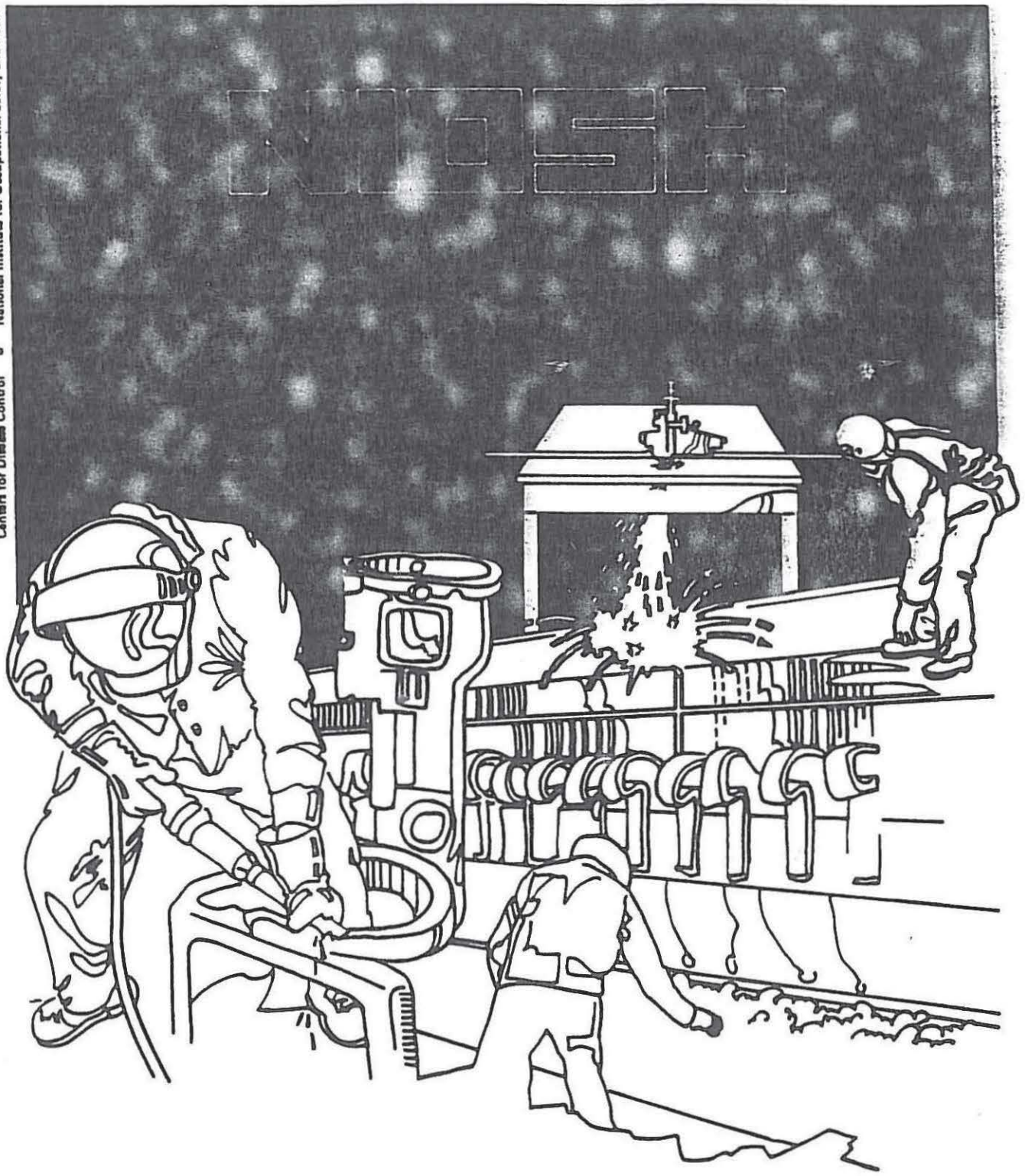
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES • Public Health Service
Centers for Disease Control • National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 84-454-1890
INTERNATIONAL ASSOCIATION
OF FIRE FIGHTERS
CINCINNATI, OHIO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 84-454-1890
MAY, 1988
INTERNATIONAL ASSOCIATION OF FIRE FIGHTERS
CINCINNATI, OHIO

NIOSH INVESTIGATORS:
Randy L. Tubbs, Ph.D.
James Melius, M.D.
Kern E. Anderson

I. SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) was contacted by the health and safety department of the International Association of Fire Fighters (IAFF) in 1984 and requested to conduct medical screening tests on the approximately 1,400 fire fighters who would be attending their convention in Cincinnati, Ohio. During August 12-16, 1984, NIOSH conducted pulmonary function tests (PFTs) and audiometric testing on interested fire fighters attending the 37th biennial convention of the IAFF.

