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June 30, 2010

Via Hand-Delivery

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Administrative Services and Policy Coordinator
Division of Oil, Gas and Mining
1594 West North Temple, Suite 300
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Steve Alder
Attorney General
Division of Oil, Gas and Mining
1594 West North Temple, Suite 300
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Re: Informal Conference, C/3070005
Winter Quarters Ventilation Facility

Gentlemen:

Thank you for the opportunity to respond to the submission of Skyline Mine and its counsel, Dorsey & Whitney, regarding the anticipated noise levels that would attend the installation of its proposed exhaust fan at the Winter Quarters Ventilation Facility. Under the scheduling order entered by Mr. Schneider at the informal conference, our response is due today and the hearing will close as of 5:00 p.m. this afternoon. We appreciate your attention and consideration at the conference and throughout these proceedings.

With all respect to the mine and its counsel, their submission does not alleviate Mr. Liodakis's concerns and we are therefore constrained to maintain his objection to their proposal. The reason is simply this: lack of direct answers to direct questions that we have posed to the mine, through its counsel, over the last several months and continuing to this day.

Boiled down to its essence, the mine's response to the objection is basically this (we paraphrase): "The fan will be large, 10 feet in diameter, but trust us. We'll use the best commercially available technology for reducing noise. Besides that, the other fans we told you about are large too and don't make much noise to begin with and neither will

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this one. The fans are similar, the topography is too, and whatever noise is generated at the source will dissipate to background levels with distance." Thus, they do not describe the fan or its functionality or specs in detail, much less directly address the noise it will generate, and they provide nowhere near enough information to allow either carefully considered comment or approval.

On the contrary, you will search their submission in vain for answers to even the most basic questions. Exactly what area below the facility is going to be "ventilated"? What volume of air will be pulled per minute through this new shaft that will be 300 feet deep? How much power will that require on a continuous basis? How much noise will actually be generated at the source – that is, before any mitigation efforts? How much noise will remain at the source – after mitigation efforts. If this fan is at the outlet, where is the inlet? In other words, what is or will be the mine's source of fresh air? Does that require a separate inlet fan? How do they know that one exhaust fan 10' in diameter will do the job? What is the likelihood that another or still another may be required? What particulate or gas in addition to "clean air" (if any) will be exhausted? (They say there is no methane problem, but do not answer the basic question of exactly what particulates or gases will be emitted in what concentrations.)

Rather than address any of the questions respecting noise directly, they address them circumstantially – by measuring existing noise levels around the proposed fan and then arguing that existing fans in similar areas don't exceed or change those noise levels much as you move further from the source. Of course, as to these supposedly comparable fans too, the mine provides no detail whatsoever regarding their functionality or specifications. Thus, there is no basis at all to assess the validity or invalidity of the comparisons.

Before the hearing, we asked the mine through its counsel orally and twice by email simply to provide direct answers – answers about the functionality and specs of this proposed fan, not other ones, so that we could understand the nature and extent of the problem, if indeed there was one. The two emails are submitted herewith as Exhibits A and B. You will see that the questions they pose are essentially the same as those asked above. We received no written or email response. We were told orally only that the fan would likely be one of two makes and would have a 10' diameter. And although we advised counsel for the mine we had been unable to identify anything in the permit application regarding noise, and would appreciate any light he could shed on the matter, he did not inform us before the informal conference that the mine would somehow be relying on a noise study prepared nearly two years ago relating to a different fan at a different mine (the Green Hollow Sound Study – Sufco Mine).

In Mr. Sorensen's letter to you dated June 23, 2010, he says: "This fan will be of the axial design with an external motor house and will *likely* be a 10 ft. diameter class fan." (emphasis supplied). The "external" motor house will, as best we can tell, be sitting atop the new pad and will be a source – among others – of noise. We are not told how much noise, only that the mine will use the "best commercially available technology" to reduce noise. (Does that mean regardless of expense? We are not told.) The fact that the letter is noncommittal about the size of the fan – it will "likely" be a 10 ft. diameter class fan – is especially troubling. Is the mine asserting that it retains discretion in this respect? Again, we submit that the mine has not submitted detailed information or a "plan" as such and its application does not warrant consideration as though it were a plan when it plainly is not.

What is perhaps most perplexing about this situation is that the mine is best positioned to decide exactly what fan it needs and to get the kinds of information we are requesting from the manufacturer or other operators – that is, given the depth of the shaft and configuration of the mine below, what the technical requirements of the fan will be, how much power that will require, and what the noise level will be, at least at the source. Fan noise is not a new subject, and information like that should be readily available.

Thus, precisely because mine noise is such a problem, there is considerable literature on the noise created by large, noisy equipment within mines, including fans. Submitted herewith as Exhibit C is an article discussing six case studies concerning noise in stone/aggregate mines. At page 5 there is a discussion of the noise generated by a 25-hp Joy fan and a photograph of the fan showing that is far smaller than 10 feet in diameter. "The sound levels near the fan ranged from 90 to 106 dB(A)." What does that say about the much larger, more powerful fan proposed here? What is most disturbing is that we simply don't know and the mine will not answer the question directly.

In addition, there is considerable literature and scholarly work that has been done regarding the impact of noise on the behavior and vitality of fish and wildlife. We attach a summary of that literature as Exhibit C for your consideration. You will see that noise can and does have serious and adverse impacts. Mr. Liodakis's concerns about that are well founded.

Whatever exactly the impact will be here, it will last for decades. It may compromise the prospects for developing a site with considerable historical significance. It may, depending on the noise levels, compromise fish and wildlife. The least this body should demand before committing to such a long-term, potentially irreversible impact is a clear and comprehensive plan, not just comparisons that may or may not be germane and promises that may or may not be kept. To be sure, in this case the mine has obviously done considerable planning and engineering work. But one thing is certain. As it relates to ventilation, the plan is neither clear nor comprehensive. It omits critical detail about the proposed fan, perhaps the most basic and critical component of the ventilation plan.

Finally, we note that the letters submitted by Mr. Sorenson and Mr. Prince on June 23, 2009, both maintain that an existing lease the mine has with Mr. Liodakis permits whatever impact the facility may have on his adjoining property and residual property rights. Mr. Prince adds that apart from impacts on wildlife and vegetation, all other issues are subject to that lease and outside the jurisdiction of this body. Suffice it to say that we disagree. On the contrary, the only thing that is clearly outside the jurisdiction of DOGM is a determination of the scope or relevance of the lease. And what is squarely within the jurisdiction of DOGM is whether Skyline Mine's submission sufficiently addresses the very real concerns attending its proposed Winter Quarters Ventilation Facility. With all respect, it does not.

Thank you again for your careful consideration. We sincerely appreciate it.

