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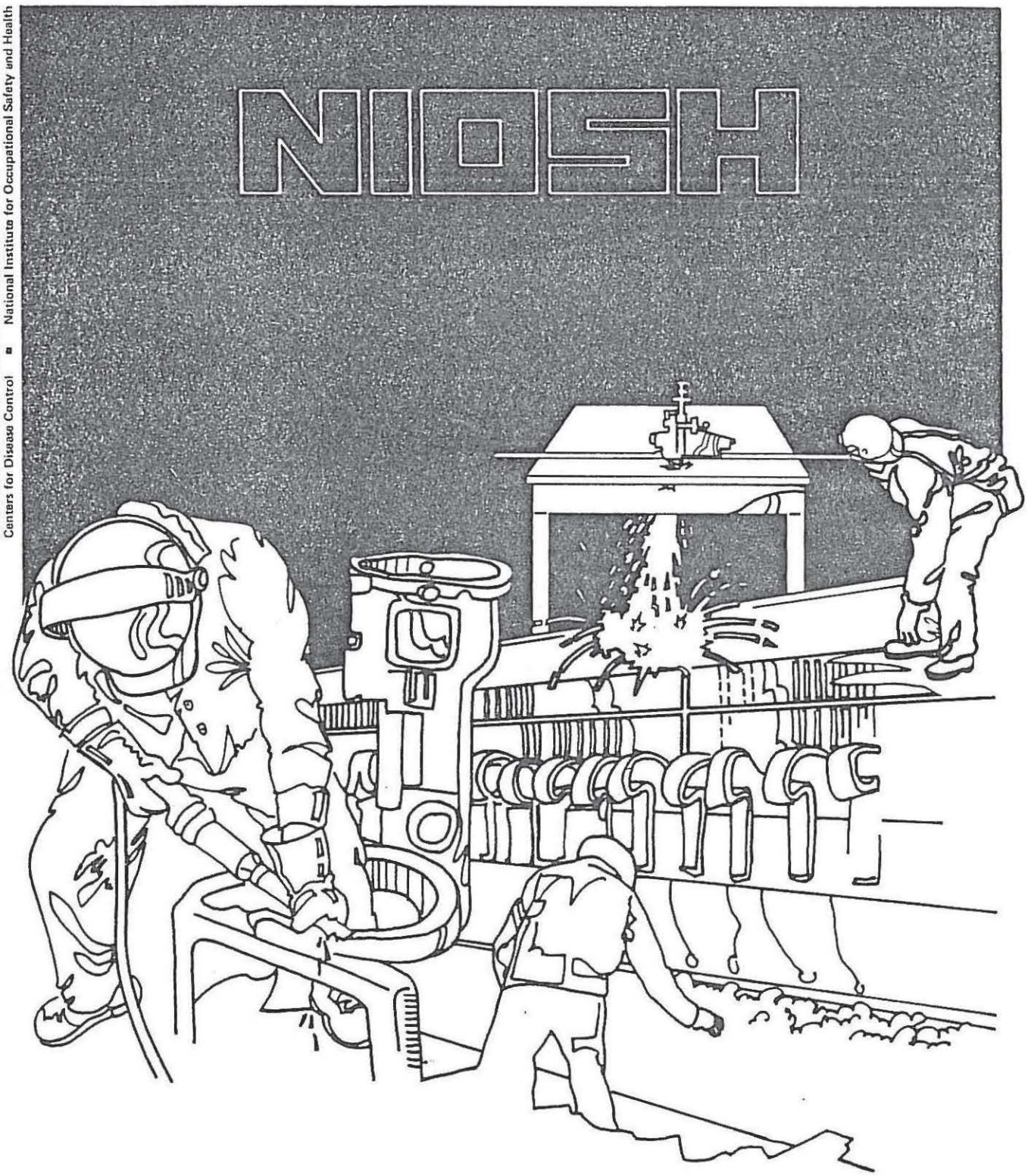
NIOSH



Health Hazard Evaluation Report

HETA 81-059-1045
NEWBURGH FIRE DEPARTMENT
NEWBURGH, NEW YORK

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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 81-059-1045
February, 1982
Newburgh Fire Department
Newburgh, New York

NIOSH INVESTIGATORS:
Randy L. Tubbs. M.A.
Jerome P. Flesch, M.S.

I. SUMMARY

In October, 1980, the National Institute for Occupational Safety and Health (NIOSH) was requested by the International Association of Fire Fighters (IAFF) on behalf of Local 589, IAFF to evaluate reported hearing losses from noise exposure in fire fighting operations in the Newburgh Fire Department, Newburgh, New York.

To determine if hearing losses reported by an outside consultant were related to fire fighting noises, NIOSH conducted a noise survey and an interview of fire fighters on February 25-26, 1981. During this initial visit, NIOSH discovered that previous hearing tests had not been conducted under standard conditions and therefore, NIOSH conducted its own audiometric examinations on June 3-5, 1981.

During the noise survey, NIOSH found that noise levels emitted by sirens and fire engines during simulated response calls ranged from 99 dBA to 116 dBA at the various riding positions on the fire vehicles. However, the dosimeter data ranged from 62.8 dBA to 85.3 dBA for an eight-hour time weighted-average (TWA) noise exposure. NIOSH recommends an 85 dBA level for an 8-hr TWA noise exposure. The current OSHA standard limits noise to 90 dBA for an 8 hour TWA exposure.

The hearing examinations conducted in June showed large hearing losses in the noise-sensitive frequencies. A mean loss of 61.8 dB HL at 6,000 Hz after a mean of 29.4 years of fire service was found in a group of five fire fighters aged 50 years and up.

On the basis of the study findings, NIOSH concludes that the fire fighters are being exposed to high noise levels in light of the intensity values found during the simulated runs, and do show large amounts of hearing loss. NIOSH, however, does recommend that further research be conducted to investigate the relationship of fire fighters' noise exposures and the apparent hearing loss observed. The recommendations given in Section VIII of this report are based on reducing noise exposure alone and thus may have to be altered or added to as further research is conducted.

KEYWORDS: SIC 9224 (Fire departments, including volunteer), fire fighting operations, noise levels, hearing loss.

II. INTRODUCTION

In October, 1980, NIOSH was requested by the International Association of Fire Fighters (IAFF) to investigate the noise levels and the associated losses of hearing found in fire fighting operations at the Newburgh, New York Fire Department (NFD).

The request came as a result of findings of audiometric examinations done on 53 of the departments fire fighters by a contract audiologists. The audiologist found that 45% of the men tested had significant high frequency hearing losses which may be due to noise exposures. The audiologist's recommendation was that an extensive noise survey be conducted on both vehicle noise and auxillary power equipment noise.

