Response to ANPR on Hearing Conservation Program for Construction Workers
Occupational Safety and Health Administration
Docket H-011G

October 22, 2002

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We welcome the opportunity to respond to OSHA's request for information concerning the extension of the Hearing Conservation Amendment to the Construction Industry. Although there are many technical and organizational challenges to effective hearing conservation in construction, workers in this industry are just as entitled to a safe and healthy workplace as workers in other industries. When effectively implemented, Hearing Conservation Programs combined with exposure control efforts have been demonstrated to be an effective preventive strategy in British Columbia and elsewhere (1) (2). Construction workers are at high risk of occupational noise induced hearing loss, and there has been little attention paid by the US construction industry in developing effective prevention programs, or by regulatory agencies in enforcing the currently required protections. OSHA should extend a complete set of protections to the construction industry at this time.

However, doing so will require creative solutions to a number of challenging problems, many of which have been identified in this ANPR. It has been our experience (when working with contractors in the Pacific Northwest) that the industry wants guidance on how to best protect their workforce. A thoughtful and effective set of regulations would provide such guidance. It is important that any standard revision be written in such a way that hearing conservation programs, including noise exposure monitoring, audiometric testing, training, and noise control efforts, can be administered for construction contractors by a third party, with responsibility for the effectiveness of the program lying with the contractor. This allowance is critical given that the small size of the majority of construction companies dictates that few contractors have a dedicated, full-time safety and health employee who could administer the program. OSHA must consider the complex relationship between the various employers on construction sites when revising this standard. Also, OSHA should consider available and future noise exposure monitoring and control technology during the revision of this standard, and should incorporate the use of this technology into the standard where possible in order to encourage development of additional products and concepts.

The comments provided here are based on work we have done over the past five years at the University of Washington in cooperation with a number of local and national contractors working in the region.

An outline of this document follows:

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I. Summary of findings to date

Much of our completed work has been summarized in two papers that characterized noise exposures to carpenters, laborers, ironworkers and operating engineers (3), and electricians (4). These manuscripts are attached. Some additional monitoring of other trades has also been conducted as part of our currently on-going study of hearing damage among newly hired construction apprentices (Seixas, PI; NIOSH Grant 1 RO1 03912). The methods used for exposure assessment in each of these studies were very similar. Briefly, workers wore datalogging noise dosimeters for an entire workshift, and were asked to report the timing and duration of the tasks they participated in and tools they used over the course of the workshift on a provided activity card. The dosimeters were programmed to simultaneously measure noise exposure levels according to the OSHA PEL and 1998 NIOSH REL criteria. TWA levels were obtained directly from the dosimeters, which also logged the average, highest peak, and highest maximum noise levels which occurred during each monitored 1-min interval. A dataset was created from the TWA levels, and the 1-minute exposure level data were incorporated into a second dataset and combined the reported task and tool data. These two datasets were then used to statistically model TWA exposure levels and task- and tool-specific exposure levels. Note that in these studies we have used methods to allow us to simultaneously record full shift time weighted averages (TWAs), and partial shift exposures associated with conducting specific tasks, or work with specific tools. Thus, we are able to compare these alternative approaches to exposure monitoring.

A brief summary of our TWA exposure findings is provided in Table 1 (3-5), along with the exposure findings listed in the ANPR for various trades in British Columbia.

Table I: Summary of TWA Construction Noise Data from UW Noise Monitoring Research