Very truly yours,

Thomas R. Karrenberg RC

Thomas R. Karrenberg

TRK/RAK

Cc: George Liodakis
William Prince, Esq.

Rick Kaplan

From: Rick Kaplan
Sent: Wednesday, May 12, 2010 1:43 PM
To: 'prince.william@dorsey.com'
Cc: Thomas R. Karrenberg
Subject: questions regarding the fn

Bill, the major concern with respect to the fan, as I've said, has to do with noise. Will the noise levels generated by the fan have an adverse impact on the health and safety of nearby property owners, such as Liodakis; and, if not that severe, what impact will the noise have on Liodakis's use and enjoyment of his property in particular. You'll recall that Mr. Buhler indicated in his correspondence to DOGM that the fan would be audible for about a mile, according to a representative of the mine. What exactly does that mean? How "audible"? How much of the time?

The concerns include questions about potential impacts not just directly on people (as it relates to their physical presence in nearby areas or development prospects, for example) but also indirectly on people as a result of the impact noise may have on the behavior and well being of fish and wildlife (as it relates to hunters, fishermen, etc.). It would be helpful to me to have as much information as you can possibly provide about what exactly the fan is that is contemplated by the permit application, what the noise levels will be and what impacts the noise will have on humans, animals, and fish and generally on Liodakis's use and enjoyment of his property

More particularly, I would like to know the make, model, type (axial or centrifugal), dimensions, housing (whether it is sitting on top of a bed of some kind, exposed to the elements or contained in some sort of structure) cfm (cubic feet of air per minute), power utilization, positive or negative pressure balance, peak and normal decibel levels, intended hours of operation, any information the manufacturer may have or the engineers may have collected about the impact of the noise that will be generated on humans, fish or other wildlife, planned steps, if any, to mitigate noise, whether the fan contemplated is a prototype or in operation elsewhere and, if so, where; and anything else you may be able to provide that would shed light on the issues I've identified above.

I appreciate your help. As I said, we are considering requesting an informal conference before DOGM to make sure these issues are addressed to the extent necessary to understand whether there are health and safety issues and, if not that severe, what impacts the noise may have of the kinds I've described.

Thanks. I appreciate your help.

Rick Kaplan

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Thank you.

Rick Kaplan

From: Rick Kaplan
Sent: Tuesday, June 15, 2010 2:11 PM
To: 'prince.william@dorsey.com'
Cc: Thomas R. Karrenberg
Subject: Tetra Tech Report -- Sulco fan compared to Skyline

Bill,

The Tetra Tech Report at page three says that as it relates to sound impacts to wildlife, the Sufco Mine and the Skyline Mine will have "similar operations." I gather that that similarity in operations is the basis for the relevance of the comparison.

We want to unpack that to enable ourselves and ultimately DOGM to make independent determinations of the usefulness of the Sulco information.

In that regard, we would appreciate it if you would please have Skyline provide us as soon as possible a comprehensive comparison of the fan in use at Sufco and the two fans they're considering installing at Winter Quarters. Please include as much detail as possible. For example, with respect to each of the three fans please include make, model, type (axial or centrifugal), dimensions, number and dimensions of blades, horse power, cubic feet of air per minute, whether the Sufco fan is an exhaust fan (the report doesn't say) or works with positive pressure, peak and normal decibel levels of the proposed fans (which should be available to you as prospective purchasers from Joy or Babcock), hours of operation and anything else you think may be pertinent. Please also compare the functionality requirements of the fans – are the ventilation requirements the same in both facilities? If not, how do they differ? Also, the report qualifies its conclusions at the bottom of page 3. Please ask Skyline to comment on the "unique topographical and vegetative characteristics that may aid or impede sound travel in the adjacent areas [in Winter Quarter's Canyon]." What are the similarities and the differences and how are the differences likely to affect the capacity of noise to travel?

In addition, if Skyline has any information available regarding fans and noise in other mines it operates, we would request that as well.

Finally, please explain how noise at Sufco is mitigated and, if the plans to mitigate noise at Skyline currently exist, how the approaches are similar and how they differ.

Thank you,

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Thank you.

Noise assessment of stone/aggregate mines: six case studies

E.R. BAUER AND D.R. BABICH

Introduction

Exposure to noise and noise-induced hearing loss (NIHL) continues to be problematic for the U.S. mining industry. The problem is particularly severe because large, noisy equipment dominates the industry. Studies have shown that 70 percent to 90 percent of all miners have NIHL great enough to be classified as a hearing disability (NIOSH, 1996). To address the issue, the U.S. Mine Safety and Health Administration (MSHA) published Health Standards for Occupational Noise Exposure (*Federal Register*, 1999). The new regulations include the adoption of a hearing-conservation program similar to that of the U.S. Occupational Safety and Health Administration (OSHA), with an "Action Level" of 85 dB(A) eight-hour time weighted average (TWA8) and a permissible exposure level (PEL) of 90 dB(A) TWA8. The regulations also state that a miner's noise exposure shall not be adjusted because of the use of personal hearing protection, and that all feasible engineering and administrative controls must be used for noise exposure reduction.

The U.S. National Institute for Occupational Safety and Health (NIOSH) has responded to this problem in a number of ways, including conducting a cross-sectional survey of noise sources and worker noise exposures in the mining industry. Initially, these surveys were conducted in surface and underground (continuous and longwall) coal mines, in coal preparation plants and in sand and gravel mines. Recently, this has included surveying stone (aggregate) mining and crushing and processing facilities. The mine sites were selected primarily through personal contacts within the mining industry. Participation in the surveys was voluntary for the mine sites, but 100 percent of the mines contacted participated. All the surveys were completed between May and October 2005. The surveys are designed to monitor worker dose, to measure equipment sound levels and to understand the noise source/worker dose relationship. This is accomplished through full-shift dosimetry readings, equipment noise profiles and, where possible, worker task observations.

