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Integrated into production measurement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Communication and Participation			
Delegated to subordinates	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Encourage workers' feedback	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Utilize established methods (e.g. safety meetings)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Appendix F

Survey Form Used to Validate Electrical and Mechanical Pocket Cards

ELECTRICAL POCKET CARD QUESTIONNAIRE

Name :
 Position :
 Company :
 Mining experience :

Indicate your opinion of each of the following statements about the electrical pocket cards
 (Please mark one box for each statement)

SD : strongly disagree D : disagree N : neutral
A : agree SA : strongly agree

HOW TO HANDLE CABLE	S	D	N	A	SA
1. Realistic in requirements					
2. Clearly defined and achievable					
3. Give good description of the steps for implementation					
4. Correctly cover all major tasks					
5. Includes all necessary information					
6. Meet or exceed government standards and regulations					

TRANSFORMER INSTALLATION	S	D	N	A	SA
1. Realistic in requirements					
2. Clearly defined and achievable					
3. Give good description of the steps for implementation					
4. Correctly cover all major tasks					
5. Includes all necessary information					
6. Meet or exceed government standards and regulations					

LOCK-OUT TAG-OUT PROCEDURE	S	D	N	A	SA
1. Realistic in requirements					
2. Clearly defined and achievable					
3. Give good description of the steps for implementation					
4. Correctly cover all major tasks					
5. Includes all necessary information					
6. Meet or exceed government standards and regulations					

COMMENTS AND SUGGESTIONS

MECHANICAL POCKET CARD QUESTIONNAIRE

Name :
 Position :
 Company :
 Mining experience :

Indicate your opinion of each of the following statements about the electrical pocket cards
 (Please mark one box for each statement)

SD : strongly disagrees *D* : disagree *N* : neutral
A : agree *SA* : strongly agree

MACHINE GUARDING

	S	D	N	A	SA
1. Realistic in requirements					
2. Clearly defined and achievable					
3. Give good description of the steps for implementation					
4. Correctly cover all major tasks					
5. Includes all necessary information					
6. Meet or exceed government standards and regulations					

MOVING EQUIPMENT OPERATION

	S	D	N	A	SA
1. Realistic in requirements					
2. Clearly defined and achievable					
3. Give good description of the steps for implementation					
4. Correctly cover all major tasks					
5. Includes all necessary information					
6. Meet or exceed government standards and regulations					

WORKING IN ELEVATED AREAS

	S	D	N	A	SA
1. Realistic in requirements					
2. Clearly defined and achievable					
3. Give good description of the steps for implementation					
4. Correctly cover all major tasks					
5. Includes all necessary information					
6. Meet or exceed government standards and regulations					

COMMENTS AND SUGGESTIONS

Appendix G

G1. Safe and Unsafe Work Practices and Conditions

A. Safe Work Practice and Conditions



Brass in – brass out



Transformer protected adequately

B. Unsafe Work Practice and Conditions



Improper practice of working in elevated areas



Unprotected electrical control board

Appendix G

G2. Intervention Results

A. Tunnel entrance

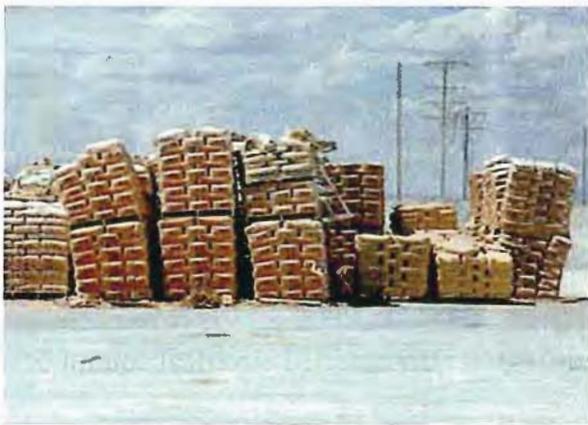


2008: No barrier at mine portal



2009: Adequate portal barrier

B. Material storage



2009: Improper stacking practice



2010: Adequate stacking practice

G2. Intervention Results (Continued)

C. Fire hazards



2009: Inadequate number of fire extinguishers

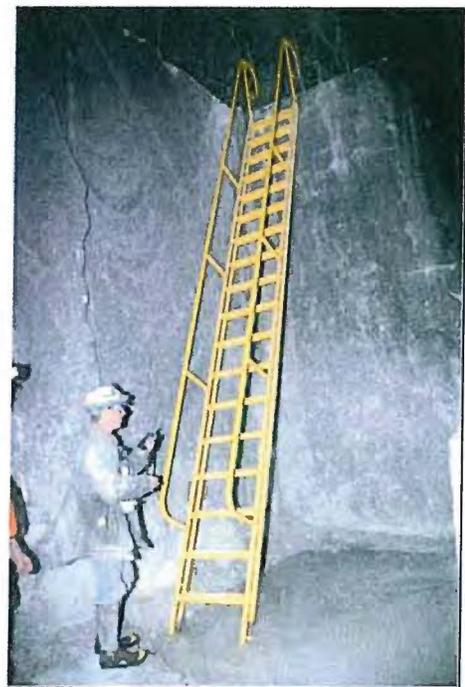


2010: Adequate number of fire extinguishers

D. Ladder



2008: Unsafe ladder & installation



2009: Adequate ladder installation

