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MINE SAFETY AND HEALTH ADMINISTRATION

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TECHNICAL SUPPORT

MINING PRACTICES REVIEW - EXPLORATORY STUDIES FACILITY
YUCCA MOUNTAIN PROJECT

April 15 and 16, 1997
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This report summarizes the observations and comments of three Mine Safety and Health Administration (MSHA) Mining Engineers who, at the Department of Energy's (DOE) request, visited the Exploratory Studies Facility (ESF), at Yucca Mountain, Nevada Test Site on April 15 and 16, 1997, and May 28, 1997. Since the visit, the Tunnel Boring Machine (TBM) has holed out (April 25, 1997) and the discussed ground support design and ventilation plan for hole-out have proven successful. Therefore, further comment on these items is moot.

For clarity, this report is divided into five sections: ventilation, rock excavation in alcoves, dust control, tunnel transport system and fire protection.

Ventilation

Prior to hole-out, intake air was supplied through the 25-ft-diameter bore up to the TBM. Return air was exhausted from behind the cutter head through a 66-inch-diameter corrugated metal duct hung from the apex of the 25-ft-diameter circular bore. Due to the length of the bore (5 miles), seven auxiliary (booster) fans were necessary. This results in some sections of the duct being on negative pressure and some sections on positive pressure. Ducting joints on positive pressure emit (leak) a small quantity of air and fine rock dust which contribute to the hazy condition observed from about 2700 meters into the bore to the TBM.

Suggestions:

1. Use a tighter sealing joint for the positive pressure side of the booster fans. Some possible suppliers are Schauenburg, Flexadux Corporation and Peabody ABC.

2. Periodically inspect the inside of the exhaust duct to insure that only minimal accumulations of dust are present in the duct to prevent weighting the duct and possibly tearing it loose from its supporting hangers.

3. Evaluate extending the exhaust duct termination point a further distance away from the north portal to ensure exhaust air is not reintroduced into intake air.

4. Check design of existing fans for required air quantities. If fan speeds can be reduced and acceptable air quantities still maintained, fan noise levels will be reduced.

5. Commercial silencers are available and may be adaptable. (Attachment I). The attached DS&HTC report also describes fan silencing by using fiberglass batts and brattice cloth (Attachment II).

6. Generally, in-line centrifugal fans are quieter than vane-axial mine fans (Attachment III).

Alternate Ventilation Plan

Many tunnels are ventilated by a single large fan located at one portal, forcing or pulling air through the entire length of the tunnel. Now that "hole-out" has been attained, this may be an option that DOE would wish to consider. The advantages would be many: elimination of the large exhaust duct; elimination of the booster fans; elimination of duct leakage which contaminates intake air with dust; probably reduced power requirements and elimination of booster fan noise by locating the large centrifugal fan outside the tunnel. However, while excavation is continuing in the alcoves, the present exhaust duct should remain in place for dust control purposes.

With the present ventilation system, the possibility of reversing the main ventilation during an emergency is possible. Consideration should be given to this option. Under some scenarios, such as a fire near the intake portal, main ventilation reversal offers an attractive means of limiting the spread of toxic gases. It is, however, of critical importance that all personnel be fully trained in emergency procedures, that conditions under which ventilation would be reversed be detailed in a written plan, and personnel be made aware that if ventilation reversal takes place, what the escape route is.

Rock Excavation in Alcoves

From discussions with ESF personnel, it is our understanding that water sprays on the Alpine miner being used to excavate the experimentation alcoves are not an option. However, as was readily apparent during the visit, a tremendous amount of dust is being generated by the current rock excavation technique. From the mineralogical make-up of the welded tuff in which the ESF is excavated, this dust is known to contain a large quantity of silica; therefore, dust control is a very important issue.