Abstract

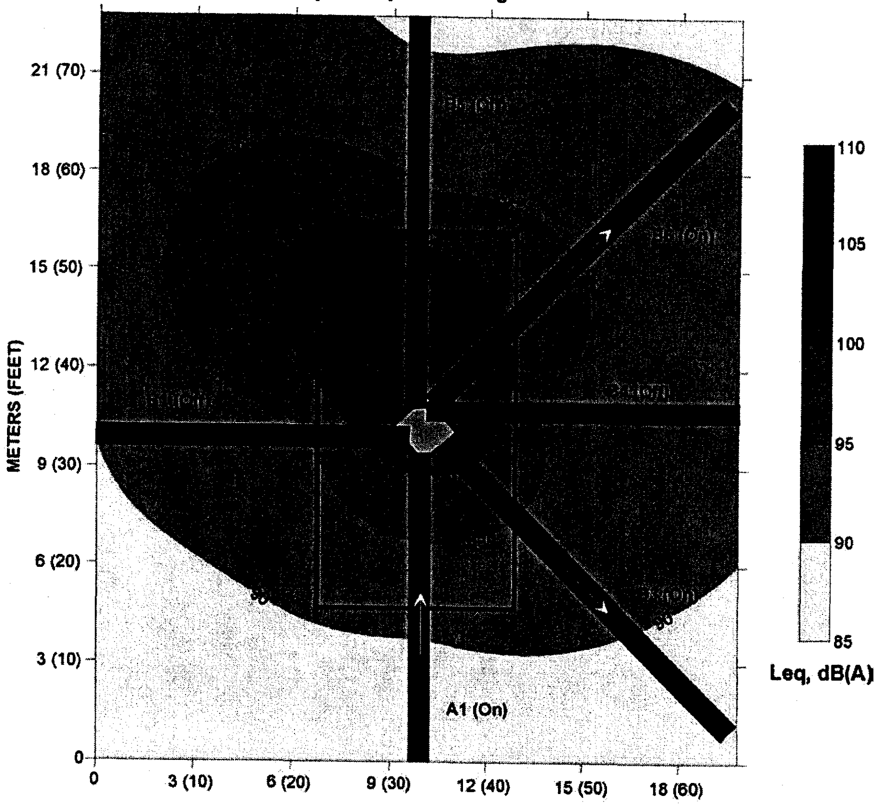
The U.S. National Institute for Occupational Safety and Health (NIOSH) is conducting a cross-sectional survey of equipment sound levels and worker noise exposures in the stone/aggregate mining industry. Six stone/aggregate mines (three surface and three underground) were recently surveyed, and the findings are presented here. The surveys consisted of sound-level measurements conducted around various equipment and machinery (including stone processing and crushing equipment) and full-shift dose measurements to determine worker noise exposures. The findings identify the equipment and machinery that are likely to cause worker overexposures and identify the workers found to be experiencing overexposures. In addition, the benefit of cabs in reducing mobile equipment operator noise exposure is discussed.

Instrumentation and data collection

Sound levels in the mines and processing facilities were measured using a Quest Model 2900 sound level meter (SLM) and Brüel & Kjær 2260 Investigator. The instruments were mounted side by side on a tripod, with the microphones 1.5 m (5 ft) from the floor (approximately ear height), angled at 70° from horizontal (in accordance with manufacturers' recommendations) and facing the noise source. An A-weighted equivalent sound pressure level (Leq) and one-third linear octave band frequencies were recorded at each location. Leq, which for these studies was the parameter of interest, is the average integrated sound level accumulated during a specified measurement period using a 3-dB exchange rate. The 3-dB exchange rate is the method most firmly supported by scientific evidence for assessing hearing impairment as a function of noise level and duration (NIOSH, 1998). A slow response rate with an averaging time (length of measurement) of 30 seconds was also employed. Measurements were made around the fans, stationary equipment and processing facilities. Both near and far field measurements were recorded. The term "near" describes measurements made

FIGURE 1

Sound profile plot for the primary screening tower.



of cabs to prevent operator noise exposure from engine and operational noise.

Case studies

Case study No. 1 — surface limestone mine

Mine characteristics: This study site consisted of one surface pit and accompanying rock processing facilities that mine and process approximately 1.13 Mt (1.25 million st) annually of crushed stone and lime products. Mining consists of bench drilling and blasting (by a contractor), and mining the limestone rock. The blasted rock is mined using front-end loaders (FELs) loading into 45.4-, 49.9- or 54.4-t- (50-, 55- or 60-st-) capacity haul trucks for removal from the pit. The haul trucks dump into a primary crusher located near the pit entrance. After passing through the primary crusher, the rock is transported by belt to the crushing and screening facilities, resulting in the desired product sizes. The daily mining and processing operations average 5.44 to 6.35 kt (6,000 to 7,000 st) of rock. Approximately 25 workers are located in the surface quarry, and 10 are located in the plant (crushing facilities). The worker classifications include FEL operator, haul-truck operator, primary crusher operator, control-room operator, plant operator, plant helper laborer and water-truck operator.

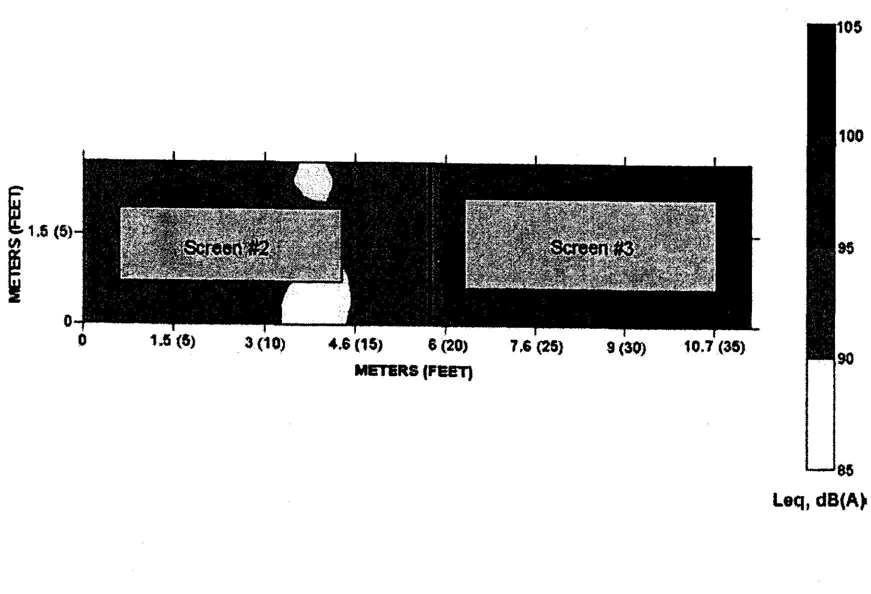
within 1 to 2 m (3 to 6 ft) of the noise source while the "far" measurements were those taken farther than 2 m (6 ft) from the source.

Worker noise exposure was monitored using Quest Q-400 noise dosimeters. The dosimeters were set to monitor an MSHA permissible exposure level (PEL) of 100 percent or an eight-hour time-weighted average (TWA8) of 90 dB(A). (Specific parameters of this setting include: A-weighting, 90 dB Threshold and Criterion Levels, 5-dB Exchange Rate, Slow Response and a 140 dB Upper Limit.) Where possible, noise dose was recorded inside and outside mobile equipment to determine efficiency

Equipment and plant sound levels: Table 1 lists the range of sound levels measured around various processing equipment and indicates that the sound levels varied greatly throughout the plants. The highest sound levels were recorded at the primary screening tower, surge tunnel, secondary crusher, secondary screening tower and the fourth level of the agricultural lime crusher. Most of the recorded readings were 93 dB(A) or less. A sound profile plot for the primary screening tower is illustrated in Fig. 1. The measurements ranged from 87 to 96 dB(A) outside the building and 105 to 107 dB(A) inside the screening tower.