		OSHA TWAs				NIOSH TWAs					
Trades Monitored by UW	Number of TWAs	Mean	SD	% >85 dBA	% >90 dBA	Mean	SD	% >85 dBA	% >90 dBA	Overexposed in British Columbia*	Overexposed in Washington State*
Brick/Tile Worker	28	75.2	17.1	22	8	86.1	7.9	52	29	No	Yes
Bricklayer	15	83.8	4.3	20	4	90.2	4.5	87	50	No	Yes
Carpenter	82	82.3	9.0	38	11	89.0	6.2	77	51	Yes	Yes
Cement Mason	26	78.9	15.6	50	10	86.5	6.3	62	34	Yes	Yes
Electrician	208	80.0	6.4	20	4	86.6	5.7	59	23	Yes	Yes
Insulation Worker	22	74.5	8.4	12	5	81.9	6.2	24	5	No	No
Ironworker	59	82.1	8.8	47	10	91.0	5.9	88	56	Yes	Yes
Laborer	58	83.3	7.1	40	14	89.7	6.3	78	38	Yes	Yes
Operating Engineer	44	83.5	6.1	41	14	88.8	5.8	80	34	Yes	Yes
Sheetmetal Worker	38	80.4	4.5	15	0	85.9	4.5	50	14	Yes	Yes
Total	583	81.4	8.0	27	15	88.2	5.5	57	39		
Trades Not Monitored by UW											
Drillers										Yes	N/A
Plumber/Pipefitter										Yes	N/A
Sprinkler Installer										Yes	N/A
Sandblasters										Yes	N/A

* Overexposed = Trade mean noise exposure level above 85 dBA

Other published research has shown that other trades have potential for exposure to noise levels above 85 dBA, including roofers (6), boilermakers (7), and piledrivers and drywallers (5).

II. Monitoring Metrics

A. TWAs (addressing ANPR II.A – Hearing Conservation Program Provisions)

Although OSHA is not considering changes in the PEL or exchange rate, we would be remiss if we did not comment on these central aspects of the standard for construction, particularly since there is a substantially greater amount of scientific knowledge on noise exposure and hearing loss available today than there was when the OSHA PEL and hearing conservation standard were promulgated. There has been sufficient work conducted by others, including NIOSH (8), to identify the considerable risk of NIHL associated with long-term work at 85 or 90 decibels, and we can add no further information regarding this point. However, the exchange rate (ER) used to calculate noise exposure levels has a great deal of relevance to construction work. In steady state noise, the condition under which almost all epidemiologic studies used in NIHL risk assessments have been conducted, the ER makes no difference. That is, the TWA calculated with a 3 dB or 5 dB ER would be the same. However, in noise environments in which levels vary within the day, a substantial difference is observed. The more variable the noise environment, the larger the difference. Because construction work entails highly variable and intermittent work tasks, and a large number of impact-based work methods, construction noise is highly variable.

The impact of varying exposures on construction workers is evident in Table 1. The overall average TWA is 81.4 dB using a 5 dB ER, and 88.2 using a 3 dB ER. Furthermore, 15% of workdays are above 90 dBA using a 5 dB ER, while nearly 40% are above 90 dBA using a 3 dB ER. Twenty-seven percent of workdays are above 85 dBA using a 5 dB ER, and 57 % are over 85 dBA using a 3 dB ER. This means that 30% of workers who are in compliance with the 85 dBA standard (and 5 dB ER) should be classified as at high risk of NIHL. The continued use of the 5 dB ER defies the recommendations of NIOSH (8), ACGIH (9), EPA (10), ISO (11) and European Union scientists, and gives construction workers in particular an undue additional risk burden.

B. Peaks (addressing ANPR II.A.2.b Hearing Conservation Program Provisions – Monitoring – Continuous, Intermittent, and Impulsive Sound)

OSHA asks (ANPR II.A.2.b) if the integration of all noise levels between 80 and 140 dBA the appropriate criteria for evaluating construction workers' noise dose. The dosimetry-based exposure research conducted by UW indicates that carpenters, laborers, ironworkers, operating engineers (3) have an average of between 5 and 23 minutes per workshift with instantaneous peaks exceeding 140 dB, and spend an average of between 1 min 16 sec and 7 min 40 sec per shift above 115 dBA (slow response). Electricians have similar exposures to high noise levels (4), as do the other trades monitored by UW (unpublished data). These measurement data indicate that construction workers have exposures which range from 80 dBA-140 dB. Therefore, instrumentation used to measure personal exposures must be able to accurately measure continuous, intermittent, and impulse noise exposures over this range. With regads to impulse noise, OSHA asks if the existing ceiling level is appropriate for impulse noise. In the absence of compelling evidence indicating that 140 dB is inappropriate for the ceiling limit, the ceiling level for impulse noise should remain in the OSHA standard. This limit should be made mandatory, and not merely advisory.

