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MEMPHIS FIRE DEPARTMENT
MEMPHIS, TENNESSEE

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I. SUMMARY

In November, 1985, the International Association of Fire Fighters (IAFF) requested assistance from the National Institute for Occupational Safety and Health (NIOSH) on behalf of their Local 1784 in Memphis, Tennessee to conduct a Health Hazard Evaluation (HHE) at the Memphis Fire Department (MFD). The request concerned the hearing levels and noise exposures of fire fighters who were assigned to two fire stations serving the Memphis International Airport. There was concern that these fire fighters were at a greater risk of accruing hearing loss because of the addition of aircraft noise to their occupational noise exposures. The city of Memphis and the MFD also requested NIOSH to investigate other fire stations in Memphis, not influenced by the airport, for noise exposures and hearing ability among more of the fire fighters.

Site visits to the MFD were made by NIOSH investigators in May, 1986, September, 1986, and March, 1987 to conduct noise surveys at five fire stations and to examine the hearing ability of 197 Memphis fire fighters. The noise surveys consisted of personal noise dosimetry on fire fighters assigned to the fire station for the entire 24-hour tour of duty over two consecutive days at each of the five stations. A NIOSH investigator accompanied the fire fighters on their vehicle to log response times and activities. The audiometric examinations were pure-tone, air conduction tests administered according to the Occupational Safety and Health Administration's (OSHA) hearing conservation amendment.

The noise dosimetry results revealed time-weighted averages (TWA) that ranged from 60 to 82 dB(A). However, the levels encountered during code three responses (warning lights, sirens, and air horns) reached 109 dB(A) for a one-minute time period. The audiometric results showed that the average Memphis fire fighter exhibited a characteristic noise-induced permanent threshold shift. This hearing loss was statistically related to the amount of time which the fire fighter had been on the job, with decreasing hearing ability as a function of years of service.

Because of the statistical relationship between hearing loss and the amount of time in the MFD, NIOSH investigators conclude that a health hazard exists for these fire fighters. A comprehensive hearing conservations program should be implemented in order to reduce the growth of hearing loss for fire fighters. Specific recommendations are presented in Section VIII of this report.

KEYWORDS: SIC 9224 (Fire departments, including volunteer), noise exposure, hearing loss, hearing conservation.

II. INTRODUCTION

In November, 1985, the International Association of Fire Fighters (IAFF) requested assistance from the National Institute for Occupational Safety and Health (NIOSH) to conduct a Health Hazard Evaluation (HHE) on behalf of their Local 1784 in Memphis, Tennessee. The initial request concerned fire fighters assigned to two Memphis Fire Department (MFD) stations serving the Memphis International Airport. The concern focused on additional noise exposures from aircraft and its effect on their hearing ability. When the city of Memphis and the fire department's administration were contacted by NIOSH about the HHE, they requested that the survey be extended to fire stations outside of the influence of the airport to investigate the noise exposures and hearing ability of fire fighters throughout the city.

In May, 1986 and September, 1986, investigators from NIOSH visited the MFD to conduct personal dosimetry for noise exposures to fire fighters assigned to five different fire stations in Memphis, including the two fire stations serving the Memphis International Airport. Additionally, audiometric examinations were conducted in March, 1987 on the fire fighters who were assigned to these five fire stations. Interim reports describing the preliminary results were furnished to the IAFF, the MFD, and Local 1784 in June, 1986, December, 1986, and July, 1987. Individual participants were sent a copy of their test results and a letter of explanation of these results. This final report represents a compilation of all of the survey results which had been previously reported in the interim reports.

III. BACKGROUND

The MFD employed approximately 1,300 fire fighters in the fire suppression and emergency ambulance service divisions during the period of the survey. These fire fighters were assigned to 47 different fire stations throughout the city of Memphis. The fire fighters generally worked a 24-hour continuous tour of duty followed by 48 hours off of the job. These two divisions averaged 52,678 alarms per year during the 10-year period of 1974-1984.

The front line apparatus fleet of the MFD consisted of 49 engines, 23 ladder trucks, 6 air crash units, and 14 ambulances. The engine manufacturers were generally American and Ward LaFrance, Pirsch, and Ford; the truck manufacturers were Pirsch, American LaFrance, and Ford; and the air crash units were manufactured by Dodge, International, Yankee-Walter, Oshkosh, and Brockway.

Two Memphis fire stations provide service to the international airport. One of these stations is on airport grounds and the other is adjacent to the airport property, separated by a 5-lane highway. The Memphis International Airport is a commercial airport serving several major U.S. and foreign air carriers. In the year ending in December, 1985, the airport registered nearly 350,000 aircraft movements and 3.6 million passenger enplanements. The airport is also the hub airport for a large overnight express mail and freight service. This activity accounts for sustained aircraft movements on all usable runways for approximately 90 minutes every day beginning at about 3:00 a.m.

