

2004 Annual Report on Work-Related Noise-Induced Hearing Loss in Michigan

A Joint Report of the Michigan State University Department of Medicine 117 West Fee Hall East Lansing, Michigan 48824-1315 (517) 353-1846

Kenneth D. Rosenman, MD, Professor of Medicine Mary Jo Reilly, MS, Epidemiologist Amy Sims, BS, NIHL Program Coordinator

and

the Michigan Department of Labor and Economic Growth Management and Technical Services Division P.O. Box 30649 Lansing, Michigan 48909-8149 (517) 322-1817

Byron Panasuk, CIH Industrial Hygienist Specialist Douglas J. Kalinowski, MS, CIH, Director Michigan Occupational Safety and Health Administration

August 2, 2005

Summary:

This is the eleventh annual report on work-related noise-induced hearing loss (NIHL) in Michigan. Over 1,500 new people with hearing loss known or suspected to be caused by noise at work were reported in 2004 to the Michigan Department of Labor and Economic Growth (MDLEG). Over half of the individuals reported have hearing loss that significantly affects their ability to understand speech. Narratives on five of the individuals reported with their audiogram are in Appendix I.

Work-related noise-induced hearing loss is affecting mainly men, with an onset at 35-64 years of age. Exposure to noise occurs in many industries but particularly in manufacturing, construction and farming.

Forty-nine of the 122 (40.2%) companies inspected as part of the surveillance system had no hearing conservation program or a deficient program despite the presence of noise levels above the legal limit (Table 14). Four of these 122 inspections were conducted in the year 2004.

There were 797 health workplace inspections that were conducted by the Michigan Occupational Safety and Health Administration (MIOSHA) in calendar year 2004. Although, these inspections were not initiated because of the noise-induced hearing loss surveillance system; 60 of the 797 companies were in violation of some portion of the noise standard. Thirty-seven of these 60 companies were cited for having the complete absence of a hearing conservation program. It is important to recognize that the majority of the 797 inspections were in response to a specific complaint or referral. Consequently, the scope of these inspections was primarily limited to the complaint or referral item and noise exposure would not have systemically been addressed unless it was observed to be a serious issue during the course of the inspection.

Noise-induced hearing loss is an insidious condition that may take years to develop to a stage where it affects an individual's ability to communicate at home and in the work place. Clearly hearing loss is greater with greater duration of exposure (Figure 8). Reduction of the occurrence of noise-induced hearing loss in select high noise industries continues to be one of the strategic goals of MIOSHA.

In 2003, we expanded the scope of our surveillance to include interviews of individuals with standard threshold shifts who were reported by company medical departments in order to assess the effectiveness of existing hearing conservation programs at these facilities. Prior to 2003, interviews were limited to individuals reported by non-company health professionals. In 2003, we also began to collect the audiograms of all reported individuals. Hearing loss being reported is very significant; over half of the individuals reported meet the National Institute for Occupational Safety and Health (NIOSH) criteria of material hearing impairment (Figure 7). Through surveillance of work-related hearing loss in Michigan along with work place interventions, the State is working to reduce noise levels in industry and the occurrence of hearing loss among future generations of Michigan workers. Noise exposure is also a problem outside of the work place. It is estimated that 1.2 million people in Michigan have hearing loss (30% of those with hearing loss, Table 20). A new strategic plan to address hearing loss

from all sources is needed.

Background:

Facilities covered by the general industry noise standard (Part 380 Noise Exposure) are required to institute hearing conservation programs to prevent noise-induced hearing loss if the 8-hour time-weighted average noise level is at or above 85 decibels. However, the construction industry as well as transportation, oil and gas well drilling and servicing, agriculture, and mining are exempted from this standard. Project SENSOR (Sentinel Event Notification System for Occupational Risks), the Michigan Department of Labor and Economic Growth's surveillance program for work-related noise-induced hearing loss, identifies facilities that lack hearing conservation programs despite excessive noise exposures.

Nationally, one million workers are estimated to have work-related hearing loss, primarily from manufacturing-related exposures to noise (Weeks et al, 1991). Based on data from the National Health Interview Survey, one would expect approximately 86,000 individuals in Michigan to have noise-induced hearing loss related to work place exposures (Ries, 1994).

In 1992, the Michigan Department of Labor and Economic Growth (formerly the Michigan Department of Consumer and Industry Services) with financial assistance from the National Institute for Occupational Safety and Health (NIOSH) initiated a special emphasis program for work-related noise-induced hearing loss (NIHL). Funding assistance from NIOSH ended in September 2000, but was restarted in 2002. The State continued to maintain work-related NIHL as a priority condition for targeting and intervention during the two-year lapse of federal funding.

The surveillance program is based on Michigan's Occupational Disease Reporting Law, Part 56 of P.A. of 1978, which specifies that any health professional who knows or suspects a patient has a work-related illness must report it to the MDLEG within ten days (Figure 1). The goal of the special emphasis program is to prevent additional work-related hearing loss by inspecting facilities where index individuals with NIHL have worked. The sources used to identify persons with work-related NIHL are: (1) reports from audiologists and otolaryngologists and (2) reports from companies. Both private practice audiologists and otolaryngologists and those working for industry send reports to the Michigan Department of Labor and Economic Growth.

An individual is considered to have occupational NIHL if a health professional determines the individual: (1) has audiometric findings consistent with noise-induced hearing loss and (2) has a history of exposure to sufficient noise at work to cause hearing loss.

The MIOSHA requirement for recording a standard threshold shift (STS) had been a 10 dB or greater decrease in hearing loss in either ear at an average of 2000, 3000 and 4000 Hz. Since January 1, 2003 the criteria for reporting a STS have changed. Now not only must the individual have the 10 dB STS average at 2000, 3000 and 4000 Hz in either ear but they must also have at least a 25 dB hearing loss in either ear. For consistency we recommend this same criteria be used for reporting a STS under the Michigan Occupational Disease Reporting Law.

In some cases a hearing health professional will not have access to a baseline audiogram to compare the current audiogram for changes in hearing ability. In response to this, the State advisory committee for work-related NIHL developed some guidelines for reporting hearing loss that do not require a baseline audiogram. The following minimum hearing loss parameters can then be used as a suggested guideline:

A fixed loss (suggested definitions: a 25 dB or greater loss in either ear at an average of: 500, 1000 and 2000 Hz, or 1000, 2,000 and 3000 Hz, or 3000, 4000, and 6000 Hz; or a 15-25 dB or greater loss in either ear at an average of 3000 and 4000 Hz).

Individuals with a standard threshold shift (STS) who are reported by a company medical department or a health professional providing screening services to a company are already enrolled in their company's hearing conservation program (HCP).

Those reported with a hearing loss by a private practice audiology clinic or by an otolaryngologist not part of a company's HCP are followed up by staff working on the NIHL surveillance program to determine if the company where they are or were exposed to noise has a HCP. All individuals with a hearing loss are administered a medical and work history questionnaire, including details on their occupational and recreational exposures to noise.

Beginning in 2003, audiograms have been requested on all individuals reported. These audiograms are used to determine hearing ability. Individuals who have an average hearing loss equal to or greater than 25 decibels at 1000, 2000 and 3000 Hertz are classified as meeting the NIOSH criteria of material hearing impairment.

After the patient has been interviewed, a referral for an industrial hygiene investigation is forwarded to the appropriate MIOSHA district if: the individual reports they were exposed to noise and were not provided regular audiometric testing and hearing protection by their employer within the last five years; the facility is in MIOSHA jurisdiction; and the facility has not been inspected within the last five years where noise issues were addressed. Follow-up is typically not performed at companies for which the law does not require the provision of a comprehensive hearing conservation program such as in construction and agriculture. An industrial hygienist conducts monitoring for noise and reviews the completeness and quality of the company's hearing conservation program, if one exists. After the investigation is completed, a report of the results and any recommendations are sent to the company and union (or designated labor representative if the company does not have a union), as well as to the reporting audiologist or otolaryngologist. If the company is cited for violations of any regulations, they must post the citations at or near the location of the violations for a minimum of three days or until the items have been corrected, whichever is later.

Results:

The results in the eleventh annual report are presented in the following order: a description of all of the occupational disease reports submitted to the MDLEG for NIHL in the year 2004; results of interviews of individuals with hearing loss identified through Project SENSOR in 2003-2004;

summary of the MIOSHA inspections conducted to follow up individuals with hearing loss, a summary of the violations of the noise standard that were found during MIOSHA inspections performed from 1/01/2004-12/31/2004 that were not conducted as part of project SENSOR, and the results of a telephone survey on hearing loss of a sample of the Michigan population.