FIGURE 2

Sound profile plot for Telsman screens 2 and 3.



Worker exposure: Worker noise exposure was collected using dosimeters worn by the workers for the full (10-hr) shift. Six occupations that were surveyed included the operators of haul trucks, front-end loaders, primary crusher and the control rooms. Plant helpers and operators were also monitored. Results of the worker dose measurements are shown in Table 2. In addition to worker dose, a dosimeter was placed outside the cab on the front end loaders (FEL) and on the haulage trucks. This provided the exposure that would occur without the protection of cabs. Although the mining and processing equipment sound level measurements suggest that there were areas that are noisy and workers could be over-exposed to noise, because the workers are in cabs or control rooms, all the workers that were monitored experienced doses well below the MSHA PEL of 100 percent (or a TWA of 90 dB(A)).

Table 1

Sound level measurements, case study No. 1, surface limestone.

Plant	Equipment	Location	Range Leq, dB(A)
Primary	Screening tower B(N)	Inside	105-107
Primary	Screening tower B(N)	Outside	87-96
Primary	Surge tunnel, surge to sec. crusher	In tunnel	88-101
Secondary	Secondary crusher	Ground level	89-93
Secondary	Secondary crusher	Upper level	97-99
Secondary	Compressor bldg.	Inside, door open	89
Secondary	Compressor bldg.	Inside, door closed	90
Secondary	Compressor bldg.	Outside	91
Secondary	152.4 cm (60 in.) hydrocyclone crushers	Ground level	82-90
Secondary	152.4 cm (60 in.) hydrocyclone crushers	Upper level	84-95
Secondary	Control room	Inside control room	72
Secondary	Screening tower E(N)	Inside	100-106
Ag Lime	Screening tower and control room	Second level	86-99
Ag Lime	Screening tower and control room	Third level	90-93
Ag Lime	Screening tower and control room	Fourth level	91-93
Ag Lime	Screening tower and control room	Inside control room	65
Ag Lime	Screening tower and control room	Fifth level	91-92
Ag Lime	Screening tower and control room	Sixth level	91-93
Ag Lime	Screening tower and control room	Seventh level	91
Ag Lime	Crusher	Ground level outside	76-90
Ag Lime	Crusher	Second level	87-89
Ag Lime	Crusher	Third level	88-89
Ag Lime	Crusher	Fourth level	81-102
Ag Lime	C3 belt tunnel	Inside	77-88
Quarry	Primary crusher	Inside control room	67
Quarry	Primary crusher	Outside	72-95
Primary	Primary plant	Area (No. 71,72,74)	74-79
Secondary	Secondary plant	Area (No. 64-70,83,84)	72-81
Ag Lime	Ag lime plant	Area (No. 73,75-82)	67-83

Case studies No. 2 and No. 3 — surface granite mines

Mine characteristics: This complex consisted of two surface pits and rock processing facilities that mine and process approximately 1.36 Mt (1.5 million st) annually of crushed stone products. Mining consists of contractor-completed bench drilling and blasting, and mining of the granite gneiss rock. The blasted rock is mined using front-end loaders (FELs) loading into 36.3-t- (40-st-) capacity haul trucks for removal from the pit. The haul trucks dump into a primary crusher located near each pit. After passing through the primary crusher, the rock is transported by conveyor belt to the crushing and screening facilities, resulting in the desired product sizes. Approximately 33 workers are located at the combined surface quarries and crushing facilities. The worker classifications involved in the mining and processing operations include operators of FELs, haul trucks, primary crusher and processing plant.

Equipment and plant sound levels — Case study No. 2: The processing facilities consisted of three stationary plants (A, B and C). Measurements were taken around transfer points, belts, crushers and screens, control rooms, miscellaneous buildings and at the primary crusher. Table 3 lists the results of the sound-level measurements around the stationary equipment and indicates that the sound levels varied greatly throughout the plants. The locations where high sound levels (greater than 90 dB(A)) were recorded included the screens and crushers in Plant A, the screening tower and primary crusher in Plant B and the screen, crusher and tunnel in Plant C. An example of

Table 2

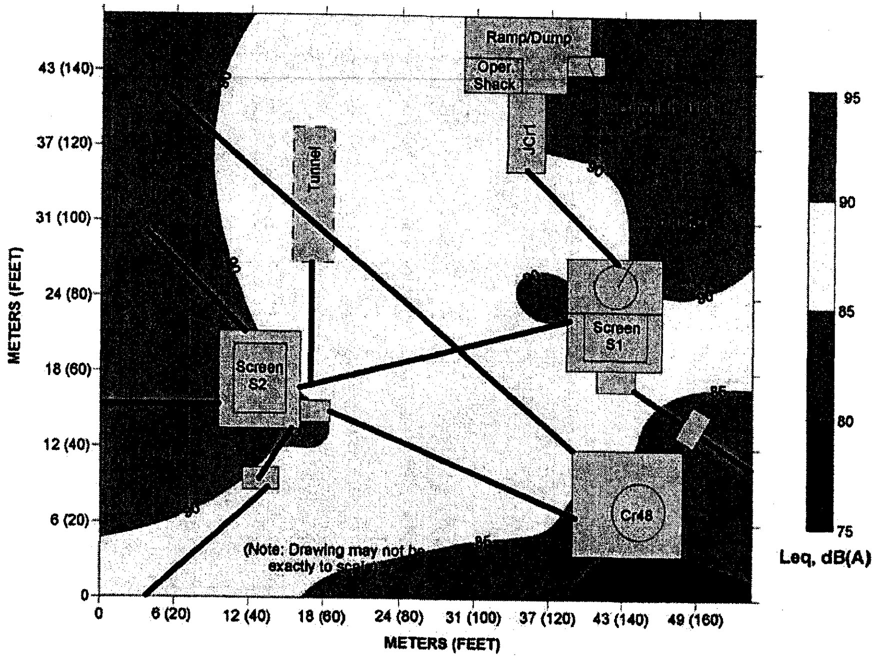
Worker exposure, case study No. 1.