IV. METHODS

The personal noise exposure measurements were taken with Metrosonic Model 301-db Metrologger dosimeters with 1/8" remote microphones clipped to the shirt collar of the fire fighter's uniform. If the fire fighters went on a code three response and put on their turnout coat, they were instructed to move the microphone to the collar of the coat so that the microphone was uncovered. Noise samples were collected over 24-hour work shifts, which neccessitated the dosimeters be changed every eight hours because of the time constraints of the Metrologgers. Two consecutive 24-hour shifts were monitored at each of the five fire stations. Generally, noise dosimeters were given to one fire fighter who rode in the cab of the engine or truck company and also to a fire fighter who rode in the jumpseat. One dosimeter per shift was given to a person assigned to the ambulance unit, and one dosimeter was worn by a fire fighter assigned to the air crash units at the airport fire station. Noise data collected with the Metrologgers were analyzed with a Metrosonics Model 653 Metroreader. The Metroreader also allowed for the storage of the data onto magnetic tape. Each dosimeter was calibrated before and after sampling, according to the manufacturer's instructions, with a traceable calibration source from the National Institute of Standards and Technology.

NIOSH investigators obtained permission from the MFD to accompany the fire fighters on the vehicles during all responses. This allowed the investigator to keep a time record of activities during the response, such as time of warning device usage, activities on a fire scene, and the time the vehicle was away from the station. The investigator would also check the microphone placements on the turnout coats, assuring that the microphones were uncovered.

The audiometric tests were administered by a Council for Accreditation in Occupational Hearing Conservation (CAOHC) certified Occupational Hearing Conservationist. Testing was conducted in Station #20 in a small office in the back of the station. An Acoustic Systems Model RE-60 Transportable Sound Booth was assembled in this room to acoustically isolate the fire fighter being tested. The audiometric testing was done on a Grason-Stadler 1703B Recording Audiometer. Pure-tone thresholds were obtained at 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hertz (Hz) separately for each of the fire fighter's ears. Total test time was approximately 10 minutes, following a brief instructional explanation of the testing procedure. The audiometer was given an exhaustive calibration immediately prior to the survey, as well as being subjected to daily biological calibration procedures. Sound levels inside the booth were monitored constantly during testing to assure that the background noise would not interfere with the test results.

A brief questionnaire was mailed to the fire fighters assigned to the fire stations surveyed for noise. Additional questionnaires were available for fire fighters not receiving one in the mail, or who neglected to bring the questionnaire to the audiometric test facility. The questionnaire obtained information on the fire fighter's job history, military history, medical history, and demographic information.

V. EVALUATION CRITERIA

A. Noise

Exposure to high levels of noise may cause temporary or permanent hearing loss. The extent of damage depends primarily upon the intensity of the noise and the duration of the exposure. There is abundant

epidemiological and laboratory evidence that protracted noise exposure above 90 dB(A) causes hearing loss in a portion of the exposed population.[1]

The Occupational Safety and Health Administration's (OSHA) existing standard for occupational exposure to noise (29 CFR 1910.95)[2] specifies a maximum permissible exposure level (PEL) of 90 dB(A)-slow response for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship. This means that in order for a person to be exposed to noise levels of 95 dB(A), the amount of time allowed at this exposure level must be cut in half in order to be within OSHA's PEL. Conversely, a person exposed to 85 dB(A) is allowed twice as much time at this level (16 hours) and is within his daily PEL. Both NIOSH, in its Criteria for a Recommended Standard,[3] and the American Conference of Governmental Industrial Hygienists

(ACGIH), in its Threshold Limit Values (TLVs),[4] propose an exposure limit of 85 dB(A) for 8 hours, 5 dB less than the OSHA standard. Both of these latter two criteria also use a 5 dB time/intensity trading relationship in calculating exposure limits.

Time-weighted average noise limits as a function of exposure duration are shown as follows:

Duration of Exposure (hrs/day)	Sound Level (dB(A)) NIOSH/ACGIH	OSHA
16	80	85
8	85	90
4	90	95
2	95	100
1	100	105
1/2	105	110
1/4	110	115 *
1/8	115 *	- **

* No exposure to continuous or intermittent noise in excess of 115 dB(A).

** Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

The OSHA regulation has an action level (AL) of 85 dB(A) which stipulates that an employer shall administer a continuing, effective hearing conservation program when the TWA value exceeds the AL. The program must include monitoring, employee notification, an audiometric testing program, hearing protectors, training programs, and recordkeeping. All of these stipulations are included in 29 CFR 1910.95, paragraphs (c) through (o).

When workers are exposed to noise levels in excess of the OSHA PEL of 90 dB(A), feasible engineering or administrative controls shall be implemented to reduce the workers' exposure levels. Also, a continuing, effective hearing conservation program shall also be implemented.

B. Audiometry

The audiometric test results obtained for the fire fighters were combined according to two different criteria to determine the degree of hearing handicap that had been sustained. Additionally, a single frequency, degree of hearing impairment criterion was used to initially screen the data to determine the amount of hearing loss found in this population. The first criterion was proposed by NIOSH in its criteria document for occupational noise exposure.[3] This criterion, which is intended to determine the amount of handicap in speech perception and communication abilities, averages the pure-tone frequencies of 1000, 2000, and 3000 Hz for both ears. This measurement will be referred to in this report as the NIOSH variable.