OSHA also inquires (ANPR II.A.2.b) about the additional costs associated with this requirement, and how these costs can be minimized. The ANSI S1.43-1997- and S1.25-1991-compliant integrating sound level meters and dosimeters currently commercially available in the US are capable of integrating sound levels over the range of interest. These instruments range in price from several hundred to several thousand dollars, and are available from a number of specialty manufacturers. Less expensive non-integrating, non-ANSI-compliant instruments are available through regular commercial retailers. Integrating instruments with a range of 80-140 dBA are essential for the measurement of exact exposure dose. However, for equipment screening or general area measurements, non-integrating (and possibly non-ANSI-compliant) sound level meters should be allowable in order to lessen the financial burden on companies. (This issue is addressed further in Section V, point 1)

III. Monitoring Strategies

OSHA considers a number of very important questions concerning exposure monitoring strategies for noise in construction in the ANPR. In order to answer these, it is important to clearly identify the purposes that monitoring should serve, which are outlined below. First, exposure assessment should help determine which companies or work sites are covered by the requirements of the standard, and which workers should be included in a hearing conservation program. Second, monitoring should provide guidance to workers and companies about where and when hearing protection devices are indicated, and what level of attenuation is required of

HPDs. Third, monitoring should help indicate where and when further engineering exposure controls are needed. Finally, there is a generic ethical requirement to inform individuals of their exposure when it puts them at risk of a chronic impairment. Of course, this ethical requirement also leads to a pragmatic and desirable result if individuals at risk of impairment take personal or collective actions to protect themselves. Collectively, these components must be integrated to identify a reasonable and effective monitoring strategy for the industry.

A. Reason for Monitoring: Who should be covered by a HCP (addressing ANPR II.A.1 - Hearing Conservation Program Provisions – Methods of Compliance and II.A.2 Hearing Conservation Program Provisions – Monitoring

OSHA requests information (ANPR II.A.1) on whether the trades identified in British Columbia as highly exposed are comparable to those in the United States, and if there are other occupations that should be presumed to be noisy enough to be a part of a hearing conservation program. The data presented in Table 1 demonstrate that it is not possible to identify specific trades that are or are not at risk of substantial exposure. Twelve to 50% of TWA exposures by trade exceeded 85 dBA (5 dB ER), and therefore all workers, regardless of their trade, are at substantial risk of NIHL and should be covered by the standard. It may be possible to identify specific worksites or work conditions under which the risk of over-exposure would be negligible, and our sample cannot address this question well since it was focused primarily on large-scale construction projects. However, because most construction workers work on multiple sites and often for several employers over the course of a year, we strongly advocate that all workers in construction trades be presumed to have frequent exposure over 85 dBA, and be included in HCPs. Because the possibility remains that a particular worker, work site or company could have consistently low noise exposures, companies must be have the option to demonstrate that an HCP is not needed in some circumstances. Such proof would have to involve a substantial repeated noise monitoring effort, or the presentation of definitive information about the setting or work that would rule out any possible noise over-exposures. OSHA also asks (ANPR II.A.2) if specific sampling strategies or approaches should be provided to the construction industry. Requiring a site-specific hearing conservation program on every construction site with possible over-exposures would insure that workers employed by a single contractor operating multiple sites are all adequately protected from the noise exposures specific to their own site.

B. Reason for Monitoring: Guidance on need for, and use of, HPDs (addressing II.A.5.a Hearing Conservation Program Provisions – Hearing Protectors – When Should Hearing Protectors be Required? and II.A.2.d Hearing Conservation Program Provisions – Monitoring – Secondary Sources of Noise Exposure

OSHA asks (ANPR II.A.5.a) if construction workers should be required to wear hearing protectors only in noise levels that exceed the PEL of 90 dBA, an action level of 85 dBA, or in all noise environments where exposures are expected to exceed a certain TWA. This is an extremely difficult question for construction workers. Construction work inherently involves intermittent and variable work and noise exposures. What makes this particularly difficult is that the noise exposure can occur suddenly and without warning, since the source may be from other workers in the general vicinity conducting work unrelated to the individual. For instance, in our analysis construction electricians with 1-4 or five or more workers in their vicinity had exposures 7 or 10 dB greater, respectively, than workers working alone (4).