On February 24-27, 1981, NIOSH investigators visited the NFD to conduct the noise survey and to administer a small questionnaire to ascertain the fire fighter's noise and work history and otological condition. During this visit, NIOSH discovered that the contract audiologist had administered the audiometric examinations in a non-approved manner. Thus a return trip to Newburgh was made on June 1-8, 1981 with NIOSH's mobile audiometric van to re-administer the audiometric examinations.

III. BACKGROUND

The NFD has 55 fulltime fire fighters. Two engine companies and one truck company operate from two fire stations. The normal duty cycle is for the fire fighter to work either a 9 hour day tour or a 15 hour night tour. In reality, however, several of the firefighters will work a day tour, followed by a night tour (24 hour duty) and then have two or three days off. The normal week does average 40 hours of duty time. The department's numbers of responses during 1976 to 1980 were: 1,543 in 1976, 1,649 in 1977, 2,046 in 1978, 2,272 in 1979, and 1,866 in 1980.

IV. Methods and Materials

a) Environmental

The vehicle noise survey was conducted on the department's front line apparatus which included a 1977 and 1974 Mack MB Pumper, a 1975 Mack Aerial Ladder Truck, and the Fire Chief's 1977 Pontiac. Second line apparatus tested were a 1963 American LaFrance Ladder Truck and a 1955 American LaFrance Pumper. The auxillary power equipment surveyed was a gas-powered cutting tool, a portable power generator located on the Mack Ladder Truck, a portable floating pump, and a air compressor located in the fire station which was used for recharging Scott Air-Packs.

Two types of noise measurements were taken on February 25 and 26, 1981. The first method was employed in order to obtain spectral information on the noise sources. This was done with a Gen Rad 1982 Sound Level Meter (SLM) set on the dBA-Slow scale. The ac signal from the SLM was fed to a Nagra IV-D tape recorder. All of these measurements were made during simulated response calls at the various riding positions on the apparatus. The recorded tapes were later analyzed with a Nicolet 444 Mini-Ubiquitous Spectrum Analyzer connected to a Tektronix 4662 Interactive Digital Plotter.

The second method of noise surveying involved the use of Metrosonics db-301/652 Metrologger dosimeters. The dosimeters were given to nine selected fire fighters representing the three companies. Individual samples were taken for 8 hours on 2 consecutive day tours and for the first 8 hours of the night tour on 2 consecutive days.

All sound survey equipment was calibrated both before and after samples were taken according to the manufactures' instructions with traceable calibration sources from the National Bureau of Standards.

b) Medical

During the February noise survey, an audiologist contracted by NIOSH conducted an otoscopic examination on the fire fighters who had received the earlier audiological tests. This was done in order to ascertain if any gross outer or middle ear abnormalities would account for the reported hearing losses.

The audiologist also administered a questionnaire to these fire fighters. It was designed to obtain a complete job and noise history of the fire fighter as well as any medical abnormalities which may have affected his hearing ability.

Because of the deficiencies in the collection methods of earlier audiograms, NIOSH returned to the NFD in June with its mobile audiometric van (Figure 1). Even though the van is constructed to allow testing of six individuals simultaneously, only one or, at most, two fire fighters were tested at a time to reduce inter-subject interference. All tests were conducted with Grason-Stadler 1703 B self-recording audiometers. All audiometers were calibrated both pre- and post- testing. The audiograms were scored and corrected for any calibration deviations on a Hewlett-Packard 9830A calculator and digitizer board with software developed by NIOSH. The scoring program averages three peaks and three valleys at each frequency for each ear tested so that a single mean value is presented for each test frequency for each ear.

V. Evaluation Criteria

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 decibels (dBA) causes hearing loss in a portion of the exposed population.

OSHA's existing standard for occupation exposure to noise (29 CFR 1910.95) [1] specifies a maximum permissible noise exposure level of 90 dBA for a duration of 8 hours, with higher levels allowed for shorter durations. NIOSH, in its Criteria for a Recommended Standard [2], proposed a limit of 85 dBA, 5 dB less than the OSHA standard.

Time-weighted average noise limits as a function of exposure duation are shown below:

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

*No exposure to continuous noise above 115 dBA

**No exposure to impact or impulse noise above 140 dB peak sound pressure level (SPL).

When workers are exposed to sound levels exceeding the OSHA standard, feasible engineering or administrative controls must be implemented to reduce levels to permissible limits. The OSHA noise standard has recently been expanded with a hearing conservation amendment.[3] For workers exposed at or above a TWA of 85 dB, the amendment will require noise exposure monitoring, audiometric testing, the use of hearing protective devices where necessary, and employee education.

The American Medical Association (AMA) has recently changed its criteria for evaluating hearing impairments. Their current criteria uses the frequencies of 500, 1,000, 2,000, and 3,000 Hz. If the average hearing loss across these four frequencies exceeds 25 dB HL, then the person is impaired. The NIOSH criteria for hearing impairment uses only 1,000, 2,000, and 3,000 Hz but still uses the 25 dB HL average for defining impairment.

VI. Results

A. Environmental

The noise survey conducted during the simulated response runs revealed that the noise intensity levels to which fire fighters are exposed are high for the 30-second sampling period obtained for each piece of fire apparatus at each position. The noises of fire fighting equipment ranged from 93 dBA to 110 dBA. The levels found at the various riding positions on the apparatus were in a range of 99 dBA to 116 dBA in the vehicles' cab, 105 dBA to 112 dBA in the jumpseat, 106 dBA to 108 dBA on the back riding step, and 91 dBA to 101 dBA at the vehicles' pump panel. The individual octave bands intensities for each of the measurements expressed both in dBA and dB SPL are given in Figure 2 through Figure 22.

The dosimeter survey showed that the 8-hr time-weighted-average (TWA) noise exposures ranged from 62.8 dBA to 85.3 dBA for the sampled fire fighters (Table 1). A sample of the dosimeter's minute-by-minute readout is given in Figure 23 for a 15 minute period during which a false alarm response occurred.

Only one dosimeter reading exceeds NIOSH's recommendation of 85 dBA and all are below the OSHA standard of a maximum 8-hr TWA exposure of 90 dBA. Also, only one of the simulated response call runs exceeded the OSHA ceiling exposure value of 115 dBA.

B. Medical

Fifty-four male fire fighters participated in the February and June, 1981 examinations. The group had a mean age of 37.7 years and a mean time of fire service of 13.2 years. A Pearson product-moment correlation coefficient was calculated between age and years of fire service and found to be 0.945 ($P < .01$). This shows that the NFD fire fighters began their careers at nearly the same age and have not left the fire service. The questionnaire findings are summarized in Table 2.