Occupation	Number of recorded doses	Worker range MSHA PEL dose, %	Outside cab range MSHA PEL dose, %
Haul truck operator	3	2.7-14.8	65.9-114.1
FEL operator	3	0.7-41.3	59.0-65.6
Primary crusher operator	1	13.4	NA
Plant operator	1	0.9	NA
Plant helper	3	17.5-33.4	NA
Ag lime control room operator	1	8.2	NA

NA = not applicable

FIGURE 3

Sound profile plot for portable plant.



the sound levels measured is illustrated in Fig. 2, which is the sound profile plot for screens 2 and 3 in Plant A. Sound levels from 88 to a little more than 100 dB(A) were recorded.

Worker exposure – Case study No. 2: Workers wore dosimeters for a full shift (10 to 10.5 hrs) to provide noise-exposure data. Dosimeters were also placed outside the cabs of the mobile equipment. Table 4 lists the worker doses for the employees at the site. No worker experienced a dose above the MSHA PEL of 100 percent. Table 4 illustrates that for the mobile equipment operators, a reasonable amount of protection from the exterior noise generated by the engines and equipment operation is provided by the cabs. Only the operator of Truck 68 had a dose near 100 percent (98 percent), which was the result of the truck's outside dose of 396 percent and some unknown engine, transmission or exhaust noise problem that was able to enter the cab.

Table 3

Sound level measurements, case study No. 2, surface granite.

Plant	equipment	Location	Range Leq, dB(A)
A	Belts, transfer points, bins	Ground level	78-91
	Crusher CrT57	Outside	94-97
	Crusher CrLJ45, Eljay	Outside	98-99
	Screen #S2, Telsman	Outside	88-99
	Screen #S3, AEI	Inside	100-102
	Ortner wash plant, W1	Outside	81-85
	Control room	Inside	74
	Control room	Outside	93
B	Belts, transfer points, bins	Ground level	72-88
	Screening tower, screen #S1	Inside	98-112
	Primary jaw crusher, B JCr1	Outside control room	93
	Primary jaw crusher, B JCr1	Inside control room	75
	Primary jaw crusher, B JCr1	Lower levels	88-105
	Electric room	Inside	58
	Oil and pump room	Inside	64
C	Belts, transfer points, bins	Ground level	75-96
	Crusher CrT52	Outside	99-102
	Screen #S6	Outside	85-94
	Electric room	Inside	68
	Tunnel, C10B belt	Inside tunnel	85-97

Equipment and plant sound levels – Case study No. 3: Measurements were taken in the plant known as the portable plant. Forty-six sound level measurements were taken around the transfer points, belts, crushers and screens, the control room and the primary pit crusher. Table 5 lists and Fig. 3 illustrates the results of the sound-level measurements around the stationary equipment. The data indicate that the sound levels varied greatly throughout the portable plant. The locations where high sound levels (greater than 90 dB(A)) were recorded included Screens S1 and S2 and Crushers JCr1 and CrLJ54.

Worker exposure – Case study No. 3: Workers wore dosimeters for a full shift (9.5 to 10.5 hrs) to provide noise exposure data. Table 6 lists the worker doses for the employees at the site. No worker experienced a dose above the MSHA PEL of 100 percent. Table 6 illustrates that, for the mobile equipment operators, the cabs are providing sufficient protection from the exterior noise generated by the engines and equipment operation.

Case studies No. 4 and No. 5 — underground limestone/sandstone mines

Mine characteristics: This operation consists of two underground mines and a common rock processing facility. Mining consists of face drilling, shooting and mining the main limestone bench, followed by drilling, shooting and removing the limestone floor rock. In addition, in some areas, the sandstone below the limestone is also mined. The blasted rock is loaded by front-end loader into 45.4- or 54.4-t- (50- or 60-st-) capacity haul trucks for removal from the mine. The haul trucks dump into one of two primary crushers, which are located midway between the two mines' portals. After passing through the primary crusher, the rock moves by conveyor belt either to the secondary crushing facilities or directly to a stockpile for loading and sale to end users. Rock sent to the secondary crushing facility passes through a series of crushers and screens, resulting in the desired product sizes. The combined annual production from both mines is about 1.36 Mt (1.5 million st) of mostly crushed limestone and some sandstone. A total of 43 workers are located at the site, working two shifts per day. The worker classifications include operators of FELs, haul trucks, jaw crusher, drill, scaler, plant and water truck. Other classifications include supervisor, mechanic, blaster and blaster helper, laborer and utility man.

Table 4

Worker exposure, case study No. 2.

Occupation	Number of recorded doses	Worker range MSHA PEL dose, %	Outside cab range MSHA PEL dose, %
Haul truck operator (65,66,68)	3	3.0-98.0	111.0-396.1
FEL operator (27,32,34)	3	0.4-28.3	33.0-284.8
Primary crusher operator (B J Cr1)	1	2.0	NA
Bin truck operator (7)	1	10.2	22.2

NA = not applicable

Equipment and plant sound levels: Measurements were taken around the main and auxiliary fans, primary jaw crushers (old and new), semi-stationary equipment and near the crushers and screens located at the secondary crushing facilities. Table 7 lists the results of the sound level measurements around the stationary and semi-stationary equipment and indicates that in most locations, sound levels greater than 90 dB(A) were present. The highest sound levels were recorded near the fans and the No. 1 cone crusher located in the secondary crushing plant. The only locations where sound levels were consistently less than 90 dB(A) were in the primary crusher operator's control booth, in the secondary crusher operator's control room, in the electrical room below the secondary crusher control room and above the sand plant.

The underground face equipment included a Tamrock floor drill and Cannon face drill (both diesel) and a Gradall scaler. Sound levels around these three pieces of equipment were high, ranging from 89 to 103 dB(A). However, the sound level measured inside the enclosed cab of the Cannon face drill was only 83 dB(A). Figures 4 and 5 include a photograph and a sound profile plot of a JOY Axivane 18.8 kW (25-hp) fan. The sound levels near the fan ranged from 90 to 106 dB(A). Another example is illustrated in Figs. 6 and 7 which are a photograph and sound contour plot for a Tamrock Ranger 500 floor drill. Figure 7 illustrates that sound levels up to 102 dB(A) were recorded near the drill.

Worker exposure: Workers at the mine wore dosimeters for a full shift (10 to 10.5 hrs) to provide noise exposure data. Table 8 lists the worker doses for both surface and underground employees. In all cases, except one of the laborers, no worker experienced a dose above the MSHA PEL of 100 percent. The one laborer experienced a dose above 100 percent because he was operating an air wrench while installing sheet metal on the protective canopy at the entrance to mine No. 2. His exposure resulted from a combination of noise sources that included the air wrench, compressor and

FIGURE 4

JOY Axivane 18.6 kw (25-hp) fan (Bauer and Babich,

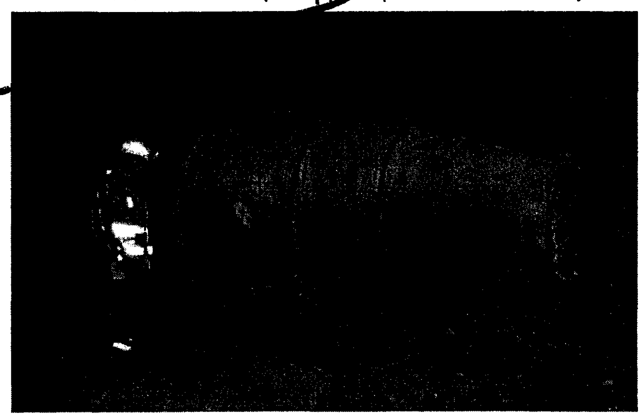


Table 5

Sound level measurements, case study No. 3, surface granite.

