the audiometric data base is essential.[5]

Knowing that a significant percentage of employees in the manufacturing industry have potentially very damaging noise exposures, the question as to the adequacy of the present OSHA noise regulations in preventing hearing loss comes into focus. Our judgment is that the present OSHA regulations, by and large, are sufficient except for the lack of an objective specification for judging the overall effectiveness of a hearing conservation program. However, the quality of implementation of hearing conservation programs in industry is often inadequate.

The authors, through their association with ANSI S12/WG12 and through projects requested by management in many industries, have analyzed the audiometric data bases for over 50 industrial hearing conservation programs to evaluate the effectiveness of the associated hearing conservation programs in protecting the employees from noise. Based on these efforts and experiences while conducting the U.S. survey mentioned earlier,[4] it is the authors' opinion that the majority of the existing industrial hearing conservation programs are not effective in preventing on-the-job, noise-induced hearing loss.

Why is this the case? It is the authors' opinion that the primary causes of the problem are the failure of OSHA to mandate some form of audiometric data base analysis[6,7] and management's failure to make use of the information about program quality available in the audiometric data base. Management typically assumes that if it has in place (on paper) the basic elements or phases of the hearing conservation program, then the program automatically will prevent hearing loss among employees. Only by evaluating program effectiveness through audiometric data base analysis can management detect deficiencies and improve program procedures to provide greater protection for employees.

Today, industry in developed countries has at its disposal sufficient hearing conservation information and supporting tools to practically eliminate hearing loss due to long-term noise exposure in the work environment.[6] However, to significantly improve the effectiveness of existing hearing conservation programs in the manufacturing industry beyond their current level of achievement, it will be necessary for OSHA to modify the present noise regulations to require some form of audiometric data base analysis. □

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Noise in the construction industry and its effect on hearing

By John R. Franks, PhD

The construction industry has been covered by its own noise standard (29 CFR 1926.52) for as long as the manufacturing industries have been covered by their standard (29 CFR 1910.95). The construction noise standard, however, does not have the additional requirements that were incorporated into paragraphs *c* through *o* of the Hearing Conservation Amendment for the manufacturing industries in 1983. Thus, the construction noise standard does not provide for periodic noise monitoring, dosimetry, periodic audiometric testing or worker education.

Instead, the construction noise standard simply requires that all workers exposed to time-weighted average levels (TWA) of greater than 90 dBA (sound level meter, slow response) for eight hours must be provided protection against excessive noise dose. The standard relies upon a 5 dB exchange rate. For example, as shown in Table 1, a worker exposed to 110 dBA of noise for more than 30 minutes must also be provided protection from the noise. The construction noise standard provides an equation to calculate the "noise exposure factor," that is the equivalent of dosage. The equation is used when the worker is exposed to many levels of noise for differing amounts of time. Lastly, the standard states that exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

Table 1. Permissible noise exposures from Table D-2 of 29 CFR 1926.52, the Occupational Noise Exposure Standard for Construction.[4]

How many construction workers are exposed to hazardous noise levels? According to the National Occupational Exposure Survey (NOES),[2] 507,049 construction workers were exposed to noise levels in excess of 85 dBA. This is 13% of the production workers in all phases of construction, as listed in Table 2.

NOES[2] also reports the availability of routine audiometric testing to the workers in the construction industry. The values are shown in Table 3. The special trades groups, while comprising a large proportion of all construction workers, are mostly individual craftsmen working alone or in small companies of less than 100 employees. Thus, it is not surprising that only 2.7% of the special trades companies provide routine audiometric tests. Approximately 2.6% of the general building contractors and 7.9% of the heavy construction companies provide routine audiometric tests to their employees.