Because hearing loss is cumulative over time, the 54 fire fighters were broken up into age groupings of less than 30 years, 30-34 yrs, 35-39 yrs, 40-44 yrs, 45-49 yrs, and 50 yrs and older. The mean value of each fire fighter's two ears at a given frequency was used in the calculations for finding the mean hearing losses at each frequency for each age group. These data are shown in Table 3. These results show a typical time of exposure related growth of noise-induced hearing loss, that is, greatest losses at 3, 4 and 6 kHz with a smaller loss at 8 kHz. Also, the "50 and up" age group exceed both the AMA and NIOSH 25 dB HL criteria for hearing impairment which was referenced in Section V.

In order to put the NFD hearing loss results into some perspective, data from a 1960-1962 National Health Survey (NHS) were obtained[4]. The American Standards Association (ASA) 1951 audiometer specifications used in the National Health Survey were corrected to the American National Standards Institute (ANSI) 1969 specifications used in this study. The data given in Table 4 are the hearing level (HL) values where the 50th percentile of the population distribution falls. The consistent finding in these data is that for the noise-affected frequencies (3, 4, and 6 kHz), the fire fighters at an early age have better hearing than the national norms, but are consistently poorer at the oldest age grouping. The better hearing for the young age group is expected since fire fighters are selected on the basis of being medically fit for duty. The poorer hearing for the oldest group is even more dramatic in light of the above.

To look at the association between growth of hearing loss and age (and thus years of fire service), each set of data were grouped into 10 year age intervals and 10 dB HL levels for each ear at each frequency tested. The gamma statistic, a measure of association between two ordinal variables comprised of tied values, was calculated to measure the association of hearing loss and age for each ear and test frequency for each of the two data sets. These results are given in Table 5. As can be seen in this table, there is generally a strong relationship between hearing loss and age in both sets.

VII. Discussion and Conclusions

The results of the environmental and medical evaluations conducted on February 25-26 and June 3-5, 1981 by NIOSH verified the high frequency hearing losses reported by the contract audiologist. However, the results of the limited noise survey do not show nearly enough noise exposure to account for the observed losses.

When one attempts to calculate average exposure times, the results are even more dramatic. Based on the total number of responses of the NFD over the last five years, the average number of runs is about 1875 responses per year. It should be noted that this number represents all runs, not just runs where sirens and air horns are being used as warning signals. The NFD works on a four squad system for each engine and truck company. Thus, if the total responses were spread equally across the four squads, then each squad would respond to nearly 468 calls per year. Using a 50 week year (2 weeks of vacation), this calculates as 9 to 10 responses per week. The dosimeters recorded two separate false alarm calls and they averaged about 9 minutes from the time the company left the fire house until the time that they returned. Using this 9 minute response average, the fire fighter's weekly noise exposure during response runs is about 85 minutes. Out of a 40 hour work week, this is less than 1.5 hours per week of noise exposures ranging from 99 to 116 dBA.

The argument that these fire fighters generally work longer than 8 hours per day and can therefore tolerate less intense exposures does not hold up according to the OSHA standard. When the 90 dBA, 8-hr noise exposure TWA is extended to longer work shifts, values of 85 dBA for 16 hours and 82 dBA for 24 hours are given.

Only 2 of the 16 dosimeter recordings at the NFD exceeded the 24 hour exposure limit. Substantial non-fire service noise exposures were not found in the questionnaire responses. The relatively high percentages of weapon use and hobby activity are tempered by a low frequency of occurrence. Only 24% of those fire fighters who used weapons, fired more than 100 rounds per year and only one fired more than 1,000 rounds per year. The most common response for the frequency of a noisy hobby was only weekly. The two highest positive medical responses were severe blows to the head and otoscopic abnormalites. However, both of these maladies should lead to a conductive-type of hearing loss which was not found in the hearing loss data.

A similar study [5,6] was conducted at the Los Angeles City Fire Department. The hearing loss data show the same trend as the NIOSH investigation of a substantial growth of high frequency hearing loss as the time spent on the fire department increases. The noise levels reported in the Los Angeles study are more intense than those found in the NIOSH noise survey. It was later discovered that the measurement techniques used in the Los Angeles survey may account for the noise intensity differences found in the two investigations.[7]

Because the observed noise levels found in the NFD do not explain the amount of hearing loss measured in the fire fighters, some other possible explanations can be investigated. One area of explanation concerns the type of noise to which fire fighters are exposed. The recommendations of the Committee on Hearing, Bioacoustics, and Biomechanics (CHABA)[8] for maximum exposures to pure tones or narrow band noises is 105 dBA for 15 minutes. The siren and air horn noise does contribute a narrow band component to the overall spectra seen in vehicle noise. (2,000 Hz and 500 Hz, respectively), however, the unweighted spectra do show substantial amounts of energy in all octave bands analyzed. Whether or not the narrow component is distinct enough to yield the observed loss remains to be investigated more thoroughly. Also, the extreme nature of intermittency of the exposures, both in time and in intensity, may cause the OSHA standard's 5 dB time/intensity doubling rule to break down and underestimate the impact of the noise on the fire fighter's hearing. It should be emphasized that no fires took place while NIOSH was conducting its noise survey. Whether or not the noise levels found at the fire scene are intense enough to cause the amount of hearing losses seen in the NFD remains to be documented.

Another possibility is in the interaction of noise with other agents found in the fire fighters' environment. It is well documented [9,10,11] that fire fighters are exposed to several toxins at the fire scene. One unresearched result of this toxic chemical dosing may be a change in the ear's physiology such that it can not tolerate as much insult from noise exposures as can a normal ear. This remains to be tested experimentally.

Even though the 8-hour TWA noise exposures do not seem great enough to cause the observed hearing losses; the trends seen in the audiograms point to noise over-exposure in the NFD. The noise intensities found during the simulated fire runs were high and were verified by the dosimeter tape of the false alarm response. It is thus NIOSH's position that the fire fighters assume that the noise associated with these response runs could be damaging and should be reduced as much as possible. Further research is needed to determine whether other controls are needed to prevent these hearing losses. NIOSH is currently planning a similar study with the New York City Fire Department to help fill this gap in the research.

VIII. Recommendations

Although the dosimeter data do not show that the fire fighters are being over-exposed to noise during the entire workshift, the amount of observed hearing loss as well as the high noise intensity values measured during the simulated runs leads NIOSH to make 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 stimuli. Thus, intermittent taps of an air horn would be more effective in moving traffic than a constant sounding of the horn.

2. Warning devices should be moved away from and isolated from the fire personnel on the vehicle. An open-cab vehicle with the siren mounted above the rearview mirror on the windshield exposes the fire fighter to the total intensity of the siren. It should be moved to a different location, possibly the front bumper or the running board, where the vehicle itself acts as a shield from the siren noise. Warning devices on the back of vehicles near the rear step riding position should be located elsewhere or even removed.