2004 Work-Related Reports for NIHL

Figure 2 shows the number of reports of hearing loss since 1985. Approximately 10.3% of all occupational disease reports submitted to the Michigan Department of Labor and Economic Growth are for hearing loss. Because of increased awareness of the reporting law by employers and health care providers, there was an increase in the overall number of reports received from 1989 through 2000, and an increase in the number of non-company reports received, especially from 1994 through 2001. In the year 2004, there were 1,551 reports of work-related hearing loss submitted to the Michigan Department of Labor and Economic Growth. Company medical departments submitted 1,107 of the 1,551 reports in 2004. Private-practice audiologists and otolaryngologists submitted the other 444 reports. Table 1 shows the number of individuals with hearing loss reported by the private-practice health professionals.

Demographics of Individuals with Hearing Loss

Ninety percent (1,400/1,549) of the reports where gender was listed are for men. Although requested, information on race was missing for 1,063/1,551 (69%) of the reports. Of the individuals for whom race was known, 82.8% were white, 15.6% were African American, 1.2% were Hispanic and 0.4% were of other descent. These percentages were similar for reports from companies as well as from private practice hearing health professionals. The mean age of individuals reported is 53 years, ranging from 20 to 92 years. Individuals reported by companies were generally younger than individuals reported by non-company audiologists and otolaryngologists (average age 51 and 58 years, respectively). Approximately 82% of the individuals reported by company medical departments were between 30 and 59 years of age compared to 55% of non-company health professionals in the same age range (Figure 3). Reports by non-company audiologists and otolaryngologists included retired individuals. All reports from companies were of current workers.

Industry

Table 2 and Figure 4 show the number of employees working at the companies where the individuals were exposed to noise. Most of the reports were of individuals who had worked at large companies employing 500 or more employees. Table 3 is a distribution of industry type of the individuals reported. Most of the reports were for individuals working in manufacturing facilities. This corresponds to companies that are more likely to have hearing conservation programs. However, the non-company health professionals reported more individuals from other types of industries, including construction (7.4%), transportation and communication services (7.1%), government (4.4%), trade (2.7%), and agriculture (0.8%) than the company or contract medical departments. Companies report individuals with NIHL as part of their hearing conservation program (HCP). In contrast, the individuals reported by non-company hearing health professionals would not necessarily be working at a company with a HCP.

Individuals with Hearing Loss, Reported by Company Medical Departments and Non-Company Audiologists and Otolaryngologists in 2003-2004

A total of 1,834 of 3,325 (55%) individuals reported to the surveillance system by company medical departments and non-company audiologists and otolaryngologists since 2003 have been interviewed. The interviews ask about all jobs where a person was exposed to noise. The data on the following pages in the Demographics and Industry sections are from the interviewed individuals reported in 2003-2004.

Demographics of Individuals with Hearing Loss

Ninety-two percent of the interviewed individuals reported in 2003-2004 were men. Of the interviewed individuals reported in 2003-2004, 86.1% were white, 9.8% were African American, 2.2% were Hispanic, 0.3% were Asian and 1.7% were other. Race was unknown for 476 individuals. Over 90% of the individuals reported were between the ages of 40 to 70 years, and includes retirees with hearing loss unlike the reports from companies that only include actively working individuals.

Industry

Table 4 shows all the industries where the individuals with hearing loss were ever exposed to noise. Overall, 79% of the 2,356 types of industries where the 1,834 individuals <u>ever</u> worked were in the manufacturing industry. The 2,356 industries identified are not unique companies; more than one patient may have worked at the same company. Therefore, the company would have been counted more than one time.

Table 5 shows the most recent industries in which the interviewed individuals were exposed to noise and whether the company provided regular hearing tests for their employees. The percentages of companies where the patient reported they did receive regular hearing testing ranged from 0% to 92% within industry types. Seventy-three percent of the most recent companies where the individuals were exposed to noise regularly tested their employees' hearing. The industries that are reported in Table 5 are not unique companies; more than one patient may have worked at the same company. Therefore, the company would have been counted more than once.

Table 6 shows whether individuals reported were provided hearing tests by the number of employees working in companies where the interviewed individuals were exposed to noise. Less than half of the workers reported having received regular hearing tests, in companies with fewer than 100 employees. The industries in Table 6 are not necessarily unique companies; more than one patient may have worked at the same company. Therefore, the company would have been counted more than once.

The interviewed individuals worked in noise for a variety of durations, ranging from less than five years to greater than 35 years. Over 74% were exposed to noise for 20 years or more (Figure 5).

Figure 6 shows the decade of the individuals' first exposure to noise. Some individuals were first exposed to noise many years ago; however, most individuals were first exposed to noise in the 1960's and later (90.7%).

Table 7 shows the decade when the interviewed individuals with hearing loss were most recently exposed to noise by industry. The percentage of individuals at companies with hearing tests increased over time within the industry types that have been required by OSHA (since 1972) to provide such hearing tests. Construction and agriculture industries had the lowest percentages of workers with regular hearing tests; these industries are not required by MIOSHA or OSHA to provide regular hearing tests.

Table 8 shows the decade in which cases most recently worked, and whether they were provided with hearing protection (plugs or muffs) by industry type. Over time, the percentage of workers who were provided hearing protection increased in all industries. The percentage of manufacturing workers given hearing protection improved the most of any industry type, with none of the workers given hearing protection in the 1950s and 98% of workers given hearing protection in the 2000s.

Table 9 shows the decade when the interviewed individuals with hearing loss were most recently exposed to noise by company size. Companies with more than 100 employees had higher percentages of workers with regular hearing tests and had greater improvement over time than smaller companies.

Table 10 shows the provision of hearing testing and hearing protection, year began using hearing protection and work injuries by self-reports of how often the individual worked in a noisy environment. Hearing protection was generally not used until the late 1980s. Table 10 also shows self reports of injuries by how often the individual worked in a noisy environment.

Fifty percent of the individuals reported with hearing loss had tinnitus (ringing in the ears) (Table 11). If tinnitus was present then 59% of the time it was daily (Table 11). Table 12 shows the occurrence of non-occupational noise exposures. Target shooting and the use of chain saws were the only two activities where half or more of the respondents indicated they used hearing protection "always or usually." If hearing protection was used, it was generally not used until the 1980s.

For the 1,613 individuals for whom we were able to obtain the actual audiogram, 871 (54.0%) met the NIOSH criteria of material hearing impairment (Figure 7). Race and industry type were very similar for those individuals with material hearing impairment and those with less severe hearing loss (Table 13). There was a significantly greater percent of men with material hearing impairment, 94.4% compared to women with 5.6%. Average age for those with material hearing impairment was 58.5 years, compared to 49.4 years for those with no material hearing impairment (Table 13). Figure 8 shows hearing loss by duration of exposure to noise at work. There is a clear exposure response with increased hearing loss at greater duration. Figure 9 shows that, on the average, hearing in the left ear is worse than the right ear.

Inspections

In response to the reports of hearing loss identified through the Project SENSOR Surveillance program, inspections were conducted at 122 companies where the person reported they had never received audiometric testing within the last five years. Of the 122 companies, 65 (53.3%) were required to have a hearing conservation program (HCP) because they had noise levels at or above 85 dBA. Of those 65 companies, 49 (75.4%) had either no HCP or a deficient HCP. Fifty-four of the 65 companies requiring a HCP were in manufacturing; five were in services; four were in government; one was in the trade industry; and one was in agriculture. Fifty-seven of the 122 companies were not required to have a HCP because noise levels were below 85dBA. Table 14 lists the characteristics of the 122 companies inspected as part of the surveillance efforts.

In addition, three other companies were identified where the person reported they had never received audiometric testing; however, these three companies had been inspected for noise prior to the start of the State's follow-up efforts, between 1987 and 1992. Two of the three had noise levels above 85dBA and no HCP. The other company also had noise levels above 85dBA and a deficient HCP. All three of these companies were in manufacturing.

In the year 2004, there were also industrial hygiene inspections assessing noise exposures that were conducted independently of those referred for inspections based on the patient interviews as part of Project SENSOR. In Michigan, limited scope complaint or referral MIOSHA inspections normally will include review of compliance with the noise standard if the company under investigation clearly has excessive noise levels and employees are observed not wearing hearing protection. During the 797 health inspections conducted in the year 2004, 60 facilities received a citation for a violation of the noise standard. These facilities were generally small. However, 11 (18.3%) of the facilities had more than 250 employees (Table 15). Similarly, ten of the 49 (20%) companies from Table 14 that were inspected in response to hearing loss and received a citation for a violation of the noise standard had more than 250 employees. Thirty-seven (61.7%) of the companies were cited for a complete lack of a hearing conservation program despite exposures to excessive levels of noise. The other companies were cited for violations of sections of the noise standard (Table 16). The manufacture of fabricated metal products, transportation equipment, and industrial and commercial machinery were the most common types of companies cited (Table 17).

Table 18 shows the estimates of the number of workers in Michigan industry currently working in conditions with noise levels of 85 decibels or greater.