The second criterion was proposed by the American Academy of Otolaryngology - Head and Neck Surgery.[5] Their criterion combines the pure-tone frequencies of 3000, 4000, and 6000 Hz. This combination will be most sensitive to the sensorineural effects on the ear from noise because of the propensity of hearing at these frequencies to deteriorate sooner when exposed to loud noise.[1] This measurement is denoted the NOISE variable.

Finally, a criterion proposed by Eagles, et al.[6] for single frequency hearing impairment scores, uses a lower "impairment fence" of 25 dB. Any person with a hearing level of 26 dB or greater at any frequency was classified as having some degree of hearing loss, ranging from mild to profound. This criterion differs from the other two criteria in that it looks at single test frequencies rather than average hearing levels across several frequencies. This criterion was used to evaluate fire fighters' hearing ability for the individual letters sent to the survey participants.

Additional analyses were conducted on these data once the effects from the normal aging process (presbycusis) were eliminated. To do this, the hearing data were corrected according to the formula described by NIOSH[3] in its criteria document. The formula uses the presbycusis curves for males published by Passchier-Vermeer[7] in 1968.

VI. RESULTS

A. Noise

The five fire stations identified by the MFD and Local 1784 for the noise survey were Stations #12/14, #24, #28, #33, and #40. Stations #33 and #40 are responsible for serving the Memphis International Airport, #24 is in a residential area, #28 is in a residential/industrial area, and #12/14 is located in an inner city residential area of Memphis. Station #24 was chosen because it averaged about the same number of responses as the airport stations. Stations #28 and #12/14 were chosen by the MFD as representative of "not as busy" and "very busy" stations, respectfully. Two consecutive 24-hour work shifts were sampled for noise at each of these stations. A NIOSH investigator was at a station for the entire sampling period. A total of 144 dosimeter samples were collected during this survey.

The results from the 8-hour dosimeter survey periods were combined to yield 24-hour dose values according to the OSHA regulations.[2] The average 24-hour dose found at each of the stations is shown in Table 1. All of the doses are well below the 100% level, which is equivalent to a TWA of 90 dB(A). The dose values also are below 50% (85 dB(A) TWA), the NIOSH and ACGIH recommended exposure limits. The two airport stations are ranked number 1 and 3 in highest mean dose values (Table 1). The ranking does not appear to be dependent on the number of code 3 responses, since the station with the highest number of runs during the noise survey (12/14) was ranked as having the lowest noise dose. The maximum 1-min period, an integrated measure of the noise over an entire one minute period, does not vary a great deal between the five fire stations.

The noise data were further analyzed by dividing the 8-hour TWA dosimeter data into vehicle categories for the airport and non-airport fire stations. These results are given in Figure 1. The dosimeter readings from fire fighters assigned to trucks and engines at the airport stations are greater than the values recorded at the non-airport stations. A small difference in the opposite direction is seen for fire fighters assigned to the EMS units. However, the variability of these data is such that these differences are not statistically significant.

The noise dosimeter used in the survey records the data in 1-min periods. This allows for an analysis of specific periods of time which relate to activities that impact on the noise exposure of the fire fighters. One of these activities is the number of code 3 responses. Table 2 shows the mean noise levels and the mean elapsed time for the code 3 responses for each riding position in the fire apparatus. A code 3 response was defined as the time from the dispatch of the alarm until the time that the unit was put out of service upon return to the fire station. Thus, this period includes the warning device noise at the beginning of the response, activity at the scene, and engine noise for the entire response time. The noise levels are highest for the engine companies, followed by the truck companies, and then the EMS units. The time spent on a code 3 response follows the inverse pattern, with the EMS units out the longest, followed by the truck and engine companies. The differences between riding positions is negligible, with the tiller position on a ladder truck being an exception. However, only one code 3 response was measured during the survey for a fire fighter riding the tiller.
The dosimeter readings from the two airport fire stations were examined for a 1-hour period (3:00-4:00 am) when the air freight company was using the airport extensively, and while the fire fighters were sleeping in the bed halls of the two stations. These data are presented in Figure 2. The results clearly show that the sound levels in the bed halls are affected by the aircraft activity. It must be noted that the dosimeters record noise levels only down to 60 dB(A). Thus, the values recorded prior to 3:10 a.m. are much less than 60 dB(A), making the sound level differential between the time of aircraft activity and no aircraft activity even greater than that shown in Figure 2.