Of the 453 fire fighters who had the PFTs, 98 (22%) reported at least one episode of smoke inhalation resulting in hospitalization or at least one day of lost work time. Among current smokers, three health effects, shortness of breath, difficulty breathing, and chest tightness, were each significantly more prevalent in participants with a history of occupational smoke inhalation (32% vs. 13% for shortness of breath, 16% vs. 5% for difficulty breathing, and 30% vs. 11% for chest tightness). Differences in fire fighters who were not current smokers were not significant, but information to assess the effect of past smoking was not collected, participants were only asked if they currently were smokers. Sixteen (3.6%) of the fire fighters had a restrictive pulmonary function pattern; 26 (5.7%) had an obstructive pattern (including one person who may also have had a restrictive effect). Measures of pulmonary function were not statistically associated with current smoking status, history of smoke inhalation, or years worked as a fire fighter.

To determine audiometric acuity, pure-tone hearing thresholds were obtained on 419 fire fighters from the audiometric screening. A total of 272 individuals (65%) showed some degree of hearing loss as defined as having a measured hearing level of 25 decibels (dB HL) or greater at one or more of the audiometric test frequencies. Additionally, two hearing level scores were computed and analyzed with a multiple linear regression procedure. The analysis revealed a statistically significant effect on average hearing ability with the number of years in the fire service.

These fire fighters have demonstrated an increased risk of developing occupationally induced hearing loss. The meaningfulness of the respiratory symptoms and PFT results is less clear. The absence of information on previous cigarette smoking and the self-selection of the survey participants precludes reaching conclusions. Recommendations to establish medical surveillance programs for hearing loss, noise monitoring, and hearing conservation are given in Section VII of this report.

KEYWORDS: SIC 9224 (Fire departments, including volunteer), hearing loss, hearing conservation, smoke inhalation, pulmonary function testing.

II. INTRODUCTION AND BACKGROUND

The International Association of Fire Fighters (IAFF) was organized in 1918 to advance and protect the interest of professional (career) fire fighters. The IAFF has over 167,000 members who belong to more than 1,900 affiliated local unions. During August 12-16, 1984, the IAFF held its 37th biennial convention in Cincinnati, Ohio with attendance at approximately 1,400. At the request of the IAFF, the National Institute for Occupational Safety and Health (NIOSH) conducted medical screening on fire fighters attending the convention. During the week-long event, NIOSH offered fire fighters pulmonary function tests and audiometric tests. The results of an individual's hearing and/or pulmonary function tests were sent to his home address shortly after the convention.

III. METHODS

All fire fighters attending the convention were eligible to participate in the NIOSH survey. Each individual was given a voluntary consent form to sign in front of a NIOSH witness prior to being allowed to continue in the testing program. A self-administered questionnaire was also provided to each fire fighter. The questionnaire asked several basic demographic questions (e.g., name, age, address, years of employment) as well as specific inquires about incidents of smoke inhalation, loud noise exposures, current cigarette smoking, and respiratory symptoms.

Pulmonary function tests (PFTs) were administered by NIOSH technicians to screen individuals for respiratory abnormalities. Ohio Medical Products dry rolling seal spirometers, connected to Spirotech Model 200B dedicated computers were used to administer the tests. The spirometers were calibrated according to manufacturer's instructions each day prior to testing of the fire fighters.Participants were taken to one of three NIOSH testing booths where the fundamentals of the test were explained to the individual before being tested. Each person was given a new spirometer mouthpiece for testing. The tests were taken while the fire fighter was in a standing position and was being "coached" by the technician. An individual's pulmonary function testing ended when three acceptable efforts were obtained that met the American Thoracic Society's criteria for reproducibility.[1]

The audiometric tests were administered by a Council for Accreditation in Occupational Hearing Conservation (CAOHC) certified Occupational Hearing Conservationist. Testing was conducted in the NIOSH mobile hearing van which was located on the convention hall floor. This van

has a large, double-walled acoustic chamber with 4 audiometric test locations separated by lead lined curtains which allows for the testing of up to 4 people simultaneously. Audiometric tests were conducted on Grason-Stadler Model 1703B Tracking Audiometers. 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 hearing test procedure. All audiometers had been exhaustively calibrated just prior to the convention as well as being subjected to daily biological calibration procedures.