Estimated Prevalence of Hearing Loss in Michigan

For the year 2003, as part of the Behavioral Risk Factor Surveillance System (BRFSS) five questions on hearing loss were included in the Michigan survey. The BRFSS is a random-digit dialed telephone survey of the civilian, non-institutionalized population age >18 years that is administered by states throughout the country. Core questions such as cigarette usage are administered in each state and then states can elect to add modules. Results of the hearing questions from the 2003 BRFSS survey in Michigan are shown in Table 19. The results in Table

19 are based on the response to the following two questions: "Do you now have deafness or trouble hearing in one or both ears?" and "Do you now use a hearing aid?" Nineteen percent of adults in Michigan indicate they have hearing loss and 2.6% use a hearing aid.

Table 19 shows that hearing loss increases with age, is more common in men than women, more common in whites than blacks, and more common in those with less education and less income. Applying these percentages to the Michigan adult population, one would estimate that 822,000 men and 574,000 women or approximately 1.4 million adults in Michigan have hearing loss, although only 200,000 of them use hearing aids.

This estimate of hearing loss in the state is much greater than previous estimates of hearing loss in Michigan which were based on the same questions administered in the National Health Interview Survey in the early 1990's (Ries, 1994). Results from that survey showed that 11% of adults reporting having hearing loss. Hearing loss increased 17% in the 1980's (Collins, 1997) and how much of the difference between the higher prevalence in Michigan in 2003 of 19% and the lower 11% national estimate from 1990-1991 is secondary to a further increase in rates versus a higher prevalence of hearing loss in Michigan is unknown.

Table 20 shows the results of the next two questions about hearing loss: "Did a doctor or other medical person ever tell you that your deafness or trouble hearing was related to noise exposure at work?" and "Did you ever tell a doctor or other medical person that your deafness or trouble hearing was related to noise exposure at work?" Among individuals with deafness or trouble hearing, 42% of the men and 12% of the women answered yes to at least one of the two questions about the work-relatedness of their deafness or trouble hearing.

The report of hearing loss related to noise exposure at work decreased in the elderly (> 75 years of age) and college graduates. Income was not related to the prevalence of work-related hearing loss. How much of the lower prevalence of hearing loss attributed to noise in the elderly is secondary to noise being less of a risk factor for hearing loss in the elderly versus the tendency to attribute hearing loss in the elderly to presbycusis is not known.

Using the percentages in Table 20 one would estimate that approximately 341,000 men, and 77,000 women, approximately 420,000 total, have hearing loss from exposure to noise at work in Michigan. This estimate is appreciably higher than our previous estimate of 86,000 based on national data (Rosenman et al, 2004).

One can question the accuracy of these estimates since they are all self-reports. However, in the field of communication disorders, prevalence statistics based on self-report data are the standard approach. Any concerns about the validity of the results would not explain the higher prevalence in Michigan versus the rest of the country since the questions and methodology to generate these results were similar in both surveys. There is one study of farmers that compared self-reported hearing loss with audiograms and found that self-reports were a useful approximation (Gomez et al, 2001).

The problem of hearing loss from noise exposure at work is large and hearing loss in general even greater. The low use of hearing aids could be due to a number of reasons: hearing loss

though prevalent is not that severe; inadequate access to health care personnel who provide hearing aids; and/or resistance to use hearing aids.

Individuals who reported hearing loss were asked when their hearing loss began. See Table 21. Most hearing loss began in adulthood. The mean year of onset was 40 years. Only 19% of hearing loss was reported to begin before the age of 20. There is active testing for hearing loss in children in school. More preventive activity is needed to address the majority of hearing loss that begins in adulthood.

Certain conditions may increase the risk of hearing loss. There are conflicting results from studies on whether there is an interaction between noise and diabetes (Ishii et al, 1992; Hodgson et al, 1987). Data from the BRFSS is shown in Table 22.

Diabetes was increased in individuals with hearing loss compared to those without for both work and non-work-related hearing in the age group <55 but was increased in the 55+ age only among those with work-related hearing loss. This data would suggest that at least in those >55, diabetes was a risk factor for noise-induced hearing loss and was a risk factor for hearing loss from all causes for those under 55.

Table 23 shows prevalence of ever smoked cigarettes by hearing status.

The prevalence of ever smoked cigarettes is greater in those with work-related noise-induced hearing loss after controlling for education, which is associated with both the prevalence of smoking and the prevalence of exposure to noise at work. This is consistent with other studies that smoking is a risk factor for hearing loss (Cruickshank et al, 1988; Vironkonas and Anttonen, 1995; Nakanishi et al, 2000).

The prevalence of high cholesterol was elevated in those with hearing loss at a younger age, but not for those with work-related hearing loss >55 years of age (See Table 24).

This data would suggest that an effect from the interaction of atherosclerosis and noise is true in younger, but not older individuals. This difference by age has not been reported in the literature (Campbell et al, 1996).

Finally, Table 25 shows the relationship between high blood pressure and hearing loss. Interpretation of this table is more complicated. Since all the data presented in the tables in this newsletter are cross-sectional one does not know which came first, the hearing loss or the risk factor. For high cholesterol, diabetes and cigarette smoking there is no suggestion that noise or hearing loss causes the risk factor. However, for high blood pressure there is an extensive literature that noise can cause high blood pressure (Vankempen et al, 2002).

This data does not support an association that noise exposure causes high blood pressure. The data in the younger age group is more suggestive that like the other risk factors for atherosclerosis, high blood pressure increases the risk of hearing loss.

The presence of risk factors for atherosclerosis may explain why some individuals and not others develop hearing loss when exposed to similar levels of noise. Interference of cochlear blood supply by atherosclerosis may be the underlying mechanism for the association between diabetes, smoking, high cholesterol, and high blood pressure. For high cholesterol and high blood pressure the association was stronger in those under 55, suggesting the risk of these factors for hearing loss is greater when atherosclerosis occurs at a younger age. Whatever the importance of these risk factors, noise exposure remains the causal factor of primary concern.

Case Narratives

Clinical histories of five of the individuals reported with their most recent audiogram are in Appendix I.

Discussion:

This is the eleventh annual report of work-related noise-induced hearing loss in Michigan. There were 1,551 reports of hearing loss submitted to the Michigan Department of Labor and Economic Growth in the year 2004. The reports submitted probably represent a substantial underestimate of the total number of individuals with work-related hearing loss. There are approximately 443 audiologists and 148 otolaryngologists in the state. Reports were received in the year 2004 from only two of the 85 estimated group practices in the state, and 27 of the 490 practitioners not known to be associated with a group practice. The number of health care practitioners reporting each year has decreased from previous years (high of 63 in 1994).

The potential number of individuals who should be reported is very likely to be much larger than the number of reports received. In Michigan, we estimate there are currently at minimum 137,100 manufacturing production workers, 25,600 construction workers, 400 oil and gas workers, 27,700 blue collar workers in wholesale and retail trade, and 9,700 workers in service industry environments exposed to daily noise levels of 85 dBA or greater (NIOSH, 1998 and Bureau of Labor Statistics, 2001). Table 18 provides estimates of blue-collar workers in Michigan who are exposed to excessive levels of noise, by industry type. Based on data from the National Health Interview Survey, we would expect approximately 86,000 workers in Michigan to have occupational noise-induced hearing loss (Ries, 1994). Based on data from the Behavioral Risk Factor Surveillance System in 2003 Michigan telephone survey, we would expect approximately 420,000 Michigan residents have work-related noise-induced hearing loss (Table 20).

The reports submitted are mainly of men between the ages of 40 and 60, who work in large manufacturing companies. Follow-up of reports from company medical departments and non-company audiologists and otolaryngologists shows that 73% of noisy companies where the individuals worked had a hearing conservation program when the individual worked there. Over time the numbers of companies that provide regular audiometric testing has increased, especially among manufacturing companies with more than 100 employees. This is not true for smaller manufacturing companies, construction companies and the farming industry (Tables 7-9).

The report of an individual with work-related hearing loss is a sentinel health event that is critical to effective occupational disease surveillance. Reports from non-company health professionals provide the base upon which meaningful information on exposures to noise at work can be gained, with the goal of intervening to prevent others from developing work-related hearing loss. There were 6,178 individuals at the worksites we inspected that had noise exposures of 85 dBA or greater, and lacked or had a deficient HCP, who directly benefited from these inspections. The results of follow-up inspections indicate that if an individual reports not being provided hearing testing and hearing protection by his or her company, that an inspection has a high rate of success in identifying a company which although legally required to have a hearing conservation program is not in compliance with the law (Table 14).