Suggestions:

1. If alcove construction is to be an ongoing activity at the ESF, a different type of excavation technique is recommended. Although, mechanical mining in hard, siliceous rocks has not been as successful as mechanical mining in softer rocks, (coals, shales, potash, trona, etc.) technology is continually advancing and new machines, cutter head designs and bits are always in the developmental stages. We advise a thorough review of existing and developing rock cutting technology to reduce the dust hazard created by the current excavation technique.

2. While the current rock cutting technique is being utilized, our preliminary analysis indicates that fugitive dust could be reduced by installing a push-pull ventilation system which would continually sweep across the face to quickly remove generated dust. This system is depicted in Figure 1 and would be in addition to the existing system. Intake and exhaust ducting should be carried from the main bore, with the existing exhaust system remaining in place. Slot size and spacing in the push system should be varied to determine maximum efficiency. Vertical tubings should be advanced with the face.

3. Directional water sprays should be considered for the road header in cases where water can be

used. Water sprays, most specifically hollow-cone sprays, have been found through U.S. Bureau of Mines research to be effective in moving air as well as suppressing dust. The Sprayfan was developed for continuous miners in coal to more effectively sweep the face when using exhausting face ventilation. Sprays are mounted on the off-tubing side of the machine to bring a clean split of air along the operators side of the machine. Additionally, sprays are mounted behind the cutting head which are oriented toward the exhausting tubing. A well designed Sprayfan significantly improves visibility and dust capture in the face. Although a Sprayfan system specifically for road headers has not been developed, the concepts should be easily adapted. "Sprayfan Systems: Requirements and Setback Guidelines" has been included as a brief summary of this technique.

4. Dust is generated each time muck is dumped or transferred. Thus, minimizing the number of transfer points and the digging or handling of the muck piles is important in reducing dust. Possible alternatives to the current method of piling the muck behind the roadheader, digging the muck pile with a loader or LHD and transporting the material to a fixed loadout would be:

a. Use an extendable belt system to load directly from the roadheader discharge belt, thus avoiding the dust created by digging into the muck piles and reducing transfer points.

b. Use a shuttle car or small truck to move muck from the roadheader discharge belt to the loadout point. This option would require the roadheader to stop cutting when the shuttle car is away from the machine. However, with the short travel distances required in the alcoves, down time would not be appreciable.

c. Keep moving the loadout point (with an extendable belt) so that it is just a short distance from the roadheader discharge belt. A small loader (capable of turning in the opening) could feed material into the loadout point without having a long-haul distance.

5. If the belt loading point in the alcove is not already fitted with a dust collector (hood) vented directly to the return, this should be considered.

6. The use of a small battery powered loader should be evaluated to eliminate the cooling fans on diesel equipment which create air currents which circulate dust. As a minimum, cooling fans on diesel equipment should be reviewed to ensure that cooling air is vented to minimize dust generation.

7. If the small Caterpillar 933 track-mounted loader is to remain in use, the operator's cab should be enclosed and air filtration equipment installed. Although an enclosed cab will not eliminate all dust contamination, it will reduce the operator's exposure to both dust and noise. Also, most factory cabs perform very well with A/C included and rarely register over 90 dB noise level.

8. A dust scrubber for the roadheader (flooded bed, wet-type scrubber) may be feasible if water

is routed to the conveyor and sprayed on the waste material

Dust Control

1. The exposed waste material carried on the belt conveyor out of the tunnel to the waste dump is a large contributor to the dusty condition in the tunnel's atmosphere. Water sprays with chemical additives do reduce dust generation. For your convenience, we have attached a listing of commonly used dust suppressants (Attachment IV). Because the material is being transported out of the tunnel to a waste pile, contamination of the material should not be a problem. If contamination of the tunnel by way of the return belt is a problem, passing the return belt through water sprays and, if needed, electric dryers to eliminate washing residue outside the portal is a possibility. If these alternatives are not possible, enclosing the conveyor system in a fiberglass or metal "trough" is another alternative. If the enclosed trough method is preferred, negative air pressure ports vented directly to the tunnels exhaust air system are recommended. Drip pans equipped with a drainage pipe would probably also be required to catch and contain any return belt moisture.