Plant	Equipment	Location	Range Leq, dB(A)
Portable	Belts, transfer points, bins	Ground level	77-94
	Crusher CrLJ55, El-Jay	Outside	92-97
	Screen #S1	Outside	88-91
	Screen #S2	Outside	97-104
	Primary crusher, P-JCr1	Outside	88-92
	Control room	Inside	71

Table 6

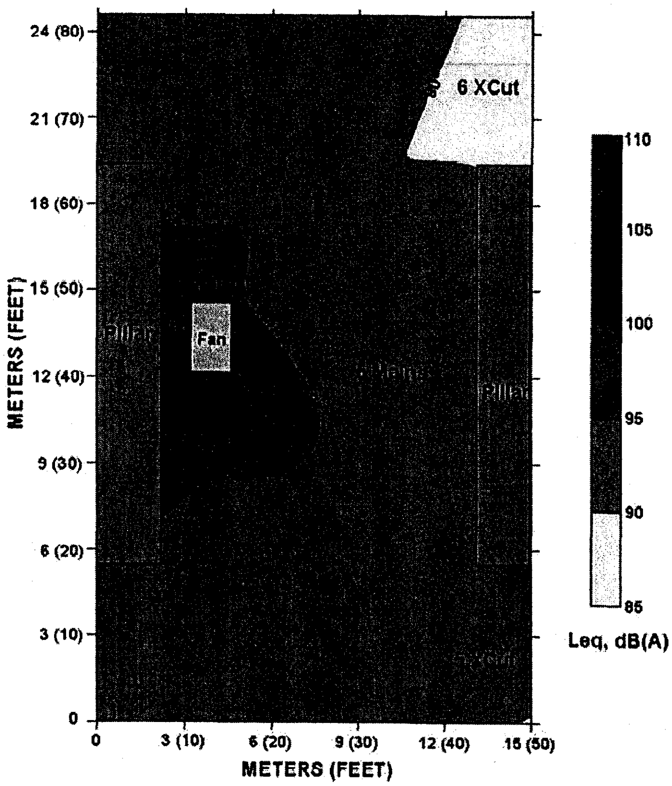
Worker exposure, case study No. 3.

Occupation	Number of recorded doses	Worker range MSHA PEL dose, %	Outside cab range MSHA PEL dose, %
Haul truck operator (69)	1	11.7	118.2
FEL operator (24, 26)	2	13.5-25.4	154.4-159.0
Primary crusher operator (P J Cr1)	1	20.4	NA

NA = not applicable

FIGURE 5

Sound profile plot for Joy Axivane 25-hp fan.



mobile equipment entering and exiting the mine. Table 8 also illustrates that for the mobile equipment operators the cabs are providing a reasonable amount of protection from the exterior noise generated by the engines and equipment operation.

Case study No. 6 — underground limestone mine

Mine characteristics: This operation consists of an underground mine and surface rock-processing facilities. Mining consists of face drilling, shooting and mining the main bench, with some mining of the floor rock. Using front-end loaders, the blasted rock is loaded into 31.8-t-(35-st-) capacity haul trucks for transport from the mine to the primary crusher. After passing through the primary crusher, the rock is transferred by belt to the crushing facility consisting of a shaker, screen and/or cone crusher to obtain the desired product sizes. Annual production for this operation is about 317.5 kt (350,000 st). From 10 to 12 workers are located at the site, working one shift per day. The worker classifications include the operators of FELs, haul trucks, crusher, drills, scaler and water truck. Other classifications include mechanic and blaster and blaster helper.

Equipment and plant sound levels: Measurements were taken around the primary jaw crusher, semi-stationary equipment and near the crushers and screens located at the crushing facilities. Table 9 lists the results of the sound-level measurements. The results indicate that a wide range of sound levels were present. In the mine, the sound levels were consistently less than 90 dB(A) around

Table 7

Sound level measurements, case study No. 4 and No. 5, underground limestone and sandstone.

Mine	Equipment	Location	Range Leq, dB(A)
No. 1	Fan systems 66HPAV2S, 1.5 m (5 ft) aux. fan	15 mains at 25 XCut	88-104
No. 1	Main fan (1.5 m (5 ft exhaust))	17 XCut in B mains	75-84
No. 1	Joy M96-50D exhaust fan	G mains at 24 XCut	86-109
No. 1	Tamrock ranger 500 floor drill	19 XCut in 9 mains	91-102
No. 2	Main fan (3.7 m (12 ft intake))	7 Mains	95-101
No. 2	Main fan (2.4 m (8 ft exhaust))	1 XCut, in 1 main	84-109
No. 2	Joy Axivane M86-26-1770 fan	5 Main at 5 XCut	90-106
No. 2	Oldenburg cannon face drill	9 XCut in 7 mains	93-103
No. 2	Gradall 5110 scaler	8 Mains at 5 XCut	89-98
Surface	Old jaw crusher (outside)	Outside control booth	83-102
Surface	Old jaw crusher (inside control booth)	Inside control booth	82
Surface	New jaw crusher (outside)	Outside control booth	84-102
Surface	New jaw crusher (inside control booth)	Inside control booth	74
Sec. Crusher	No. 1 cone crusher (2.4 m (8 ft Nordberg))	Bottom of main belt	101-107
Sec. Crusher	No. 2 cone crusher (2.4 m (8 ft))	Below main screen	99-101
Sec. Crusher	No. 3 cone crusher (Symons portable)	Adjacent to No. 2 crusher	95-98
Sec. Crusher	No. 4 lower crusher (1.8 m (6 ft))	Middle of sec. crush. plant	90-96
Sec. Crusher	Main 2.4 x 6.1 m (8 x 20 ft) screen	Above No. 2 crusher	90-99
Sec. Crusher	No. 1 & 2 double screens	Middle of sec. crush. plant	86-98
Sec. Crusher	Sand plant	Bottom of sec. crush. plant	77-98
Sec. Crusher	Control room (outside)	Outside control room	88
Sec. Crusher	Control room (inside)	Inside control room	69
Sec. Crusher	Electrical room (inside)	Below control room	75

the bucket truck and more than 90 dB(A) near the water pump, scaler and face drill. The face drill had the highest measured sound levels, ranging from 86 to 105 dB(A) (Fig. 8). In the processing facilities, sound levels above 90 dB(A) were recorded nearly everywhere except in the jaw crusher control room and at the belt drives (Fig. 9).