IV. EVALUATION CRITERIA

A. Pulmonary function

Three measures of breathing ability were obtained in the PFTs. The forced vital capacity (FVC, the volume of air forced out of the lungs after breathing in as deeply as possible) and the one-second forced expiratory volume (FEV_1, the amount of air forcibly exhaled during the first second of expiration) were measured directly and the ratio FEV_1/FVC was calculated. Predicted values for FEV_1 and FVC, based on the fire fighter's age, height, and sex were calculated using the equations of Knudson, et al.[2] The calculated Knudson values were multiplied by 0.85 to obtain the predicted values for blacks.[3]

All PFT results were calculated based upon the "best" test result from a minimum of three acceptable efforts where the FEV_1 and the FVC from the two best curves differed by no more than 5%. The FEV_1/FVC ratio was calculated based on the best observed readings regardless of which tracing they were selected.[1] For interpretation of the test results, pulmonary function was considered "normal" if the FEV_1 and the FVC were each 80% or more of the values predicted for an individual, and if the FEV_1/FVC ratio is 70% or more. For epidemiologic analysis of the study data, FVC $<$ 80% of predicted with FEV_1/FVC equal to or greater than 70% was considered a restrictive pattern, FVC equal to or greater than 80% of predicted with $FEV_1/FVC < 70\%$ was considered an obstructive pattern, and FVC equal to or greater than 80% with FEV_1/FVC equal to or greater than 70% was considered a normal pattern.

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.[4] This criterion, which is intended to determine the amount of handicap in speech perception and communication abilities, averages the hearing level in decibels (dB HL re ANSI 1969) 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". This criterion incorporates a 25 dB "low fence" value. That means that the dB HL average value must exceed 25 dB before a hearing impairment is said to exist. The percent of impairment is calculated by multiplying each decibel in excess of 25 dB HL by 1.5%. Thus, an average dB HL of 40 for the NIOSH variable would represent a 22.5% hearing impairment.

The second variable has been 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 these frequencies to deteriorate sooner when exposed to loud noise.[6] This measurement is denoted the NOISE variable.

A criteria proposed by Eagles, et al.[7] for single frequency hearing impairment scores also uses a lower fence of 25 dB HL. This criterion differs from the other two criteria in that it looks at single test frequencies rather than average hearing levels across several frequencies. Thus, any person who had a hearing level of 26 dB HL or greater averaged for both ears was classified as having some degree of hearing loss. Additional analyses were conducted on these data when the effects from the normal aging process (presbycusis) had been eliminated. In order to do this, the hearing data were corrected according to the formula described by NIOSH[4] in its criteria document. The formula uses the presbycusis curves published by Passchier-Vermeer[8] in 1968 for males.

V. RESULTS

A total of 460 individuals filled out the self-administered questionnaire during the five days of the convention. This represents approximately 33% of the people who attended the convention. It should

be noted that some individuals were not tested who wanted to participate because of the long waiting periods sometimes encountered at the testing booths. The participants were generally white, male fire fighters with a few (<20) non-white male fire fighters, one white female fire fighter, and a number of spouses of fire fighters taking part in the medical screening program. Individuals from 38 states, the Washington, D.C. area, and Canada were included in the testing. The fire fighters who were tested ranged in age from 20 to 61 years with a mean of 40 years. Their experience as a fire fighter ranged from 0 to 35 years with a mean of 15 years of service.

Four hundred fifty-two male and one female fire fighter of the 460 people who filled out questionnaires had pulmonary function tests. They ranged in age from 24 to 61 years, with a mean of 40 years and a median of 38 years. They had worked as a fire fighter from 1 to 35 years, with a mean of 15 years and a median of 14 years. Ninety-eight (22%) participants reported at least one episode of smoke inhalation resulting in hospitalization or at least one day of lost work time during their fire fighting careers. Fifteen reported two such episodes, and six reported three or more. One hundred forty-seven (32.5%) participants were current cigarette smokers. The questionnaire did not ask about past smoking, so former smokers could not be distinguished from those who had never smoked.

The prevalence of symptoms present three or more days per week during the preceding 12 months was 12% for chest tightness, 11% for wheezing or a whistling sound in the chest, 11% for shortness of breath, and 7% for difficulty breathing. Shortness of breath and wheezing were significantly more prevalent in current smokers (Table 1). The prevalence of each of the four symptoms seemed higher in participants who reported an episode of smoke inhalation, but the difference was statistically significant only for shortness of breath and chest tightness, and none of the differences were significant in participants who were not current smokers (Table 2). Among current smokers, however, all symptoms except wheezing were significantly more prevalent among fire fighters who had reported an episode of smoke inhalation.