2. Dust control in the experimentation alcoves has been addressed in the rock excavation section.

3. Belt transfer points should be fitted with dust collection hoods vented directly into the tunnels return air duct.

Intake air dust contamination should be investigated. Roadway treatment may be effective in reducing intake contamination.

Tunnel Transport System

Supply and personnel trains traveling through the tunnel are both a source of dust regeneration and noise.

To reduce dust, a rail mounted, water car capable of misting water over the floor of the tunnel would help control the dust stirred-up by movement of the train. Now that the major construction effort is over and a large number of visitors is anticipated, new, longer man-trip cars equipped with underbelly water tanks would serve the dual purpose of spraying water and reducing noise when the belly tanks are full due to increased car weight. Visitor comfort could be increased by using enclosed cars to reduce air, fan and track noise.

Rail alignment to reduce the hammering of the wheels at the track joints is absolutely essential for quiet train operation. Realignment of the track system is suggested. Wheel noise can be minimized through the use of welded rail. Lining the inside of man trip cars with sound dampening material would also quiet the ride.

To minimize noise generation by the locomotive, the use of battery powered locomotives for mantrips or passenger service should be evaluated. Our preliminary survey indicated that the tunnel length is not too great to use battery locomotives; however, locomotive manufacturers should be consulted. If battery locomotives are selected, battery charging stations should be located outside the tunnel, or monitored by a mine-wide monitoring system.

The exhaust muffler on the diesel engine is the most important noise control. For the ESF, the use of a VIBRATION-ISOLATED cab on the locomotives will provide good noise reduction, probably 5-10 decibels. If the cab is welded or bolted to the locomotive frame, there will be virtually no noise reduction since the cab will become a noise source itself. Acoustic foam inside the cab and heavy floormats are standard treatments for cab interiors. Positive-pressure ventilation with filtered intake air or air-conditioning systems are also recommended to keep the operator comfortable and to control dust exposure. Locomotive cabs are feasible for the ESF due to the large tunnel size.

Fire Protection

In our opinion three main sources of fire exist within the ESF: the diesel locomotives, conveyor belts, and the power centers (transformers).

If the diesel locomotives are retained, the fire potential could be minimized by equipping the locomotives with automatic fire suppression systems, cooling jackets on exhaust manifolds, and reinforced and remotely located fuel tanks. Although the ESF is not a gassy mine atmosphere, many of the fire and explosion protections published in Code of Federal Regulations, Title 30, Part 36 regulations would enhance safety and minimize the fire danger from mobile equipment within the ESF. We suggest a review of Part 36 requirements for adaptability to mobile diesel powered equipment being used within the ESF.

Power centers should be placed in niches to provide protection from any accidental collision or impact with equipment traveling in the tunnel. Power centers should also be equipped with hoods and vented directly into the exhaust air duct. In the event of a fire, any smoke or poisonous, gases could be immediately vented into return air. Also, automatic fire suppression systems should be located with each transformer.

It is suggested that DOE consider installing a mine-wide monitoring system within the ESF. Carbon monoxide and heat sensors could be installed at each potential ignition source - power centers, conveyor belt drives, alcove return air ducts, fans and at intervals along the conveyor belt. This system would provide early warning of a fire and its location for quick fire fighting response. If DOE decides to consider the use of a mine-wide monitoring system, we can suggest several western mines which would most likely accommodate a visit for observation and evaluation of an operating system. If diesel locomotives or other diesel materials handling equipment is retained, some difficulty will likely be encountered in establishing CO monitor alarm levels.

The current use of the W-65 Self-Rescuer affords a limited amount of protection (protection against carbon monoxide poisoning for 1-hour). Supplementing the W-65's with oxygen generating, self-contained self rescuers, (SCSR), as DOE is doing, affords ESF personnel a much higher level of protection against smoke and carbon monoxide. It is suggested that quantities of SCSR's be cached at intervals along the tunnel to aide personnel in evacuating the tunnel under emergency conditions.

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