Worker exposure: Workers at the mine wore dosimeters for a full shift (9.5 to 10.5 hrs) to provide noise exposure data. Table 10 lists the worker doses for both surface and underground employees. In all cases, no worker experienced a dose above the MSHA PEL of 100 percent. Table 10 also illustrates for the mobile equipment operators that the cabs are providing a reasonable amount of protection from the exterior noise generated by the engines and equipment operation.

Implications for exposure reduction

The sound level measurements suggest that there are areas that are noisy and could subject workers to overexposure to noise. Nearly all workers monitored experienced doses well below the MSHA PEL of 100 percent (or a TWA of 90 dB(A)), even though equipment sound levels were generally above 90 dB(A). These exposure results do not suggest that the workers are "safe" from noise-induced hearing loss, only that the workers are limiting their time of exposure near these high noise sources. Health surveillance of hearing by use of audiometry and exposure monitoring is essential, both base-line and after noise exposure if NIHL is to be reduced in the mining industry.

One laborer experienced a dose of 119 percent while using an air wrench to install a protective canopy at the portal of an underground mine. Mobile equipment and crusher operators were protected from overexposure to noise as illustrated by the results of the dose measurements because the cabs and control rooms had sufficient acoustical treatments to prevent equipment sound levels from reaching the operators. Although only one worker was overexposed, the prevalence of noisy equipment suggests that engineering and administrative noise controls could be used to reduce sound levels and noise ex-

FIGURE 6

Tamrock floor drill.

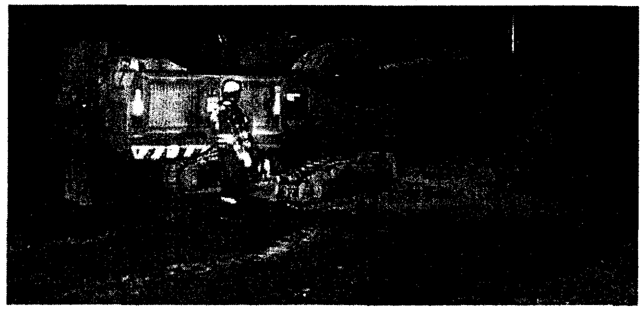


FIGURE 7

Sound profile plot for Tamrock floor drill.

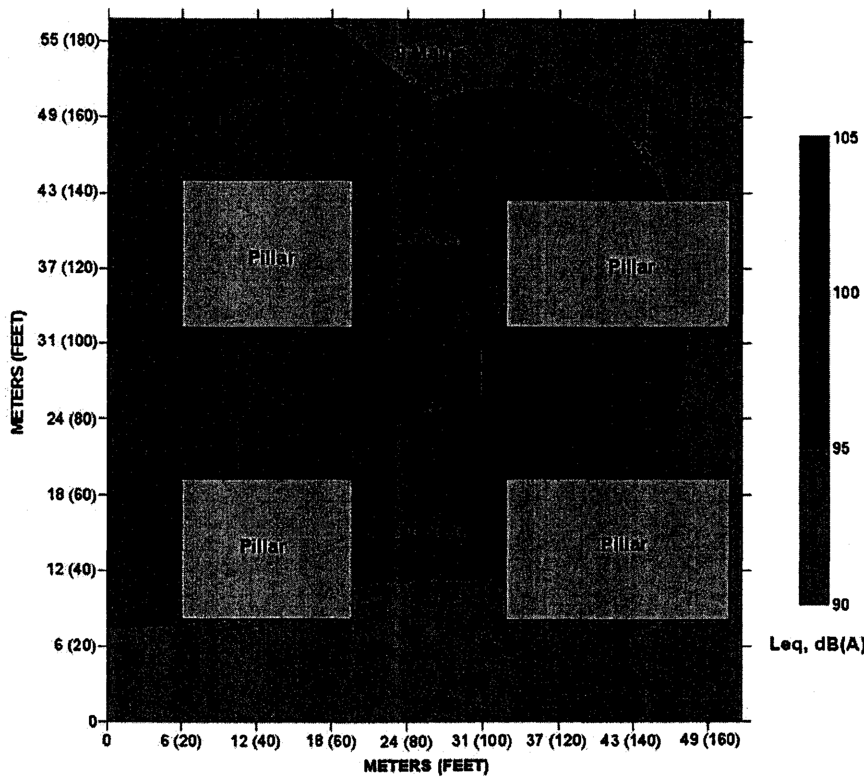


Table 8

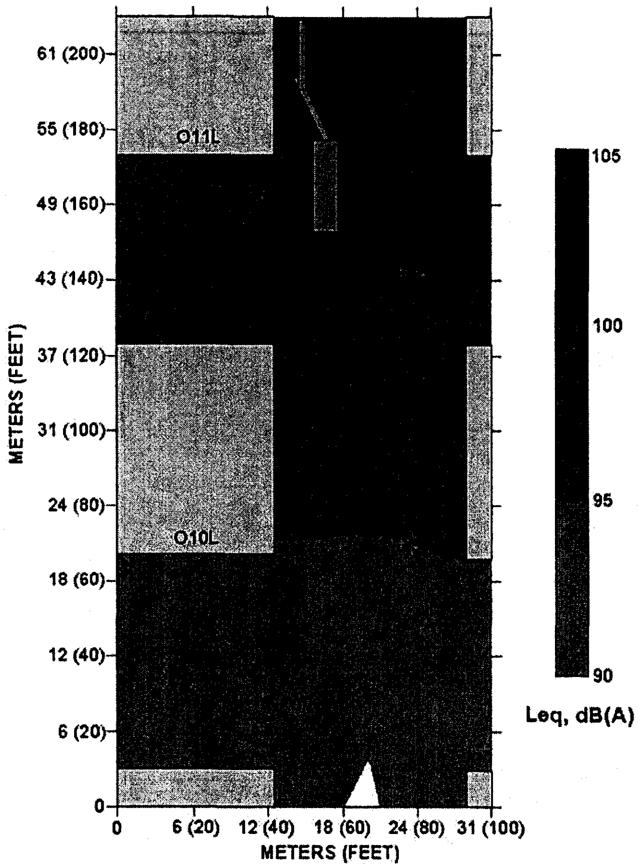
Worker exposure, case studies No. 4 and No. 5.