The Michigan Department of Labor and Economic Growth has been focusing on hearing loss for 13 years now. In 1993, letters were sent to otolaryngologists, audiologists, speech and hearing clinics, occupational health nurses and mobile van units to educate these groups of health professionals about the reporting law and the importance of reporting known or suspected work-related hearing loss. In 1995, a reminder letter was sent to the state's audiologists and otolaryngologists. Other outreach efforts include presenting mini-seminars at the Michigan Speech-Language-Hearing Association's annual conferences, exhibiting an educational booth about work-related hearing loss at various conferences and providing information on the status of the surveillance efforts through various association newsletters. In 1998, we initiated a quarterly newsletter on occupational NIHL that is mailed to the state's approximately 635 audiologists, otolaryngologists, mobile vans and clinics. In 1998, an internet web site that contains the annual reports and newsletters was developed; it can be accessed at: www.oem.msu.edu.

In January 2000, a letter was sent to 719 Michigan hearing health professionals to provide them with a reminder about their obligation to report known or suspected occupational noise-induced hearing loss. In January 2001, a secure server was created to allow for electronic occupational disease report submission via the web site previously mentioned. In 2003, we added the ability to report the audiometric results electronically. Despite these efforts the number of hearing professional reporting work-related noise-induced hearing loss is definitely not increasing, but rather appears to be decreasing. At the same time, the number of reports of hearing loss submitted by non-company hearing health professionals have not shown a consistent trend, they increased until 1995, decreased in 1996, increased in 1997, decreased in 1998, increased in 1999, 2000, 2001, decreased in 2002, increased in 2003, and then decreased in 2004. Further efforts in conjunction with the new licensing regulations for audiologists to encourage reporting are being planned.

In June 2000, MIOSHA initiated an Occupational Noise Exposure Local Emphasis Program (LEP) to comply with their Strategic Plan Goal to reduce NIHL/STS by 15%. Twenty-six categories of manufacturing industries are the focus of this initiative; these are industries known to have large numbers of noise-exposed workers. Inspections are conducted as planned program inspections (i.e. selected because they fell within the targeted industry categories) or as rollover inspections (i.e. the inspection was initiated for a reason other than noise but the facility falls within the LEP's targeted industry categories). At each inspection, the MIOSHA enforcement industrial hygienist provides the employer with informational handouts that are appropriate to the operations carried out at that facility. Just like any other MIOSHA enforcement inspection, the

company is required to correct any violations of the Michigan noise standard.

The degree of hearing loss among individuals who were reported was significant. Over half met the NIOSH criteria for material hearing impairment and would be expected to have difficulty hearing normal speech (Figure 7). Hearing was worse in the left ear as compared to the right (Figure 9) and was worse with increasing duration of exposure (Figure 8). Half were bothered by tinnitus. Most individuals did not begin to use hearing protection until the late 1980s and most are still not using such protection in noisy activities outside of work. We will continue to see the effects of this relatively recent initiation of the use of hearing protection. If noise cannot be engineered out of a work place or work process, then more effort is needed to ensure that individuals wear the appropriate hearing protection. This effort must cover work as well as recreational noise. Individuals must also be encouraged to use hearing protection during noisy activities outside of the work place.

A process to develop a strategic plan for all sources of noise, not just work place noise, was to be initiated by the Michigan Department of Community Health, but has been delayed because of a lack of funding. An effort to develop strategies to increase awareness of the hazards of noise exposure in both occupational and environmental situations and the development of strategies to increase preventive actions will be the goal of this strategic plan.

Ongoing and renewed outreach efforts are needed to increase the number of workers covered by hearing conservation programs, and improve the effectiveness of existing hearing conservation programs. We will continue to encourage health care practitioners to report their patients who have work-related noise-induced hearing loss.

References:

- Bureau of Labor Statistics. Annual Report on Employment, Hours and Earnings, Production Workers, Michigan 2001.
- Campbell KCM, Rybak LP, and Khardori R., Sensorineural Hearing Loss and Dyslipidemia. American Journal of Audiology 1996; 5:11-14.
- Collins, JG. Prevalence of Selected Chronic Conditions: United States 1990-1992. National Center for Health Statistics. Vital Health Statistics. 1997; 10:1-89.
- Cruickshanks KJ, Klein R, Klein BEK, Wiley TL, Nondahl DM, and Tweed TS., Cigarette Smoking and Hearing Loss. The Epidemiology of Hearing Loss Study. JAMA 1998;279:1715-1719.
- Gomez MI, Hwang SA, Sobotova L, Stark AD, and May JJ., A Comparison of Self-Reported Hearing Loss and Audiometry in a Cohort of New York Farmers. Journal of Speech, Language, and Hearing Research. 2001; 44:1201-1208.
- Hodgson MJ, Talbott E, Helmkamp JC, and Kuller LH., Diabetes, Noise Exposure, and Hearing Loss. Journal of Occupational Medicine 1987; 29:576-579.
- Ishii EK, Talbott EO, Findlay RD, D'Antonio JA, and Kuller LH., Is NIDDM a Risk Factor for Noise-Induced Hearing Loss in an Occupationally Noise Exposed Cohort? The Science of the Total Environment 1992; 127:155-165.
- Nakanishi N, Okamoto M, Nakamura K, Suzuki K, and Tatara K., Cigarette Smoking and Risk for Hearing Impairment: A Longitudinal Study in Japanese Male Office Workers. JOEM 2000; 42:1045-1049.
- National Institute for Occupational Safety and Health. Criteria for a Recommended Standard, Occupational Noise Exposure Revised Criteria 1998. June 1998, DHHS (NIOSH) Publication No. 98-126.
- Ries PW. Prevalence and Characteristics of Persons with Hearing Trouble: United States 1990-1991. Vital Health Statistics (10). 1994; No. 188. DHHS Publication PHS 94-1516.
- Rosenman KD, Reilly MJ, Sims AS, Kalinowski DJ. 2003 Annual Report on Occupational Noise-Induced Hearing Loss in Michigan. 2004.
- VanKempen EEMM, Kruize H, Boshuizen HC, Ameling CB, Staatsen BAM, de Hollander AEM. The Association Between Noise Exposure and Blood Pressure and Ischemic Heart Disease: A Meta-Analysis. Environmental Health Perspectives 2002; 110:307-317.
- Virokannas H, and Anttonen H. Dose-Response Relationship Between Smoking and Impairment of Hearing Acuity in Workers Exposed to Noise. Scand Audiol 1995;24:211-216.

Weeks JL, Levy BS and GR Wagner, eds. Preventing Occupational Disease and Injury. American Public Health Association, 1991. Known or Suspected Occupational Disease Report (Information will be held confidential as prescribed in Act.)

EMPLOYEE	AFFECTEE)				
Name (Last, First, Middle)	Age	Sex M	F	Race:	White C Other	Black Hispanic
Street		City			State	Zip
Home Phone Number	Social S	iecurity N	umber		1	
CURRENT E		ł				
Current Employer Name	Worksit	te County				
Worksite Address		City			State	Zip
Business Phone	lf Know	n, Indicat	e Busine	ess Type (produ	icts manu	factured or work done)
Number of Employees 25-100 100-500 > 500						
Employee's Work Unit/Department	Dates o	f Employr From: <u>-</u>	nent Mo	T Day Year	Го: N	10 Day Year
Employee's Job Title or Description of Work	·					

ILLNESS INFORMATION

Nature of Illness or Health Condition (Examples: Headache, Nausea, Difficulty Bre	Date of Diagnosis			
		Мо	Day Year	
Suspected Causative Agents (Chemicals, Physical Agents, Conditions)	Did Employee Die?	If Yes, Date of De	eath	
		Mo	Day Year	
If Physician, Indicate Clinical Impression for Suspected Occupational Disease, or E	Diagnosis of Confirmed Occupat	ional Disease		

ADDITIONAL COMMENTS

\bigcirc						
Yes No Don't Know						
State	Zip					
Non-Ph	ysician 🔿					
State	Zip					
	Date					
	No Do State Non-Ph State	No Don't Know State Zip Non-Physician State Zip Date Unit of the second seco				

Michigan Department of Labor and Economic Growth is an equal opportunity, affirmative action employer, service provider and buye

Return completed form to:

Michigan Department of Labor and Economic Growth Michigan Occupational Safety and Health Administration Management and Technical Services Division 7150 Harris Drive, P.O. Box 30649 Lansing, MI 48909-8149

Authority: P.A. 368 of 1978 Completion: Required Penalty: Misdemeanor

MIOSHA-MTSD-51 (12/03)

Figure 2. All Individuals with Noise-Induced Hearing Loss Reported to the Michigan Department of Labor and Economic Growth: 1985 - 2004



^{*}All reports combined (Fixed Loss and STS). **Fixed Loss Reports.

Figure 3. All Individuals Reported with Noise-Induced Hearing Loss in 2004: Age Range* by Reporting Source



^{*}Age was unknown for 25 individuals reported by company medical departments and 11 individuals reported by non-company hearing health professionals.