3. Existing warning devices should be reduced in intensity to the lowest level at which they are still effective at alerting traffic. Remember, louder is not better.

4. Existing narrow band, high frequency warning devices, particularly mechanical sirens, should be replaced with broader band, lower frequency warning devices. An example of this latter device is an electronic European-type two-tone siren. The narrow band, high frequency devices are both more damaging to the fire fighter's hearing and a less effective warning device. The sirens' high frequency sound will hit a vehicle in front of the fire apparatus and be reflected rather than penetrate the vehicle. Lower frequencies have much less reflection. Also, the two-toned device 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 source. Sound-absorbing material packed into the wall of a cab of a rescue vehicle have been reported to reduce the noise intensity inside the cab by 3 dB. Similar application of sound-absorbing around the engine compartment will reduce the noise levels to which fire fighters riding in the jumpseat are exposed.

Finally, sirens and air horns mounted on the top of vehicles should use isolation mounting devices rather than the thin, rubber or plastic washers which are normally used.

6. Specifications for new apparatus should take into consideration both the frequencies and intensities of the noise that the vehicle emits. The input of a qualified acoustical consultant during the designing of apparatus would be very beneficial.

7. The use of personal protective devices should be used as an interim solution until the noise levels of the vehicle are or can be reduced. Ear muffs, the protective device of choice for the fire fighters, should be worn during the response to a call. Ear plugs are not warranted for fire fighters since their effectiveness is highly dependent on proper fit and proper insertion.[12] Because of the very limited time fire fighters are given to prepare to respond to a call, the chances that ear plugs would be properly inserted is remote.

8. NIOSH has seen one instance where a small speaker has been placed on the inside of one of the cups of a pair of ear muffs and connected to a jack which is wired into the vehicle's communication system. This arrangement is highly recommended for all fire fighters who must hear communications during the response as well as for the fire fighter who is responsible for operating and monitoring the pump panel at the fire scene. Each set of muffs should have its own volume control similar to the kind found on stereo headphones.

9. A hearing conservation program should be implemented for fire fighters. Included in this program should be pre-employment, baseline audiograms and annual audiograms for active duty personnel. These audiograms should be taken under approved standard conditions (ANSI). The program should also include periodic monitoring of the noise levels of the apparatus to be sure that the intensity of the noise does not increase with wear and tear on the apparatus. Finally, fire fighters should be made more aware of noise and its effects on hearing. Cases of tinnitus (ringing or buzzing in the ears) following a response should be reported. Reduction of off-the-job noise exposures should also be emphasized.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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XI. 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, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

Copies of this report have been sent to:

1. Chief, Newburgh Fire Department, Newburgh, New York
2. Local 589 President, International Association of Fire Fighters, Newburgh, New York
3. Occupational Health and Safety Coordinator, International Association of Fire Fighters, Washington, D.C.
4. U.S. Department of Labor - OSHA, Region II
5. New York State Department of Labor, Director of DOSH
6. NIOSH, Region II

For the purpose of informing the 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.

IX. References

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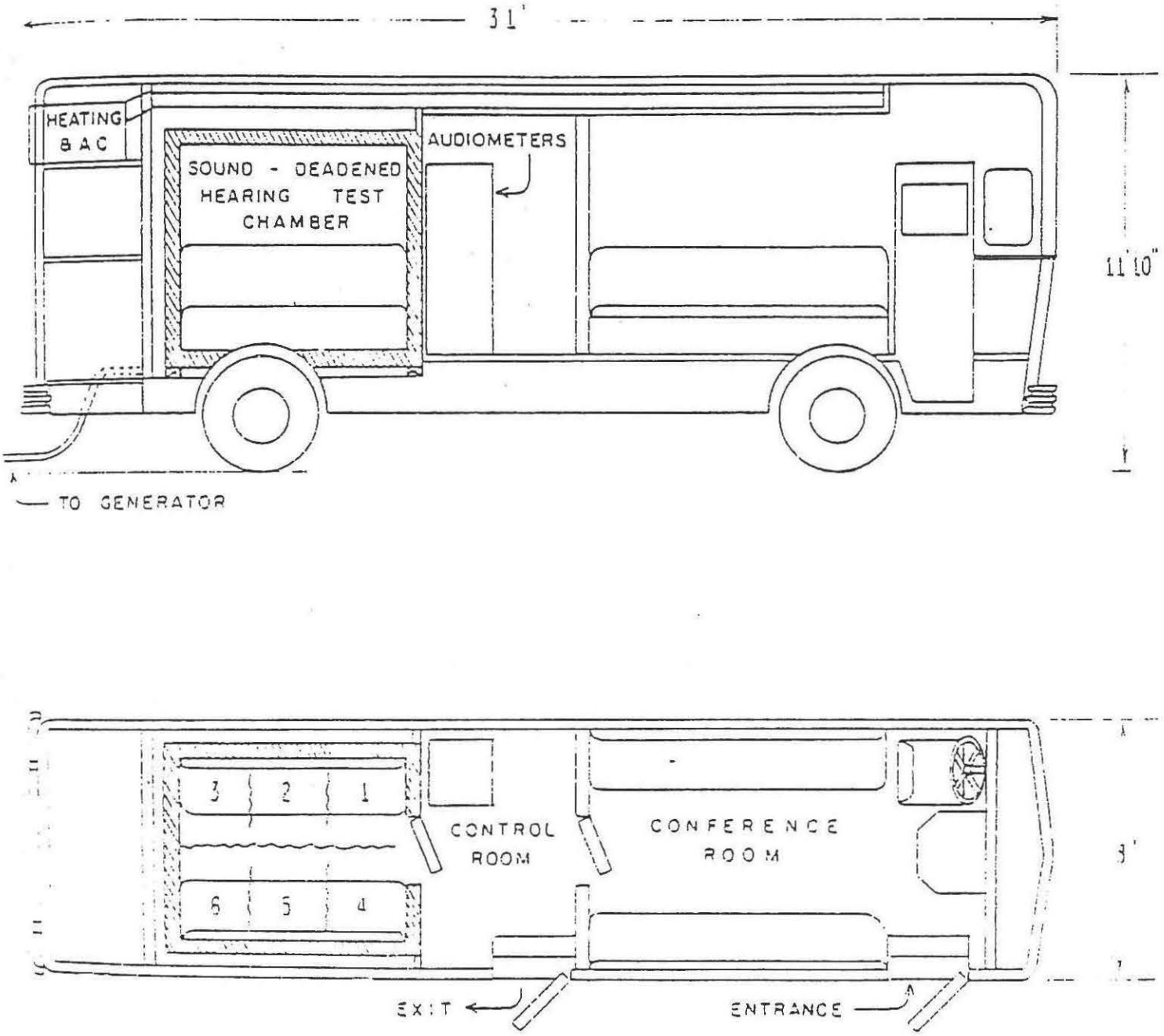


Figure 1. LAYOUT OF AUDIOMETRIC VAN

Newburgh Fire Dept.