B. Audiometry

The hearing abilities of 197 fire fighters from the MFD were tested during the six days of the evaluation. Only three females were included in this total. The age of the tested fire fighters ranged from 23 to 58 years, with a mean age of 40.6 years. These fire fighters averaged 15.7 years of service as fire fighters, ranging from less than 1 year up to 31 years on the job. The fire fighters were categorized into five occupational categories as follows: fire fighter (86), driver (45), officer (46), paramedic (18), and other (2). The current station assignment was also noted. Totals for this categorization are station #12/14, 42; station #20, 12; station #24, 28; station #28, 24; station #33, 56; station #40, 19; and other stations, 16. Audiometric testing was conducted at station

#20. The fire fighters assigned to this station were included in the testing to increase the sample size. Any fire fighter who wasn't normally assigned to a company, but had been detailed to cover for an absence, was given the opportunity to fill out a questionnaire and have his/her hearing tested. Most fire fighters in this latter category did participate in the testing. This accounts for the 16 "other station" assignments noted above.

Audiometric testing was conducted on both ears of each fire fighter at the frequencies of 500, 1,000, 2,000, 3,000, 4,000, 6,000, and 8,000 Hertz (Hz). To ascertain the hearing profile of the tested MFD personnel, the hearing levels, in decibels (dB HL), were averaged for the left and right ears of each fire fighter. The fire fighters were then categorized into the following six age groupings: less than 30 years (17), 30 to 34 years (29), 35 to 39 years (34), 40 to 44 years (62), 45 to 49 years (30), and 50 years and older (25). The average hearing levels seen for the age groupings are shown in Figure 3. It can be seen in the graph that the fire fighters' hearing levels begin to decline (i.e., have larger dB HL values) in the 3,000 to 6,000 Hz range with a slight recovery at 8,000 Hz even in the youngest age group (less than 30 years). This decline continues as the average age of the fire fighter increases, as is evidenced by the larger dB HL values seen for the older age groupings. The decline has the shape characteristic of a noise-induced permanent threshold shift (NIPTS), which is sometimes referred to as a "noise notch".

One of the initial concerns of the HHE request was whether or not the fire fighters who were assigned to the two Memphis International Airport fire stations were at greater risk for hearing loss than fire fighters who were assigned to other stations. To evaluate this, airport fire personnel were compared to non-airport fire personnel. Fire fighters currently assigned to either station #33 or #40 were separated from the rest of the group and were also sorted into the six age groupings previously defined. These results are shown in Figure 4 and Figure 5. The same type of NIPTS patterns are seen in these two figures as was seen in Figure 3. The area of initial decline in hearing ability is seen at 3,000 - 6,000 Hz, and the decline increase as the age of the fire fighter increases. However, the fire fighters currently assigned to the airport fire stations appear to maintain better hearing (i.e., lower dB HL values) for a longer period of time, as is seen in the comparison of the less than 30 years and
30 - 34 years groups for the two types of fire stations.

A Pearson product-moment correlation coefficient between the fire fighters' ages and the time that they had been a fire fighter was +0.898, a statistically significant positive relationship. Thus, before any further statistical analyses were performed on these data, the hearing changes resulting from aging effects had to be separated from the effects of time on the job as a fire fighter. This was done by using the age correction procedures published in Appendix F of the OSHA Noise Regulation.[2] These corrections attempt to subtract from the observed audiometric test results that portion of hearing loss which is likely due solely to normal aging effects, leaving a residual loss resulting from some other source, which in this case is presumed to be noise. Additionally, the fire fighters were divided into six different years of service categories. The six categories and the respective number of fire fighters falling into each one is as follows: less than 5 years, 28; 5 to 9 years, 15; 10 to 14 years, 33; 15 to 19 years, 67; 20 to 24 years, 31; and 25 years or greater, 23. Finally, to simplify the analyses, the two hearing level variables, "NIOSH" and "NOISE", were calculated.

A two-factor Analysis of Variance (ANOVA) was calculated for each of the two age-corrected hearing level variables. One of the factors was station assignment, which could be either airport or non-airport. The other factor was fire fighter years which represented the six years of service groupings. The results of the

"NIOSH" variable ANOVA were, for station assignment, a F value of 0.06 ($p = 0.81$), for fire fighter years, a F value of 1.54 ($p = 0.18$), and for the interaction of the two factors, a F value of 0.90 ($p = 0.48$). Thus, neither station assignment nor years of service as a fire fighter was associated with hearing loss and there was no significant interaction between these two factors. The results of the "NOISE" variable ANOVA were slightly different. As was seen in the other analysis, neither the station factor nor the interaction of the two factors was found to be statistically significant, yielding F values of 0.61 ($p = 0.43$) and 0.97 ($p = 0.44$), respectively. However, the effect of fire fighter years was found to be statistically significant with a F value of 2.58 ($p < 0.03$).

VII. DISCUSSION AND CONCLUSIONS

The 8-hour TWA noise exposures measured during the survey period were all less than the OSHA PEL of 90 dB(A). Even when the dose equivalents for the three, 8-hour periods for each fire fighter were summed to reflect the 24-hour work shifts, the dose values only approached a value of 50% of the allowable daily noise dose. This result is very similar the findings reported in a NIOSH study at the Newburgh, New York Fire Department.[8] The dosimeter readings for the work shift were generally less than 85 dB(A) TWA for the fire fighters surveyed in this department. The noise exposure values for the fire fighters assigned to the Memphis International Airport fire stations were slightly higher than for the fire fighters assigned to the three non-airport fire stations. Perhaps, because of the variability inherent in these data, the differences were not statistically significant.