OSHA inquires (ANPR II.A.2.d) if there are methods other than direct employee noise monitoring on a site-by-site basis that would characterize elevated noise exposure to workers not using tools or equipment which generate loud noise. A standard subjective test for the need for wearing HPDs (i.e the need for a worker to raise their voice to be heard at arm's length) is an important concept for training purposes, but is in no way a rigorous indicator of HPD need. New technologies intended to inform workers in real-time of their noise exposure levels are being developed in the US and internationally. For example, Bruel and Kjaer has designed the SoundEar noise level indicator (a display that turns different colors at certain noise levels) and Quest Technologies, Inc. is currently testing a new noise level indicator that would provide a signal to the wearer when sound levels exceed pre-determined levels.

We have proposed to NIOSH a study of the effectiveness of such a device for assisting workers in deciding when HPDs are needed and are awaiting a response from NIOSH. If funded, this study will help address this important issue. Until a better method of informing and protecting workers is available, we believe that workers must be provided with a choice of HPD types, and trained on the relative effectiveness of each.

Workers should each have access to one insert type ear plug that can provide a reasonable level of protection for extended periods, and one super-aural (or semi-insert) ear plug or ear muff that can be used conveniently for especially loud environments, and under highly intermittent task circumstances. OSHA should also encourage the use of technologically-advanced HPDs like electronic earmuffs which amplify sounds below a certain noise level and provide attenuation only above that level. These types of muffs are highly appropriate for variable noise environments like construction sites.

C. Reason for Monitoring: Need for engineering controls (addressing ANPR II.D.1 Noise Exposure Control – Engineering and Administrative Controls)

OSHA is interested (ANPR II.D.1) in collecting information regarding the use of noise controls in construction. Demonstration of over-exposure by monitoring is a powerful indicator that exposure controls are inadequate and that further work is necessary. In this context, we feel that OSHA OSHA Compliance letter 2-2.35A, which specifies that employers will not be cited for lack of engineering control implementation if an “effective” hearing conservation program is in place and employee’s TWA exposures are below 100 dBA, should be rescinded immediately. This memo effectively removes the requirement for the majority of workplaces, including construction sites, to implement noise controls, and defeats the preventative potential of the standard, especially in construction where HPDs are only partially effective. However, if a presumption of exposure is adopted (as suggested above Section 3, Point A) then why should additional monitoring be conducted? It is important that some monitoring requirements be included in the regulation in order to provide an incentive for reducing exposure levels, thereby reducing reliance on HPDs, and ultimately preventing NIHL.

D. Reason for Monitoring: Right to Know (addressing ANPR II.A.3 Hearing Conservation Program Provisions –Employee Notification)

OSHA inquires (ANPR II.A.3) as to whether employers should be required to notify construction workers within a certain time period of the results of noise exposure monitoring. Workers at risk of NIHL have an inherent and statutory right to know that they are at risk as a result of their exposure. In addition to this right, workers who recognize that the noise levels at work put them at risk of hearing damage are better able and motivated to protect themselves through the use of HPDs and implementation of engineering control strategies, as well as advocating for more effective control by their employer. It is imperative that workers have access to information about their noise exposure levels for all these reasons. However, given the nature of construction work, providing relevant and meaningful data to them presents major problems. Two approaches could be utilized to insure workers have access to pertinent exposure information. The first is to provide individual monitored workers with basic written information (i.e. TWA level) regarding their own exposure levels within several business days after monitoring. The second is to post trade-specific exposure monitoring results in the workplace in an accessible area continuously, with updates occurring regularly, with the monitoring schedule perhaps tied to specific points in the progress of construction.

IV. <u>Possible Approaches to Exposure Monitoring</u> (addressing ANPR **II.A.2 Hearing Conservation Program Provisions – Monitoring)**

OSHA asks (ANPR II.A.2) which approach is the most appropriate for evaluating and controlling noise exposures in construction, and whether specific sampling strategies should be provided to the construction industry. OSHA also asks when exposure monitoring is appropriate for the construction industry, and what criteria should trigger noise exposure monitoring? We have provided three alternative approaches below which address these questions and provide potential solutions.