Figure 4. All Individuals Reported with Noise-Induced Hearing Loss in 2004: Number of Employees* at the Company Where Exposure to Noise Occurred



*Number of employees was unknown for seven individuals reported by company medical departments and 173 individuals reported by non-company hearing health professionals.

Figure 5. All Interviewed Individuals with Hearing Loss: Total Duration of Years Worked* in Noise, Michigan: 2003-2004



*Duration was unknown for 184 individuals identified in 2003-2004.

Figure 6. All Interviewed Individuals with Hearing Loss: Distribution of Decade of First Exposure* to Noise, Michigan: 2003-2004



*Decade was unknown for 191 individuals identified in 2003-2004.

Figure 7. Distribution of the Average of the Hearing Threshold Level (HTL) at 1000, 2000, 3000 Hz in Both Ears, for 1,613 individuals with Audiometric Testing Results, Michigan: 2003-2004



Figure 8. Average Hearing Threshold Levels at 250 to 8000 Hz by Years Worked in Noisy Environment (Worst Ear), Michigan: 2003-2004



Figure 9. Average Hearing Threshold Levels at All Test Frequencies, Michigan: 2003-2004



Table 1. Number of Non-Company Based HealthProfessionals Reporting Individuals with Noise-InducedHearing Loss in Michigan, in Calendar Year 2004

Range of	Health Prof	essionals	Total Number of			
Individuals Reported	Number	Percent	Individuals Reported			
1	13	48.1	13			
2-10	9	33.3	46			
11-50	3	11.1	93			
51+	2	7.4	292			
TOTAL	27 *	100.0	444			

*This includes two group practices.

Table 2. All Company and Non-Company Individuals with
Noise-Induced Hearing Loss Reported in Calendar Year
2004: Number of Employees at the Company Where
Exposure to Noise Occurred

Number of Employees	Tot Number	al Percent	STS Number	** Percent	Fixed L Number	oss*** Percent
<25	34	2.5	1	0.1	33	12.2
25-100	21	1.5	1	0.1	20	7.4
101-500	33	2.4	14	1.3	19	7.0
>500	1283	93.6	1084	98.5	199	73.4
TOTAL*	1371	100.0	1100	100.0	271	100.0

* Number of employees was unknown for seven individuals reported by company medical departments and 173 individuals reported by non-company hearing health professionals.
 ** STS=Standard Threshold Shift, reported by company.

*** Fixed=reported by audiologist/otolaryngologist in private practice.

Table 3. Calendar Year 2004 Occupational Disease Reports of Noise-Induced Hearing Loss: Industry of Individuals Reported

			STS**	Fixed Loss*	***	
	Number of		Number of		Number of	
Standard Industrial Classification (SIC)*	Individuals	Percent	Individuals	Percent	Individuals	Percent
Agriculture/Forestry (01-08)	3	0.2	0		3	0.8
Mining (10-14)	2	0.1	0		2	0.5
Construction (15-17)	28	1.9	1	0.1	27	7.4
Manufacturing (20-39)						
Food and Kindred Products (20)	2	0.1	2	0.2	0	
Lumber and Wood (24)	4	0.3	1	0.1	3	0.8
Furniture (25)	2	0.1	0		2	0.5
Paper (26)	2	0.1	0		2	0.5
Printing and Publishing (27)	1	0.1	0		1	0.3
Chemicals (28)	19	1.3	14	1.3	5	1.4
Rubber and Misc. Plastics Products (30)	15	1.0	13	1.2	2	0.5
Stone/Clay/Glass (32)	1	0.1	0		1	0.3
Primary Metals (33)	117	8.0	71	6.4	46	12.6
Metal Fabrication (34)	204	13.9	194	17.6	10	2.7
Machinery (35)	18	1.2	6	0.5	12	3.3
Electronics (36)	18	1.2	15	1.4	3	0.8
Transportation (37)	882	60.1	756	68.5	126	34.6
Measuring, Analyzing, Controlling Instr. (38)	1	0.1	0		1	0.3
Miscellaneous Mfg Industries (39)	7	0.5	1	0.1	6	1.6
Transport./Comm. Svcs. (40-49)	26	1.8	0		26	7.1
Retail Trade (50-59)	19	1.3	9	0.8	10	2.7
Finance, Insurance & Real Estate (60-67)	5	0.3	0		5	1.4
Services (70-89)	-				-	
Lodging Places (70)	1	0.1	0		1	0.3
Business Services (73)	4	0.3	0		4	1.1
Automotive Repair (75)	6	0.4	0		6	1.6
Misc. Repair Services (76)	1	0.1	1	0.1	0	
Health (80)	11	0.7	0		11	3.0
Education (82)	32	2.2	7	0.6	25	6.9
Social Services (83)	1	0.1	0		1	0.3
Membership Organizations (86)	2	0.1	1	0.1	1	0.3
Engineering/Management (87)	4	0.3	0		4	11
Private Households (88)	2	0.1	0		2	0.5
Public Administration (91-97)	_		-		_	
Government (91)	11	07	4	04	7	19
Police (92)	13	0.9	6	0.5	, 7	1.9
Human Resources (94)	1	0.1	0		, 1	0.3
Admin. of Environmental Ouality (95)	1	0.1	1	0.1	0	
Admin. Economic Programs (96)	1	0.1	1	0.1	0	
National Security and International Affairs (97)	1	0.1	0		1	03
Total	1.468	100.0	1104 *	* 100.0	364 **	* 100.0

*Standard Industrial Classification (1987 Manual).

**SIC was unknown for three individuals reported by company medical departments and 80 individuals reported by private practice health professionals.

***STS=Standard Threshold Shift, reported by company.

****Fixed=reported by audiologist/otolaryngologist in private practice.

Table 4. Individuals with Hearing Loss: Type of IndustryWhere Exposed to Noise: Michigan 2003-2004

Standard Industrial Classification (SIC)* Reports by Industry Pe	rcent
Agricultural Production & Services (01-08)	0.8
Forestry (08) 0	0.0
Mining (10-14) 10	0.4
Construction (15-17) 143	6.1
Manufacturing (20-39)	
Food (20) 10	0.4
Apparel (23) 0	0.0
Textile Goods, NEC (22) 1	0.0
Wood (24) 6	0.3
Furniture (25) 15	0.6
Paper (26) 11	0.5
Printing (27) 5	0.2
Chemicals (28) 47	2.0
Petroleum Refining (29) 2	0.1
Rubber (30) 32	1.4
Leather (31) 0	0.0
Stone/Clay/Glass (32) 7	0.3
Primary Metals (33) 205	8.7
Metal Fabrication (34) 246	10.4
Machinery (35) 56	2.4
Electronics (36) 34	1.4
Transportation (37) 1,145	48.6
Measuring Instruments (38) 1	0.0
Miscellaneous Mfg Industries (39) 35	1.5
Transportation/Communication Services (40-49) 84	3.6
Retail Trade (50-59) 52	2.2
Finance, Insurance & Real Estate (60-67) 4	0.2
Services (70-89)	
Hotels (70) 0	0.0
Hotels and Motels, Including Casinos (70) 2	0.1
Personal Services (72)	0.0
Business (73) 5	0.2
Automotive Repair (75) 20	0.8
Repair (76) 6	0.3
Motion Pictures (78) 0	0.0
Recreation (79) 8	0.3
Health (80) 9	0.4
Legal Services (81)	0.0
Education (82) 83	3.5
Social Services (83)	0.0
Parks (84) 0 Mombarship Organizations (86)	0.0
Engineering (Management (87)	0.0
Coology (20)	0.0
Engineering Services (87)	0.0
$\frac{\text{Bigmeening Services } (67)}{\text{Services NEC } (80)} \qquad \qquad$	0.2
Scivico, NEC (07) 1 Public Administration (01_07) 45	1.0
Total 2 356 **	00.0

*Standard Industrial Classification (1987 Manual).

**SIC was unknown for 90 work locations from individuals identified in 2003-2004.

Table 5. All Interviewed Individuals with Hearing Loss:Type of Industry and Performance of Regular HearingTesting at Most Recent Company Exposed to Noise:Michigan 2003-2004

	Number of	Percent Have
Standard Industrial Classification (SIC)*	Reports by Industry	Hearing Testing
Agricultural Production & Services (01-07)	6	25
Mining (10-13)	5	33
Construction (15-17)	79	6
Manufacturing (20-39)		
Food (20)	3	50
Wood (24)	2	50
Furniture (25)	14	92
Paper (26)	7	75
Printing (27)	1	0
Chemicals (28)	38	65
Petroleum Refining (29)	1	0
Rubber (30)	23	79
Stone/Clay/Glass (32)	5	50
Primary Metals (33)	171	70
Metal Fabrication (34)	203	90
Machinery (35)	22	39
Electronics (36)	31	83
Transportation (37)	934	88
Miscellaneous Mfg Industries (39)	12	29
Transportation/Communication Services (40-49)	46	50
Retail Trade (50-59)	21	31
Finance, Insurance & Real Estate (60-67)	3	0
Services (70-89)		
Lodging Places (70)	2	0
Business (73)	4	0
Automotive Repair (75)	5	33
Repair (76)	2	0
Recreation (79)	3	0
Health (80)	7	0
Legal Services (81)	1	0
Education (82)	79	44
Engineering/Management (87)	1	0
Public Administration (91-97)	30	41
Total	1,761 **	73

*Standard Industrial Classification (1987 Manual).