Close inspection of the individual dosimeter readouts show that the major source of noise exposure is the code 3 response. The 1-min noise levels initially rise to values in excess of 105 dB(A), which represents the effects of the siren and air horns. However, the diesel engine noise from the trucks and engines also contributes to the fire fighter's noise exposure. The mean noise levels for the complete code 3 response from dispatch of the alarm to the return of the vehicle to the station yielded values of 75 to 88 dB(A). The EMS units were slightly lower, at 77.5 dB(A). It is important to note that all vehicle types tested did have maximum noise levels in excess of 90 dB(A). This value of 90 dB(A) is used by the National Fire Protection Association (NFPA) in its Standard on Fire Department Occupational Safety and Health Program, NFPA 1500[9] as the level at which fire fighters are required to be provided and to wear hearing protection devices.

The noise associated with the early morning aircraft activity from the air freight company impacts on the two fire stations which serve the airport. The noise levels from this activity are not great enough to cause any hearing damage. They do, however, disrupt the sleep of the fire fighters. During the nights spent at the fire stations by the NIOSH investigators, the initial aircraft flyovers caused the investigators to be awakened. The fire fighters, some of whom reported that their sleep was not disturbed, did show signs of altered sleep. The snoring in the bed hall disappeared while the aircraft took off for the 1-1 1/2 hours of activity. Fire fighters were also observed "tossing and turning" in their beds during the aircraft activity.

The results of the ANOVA statistical test of the audiometric data show that the average hearing levels for the noise-sensitive frequencies of 3,000, 4,000, and 6,000 Hz are significantly reduced as a function of time on the job as a fire fighter. This significant loss, however, does not extend downward to the lower frequencies of 1,000, 2,000, and 3,000 Hz. This does not mean that these fire fighters will never experience a significant loss of hearing in these frequencies if they continue to expose themselves to additional noise. In fact, quite the opposite may be expected since research has shown that NIPTS is the result of cumulative trauma to the ears which shows declining hearing as

long as the ear is exposed to noise.[1] However, in neither analysis is there the indication that being assigned to one of the airport fire stations will put a fire fighter at greater risk for potential hearing loss from noise exposure. The data show that the fire fighter will accrue hearing loss at any station where he is assigned under current practices of the MFD. The association between high frequency hearing loss and time spent as a fire fighter has also been reported among fire fighters who participated in the NIOSH audiometric testing at the IAFF Convention in Cincinnati, Ohio.

These data are paradoxical in that the noise data were all below current noise standards, but that the measured hearing losses were associated with the amount of time spent in the fire service. This could be explained if this survey were not representative of the fire fighters' noise exposure histories or it may be evidence that the current noise regulations are not fully protective for workers' hearing. Certainly, the potential for high noise exposure was seen in the noise dosimeter data. Perhaps, if the activity of the fire department was greater during the survey period, then the TWA values might have exceeded current noise standards. The survey also did not take measurements of non-occupational noise exposures or measurements of unique noise events such as explosions, broken sirens or air horns that would not turn off, or other loud events which could have immediate impact on a fire fighter's hearing ability. The fact remains that these data are further indicators of a body of evidence which shows a statistical relationship between occupational noise exposures and hearing loss for fire fighters.

VIII. RECOMMENDATIONS

Although the dosimeter data do not exceed the OSHA PEL or the NIOSH REL for noise exposure for the entire work shift, the statistical association between high-frequency hearing loss and the time a fire fighter spends in the fire service, as well as the short term high noise levels measured during code 3 responses, lead to the following recommendations.

1. Limit the use of warning devices as much as legally and practically possible. It is known that people are more perceptually aware of changes in stimuli rather than constant stimulation. Thus, intermittent taps of an air horn are more effective in moving traffic that the constant sounding of the device.

2. Warning devices should be moved away and isolated from the personnel on the vehicle. They should be placed on or below the front bumper where the vehicle will act as a sound shield from the siren and air horn noise.

3. Warning devices should be reduced in sound intensity to the lowest level at which they are still effective at alerting traffic.

4. Existing narrow-band, high frequency warning devices, particularly mechanical sirens, should be replaced with broadband, lower frequency warning devices. An example of this is an electronic two-tone (High-Low) siren. The narrow-band, high-frequency devices are both more damaging to the fire fighter's hearing and less effective at warning the public. The siren's high frequency sound will hit a vehicle in front of the fire apparatus and be reflected rather than penetrate the vehicle. Lower frequencies are better able to penetrate other vehicles. Also, the two-tone siren is a constantly changing stimulus which is, as mentioned previously, more perceptually arousing to people.

5. Sound absorption material can be added to existing fire apparatus to isolate the fire fighters from the noise sources. Sound-absorbing material around the engine compartment will reduce noise exposures to fire fighters who must sit near the engine. Also, heat-resistant, sound damping wraps around exhaust manifolds and exhaust pipes will reduce diesel engine noise.