Sixteen (3.6%) of the participants had a restrictive pulmonary function pattern; 26 (5.7%) had an obstructive pattern (including one person who may also have had a restrictive effect). Neither current smoking status nor history of smoke inhalation was associated with the measures of restrictive and obstructive effect (Table 3). Percent predicted FVC was not correlated with years of service as a fire fighter [Pearson correlation coefficient[9] (r) = -0.0256, probability (p) = 0.599]. FEV_1/FVC was correlated with years of service as a fire fighter (r = -0.0256, p = 0.0063), but this was confounded by the high correlation

between age of the fire fighter and years of service ($r = 0.893$, $p = 0.0001$). In a multiple linear regression analysis[9], age was significantly associated with FEV_1/FVC ($\beta = -0.25$, $p = 0.0028$) but years as a fire fighter was not ($\beta = 0.14$, $p = 0.16$).

A total of 424 people of the 460 who filled out the questionnaire completed the audiometric testing. Five of these individuals were non-fire fighter personnel and were thus dropped from further analyses. Initially, the hearing test results were observed for each ear of the 419 fire fighters who had been tested. When these data were compared to the Eagles, et al. hearing impairment scale, it was found that 272 fire fighters, or 65% of the tested population, experienced some degree of hearing loss.

These data were categorized into seven groups based on the age of the fire fighter. The categories were fire fighters (1) less than 30 years, (2) 30-34 years, (3) 35-39 years, (4) 40-44 years, (5) 45-49 years, (6) 50-54 years, and (7) 55 years of age or greater. These data are graphically presented in Figures 1 and 2. Two major occurrences can be observed in these figures. First, the losses predominately occur in the frequency range above 2000 Hz. Second, the hearing losses increase as the age of the fire fighter increases.

A significant correlation coefficient was calculated for the relationship between the age of the fire fighter and the cumulative years of service as a fire fighter. Since hearing loss can be influenced by both aging and noise exposure, the effects due to aging, or presbycusis, were subtracted from the hearing level scores according to the NIOSH formula.[4] The age-corrected hearing data were averaged for both ears of the tested fire fighters. The fire fighters were then grouped according to their length of time spent in the fire service. This analysis yielded seven groups from those with less than 5 years of fire service to those with 30 or more years as a fire fighter. These data are presented in Figure 3.

The number of people in each of the seven categories of fire fighter years going from the least to the most amount of service is 14, 86, 122, 96, 55, 35, and 11 individuals, respectively. Normal hearing on this figure is at the 0 dB level. Any decrement in hearing ability other than the effects of aging is represented by dB values greater than zero. Values less than zero are better than normal hearing abilities. The figure does reveal decrements in hearing at frequencies above 2000 Hz. The decrements also do appear to increase as a function of the amount of time a fire fighter spends in the fire service. This was statistically tested with a series of Student t tests[9] which were calculated to compare the mean NIOSH and NOISE variables to zero. The statistics revealed that all but the less than five years and greater than 30 years categories showed significant hearing loss.

This last observation was further tested statistically with two separate multiple linear regression procedures.[9] In the first statistical test, the hearing loss data were averaged according to the NIOSH criterion for hearing impairment. Thus, the average hearing loss at 1000, 2000, and 3000 Hz was calculated for each fire fighter. The dependent NIOSH outcome variable was fitted into a "least squares" regression model with age and years of service as the independent variables. This analysis revealed that years of service was significantly related ($p=0.04$) to the NIOSH variable after correcting for the effects of age. The analysis calculated a slope of 0.27 whichsays that the average fire fighter will have increased hearing loss of 0.27 decibels per year spent in the fire service independent of the loss in hearing from presbycusis.

The second regression procedure used the NOISE variable (average loss at 3, 4, and 6 kHz) in a model with age and years of service as the independent variables. This analysis showed that both age and years of service were significantly related ($p=0.01$ and $p=0.03$, respectively) to the growth of hearing loss for the noise sensitive frequencies. The slopes for these two parameters were 0.50 for each independent variable. Thus, the average fire fighter would show an increase of one-half of a decibel for the average hearing level at the noise sensitive frequencies for each year of service and for each year of aging.

VI. DISCUSSION AND CONCLUSIONS

The pulmonary function results revealed that, at least among current cigarette smokers, respiratory symptoms were significantly more prevalent in fire fighters with a history of occupational smoke inhalation. Measures of pulmonary function, however, were associated with neither current smoking status nor history of smoke inhalation. The meaningfulness of these results is limited by the absence of information on previous cigarette smoking and by the composition of the surveyed group since the participants were self-selected from among a group of fire fighters attending an annual convention.

The results of the audiometric testing shows that the fire fighters who took part in the screening had high frequency hearing losses that progressively got worse as the age of the fire fighters increased (Figure 1 and 2). This loss persists despite any adjustments which were made for normal aging effects. This is seen in Figure 3. The statistical analyses show that the average high frequency hearing declines at the rate of one-half of a decibel per year spent as a fire fighter. Thus, it appears that this progressive loss of hearing is occupationally related for this group of fire fighters.