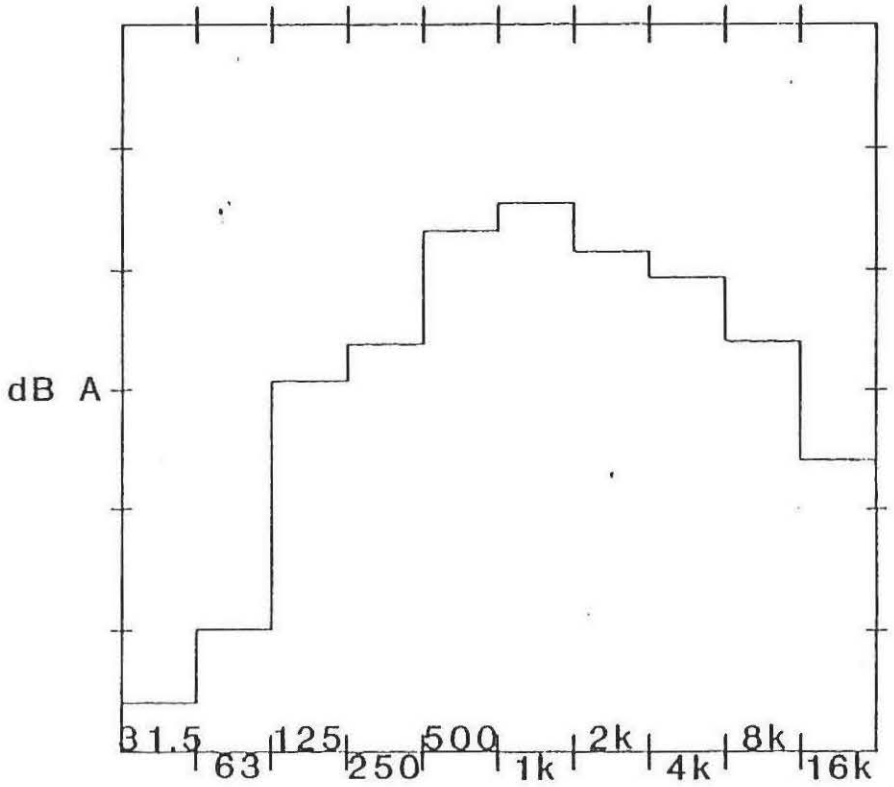
Newburgh, NY
HETA 81-059
June 3-5, 1981

Figure 2 Through Figure 22

The averaged spectral values obtained from various vehicles and equipment during simulated operations. The graphic display is the A-weighted spectrum. Both the dBA and the dB SPL values at each octave center frequency are given in the columns of numbers. The tic marks on the ordinate represent 10 dBA increments. For example, in Figure 2's graphic display, the 31.5 Hz octave band equals 66 dBA, the 63 Hz octave band equals 71 dBA, etc.

Figure 2

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981

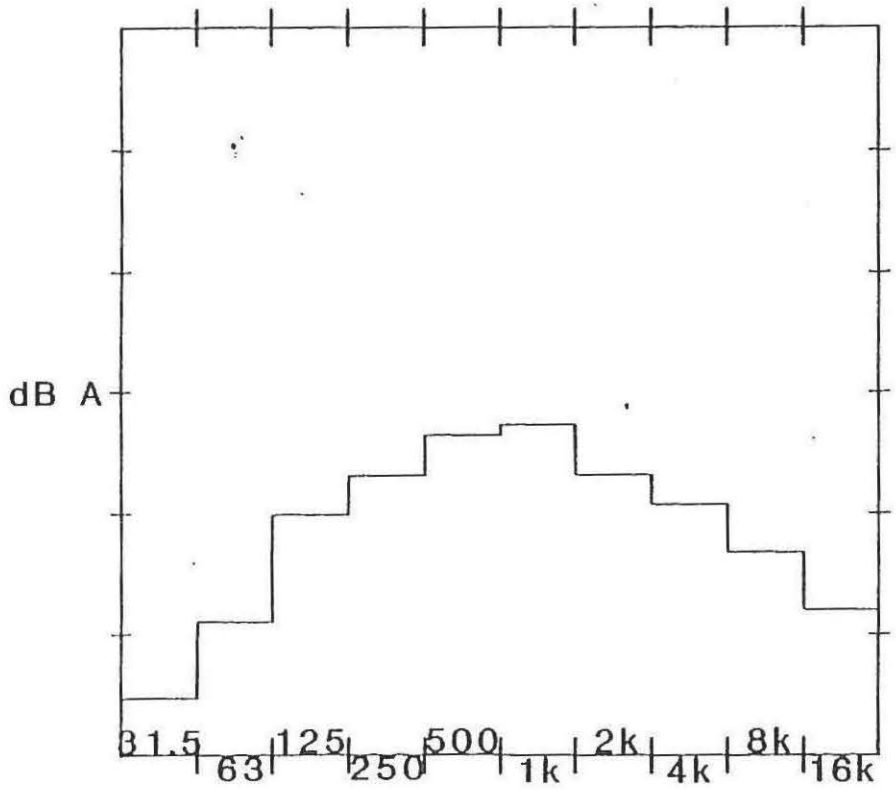


Cutting Tool

Hz	dB A	dB SPL
31.5	66	105
63	71	98
125	92	108
250	95	104
500	105	108
1 k	107	107
2 k	103	102
4 k	101	100
8 k	95	96
16 k	85	92
overall	110	114