**SIC was unknown for 73 work locations from individuals identified in 2003-2004.

Table 6. All Interviewed Individuals withHearing Loss: Number of Employees in MostRecent Company Exposed to Noise by Statusof Hearing Testing: Michigan 2003-2004

Company Size: Number of Employees	Number of Repor	ts vv*	Have Ho Number	learing Testing Percen		
<25	47	(40)	7	18		
25 100	56	(10)	20	10		
25-100	50	(43)	20	47		
101-500	48	(38)	24	63		
>500	1,303	(785)	686	87		
TOTAL	1,454	(906)	737	81		

*This total excludes 268 individuals identified in 2003-2004 with unknown number of employees and 548 individuals who we were unable to determine if they had been provided hearing testing while working. The number in parentheses are the number of individuals we were able to determine if they had been provided hearing testing while working.

Table 7. All Interviewed Individuals with Hearing Loss: Decade Last Workedand Status of Regular Hearing Testing at Most Recent Company Exposed toNoise, by Industry Type*: Michigan 2003-2004

	Decade Last Exposed to Noise and Hearing Testing Status															
		1910s	19	940s	19	950s	19	960s	19	70s	19	980s	19	90s	20	00s
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
	of	Have	of	Have	of	Have	of	Have	of	Have	of	Have	of	Have	of	Have
Industry Type (SIC)**	Pts.	RHT***	Pts.	RHT												
Agriculture/Forestry (01-08)	0		1	0	0		1	0	0		1	100	0		2	0
Mining (10-14)	0		0		0		0		0		2	0	1	0	2	50
Construction (15-17)	1	0	0		1	0	0		3	0	10	17	16	0	39	7
Manufacturing (20-39)	0		1	0	3	0	10	0	24	18	77	32	115	74	1173	91
Transportation (40-49)	0		1	0	0		0		1	0	4	0	7	60	27	55
Trade (50-59)	0		0		0		0		0		1	0	0		13	33
Finance (60-67)	0		0		0		0		0		0		1	0	2	0
Services (70-89)	0		0		1	0	0		0		3	0	5	0	86	40
Public Administration (91-97)	0		0		0		0		1	0	2	100	7	50	20	33

*For 165 individuals, either industry type or decade last exposed to noise was unknown.

**Standard Industrial Classification (1987 Manual).

***Regular Hearing Test.

Table 8. All Interviewed Individuals with Hearing Loss: Decade Last Workedand Status of Hearing Protection at Most Recent Company Exposed to Noise,by Industry Type*: Michigan 2003-2004

		Decade Last Exposed to Noise and Offered Hearing Protection Device														
		1910s	19	1940s		1950s 19		1960s 19		970s 19		80s 1		990s 20		00s
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
	of	Have	of	Have	of	Have	of	Have	of	Have	of	Have	of	Have	of	Have
Industry Type (SIC)**	Pts.	RHT***	Pts.	HPD	Pts.	HPD	Pts.	HPD	Pts.	HPD	Pts.	HPD	Pts.	HPD	Pts.	HPD
Agriculture/Forestry (01-08)	0		1	100	0		1	0	0		1	0	0		2	100
Mining (10-14)	0		0		0		0		0		2	100	1	0	2	100
Construction (15-17)	1	0	0		1	0	0		3	0	10	20	16	46	39	71
Manufacturing (20-39)	0		1	0	3	0	10	25	24	57	77	56	115	93	1173	98
Transportation (40-49)	0		1	0	0		0		1	0	4	0	7	80	27	62
Trade (50-59)	0		0		0		0		0		1	0	0		13	50
Finance (60-67)	0		0		0		0		0		0		1	0	2	50
Services (70-89)	0		0		1	0	0		0		3	67	5	25	86	75
Public Administration (91-97)	0		0		0		0		1	0	2	100	6	17	20	61

*For 165 individuals, either industry type or decade last exposed to noise was unknown.

**Standard Industrial Classification (1987 Manual).

***Hearing Protestion Device (ear plugs or muffs).

Table 9. All Interviewed Individuals with Hearing Loss: Decade Last Worked and Status of Regular Hearing Testing at Most Recent Company Exposed to Noise, by Industry Size*: Michigan 2003-2004

	Company Size (Number of Employees)												
	<2	25	25-1	100	101-	500	>500						
	Number	%	Number	%	Number	%	Number	%					
	of	Have	of	Have	of	Have	of	Have					
Decade	Patients	RHT**	Patients	RHT	Patients	RHT	Patients	RHT					
1940s	1	0	0		0		1	0					
1950s	0		0		0		3	0					
1960s	0		2	0	1	0	6	0					
1970s	1	0	1	0	2	0	16	14					
1980s	4	50	3	0	3	0	37	43					
1990s	10	0	3	100	6	67	78	83					
2000s	27	19	42	50	33	80	1114	92					

*For 440 individuals, either company size or decade last exposed to noise was unknown. **Regular Hearing Test.

Table 10. All Interviewed Individuals with Hearing Loss: Provision of RegularHearing Testing, Hearing Protection, Year Began Using Hearing Protectionand Occurrence of Work Injuries by Self Report of Noise: Michigan 2003-2004

	Noi All the	sy Time	Noi Most of	sy Time	Noi Somet	isy times	Noi Seld	sy om	Noi Rarelv/	sy Never
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Regular Hearing Testing	712	65.9	94	48.5	103	40.7	22	44.0	11	33.3
Hearing Protection	919	82.3	142	71.7	181	67.5	35	58.3	14	28.6
Avg Year Began Use	694	1987	105	1988	122	1987	16	1991	9	1981
Work Injuries	473	42.8	70	34.5	67	25.4	9	15.5	8	17.8

Table 11. All Interviewed Individuals with Hearing Loss:Bothered by Ringing, Roaring or Buzzing:Michigan 2003-2004

	Number	Percent
No	577	50.0
Yes	577*	50.0
Daily Symptoms	332	(58.9)
Weekly Symptoms	100	(17.7)
Monthly Symptoms	76	(13.5)
Seldom Symptoms	56	(9.9)

*Thirteen individuals did not report frequency of symptoms.

Table 12. All Interviewed Individuals with Hearing Loss:Non-Work Noise Exposures: Michigan 2003-2004

			Hearing Protection		Average	
	Ye	S	Always or	Usually	Year B	egan
	Number	Percent	Number	Percent	Always or	Usually
Hunting	418	36.4	75	18.4	66	1979
Target Shooting	247	21.5	197	80.4	168	1982
Snowmobiling	155	13.5	45	29.6	28	1980
Power Tools	285	24.8	126	44.5	118	1987
Chain Saw	262	22.8	133	51.8	111	1989
Loud Music	161	14.0	6	3.8	5	1996
Motor Boat/Jet Ski	147	12.8	4	2.8	3	1984
Lawn Work	820	71.4	254	31.3	237	1991
Other	177	15.6	68	38.6	54	1986
Any	976	53.2	529	54.2	478	1985

Table 13. All Interviewed Individuals with Hearing Loss: Meet NIOSH's Criteria of "Material Hearing Impairment": Michigan 2003-2004

	Average 1000, 2000 and 3000 Hertz				
	< 25	dB	<u>> 25</u>	dB	
	Number	Percent	Number	Percent	
Gender					
Male	677	91.2 **	822	94.4 **	
Female	65	8.8	49	5.6	
Race					
White	456	86.7	572	85.0	
African American	52	9.9	67	10.0	
Asian/Pacific Islander	1	0.2	2	0.3	
White Hispanic	10	1.9	18	2.7	
Alaskan/American Indian	1	0.2	3	0.4	
Other Hispanic	1	0.2	0	0.0	
Other	5	1.0	11	1.6	
Age (Years)	49.4 ⁻	**	58.5	**	
Standard Industrial Classification (SIC)*					
Mining (10-14)	2	0.3	3	0.4	
Construction (15-17)	19	2.6	48	5.9	
Manufacturing (20-39)	622	85.6	674	82.6	
Transport./Comm. Svcs. (40-49)	15	2.1	25	3.1	
Wholesale Trade (50-51)	3	0.4	5	0.6	
Retail Trade (52-59)	3	0.4	7	0.9	
Finance, Insurance & Real Estate (60-67)	1	0.1	2	0.2	
Services (70-89)	50	6.9	38	4.7	
Public Administration (91-97)	12	1.7	14	1.7	

*Standard Industrial Classification (1987 Manual).