The assertion that self selection of the fire fighters at this convention might have influenced the pattern of the results observed in the audiometric tests is refuted by the observation that the youngest fire fighters tested exhibit better than normal hearing. This is shown in Figure 3. If the person who would present himself for audiometric testing was one who thought that he had hearing problems, then one would expect to see hearing losses in all age groups tested. This was not the case for these fire fighters. The results obtained in this service project are similar to results of progressive hearing loss in fire fighters reported in other studies.[10,11,12,13] These reports also show that fire fighters exhibit growths in high frequency hearing loss as a function of the age of the fire fighter. This growing body of evidence of occupationally induced hearing loss points to the conclusion that fire fighting can cause loss of hearing. Regulations have been promulgated by the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA)[14] for other industries to monitor occupational hearing loss and help to alleviate its progression through noise reduction engineering, personal protective devices, and worker education. Similar recommendations are needed in the fire service to help to reduce the amount of occupational hearing loss which a fire fighter might accrue.

The results of the audiometric testing show that the fire fighters who took part in the screening had high frequency hearing losses that progressively got worse as the age of the fire fighters increased. This is clearly seen in Figures 1 and 2. One of the more important findings of these data is that there continues to be a progressive loss in hearing after effects due to aging have been removed from the test results. The analysis shows that high frequency hearing declines at the rate of one-half of a decibel per year spent as a fire fighter. It is concluded that this progressive loss of hearing is occupationally related for this group of fire fighters.

Similar results of progressive hearing loss in fire fighters have been reported in studies by Reischl, et al.[10] and in another NIOSH Hazard Evaluation Report.[11]. These two reports also showed that fire fighters exhibit growths in high frequency hearing loss as a function of the age of the fire fighter in two different fire departments. This growing body of evidence of occupationally induced hearing loss points to the conclusion that fire fighting can cause loss of hearing. Regulations have been promulgated by the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA)[12] for other industries to monitor occupational hearing loss and help to alleviate its progression through noise reduction engineering, personal protective devices, and worker education. Similar recommendations are needed in the fire service to help to reduce the amount of occupational hearing loss which a fire fighter might accrue.

The pulmonary function results revealed that, at least among current cigarette smokers, respiratory symptoms were significantly more prevalent in fire fighters with a history of occupational smoke inhalation. Measures of pulmonary function, however, were associatedwith neither current smoking status nor history of smoke inhalation. The meaningfulness of these results is limited by the absence of information on previous cigarette smoking and by the composition of the surveyed group since the participants were self-selected from among a group of fire fighters attending an annual convention.

VII. RECOMMENDATIONS

The increase in occupational, high frequency hearing losses leads us to make the following recommendations.

1. Implement hearing conservation programs for individual fire departments. These programs can be tailored to meet the requirements of individual departments, but should meet the minimum requirements set forth by the U.S. Department of Labor, OSHA.

2. 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, fire fighters should be tested on an annual basis throughout their fire service career.

3. The use of hearing protection devices should be mandated for fire fighting operations that exceed a noise level of 90 decibels, A-weighted (dB(A)). This includes riding on vehicles during emergency and non-emergency responses, training, equipment usage, and fire ground operations.

4. Noise surveys should be conducted to document events which have the potential for noise over exposure.

5. New vehicle and equipment purchases should include specifications on 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.

6. 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.

7. Since fire fighters are potentially exposed to a variety of substances that can adversely affect the lungs, they should use appropriate respiratory protection. Because of the possibility of pulmonary function impairment resulting from these exposures, fire fighters' pre-placement and periodic medical evaluations should include basic spirometry. In order to evaluate an individual's changes in pulmonary function over a period of time, spirometry equipment and testing procedures should conform to the revised American Thoracic Society criteria.[15]

VIII. REFERENCES

1. American Thoracic Society. ATS Statement - Snowbird workshop on standardization of spirometry. American Review of Respiratory Disease, 119:831-838, 1979.

2. Knudson RJ, Slatin RC, Lebowitz MD, and Burrows B. The maximal expiratory flow-volume curve. Normal standards, variability, and effects of age. American Review of Respiratory Disease, 113:587-600, 1976.

3. Lanese RR, Keller RD, Foley MF, and Underwood EH. Differences in pulmonary function among whites, blacks, and American Indians in a textile company. Journal of Occupational Medicine, 20:39-44, 1978.

4. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to noise. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1972. (DHEW (NIOSH) publication no. 73-11001).

5. American Academy of Otolaryngology - Head and Neck Surgery. Otologic referral criteria for occupational hearing conservation programs. Washington, D.C.: AAO - HNS Board of Directors, May, 1983.