Figure 3

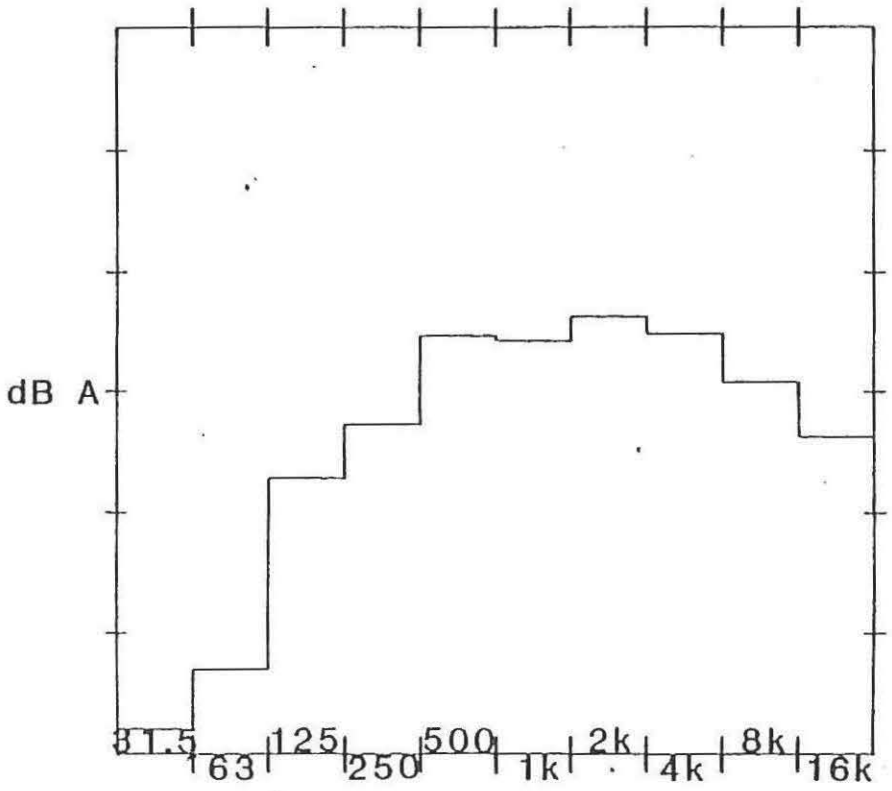
Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



Generator		
Hz	dB A	dB SPL
31.5	66	105
63	72	99
125	81	97
250	84	93
500	88	91
1 k	88	88
2 k	84	83
4 k	82	81
8 k	78	79
16 k	73	80
overall	93	107

Figure 4

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981

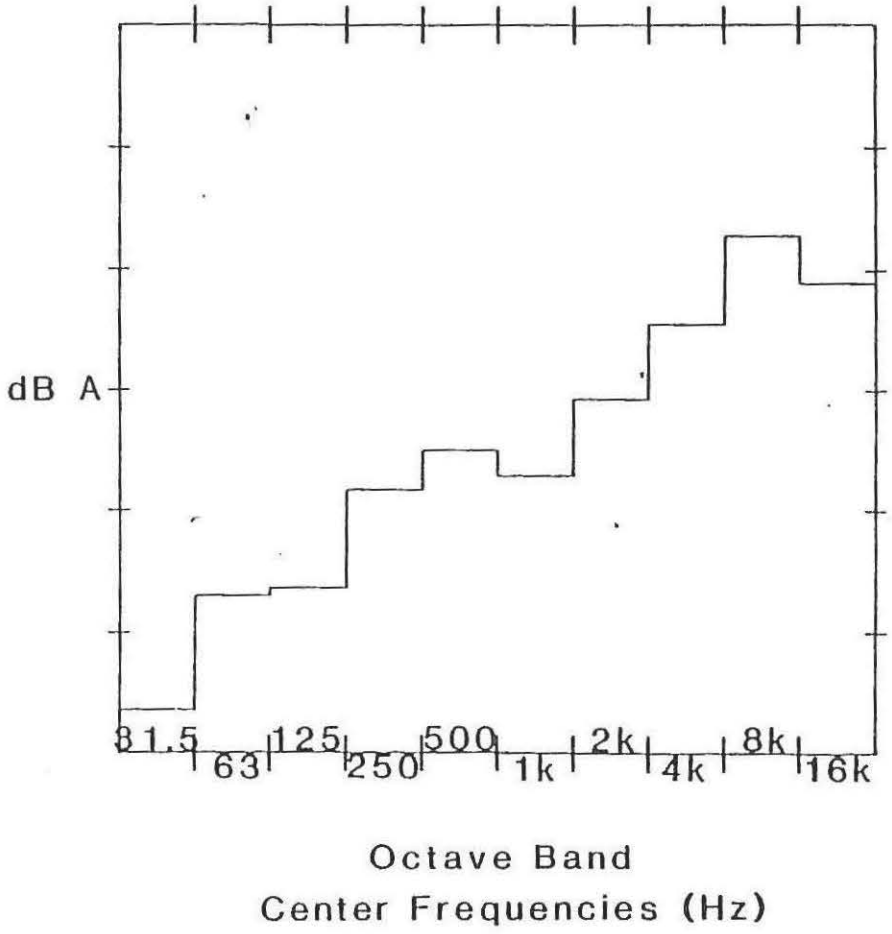


Floating Pump

Hz	dB A	dB SPL
31.5	64	103
63	69	95
125	84	101
250	89	97
500	96	99
1 k	96	96
2 k	98	96
4 k	96	95
8 k	92	93
16 k	88	94
overall	103	108

Figure 5

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981

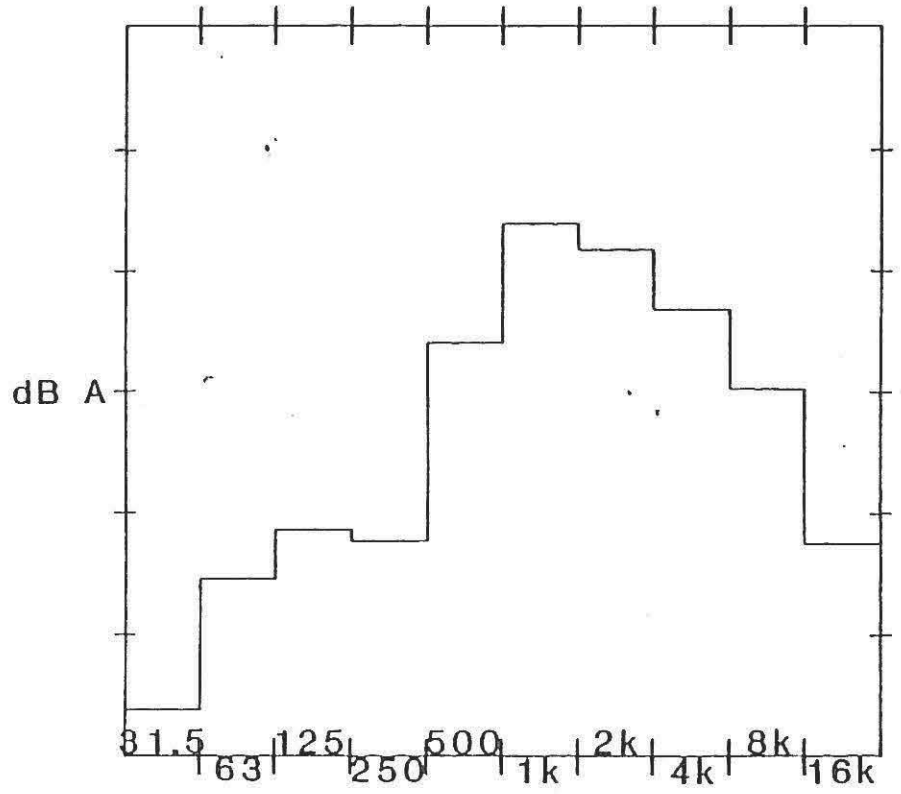


Air Compressor

Hz	dB A	dB SPL
31.5	65	104
63	74	101
125	75	91
250	83	92
500	86	90
1 k	84	84
2 k	90	89
4 k	97	96
8 k	104	105
16 k	100	107
overall	106	111