A. Alternative Monitoring Strategy 1: Task-Based Monitoring

Given the difficulties in noise exposure monitoring identified previously, one attractive possibility for required exposure monitoring would be the use of a "task-based" strategy in which exposure levels associated with specific tasks or tools might be monitored for relatively short periods of time. Task-associated levels could be used both to identify sources of high exposure requiring exposure control intervention, and, together with individual worker activity profiles, to estimate full shift TWA exposures for individual subjects. Such a strategy has many attractive features in the construction setting, and has been advocated by a number of writers for noise exposures in other industrial settings (13, 14), and in construction (3, 4, 15, 16).

However, in recent research based on our extensive construction noise exposure monitoring, we have identified major limitations in this strategy. A manuscript (accepted for publication) is attached describing this work. In brief, we compared estimates of exposure constructed from task-associated short term measurements with the full shift measurement of noise level. We found very poor correlation (r^2=0.1 to 0.6) between these direct measures and the task-based estimates, which were dependent on how the task was defined. In essence, these results show that even when you construct your estimates from the same dataset from which the full shift measures are derived, the prediction of an individual worker's TWA from the

short term measures is very poor. In addition to showing that the prediction for an individual is poor, this also indicates that it would be difficult to determine from task-based measures if workers on a particular worksite were likely to be exposed under or over a particular threshold. Certainly, such a prediction could be made for some workers who conduct a single task (such as operating a piece of heavy equipment). But for most workers with highly intermittent tasks taking place in constantly varying environments and situations, it would be almost impossible. For these reasons, we do not believe that a task-based exposure assessment would be an effective means of characterizing individual exposures or risks. However, the information developed on noise levels from certain tools or tasks may still be useful in guiding HPD use and directing noise control efforts.

B. Alternative Monitoring Strategy 2: Full Shift Dosimetry

Traditional full shift measures of exposure using an integrating dosimeter present a clear alternative strategy. While such instruments provide valid and interpretable results, there are limitations here, too. First, TWAs will vary substantially from day to day, and are only partially determined by the trade, site and activities of the worker. We found only 27% of the variability in TWAs could be explained by site, trade and stage of construction using multiple regression. This means that a measurement taken on one day would contain little information on the exposures likely to occur the next day – even to the same worker. As a result, monitoring would have to be quite frequent, and on a relatively large sample of workers on each site, and over time, in order to provide truly meaningful results. Second, the cost of dosimeters is high, making it unlikely that construction firms would be able, or willing to purchase, maintain and use enough of the samplers to provide stable results. However, this cost may be reduced in the future (see Section V, point 1).

In light of the fact that task-based assessment does not appear to be a highly accurate technique for estimating full shift noise levels, OSHA should consider requiring contractors to conduct personal noise dosimetry and area sound level meter measurements repeatedly over the duration of construction for each project and reporting these results to their workers regularly.

C. Alternative Monitoring Strategy 3: Combined Strategy

A third alternative would be to require an exposure monitoring strategy that would document the actual exposures to workers using full shift dosimetry, while also requiring a targeted task, or tool-focused measurement strategy to help identify who should be wearing HPDs, and indicate where exposure controls should be applied.

Full shift dosimetry should be conducted on a random sample of workers in each trade, and on a regular basis. Although such measurements are simple to conduct, the instrumentation is expensive. Possible developments on the cost of these instruments are discussed below in Section V, point 1.

In order to provide guidance for workers on HPD use, we recommend developing a system for noise oriented job hazard analysis. For each job or task within a company's work operations, an inventory of the noise-producing tools or machines likely to be encountered would be developed. The sound levels for each of these sources would documented based on measurements taken with a sound level meter. The use of this data would allow the level of

hearing protection needed for each job to be identified prior to commencement of work. As source-specific sound levels are identified, each piece of equipment assessed could also be labeled with a simple color-coded sticker, indicating the sound level likely to be encountered, and indicating the type of HPDs that should be in use. Thus, both the operator of the tool or equipment and others working in the vicinity would have an indication of their own HPD requirements.