6. New vehicle and equipment purchases should include specifications on maximum noise levels which can be allowed in the operation of this equipment. If at all feasible, a "not to exceed" level of 90 dB(A) should be stipulated to meet NFPA 1500 specifications.[9]

7. Noise surveys should be conducted periodically throughout the entire department to document events which have the potential for excess noise exposure.

8. Implement a hearing conservation program for the fire department. The program can be tailored to meet the specific needs of the Memphis Fire Department, but should meet the minimum requirements set forth by the U.S. Department of Labor, OSHA.[2]

9. The hearing conservation program should include audiometric testing. Pre-employment physical examinations should include a hearing test, which will serve as a baseline audiogram. Additionally, all fire fighters should be tested on an annual basis throughout their fire service career.

10. The use of hearing protection devices should be mandated for fire fighting operations that exceed a noise level of 90 dB(A). This includes riding on the vehicles during emergency and non-emergency responses, training, equipment usage, and fire ground operations. The hearing protection devices should be furnished to the fire fighters by the department in the same manner as other safety and fire fighting equipment is issued.

11. Fire fighters should be trained about the effects of noise exposure and hearing loss. They should be encouraged to reduce both occupational and recreational noise to help prevent the occurrence of permanent noise-induced loss of hearing.

IX. REFERENCES

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluation and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. International Association of Fire Fighters
2. President, Local 1784
3. Fire Chief, Memphis Fire Department
4. NIOSH, Atlanta Region
5. OSHA, Region IV

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE 1

24-Hour Noise Exposures for Each Fire Station

HETA 86-138
Memphis Fire Department
Memphis, Tennessee
September 1986

	Station Number				
	12/14	24	28	33	40
Mean 24-hr OSHA PEL Dose	22.2%	39.2%	25.0%	36.3%	49.2%
(Standard Deviation)	(7.5)	(11.0)	(5.8)	(12.2)	(10.2)
Maximum 1-min Period	106 dB[A]	109 dB[A]	105 dB[A]	106 dB[A]	108 dB[A]
No. Code 3 Responses	26	16	4	6	15

TABLE 2

Noise Levels Observed During Code 3 Responses

HETA 86-138
Memphis Fire Department
Memphis, Tennessee
September 1986

	Vehicle Type					
	Engine		Truck			EMS Unit
	Cab	Jumpseat	Cab	Jumpseat	Tiller	
Mean dB[A] Level	88.0	88.0	84.4	84.7	75.0	77.5
(Standard Deviation)	(4.8)	(5.4)	(6.5)	(5.4)	(-)	(4.5)
Maximum 1-min Period (dB[A])	106	106	109	105	97	100
Mean Elapsed Time (min)	16.8	17.7	27.3	28.0	21.0	45.4
(Standard Deviation)	(8.4)	(9.4)	(15.5)	(16.3)	(-)	(31.9)
No. Code 3 Responses	15	11	10	9	1	44

Figure 1

Average Dosimeter Noise Levels
HETA 86-138
Memphis Fire Department
September, 1986