Figure 6

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



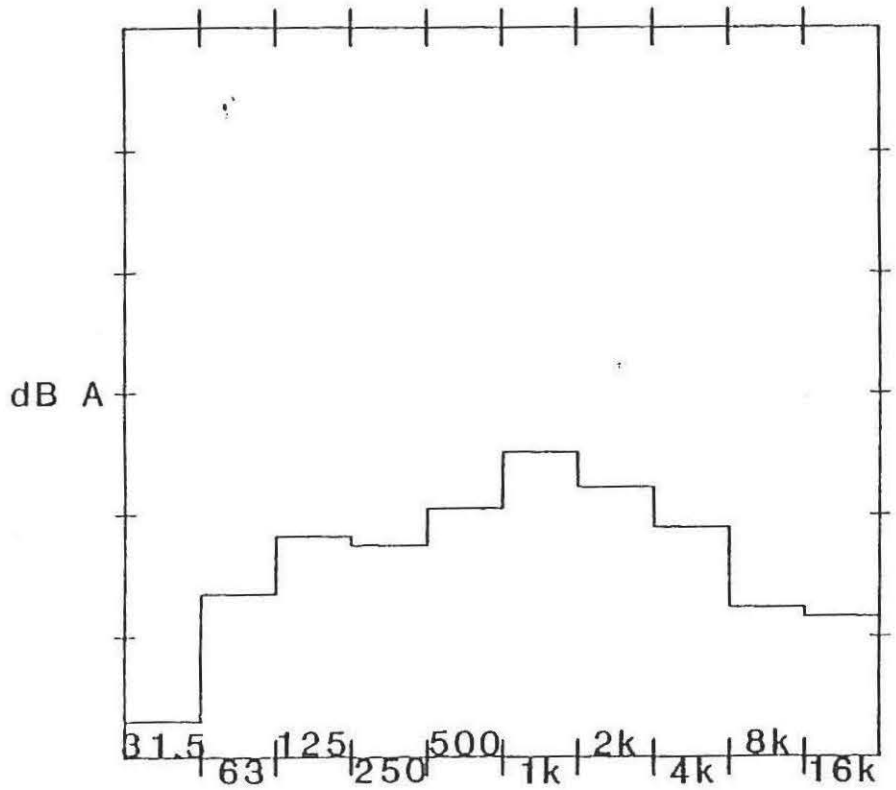
1977 Mack MB Pumper

Back-Step

Hz	dB A	dB SPL
31.5	65	105
63	76	102
125	80	96
250	79	88
500	96	99
1 k	105	105
2 k	103	102
4 k	98	97
8 k	92	93
16 k	79	86
overall	108	111

Figure 7

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



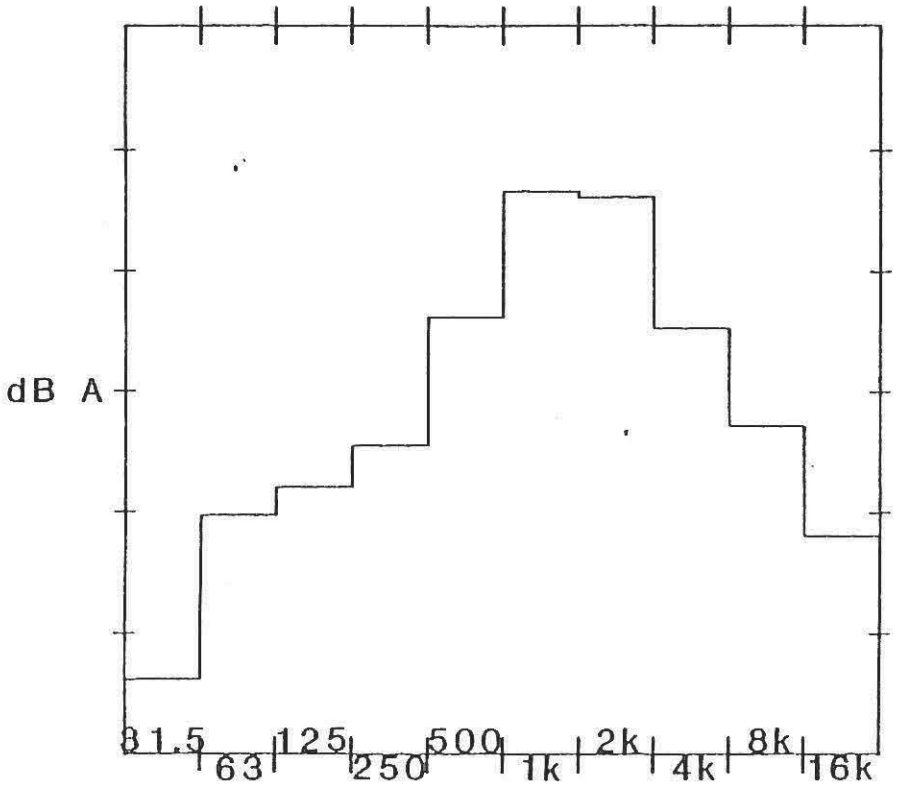
1977 Mack MB Pumper

Pump Position

Hz	dB A	dB SPL
31.5	65	104
63	75	101
125	80	96
250	79	88
500	82	85
1 k	87	87
2 k	84	83
4 k	80	80
8 k	74	75
16 k	73	80
overall	91	106