**p < 0.05

Table 14. One Hundred Twenty-Two Companies Inspected Where Individuals ReportedThey Had Not Received Audiometric Testing: Michigan 1992-2004

			Hea Conse	aring rvation	(Citation Iss	sued		Total Number o Exposed to	f Employees o Noise
Industry (SIC)*	T Insp	otal ections	Progran Req	n (HCP) uired	HCP D	eficient	HCI	P Absent	HCP Deficient	HCP Absent
	#	%	#	%	#	%	#	%	#	#
Agricultural Services (07)	1	(0.8)	1	(100.0)	0		0			
Construction (15-17)	3	(2.5)	***		0		1	(33.3)		562
Manufacturing (20-39)	89	(73.0)	54	(60.7)	24	(44.4)	17	(31.5)	3,251	1,603
Transportation (40-49)	3	(2.5)	0		0		0			
Trade (50-59)	9	(7.4)	1	(11.1)	0		1	(100.0)		14
Services (70-89)	11	(9.0)	5	(55.6)	0		3	(60.0)		40
Government (91-97)	6	(4.9)	4	(66.7)	3	(75.0)	0		708****	
TOTAL	122	(100.1)**	65	(53.3)	27	(41.5)	22	(33.8)	3,959	2,219

* Standard Industrial Classification (1987 Manual).

** Percentage does not add to 100% due to rounding.

*** Construction has separate regulations that require a less comprehensive program.

**** Number employees unknown for one company.

Table 15. Size of Companies Cited for Violations of the Noise Standard in Michigan: MIOSHA Inspections Conducted 01/01/2004 to 12/31/2004

	Compar	nies
Number of Employees	Number	Percent
<u><</u> 50	22	36.7
51 - 250	27	45.0
251+	11	18.3
TOTAL	60	100.0

Table 16. Violations of the Noise Standard in Michigan:MIOSHA Inspections Conducted 01/01/2004 to 12/31/2004

	Companies Cited for Star		for Standard
Standard Violated (Part 380. Occupational Noise Exposure)	of Citations	Percent*	Percent**
Hearing conservation program (R325.60107)	37	39.8	61.7
Employee training program (R325.60123)	14	15.1	23.3
Permissible noise exposure; noise controls (R325.60104)	8	8.6	13.3
Follow-up procedures (R325.60116)	7	7.5	11.7
Annual audiogram (R325.60114)	5	5.4	8.3
Noise monitoring program (R325.60108)	5	5.4	8.3
Audiometric testing program (R325.60112)	4	4.3	6.7
Evaluation of audiogram (R325.60115)	4	4.3	6.7
Recordkeeping (R325.60125)	3	3.2	5.0
Access to information and training materials (R325.60124)	2	2.2	3.3
Hearing protectors (R325.60121)	2	2.2	3.3
Baseline audiogram (R325.60113)	1	1.1	1.7
Records; retention; provision; access; transfer (R325.60126)	1	1.1	1.7
Total	93	100.0	

*Percentages based on a total of 93 violations.

**A company may be cited for more than one type of violation, therefore these percentages are based on a total of 60 companies cited.

Table 17. Type of Industry Cited for Violations of the Noise Standard in Michigan: MIOSHA Inspections Conducted 01/01/2004 to 12/31/2004

	Comp	anies
Standard Industrial Classification (SIC)*	Number	Percent
Manufacture of (20-39):		
Fabricated Metal Products (34)	18	30.0
Transportation Equipment (37)	11	18.3
Industrial and Commercial Machinery (35)	8	13.3
Furniture (25)	6	10.0
Primary Metal (33)	5	8.3
Food and Kindred Products (20)	2	3.3
Lumber (24)	1	1.7
Stone/Clay/Glass (32)	1	1.7
Miscellaneous Mfg. Industries (39)	1	1.7
Transport./Comm. Services (40-49)	3	5.0
Retail Trade (50-59)	1	1.7
Services (70-89):		
Repair (76)	1	1.7
Recreation (79)	1	1.7
Public Administration (91-97)		
Government	1	1.7
TOTAL	60	100.0

*Standard Industrial Classification (1987 Manual).

Total No. % Exposed No. Workers Industry (SIC)* of Workers** to Noise*** Noise-Exposed MINING Oil and Gas Extraction (13) 1,600 23.1 370 **CONSTRUCTION** General Building Contractors (15) 31,000 15.8 4,898 Heavy Construction (16) 15,600 24.03,744 Special Trade Contractors (17) 108,600 15.6 16,942 MANUFACTURING Food and Kindred Products (20) 26,900 28.9 7,774 Textile Mill Products (22) 1,000 42.6 426 Apparel and Other Textiles (23) 15,100 13.9 2,099 Lumber and Wood Products (24) 13,400 41.3 5,534 Furniture and Fixtures (25) 28,200 28.3 7,981 Paper and Allied Products (26) 13,900 33.8 4,698 Printing and Publishing (27) 22,800 21.4 4,879 Chemicals and Allied Products (28) 17.3 20,100 3,477 Petroleum and Coal Products (29) 800 19.9 159 Rubber and Plastics (30) 43,200 22.8 9,850 Leather (31) 3,000 6.5 195 Stone, Clay and Glass (32) 14,200 21.5 3,053 Primary Metals (33) 28,100 32.7 9,189 Fabricated Metals (34) 96,000 29.3 28,128 Industrial Machinery (35) 80,700 14.9 12,024 Electronic Equipment (36) 25,600 8.1 2,074 Transportation Equipment (37) 188,300 18.2 34,271 Instruments and Related (38) 9,400 8.7 818 Miscellaneous Manufacturing (39) 5,200 9.4 489 TRANSPORTATION Freight (42) 41,500 7.0 2,905 TRADE Wholesale Durable Goods (50) 113,200 20.9 23,659 Wholesale Nondurable Goods (51) 57,100 5.3 3,026 Retail (55) 71,900 1.4 1,007 SERVICES Business (73) 278,800 1.5 4,182 Automotive Repair and Parking (75) 33,900 3,593 10.6

Table 18. Estimates of the Number of Blue-Collar Workers in Michigan Exposed toExcessive Levels of Noise, by Industry Type

*Standard Industrial Classification (1987 Manual).

Health Services (80)

TOTAL

**Source: Bureau of Labor Statistics, Michigan Employment Security Commission, Current Employment Statistics. 2001 Annual Report of Michigan Production/NonSupervisory Workers.

***Source: National Institute for Occupational Safety and Health, Criteria for a Recommended Standard, Occupational Noise Exposure Revised Criteria 1998. June 1998, DHHS (NIOSH) Publication No. 98-126, Table 2-1. Percentages are estimates based on data collected in the National Occupational Exposure Survey (NOES). Excessive noise is defined as at or above 85dBA.

324,700

1,713,800

0.6

1,948

203.391

Table 19. Hearing Loss, 2003 Michigan BRFS
(% ± 95% Confidence Interval Limit)

Demographic		Hearing Loss in One	
Characteristics	Hearing Loss ^a	or Both Ears ^b	Used Hearing Aid ^c
Total	19.0 ± 1.4	18.9 ± 1.4	2.6 ± 0.5
Age			
18-44	10.2 ± 1.8	10.2 ± 1.8	0.4 ± 0.4
45-54	21.3 ± 3.4	21.3 ± 3.4	0.9 ± 0.7
55-64	25.7 ± 3.9	25.5 ± 3.9	3.0 ± 1.5
65-74	33.1 ± 5.1	33.1 ± 5.1	7.7 ± 2.7
75+	44.2 ± 5.3	43.1 ± 5.3	14.9 ± 3.7
Gender			
Male	23.2 ± 2.4	23.2 ± 2.4	3.0 ± 0.8
Female	15.1 ± 1.6	14.9 ± 1.6	2.2 ± 0.6
Race			
White	20.5 ± 1.6	20.3 ± 1.6	3.0 ± 0.6
Black	11.7 ± 4.1	11.7 ± 4.1	$0.4 \pm 0.6*$
Education			
Less than high school	23.5 ± 4.8	23.4 ± 4.8	4.4 ± 2.0
High school graduate	20.5 ± 2.6	20.3 ± 2.6	2.8 ± 0.9
Some college	21.0 ± 2.9	20.9 ± 2.9	2.0 ± 0.8
College graduate	13.7 ± 2.2	13.6 ± 2.2	2.4 ± 0.9
Household Income			
< \$20,000	22.0 ± 3.8	21.9 ± 3.8	3.2 ± 1.3
\$20,000-\$34,999	22.2 ± 3.3	22.1 ± 3.3	3.9 ± 1.3
\$35,000-\$49,999	19.7 ± 3.7	19.6 ± 3.7	2.2 ± 1.2
\$50,000+	14.8 ± 2.1	14.7 ± 2.1	1.5 ± 0.7

^aThe proportion who reported that they had deafness or trouble hearing in one or both ears, or that they used a ^bThe proportion who reported that they had deafness or trouble hearing in one or both ears, or the bearing aid now.
^bThe proportion who reported that they had deafness or trouble hearing in one or both ears now.
^cThe proportion who reported that they used a hearing aid now.
*The 95% confidence interval exceeds possible limits.