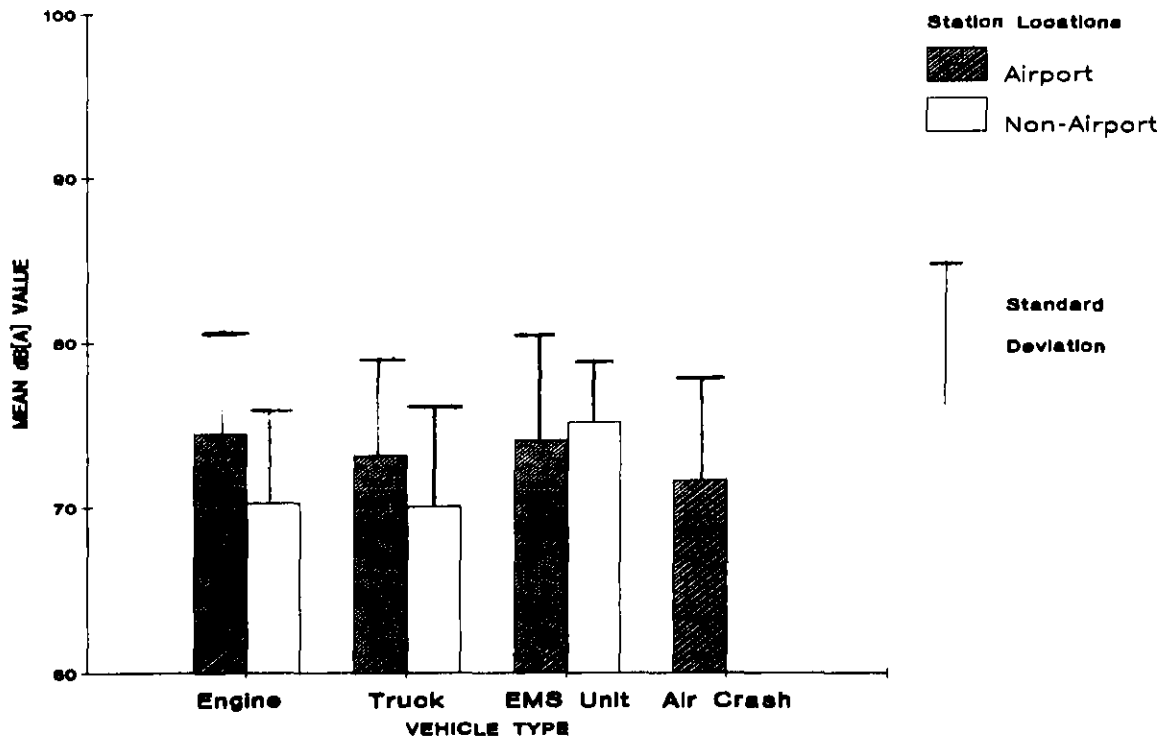

Figure 2

NIGHT TIME STATION NOISE LEVELS
HETA 86-138
Memphis Fire Department
May 14, 1986

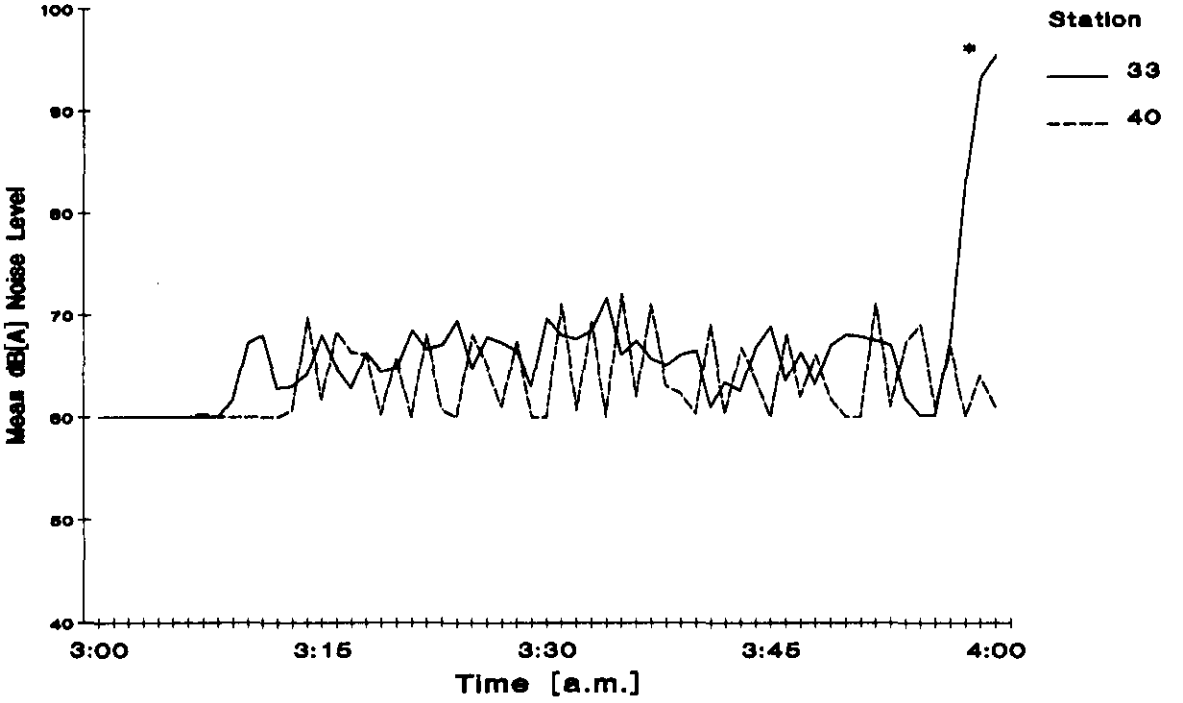

Figure 3

AVERAGE HEARING LEVELS BY AGE GROUP
HETA 86-138
Memphis Fire Department
March 1987