6. Kryter KD. The effects of noise on man. New York: Academic Press, 1970.

7. Eagles EL, Hardy WG, and Catlin FI. Human communication: The public health aspects of hearing, language, and speech disorders (NINDB Monograph #7). Washington, D.C.: Government Printing Office, 1968. (USPHS publication no. 1745).

8. Passchier-Vermeer, W. Hearing loss due to exposure to steady-state broadband noise. Delft, Netherlands: IG-TNO Research Institute for Public Health Engineering, 1968. (Report no. 35).

9. Hays, WL and Winkler, RL. Statistics: Probability, inference, and decision. New York: Holt, Rinehart and Winston, Inc., 1971.

10. Reischl U, Hanks TG, and Reischl P. Occupation related fire fighter hearing loss. American Industrial Hygiene Association Journal, 40:656-662, 1981.

11. Tubbs RL and Flesch JP. Health hazard evaluation report HETA 81-059-1045, Newburgh Fire Department, NIOSH/CDC, Cincinnati, Ohio, 1982.

12. Tubbs, RL. Health hazard evaluation interim report HETA 86-138, Memphis Fire Department, NIOSH/CDC, Cincinnati, Ohio, July 9, 1987.

13. Pepe PE, Jerger J, Miller RH, and Jerger S. Accelerated hearing loss in urban emergency medical services fire fighters. Annals of Emergency Medicine, 14:438-442, 1985.

14. U.S. Department of Labor, Occupational Safety and Health Administration. Code of Federal Regulations, Labor, 29, Parts 1900 to 1910, revised as of July 1, 1985.

15. American Thoracic Society. Standardization of Spirometry - 1987 update. American Review of Respiratory Disease, 136:1285-1298, 1987.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By:

Randy L. Tubbs, Ph.D.
Psychoacoustician
Hazard Evaluation and Technical Assistance Branch

Mitchell Singal, M.D., M.P.H.
Medical Officer
Hazard Evaluation and Technical Assistance Branch

Kern E. Anderson
Public Health Advisor
Hazard Evaluation and Technical Assistance Branch

Medical Evaluation:	James Melius, M.D. Director Division of Surveillance, Hazard Evaluations, and Field Studies
Data Analysis By:	Donald F. Bates Computer Programmer Hazard Evaluation and Technical Assistance Branch
Originating Office:	Hazard Evaluation and Technical Assistance Branch Division of Surveillance, Hazard Evaluation, and Field Studies
Report Typed By:	Linda Morris Clerk Typist Hazard Evaluation and Technical Assistance Branch

X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 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 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. NIOSH, Cincinnati Region

TABLE 1

Prevalence of Respiratory Symptoms According to Current Smoking Status

International Association of Fire Fighters Convention
Cincinnati, Ohio
HETA 84-454
August 1984

	Current Smokers		Not Current Smokers			
SYMPTOMS	Number	No. and (%) w/ symptoms	Number	No. and (%) w/ symptoms	RR[1]	95% CI[2]
Shortness of breath	146	26 (17.8)	301	23 (7.6)	2.33	1.39-3.90
Wheezing	147	33 (22.5)	300	16 (5.3)	4.21	2.51-7.07
Difficulty breathing	145	11 (7.6)	300	21 (7.0)	1.08	0.54-2.19
Chest Tightness	145	23 (15.9)	301	31 (10.3)	1.54	0.93-2.55

1 - Relative Risk

2 - Confidence Interval

TABLE 2

Prevalence of Respiratory Symptoms According to History of Smoke Inhalation and Current Smoking Status

International Association of Fire Fighters Convention
Cincinnati, Ohio
HETA 84-454
August 1984

	CURRENT SMOKERS				NOT CURRENT SMOKERS				ALL PARTICIPANTS			
	Smoke Inhalation				Smoke Inhalation				Smoke Inhalation			
Symptoms Reported	Yes	No	RR[1]	95% CI[2]	Yes	No	RR	95% CI	Yes	No	RR	95% CI
Shortness of Breath	12/37 (32.4)[3]	14/109 (12.8)	2.53	1.28-4.97	7/64 (10.9)	16/236 (6.8)	1.61	0.69-3.76	19/101 (18.8)	30/346 (8.7)	2.17	1.28-3.68
Wheezing	11/37 (29.7)	22/110 (20.0)	1.49	0.79-2.81	5/63 (7.9)	11/236 (4.7)	1.70	0.62-4.71	16/100 (16.0)	33/347 (9.5)	1.68	0.96-2.94
Difficulty Breathing	6/37 (16.2)	5/108 (4.6)	3.50	1.20-10.24	5/63 (7.9)	16/236 (6.8)	1.17	0.44-3.08	11/100 (11.0)	21/345 (6.1)	1.81	0.90-3.62
Chest Tightness	11/37 (29.7)	12/108 (11.1)	2.66	1.30-5.52	9/63 (14.3)	22/237 (9.3)	1.54	0.74-3.19	20/100 (20.0)	34/346 (9.8)	2.04	1.23-3.38