Noise Source Measurements

The noise source measurements would have to be made according to some standardized procedure; OSHA could provide this procedure based on existing ANSI standards, though the protocols in these standards would have to be relaxed considerably to allow them to be done in an uncontrolled acoustic setting. The basic requirements of these measurements would be that they be done at the operator's ear and then repeated at the distances associated with various sound pressure levels, i.e. 95 dBA, 90 dBA, and 85 dBA. This latter approach would allow for equipment labels to indicate the distance from the equipment at which workers would no longer need to wear HPDs.

Noise Source Labeling

The labels used to indicate the level associated with each piece of equipment might follow a color scheme corresponding to various exposure levels at the operator's ear: for example, green for levels below 85 dBA, blue for levels from 85-90 dBA (requiring an HPD with an NRR of approximately 5-10 dB), yellow for levels above 90 dBA (requiring an HPD with an NRR of more than 10 dB), and red for levels above 100 dBA (requiring an HPD with an NRR of more than 20 dB). OSHA should consider modeling labeling requirements after the European Noise Directive, which specifies requirements for the labeling of certain types of construction equipment. Measurements would have to be made periodically to account for any substantial changes in noise level due to poor maintenance or other causes. The hearing protection requirements for operators of different equipment would then be determined by the label on the equipment. Workers could be familiarized with their employer's labeling methodology as part of required hearing conservation training.

This combination of equipment-specific monitoring and full shift TWA dosimetry, with subsequent information transfer to exposed workers would combine the best elements of traditional exposure assessment methodologies promulgated by OSHA, with focused tool-specific exposure indicators.

V. Other Issues Related to Monitoring Methods (addressing ANPR II.B.3 – Other Hearing Conservation Issues Raised by NIOSH in its Criteria Document – ANSI standards)

OSHA asks (ANPR II.B.3) if it should adopt the most recent ANSI standards for noise dosimeters and sound level meters. There has been an inadequate attempt by manufacturers to develop low cost dosimeters of sufficient quality to provide reliable results. OSHA should fully consider the possibility of exercising its right to be 'technology forcing' to stimulate the development and production of low cost dosimeters. Several companies are currently developing or marketing this type of low-cost instrumentation (for example, Cirrus Research, which makes the DoseBadge, a miniature and relatively inexpensive noise dosimeter). The additional demand for low-cost dosimeters which a properly-revised OSHA construction noise standard would create would undoubtedly lead to additional competition in this market, which would further lower the cost of noise dosimeters. Again, some relaxation of the ANSI standards

for Type II meters might be appropriate in this context to encourage contractors to conduct exposure assessments. However, for personal exposure assessment conducted by OSHA officers for compliance inspections which might result in citations and fines to the contractor under inspection, or for OSHA consultation visits, instrumentation using the most current ANSI standards for integrating sound level meters and dosimeters should be required.

VI. Noise Control Strategies

1. **Engineering (Machine Design, Retrofit, and Substitutions) and Administrative Controls** (addressing ANPR II.D.1 Noise Exposure Control – Engineering and Administrative Controls and II.D.2 Noise Exposure Control – Machine Design, Retrofit, and Substitutions)

   OSHA asks (ANPR II.D.1 and II.D.2) what types of engineering controls and administrative controls have proved most effective, and how have those controls affected operations on construction sites? Once high exposure levels have been identified, contractors must be required to implement noise controls, or to document the specific reasons noise controls were determined to be infeasible. Although noise controls have been historically viewed as impractical for the US construction industry, there is abundant evidence to the contrary.

   The Noise Control Partnership, spearheaded by the Laborers Health and Safety Fund of North America, has partnered with academic institutions (including the University of Washington), equipment manufacturers, contractors, labor, and regulatory and research agencies (including OSHA and NIOSH) in an effort to identify and publicize successful construction noise control measures. Other organizations in the US and around the world have already identified a range of techniques and methods for the reduction of construction noise. For example:

   - Worksafe Western Australia has recently published a guide on construction noise management ("Noise Management in the Construction Industry: A Practical Guide," available at: http://www.safetyline.wa.gov.au/pagebin/pg000223.htm), has issued a number of case studies on construction noise reduction, including ways to quiet piledrivers, compressors, cutting saws, etc, and has also created reports documenting successful noise control implementation with a number of Australian contractors (see http://www.safetyline.wa.gov.au/sub30.htm).
   - The commonwealth of Massachussetts created a comprehensive noise control program for the construction of the Boston Central Artery/Tunnel (documented in (17)), which specifies noise controls which must be implemented given certain exposure criteria (see http://www.nonoise.org/resource/construc/bigdig.htm).
   - The Hong Kong Environmental Protection Department has issued a useful document titled "A Practical Guide for the Reduction of Noise from Construction Works," (18) which describes numerous ways to minimize noise from a variety of construction operations.
   - The Workers' Compensation Board of British Columbia has issued a document titled "Construction Noise" which includes a number of noise

control solutions (5) (see http://www.healthandsafetycentre.org/pdfs/hearing/ConstructionNoise.pdf).

- The United States Department of the Interior, Bureau of Mines developed a document titled "Mining Machinery Noise Control Guidelines, 1983" (19) which describes a variety of methods which can employed on different pieces of large mining equipment, often identical to that used in construction, with estimates of costs and applicability.
- The new Noise Directive from the Commission of the European Communities (Council Directive 2000/14/EC, implemented 1/2002, fully effective 1/2006) requires manufacturers to reduce the noise levels of construction and other equipment marketed in the European Union (see http://europa.eu.int/comm/environment/noise/d0014_en.pdf).
- The Brookhaven National Laboratory has recently developed a prototype piece of equipment which may be able to lower the noise from construction roadbreaking operations substantially (see http://www.bnl.gov/bnlweb/pubaf/pr/1999/bnlpr072099.html).
- NIOSH has also partnered with universities (for example, the University of Cincinnati, Penn State University, and Purdue University) to develop noise controls for hand-held construction tools, with very impressive results (see http://www.cdc.gov/niosh/noise/index.html).

In short, there are a variety of organizations which have demonstrated that construction noise controls are practical and feasible, and many more organizations which are developing additional control technologies.

OSHA requests (ANPR II.D.1) information about the noise exposures of operators of heavy equipment and those who work nearby. The data in Table I indicate that operating engineers are very highly exposed by both OSHA and NIOSH criteria. Given the high exposures associated with heavy equipment, which is more easily altered or refitted with noise reducing devices than smaller hand-held equipment, noise controls should be particularly emphasized for contractors employing operating engineers or using heavy equipment. Heavy equipment can contribute a significant portion of, or in some cases even drive, the exposure of adjacent workers (4). Heavy equipment noise controls can therefore reduce not only the operator's exposure, but also those of nearby workers. Operators working inside glass-enclosed cabs have been shown to have substantially lower (6 dB reduction) exposures than those worker in non-enclosed cabs (3, 20). Heavy equipment noise levels appear to have dropped over the past 15 years, based on a comparison between the exposure levels reported above and those reported in 1985 (21). Some control cost information is presented in the US Department of the Interior, Bureau of Mines' "Mining Machinery Noise Control Guidelines, 1983"(19), which includes cost estimates for noise controls on heavy earthmoving equipment ranging from $100 for the addition of a muffler to $15,000 for the addition of an acoustic cab, and a wide variety of options in between. OSHA should explore and update the equipment control methods provided in this document as a basis for providing noise control suggestions to contractors, possibly in conjunction with the Noise Control Partnership.

2. **Administrative Controls** (addressing ANPR II.D.3 Noise Exposure Control – Administrative Controls)

OSHA asks (ANPR II.D.3) to what degree administrative controls are feasible or desirable in the construction industry. Administrative controls are not particularly effective in work environments like construction where exposures are intermittent and unpredictable and where workers are hired to do the specific tasks for which they are trained. We do not recommend the adoption of the traditional administrative controls of job rotation and limitation of exposure duration for the construction industry.