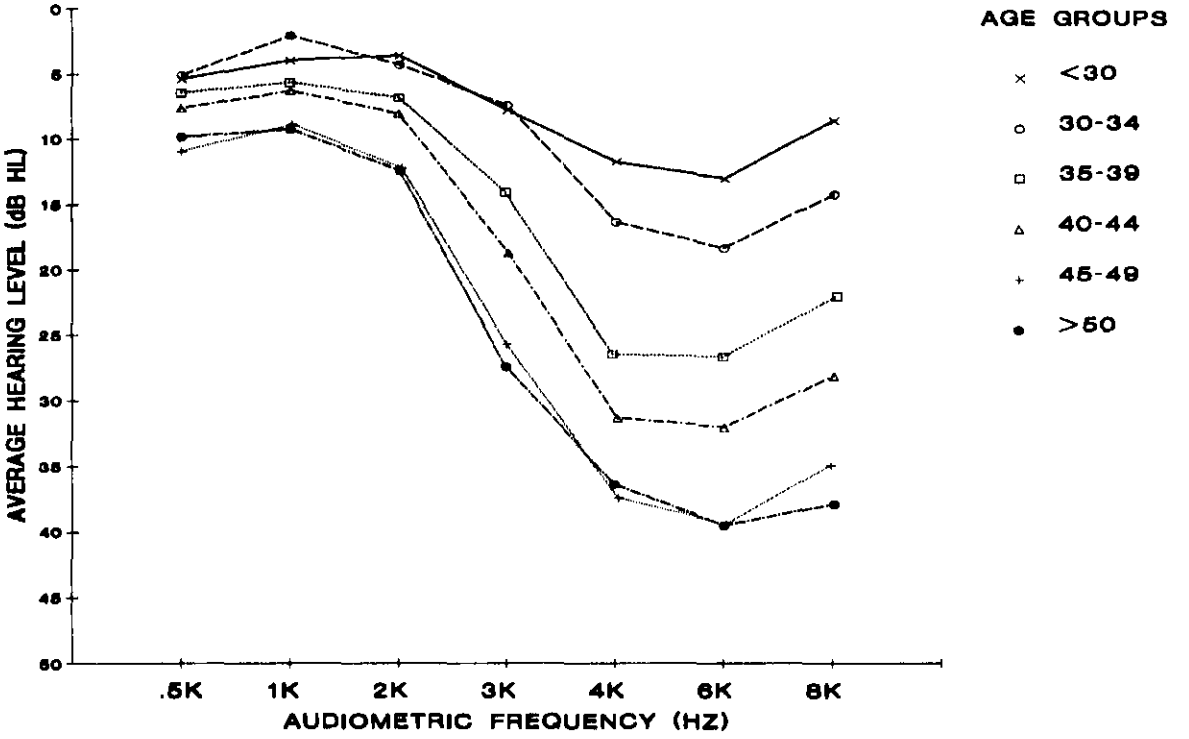

Figure 4

AIRPORT FIRE FIGHTERS' HEARING LEVELS
HETA 86-138
Memphis Fire Department
March 1987

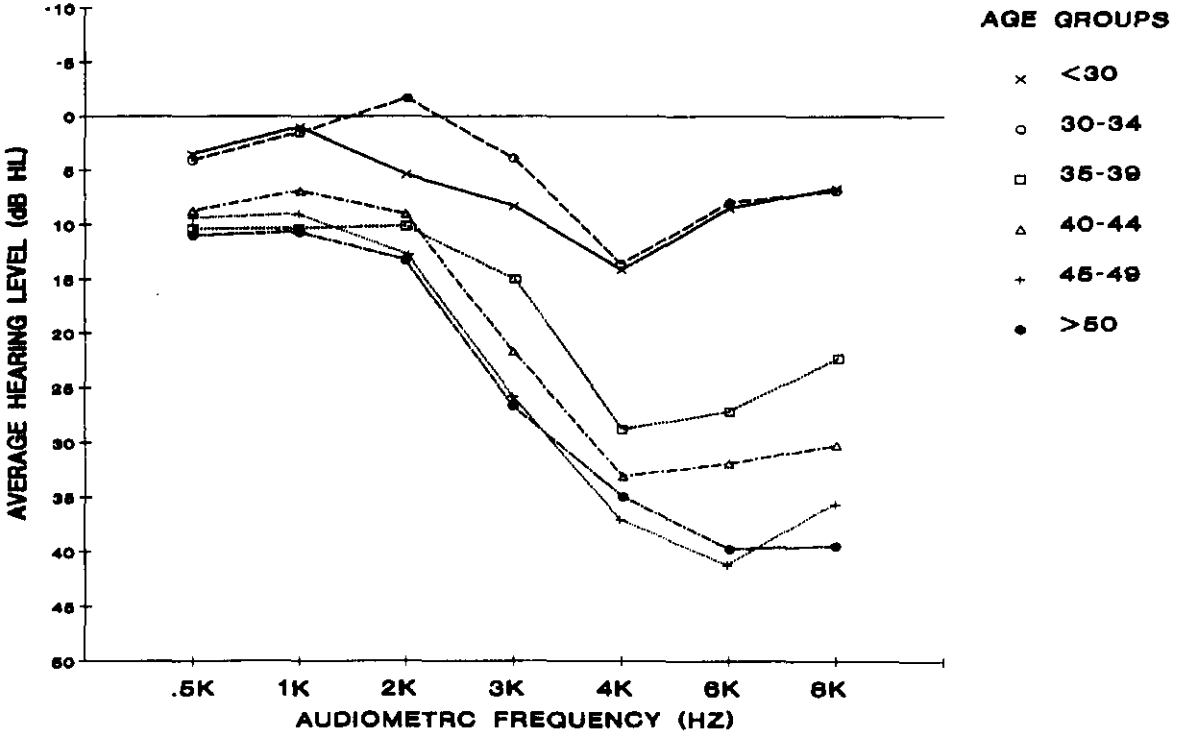

Figure 5

NON-AIPORT FIRE FIGHTERS' HEARING LEVELS
HETA 86-138
Memphis Fire Department
March 1987