Table 20. Noise Exposure at Work, 2003 MichiganBRFS (% ± 95% Confidence Interval Limit)

	Health Care	Respondent Ever Told	Either a Health Care
	Professional Ever Told	Health Care	Professional or the
	that Respondent's	Professional that	Respondent Ever Told
	Deafness or Trouble	Deafness or Trouble	Deafness or Trouble
Demographic	Hearing Due to Noise	Hearing Due to Noise	Hearing Due to Noise
Characteristics	Exposure at Work ^a	Exposure at Work ^b	Exposure at Work ^c
Total	25.9 ± 3.9	20.4 ± 3.5	29.9 ± 4.0
Age			
18-44	27.3 ± 9.9	17.8 ± 8.3	30.6 ± 10.2
45-54	27.9 ± 8.5	26.6 ± 8.6	31.5 ± 9.0
55-64	33.2 ± 8.6	26.6 ± 7.9	39.2 ± 8.9
65-74	30.6 ± 9.4	21.6 ± 8.4	33.8 ± 9.4
75+	10.9 ± 5.0	9.6 ± 4.6	15.4 ± 5.7
Gender			
Male	36.4 ± 5.7	27.9 ± 5.3	41.6 ± 5.9
Female	9.8 ± 3.4	9.1 ± 3.4	12.4 ± 3.8
Education			
Less than high school	27.3 ± 10.7	15.7 ± 7.7	30.9 ± 10.9
High school graduate	27.9 ± 6.8	23.1 ± 6.6	33.5 ± 7.2
Some college	29.3 ± 7.4	23.4 ± 6.7	33.4 ± 7.6
College graduate	16.8 ± 6.9	15.3 ± 6.6	18.6 ± 7.1
Household Income			
< \$20,000	26.8 ± 8.7	17.0 ± 6.9	30.2 ± 8.9
\$20,000-\$34,999	22.8 ± 7.5	22.5 ± 7.5	30.7 ± 8.3
\$35,000-\$49,999	26.9 ± 10.4	18.6 ± 8.8	30.8 ± 10.8
\$50,000+	28.0 ± 7.6	23.9 ± 7.3	31.1 ± 7.8

^aAmong those who reported having trouble hearing or using a hearing aid, the proportion who reported that a health care professional ever told them that their deafness or trouble hearing was related to noise exposure at work. ^bAmong those who reported having trouble hearing or using a hearing aid, the proportion who reported that they ever told a health care professional that their deafness or trouble hearing was related to noise exposure at work. ^cAmong those who reported having trouble hearing or using a hearing aid, the proportion who reported either that a health care professional ever told them or that they ever told a health care professional that their deafness or trouble hearing was related to noise exposure at work.

Age	n	% ± 95% CI Limit
0-9	54	8.9 ± 2.6
10-19	50	9.9 ± 3.0
20-29	75	14.2 ± 3.3
30-39	80	13.9 ± 3.1
40-49	106	16.6 ± 3.1
50-59	108	14.0 ± 2.8
60-69	91	10.9 ± 2.3
70+	108	11.6 ± 2.3

Table 21. Age Distribution of When Hearing Loss First Developed,2003 Michigan BRFS

Table 22. Diabetes Among Those With and Without Hearing LossBy Self Reported Cause of Hearing Loss, Michigan 2003,BRFS (% ± 95% Confidence Limit)

Diabetes and Hearing Loss						
			Diabetes and No			
Age	Work-Related	Not Work-Related	Hearing Loss			
All Ages	17.4 ± 5.6	12.6 ± 3.2	6.6 ± 1.0			
18-54	11.1 ± 7.2	8.7 ± 4.7	3.8 ± 0.9			
<u>> 50</u>	23.4 ± 8.2	15.5 ± 4.4	15.5 ± 2.7			

Table 23. Ever Smokes Cigarettes Among Those With and WithoutHearing Loss By Self Reported Cause of Hearing Loss,
Michigan 2003, BRFS

Ever Smoked and Hearing Loss					
		-	Ever Smoked and		
Education	Work-Related	Not Work-Related	No Hearing Loss		
All	71.9	56.6	47.9		
HS Grad or Less	80.8	58.3	61.5		
Some College or More	62.2	54.9	40.5		

Table 24. High Cholesterol Among Those With and Without Hearing Loss By Self Reported Cause of Hearing Loss, Michigan 2003, BRFS (% ± 95% Confidence Limit)

High Cholesterol and Hearing Loss					
			High Cholesterol and		
Age	Work-Related	Not Work-Related	No Hearing Loss		
All Ages	50.2 ± 8.5	51.1 ± 5.5	34.8 ± 2.2		
18-54	45.4 ± 14.1	35.9 ± 9.0	28.3 ± 2.7		
<u>> 55</u>	53.4 ± 10.1	61.9 ± 6.1	50.2 ± 3.7		

Table 25. High Blood Pressure Among Those With and WithoutHearing Loss By Self Reported Cause of Hearing Loss,Michigan 2003, BRFS (% ± 95% Confidence Limit)

High Blood Pressure and Hearing Loss					
	-	-	High Blood Pressure		
Age	Work-Related	Not Work-Related	and No Hearing Loss		
All Ages	37.9 ± 7.6	42.6 ± 5.1	23.8 ± 1.8		
18-54	22.9 ± 10.6	23.9 ± 7.6	15.2 ± 1.8		
<u>> 55</u>	52.3 ± 9.9	58.2 ± 5.9	50.9 ± 3.6		

APPENDIX I

Narratives of Five Individuals with Noise-Induced Hearing Loss in 2004

Case 1. A man in his late 30's had high frequency hearing loss identified as part of his company's hearing conservation program, eight years after he began working for a pharmaceutical company. His audiogram showed increased high frequency loss. Prior to working at the pharmaceutical company he had been in the Army for six years. He denied having tinnitus. He indicated he usually wore custom plugs or earmuffs. He had been exposed to a number of chemical ototoxins. He was also exposed to noise outside of work; snowmobiling, power tools, and lawn work. He indicated he usually or always wore hearing protection in these activities outside of work. He had not been told why he had hearing loss. His audiogram with baseline values is shown in Figure 1.



Case 2. A man in his early 60's had high frequency hearing loss identified after seeing an audiologist. He had worked at a metal bolt manufacturer for 13 years where he was provided hearing testing and usually wore foam plugs. He was exposed to chemical ototoxins. Prior to that he worked 20 or so years for a police department where he did not use hearing protection. He had been in the Navy for four years. He had daily tinnitus for the past ten years. He hunted and did target shooting. He always wore hearing protection when doing target shooting but rarely when hunting. He had not been told why he had hearing loss. His audiogram is shown in Figure 2.



Case 3. A man in his 40's had hearing loss across all frequencies for which he wore hearing aids. He had worked since high school as a laborer and equipment operator for the State of Michigan. He had not been provided hearing testing by his employer and did not wear hearing protection in the first ten years of work. He had had no other jobs and had never been in the military. He was bothered by tinnitus but only infrequently. He had been exposed to a number of chemical ototoxins. He was exposed to noise outside of work including hunting, snowmobiling for four years, listening to loud music for seven years, and lawn work. He only wore hearing protection with lawn work. He had not been told why he had hearing loss. His audiogram is shown in Figure 3.



Case 4. A man in his early 50's had high frequency hearing loss. He had worked for six years, 20 years ago, for a car dealer doing auto repair. He used no hearing protection. He had no other jobs with noise exposure and had never been in the

Appendix I - 2

military. He was bothered daily by tinnitus. Outside of work he indicated he had a hobby where he had used power tools for the past 20 years, and usually wore hearing protection except for the first year. He had not been told why he had hearing loss. His audiogram is shown in Figure 4.



Case 5. A woman in her early 60's had worked for 30 years at an auto manufacturer. She had held different jobs including engine assembly and seat upholstering. She had been provided regular audiograms but rarely wore hearing protection. She had never been in the military nor had had any other jobs. She occasionally was bothered by tinnitus. She had no noise exposure outside of work. She was not exposed to chemical ototoxins at work. She had been told her hearing loss was due to noise at work and may be hereditary. Her audiogram with baseline values is shown in Figure 5.