The noises to which construction workers are exposed vary widely in intensity. In addition, their spectra have not been well documented. McClymount and Simpson[1] published sound level measurements for a small sample of equipment and power tools. Their data are shown in Table 4. It can be seen that many construction activities result in a wide range of noise intensities. A complicating factor is that many of these activities occur intermittently over the course of the workday. Thus, a construction worker's total exposure for the day may not equal the 85 dBA TWA of the Hearing Conservation Amendment[5] or the 90 dBA/eight-

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Construction area	Total workers	Production workers
General building contractors (Total)	1,293.3	968
Residential	655.3	490
Operative builders	56.4	42
Non residential	581.6	436
Heavy construction (Total)	778.2	643
Highway and street	271.9	225
Non highway	506.2	418
Special trades (Total)	2,832.1	2,291
Plumbing, heating, cooling	625.9	507
Painting, paper hanging	163.1	132
Electrical	522.2	423
Masonry, plastering	460.7	373
Carpentering, flooring	173.7	141
Roofing and sheet metal	207.0	167
Concrete	184.2	149
Water well drilling	16.7	13
Special trades	478.6	293
Total all workers in construction	4,903.6	3,902

Note: Number of production workers within each specialty group is extrapolated from U.S. Department of Labor, Bureau of Labor Statistics, figures for ratio of production workers to total workers for each major division. Numbers may not add accurately due to rounding. Those workers included in the Total Workers Column include all production workers and all other workers in the industry, including management, sales and clerical personnel.

Table 2. Number of total workers and production workers in construction in 1987, broken down by area of specialty in thousands. NOTE: The number of production workers within each speciality group is extrapolated from U.S. Dept. of Labor, Bureau of Labor Statistics, figures for ratio of production workers to total workers for each major division. Numbers may not add accurately due to rounding. Those workers included in the Total Workers Column include all production workers and all other workers in the industry, including management, sales and clerical personnel.[3]

Specialty group	Percentage
General building contractors	15.1
Heavy construction	15.2
Special trades	4.2

Table 3. Percentage of workers for whom routine audiometric testing is available in the various construction industry groups as reported by the National Occupational Exposure Survey.[2]

hour equivalent noise exposure factor of the Construction Occupational Noise Standard (29 CFR 1926.52).[4]

The variability of noise exposures and the fact that construction workers tend to be transient or itinerant because of the nature of the work increases the complexity of providing hearing conservation services to these workers. To provide adequate hearing conservation programs to construction workers, a number of areas need to be addressed:

1. Methods of dosimetry which more accurately incorporate the combined exposures to impact and continuous noise need to be established.
2. Noise-exposure profiles created from dosimetry data which are appropriate for different types of construction jobs, such as home building and highway construction, should be generated.
3. Periodic audiometric testing for all construction workers either by their unions, their employers or by occupational safety and health agencies should be instituted.
4. Methods of recordkeeping which allow reasonable access to past information, so that workers experiencing noise-induced hearing loss can be appropriately managed and program effectiveness can be determined, should be formulated.
5. A worker-education program which will be readily available to the construction workers and which will assist them in being responsible for their own hearing health should be started. □

Device or activity	Sound level dBA
Hammer on nail in stud	122 (peak)
Portable circular saw	113
Hammer drill	105
Electric lawn mower	103
Orbital sander	100
Portable generator	97
Jig saw	97
Electric drill	94
Hand saw	85

Table 4. Sound levels for typical equipment and activities in the construction industry.[1]

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Noise in the military and its effect on hearing

By Donald C. Gasaway, MA

Prior to the decade of the 1950s, the medical departments of the branches of the military service did recognize the need to conserve the hearing of military personnel and civilian employees within the military services. These early directives were rudimentary by current standards. They did, however, clearly establish the foundation from which later far more comprehensive programs would evolve.

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Occupational hearing conservation programs (OHCP) that exist within each of the services today represent innovative approaches to managing large numbers of noise-exposed personnel. During the 1940s, both the medical departments of the Army and Navy established aural rehabilitation centers to handle the large number of people who had acquired hearing losses while serving in World War II.[2] From these early clinical efforts, the need to conserve hearing, rather than to "correct" the problem after overexposure to noise, was well recognized. All branches of the military service adopted approaches to prevent noise-induced hearing loss: 1948 for the Air Force (USAF became a separate service in 1947), 1955 for the Navy (including the Marine Corps) and 1956 for the Army.

Regulatory directives strictly dealing with the establishment and conduct of OHCP within each service today have expanded to include very detailed and comprehensive approaches. Each succeeding revision of the regulations has contained criteria, guidance and procedures for optimizing each service's program effectiveness: Air Force (initialized 1948) revised 1953, 1956, 1973 and 1982;[3] Navy (initialized 1955) revised 1955, 1959, 1970, 1979 and 1984;[4] and Army (initialized 1956) revised 1965, 1972, 1980 and 1990.[5]

The number of military and civilian