3. **Hearing Protector Attenuation** (addressing ANPR II.A.5.c Hearing Conservation Program Provisions – Hearing Protectors – Hearing Protector Attenuation)

   OSHA inquires (ANPR II.A.5.c) as to whether it should adopt the 1998 NIOSH device-dependent derating formula. NIOSH has moved away from the use of the 7 dB OSHA de-rating formula in favor of a device dependent de-rating, and OSHA should do the same. The NIOSH approach gives the lowest de-rating (25% of the NRR) to earmuffs, which have been shown to provide the most consistent attenuation between field and laboratory, followed by insert-type earplugs (50% de-rating of the NRR), followed by other types of plugs (75% de-rating of the NRR). Adopting this de-rating strategy will encourage contractors to provide earmuffs, and should also help reduce the phenomenon of overprotection, which is common among construction contractors, by providing a reasonable strategy for estimating the attenuation of HPDs. Recent research (12) indicates that workers are more likely to use protectors which have less attenuation but are more comfortable, which reinforces the notion that the protector with the highest NRR is not always the best choice. Regardless of the attenuation rating scheme selected, however, monitoring is necessary to identify the TWA exposure which the HPD must attenuate to acceptable levels.

   While construction noise exposure levels frequently exceed 85 dBA, 95% of our OSHA TWA construction noise exposure measurements made to date were below 92 dBA. For a worker achieving this TWA through a relatively constant exposure level (i.e. an operating engineer running a piece of heavy equipment), using the NIOSH recommendations, an earmuff with an NRR of 9 dB and a formable earplug with an NRR of 11 dB would provide adequate attenuation. Even using the OSHA de-rating of 7 dB, the required NRR would be only 14 dB. An HPD with an NRR of 30 dB or more – like those often selected by construction contractors for maximum protection - will therefore overprotect workers in almost any exposure situation, preventing them from communicating normally and hearing warning signals, and effectively isolating them from their work environment. It is important to note that workers with high TWA noise levels resulting from intermittent noise exposures will not be adequately protected from high excursions by using an HPD with an attenuation based on the TWA level. Workers in this exposure scenario, which is common in the construction industry, must have a range of hearing protectors and attenuation levels available to them, and must be trained on selection of proper protection.

4. **Warning Signs** (addressing ANPR II.B.1.a Other Hearing Conservation Issues Raised by NIOSH in its Criteria Document – Hazard Communication – Warning Signs)

   OSHA asks (ANPR II.B.1.a) if a hearing conservation rule for construction should have a requirement for warning signs and regulated areas. The hearing conservation standard

should have a requirement for warning signs and regulated areas. OSHA should require that warning signs be posted around areas or equipment where noise levels may exceed 115 dBA briefly, or where an exposed worker may be exposed to a TWA above 85 dBA. These levels can only be determined through monitoring, and so the presence of appropriate signage is dependent upon an ongoing monitoring program. The placement of signs could be based on the equipment noise hazard analysis described previously, and would also be augmented by regular area monitoring.

5. **Noise Labeling of Equipment and Tools** (addressing II.B.1.b Other Hearing Conservation Issues Raised by NIOSH in its Criteria Document – Hazard Communication – Noise Labeling of Equipment and Tools)

   OSHA requests (ANPR II.B.1.b) information or ideas regarding noise labeling requirements for equipment. As described previously, labels could be used to convey HPD requirements for specific equipment, and would also serve as a useful reminder of the high noise levels that may be encountered by nearby workers. OSHA should strongly consider requiring noise labels as part of any hearing conservation standard revision.

VII. Summary and Conclusions

Given the current and future feasibility of noise control alternatives, OSHA should take an aggressive stance towards requiring contractors to implement noise controls. As with other exposures, engineering controls are the best option for reducing the high exposure levels prevalent in the construction industry, although effective hearing conservation programs will likely always be a necessity in this industry.

In summary, we urge OSHA to:

- Extend full hearing conservation program requirements to the construction industry
- Adopt a 3 dB exchange rate to better protect construction workers from NIHL
- Develop an exposure monitoring strategy that will provide individuals with information about their exposure level and risk of hearing damage, while also identifying important sources of high exposure and the need for hearing protection devices. Priority should be given to a strategy such as the tool-specific measurements and job noise hazard analysis described earlier. Full shift dosimetry would have the added benefit of characterizing risk and providing the information needed to advocate for continued exposure reduction interventions
- Develop minimal standards for dosimeters that would promote market innovation to reduce equipment costs and thereby stimulate more exposure monitoring
- Require contractors to reduce exposure through a variety of engineering solutions prior to relying on hearing protection devices
- Develop equipment noise level labeling requirements to assist in noise reduction efforts

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