1 - RR = Relative Risk

2 - CI = Confidence Interval

3 - Number with symptoms/number in category (% with symptoms)

TABLE 5

Pulmonary Function According to Current Smoking Status and History of Smoke Inhalation

International Association of Fire Fighters Convention
Cincinnati, Ohio
HETA 84-454
August 1984

Exposure Group	Number in group	Percent predicted FVC Mean (Std. Dev.)		FEV_1/FVC Mean (Std. Dev.)	
Current Smokers	140	100.3	(15.3)	77.9	(6.9)
Not Current Smokers	299	101.0	(11.5)	78.0	(6.0)
History of Smoke Inhalation	98	101.1	(12.8)	78.9	(6.2)
No History of Smoke Inhalation	340	100.6	(12.9)	79.4	(6.4)

Figure 1

IAFF CINCINNATI CONVENTION

Hearing Levels for Age Groupings
LEFT EAR

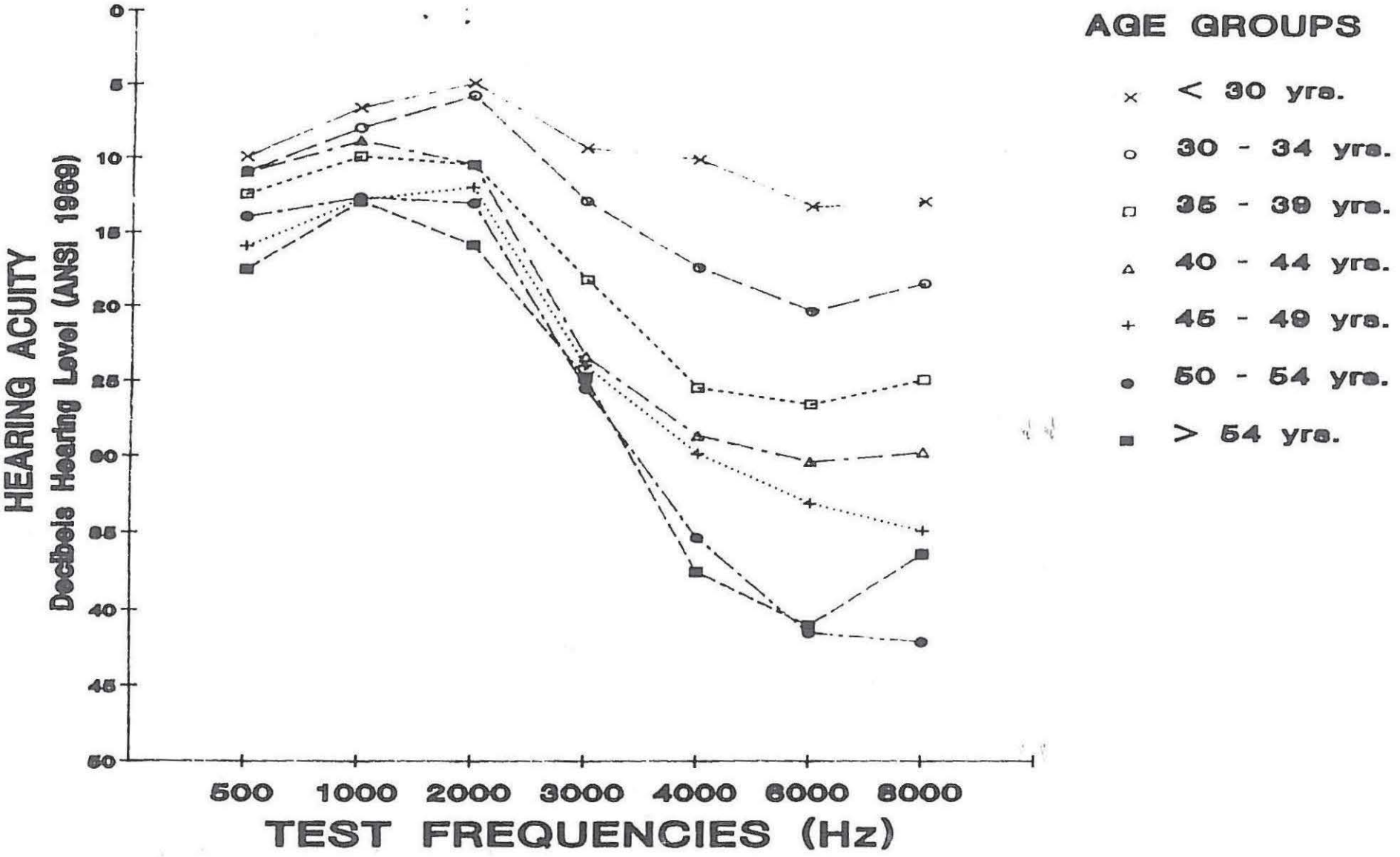


Figure 2

IAFF CINCINNATI CONVENTION

Hearing Levels for Age Groupings
RIGHT EAR

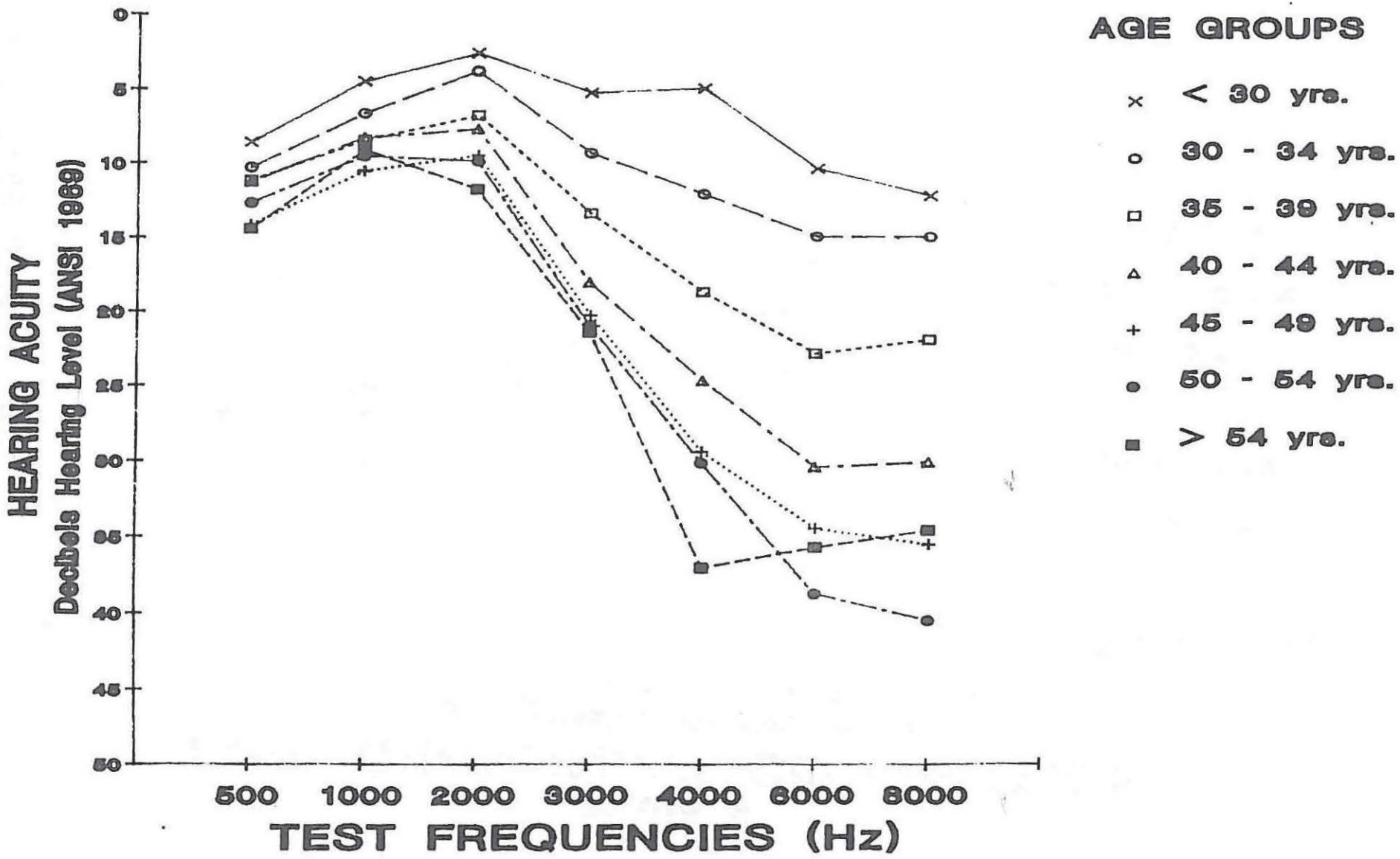


Figure 3

IAFF CINCINNATI CONVENTION

Age Corrected Hearing Levels For Years of Service