Occupation	Number of recorded doses	Worker range MSHA PEL dose, %	Outside cab range MSHA PEL dose, %
Haul truck operator	6	0.6-9.5	181.6-187.5
FEL operator	4	2.9-64.2	141.7-262.8
Drill operator	2	26.8-31.4	293.7-487.3
Scaler	2	1.1-1.20	187.8-209.0
Crusher operator	1	5.9	ND
Blaster/blaster helper	2	27.8-28.6	ND
Water truck operator	1	35.8	ND
Laborer	2	59.0-119.3	NA
Sec. crush. plant oper	1	32.3	NA
Mechanic	1	8.9	NA

ND = not determined
NA = not applicable

FIGURE 8

Sound profile plot for Gardner Denver MK45H face drill.



posures. The use of acoustic material inside cabs, control rooms, screening towers and compressor buildings should be considered. Crushers and other stationary equipment may be addressed using mass-loaded barrier curtains and enclosures. Screen modifications can include acoustically treated decking and new suspension screens, as well. Underground fan systems should be equipped with silencers, muffler ducts, treated fan vanes and quiet motor technology (MSHA, 1999). Administrative controls such as job rotation, worker relocation and improved equipment operation can limit exposure to high sound levels and reduce worker noise exposures.

It would be prudent to restrict time spent in and around the crushing and screening facilities because sound levels as high as 112 dB(A) were recorded. Mobile and semi-mobile (such as drills) equipment operators should be required to keep all doors and windows closed while the equipment is in operation because outside doses up to 487 percent were measured.

All workers should be made aware of the sound levels around all equipment and in the processing plants and be instructed to utilize hearing protection based on NIOSH's recommended exposure limit (REL) of 85 dB, A-weighted, as an 8-hour time-weighted average (TWA8). Exposures at or above this REL are hazardous, creating an excess risk of developing occupational NIHL. For workers whose noise exposures equal or exceed 85 dB(A), NIOSH recommends proper use of hearing protection, among other assessment, training and prevention approaches. Any area that has a sound level of 85 dB(A) or higher has the potential to exceed the NIOSH REL depending on the exposure time (NIOSH, 1998). Because the length of exposure can vary and/or is not known prior to entering a high sound area, the potential adverse ef-

Table 9

Sound level measurements, case study No. 6, undergound limestone.

Mine/surface	Equipment	Location	Range Leq, dB(A)
Mine	Blaster's bucket truck	Adjacent to and around	76-81
Mine	Gorman-Rupp diesel water pump	Adjacent to and around	89-98
Mine	Gardner Denver MK45H face drill	Adjacent to and around	86-109
Mine	Gradall XL4300 II scaler	6.1-12.2 m (20-40 ft) away	89-94
Surface	Jaw crusher (upper level)	Outside control booth	91-99
Surface	Jaw crusher (lower level)	Below control room	89-93
Surface	Jaw crusher (control booth)	Inside control booth	73
Surface	Small Tyler double shaker screen	Adjacent to and around	104-111
Surface	Large Tyler screen	Adjacent to and around	94-103
Surface	Hazemag cone crusher	Adjacent to and around	96-102
Surface	Tunnel	Just inside by belt	93
Surface	No. 1 belt drive	Next to drive motor	89
Surface	No. 2 belt drive	Next to drive motor	101
Surface	No. 4 belt drive	Next to drive motor	85
Surface	No. 6 belt drive	Next to drive motor	94
Surface	No. 8 belt drive	Next to drive motor	85
Surface	No. 9 belt drive	Next to drive motor	81
Surface	No. 11 belt drive	Next to drive motor	82
Surface	Ground level	On ground	89-101

fects on a worker's hearing are also not known, and thus it makes sense to use hearing protection when in areas where the sound levels are 85 dB(A) or greater.

Finally, workers should realize that any exposure that results in an MSHA PEL dose above zero percent indicates that during their shift they encountered sound levels above 90 dB(A). Because each individual reacts differently to high noise, there is no assurance that a dose below the MSHA PEL of 100 percent is safe and will not cause hearing loss. In addition, when the TWA of a worker exceeds 85 dB(A), the MSHA Action Level is exceeded and the worker must be enrolled in a hearing conservation program. Therefore, wearing hearing protection is a good idea at all times while operating equipment or working in the crushing and screening facilities.

Table 10

Worker exposure, case study No. 6.

Occupation	Number of recorded doses	Worker range MSHA PEL dose, %	Outside cab range MSHA PEL dose, %
Haul truck operator	2	38.5 and 49.7	168.7 and 175.3
FEL operator (inside)	1	0.3	89.4
FEL operator (outside)	1	14.3	107.2
Drill operator	1	24.6	437.3
Scaler operator	1	50.2	162.3
Crusher operator	1	9.7	219.4
Blaster/Blaster helper	2	13.3 and 15.2	0.7

Summary

Stone (aggregate) mining can be noisy and can subject workers to overexposures if they are not in cabs or control rooms. Sound-level measurements indicted that screens, crushers, drills, fans and mobile equipment generate sound levels high enough to be potential sources of worker overexposure depending on time of exposure. Fortunately, exposure measurements revealed that nearly all workers were avoiding exposures as revealed by doses under the MSHA PEL of 100 percent. Only one laborer was overexposed, a result of operating an air wrench for much of his shift. It can be concluded that mine operators and workers are successfully avoiding noise exposures through a combination of training, hazard awareness, engineering noise controls and administrative noise controls. ■

References

Bauer, E.R., and Babich, D.R., 2006, "Limestone mining: Is it noisy or not?" *Mining Engineering*, Vol. 58, No. 10, October, pp. 37-42.

Federal Register, 1999, "Health Standards for Occupational Noise Exposure: Final Rule," Department of Labor, Mine Safety and Health Administration, 30 CFR Parts 56 and 57 et al., Vol. 64, No. 176, Sept. 13, pp. 49548-49634.

MSHA, 1999, "Noise Control Resource Guides: Surface Mining; Underground Mining; Mills and Preparation Plants," Dept. of Labor, Mine Safety and Health Administration, http://www.msha.gov/1999noise/noiseresources.htm.

NIOSH, 1996, "Analysis of Audiograms for a Large Cohort of Noise-Exposed Miners," John Franks, National Institute for Occupational Safety and Health, Cincinnati, OH, Internal Report, 7 p.

NIOSH, 1998, "Criteria for Recommended Standard, Occupational Noise Exposure, Revised Criteria 1998," National Institute for Occupational Safety and Health, Cincinnati, OH, DHHS (NIOSH) Publication 98-126, 105 p.

Disclaimer

The findings and conclusions in this report have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy.

FIGURE 9

Sound profile plot of processing facilities (Bauer and Babich, 2006).