Figure 8

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



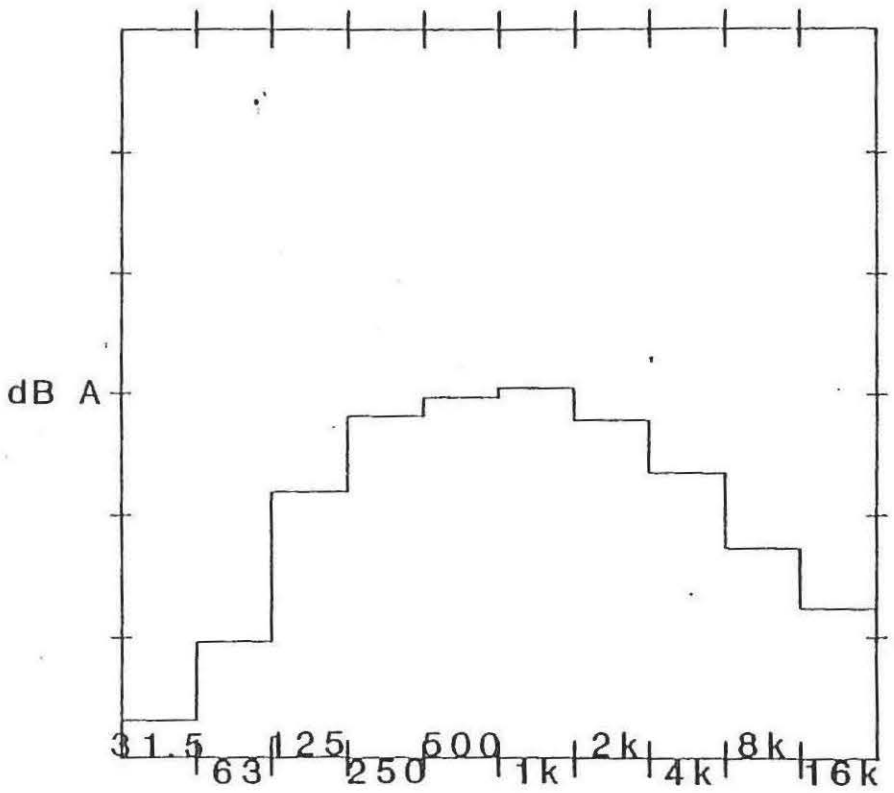
1974 Mack MB Pumper

Jumpseal

Hz	dB A	dB SPL
31.5	68	108
63	82	108
125	84	100
250	88	96
500	98	102
1 k	109	109
2 k	108	107
4 k	97	96
8 k	89	90
16 k	80	87
overall	112	114

Figure 9

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



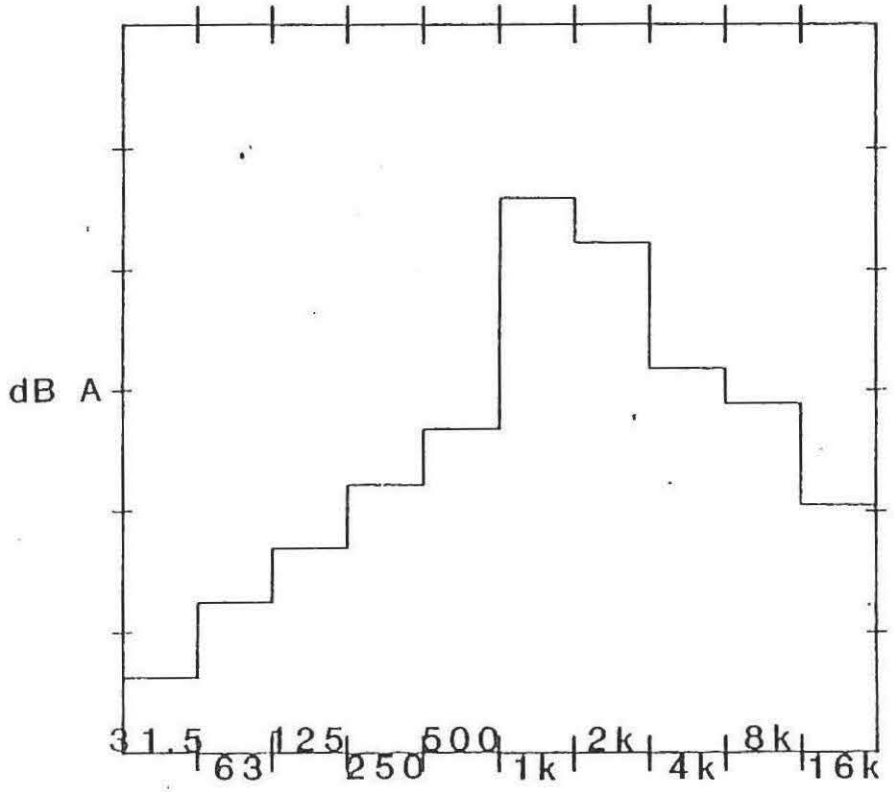
1974 Mack MB Pumper

Pump Position

Hz	dB A	dB SPL
31.5	64	104
63	70	97
125	83	99
250	89	98
500	91	94
1 k	92	92
2 k	89	88
4 k	85	84
8 k	79	80
16 k	74	80
overall	97	107

Figure 10

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



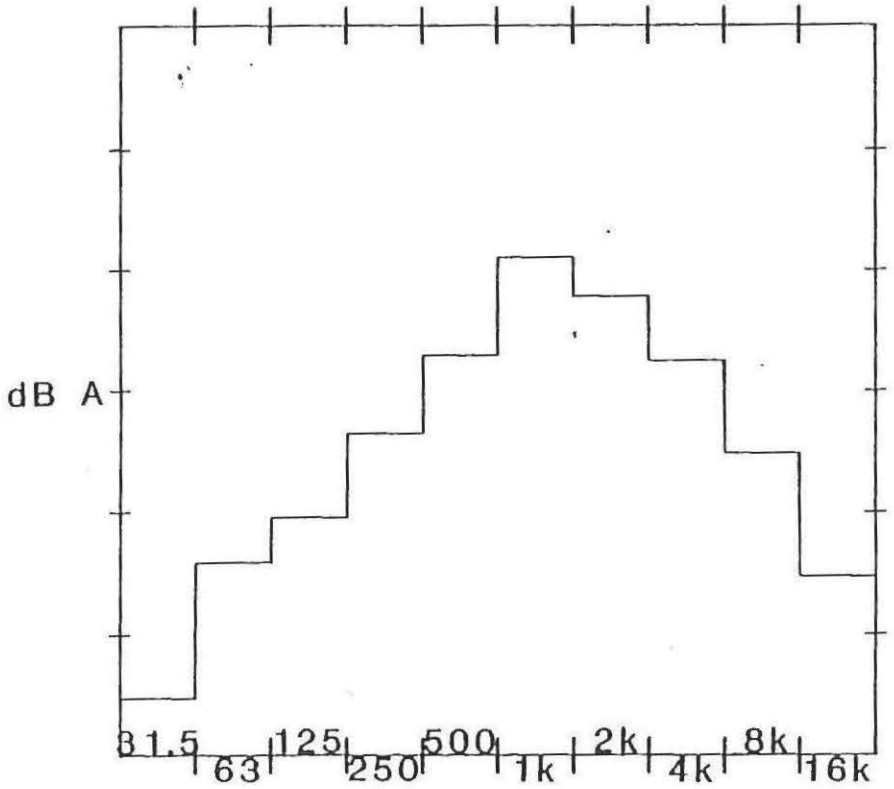
1974 Mack MB Pumper

Cab

Hz	dB A	dB SPL
31.5	68	108
63	75	101
125	79	95
250	84	93
500	89	92
1 k	108	108
2 k	104	103
4 k	94	93
8 k	91	92
16 k	83	89
overall	110	112

Figure 11

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



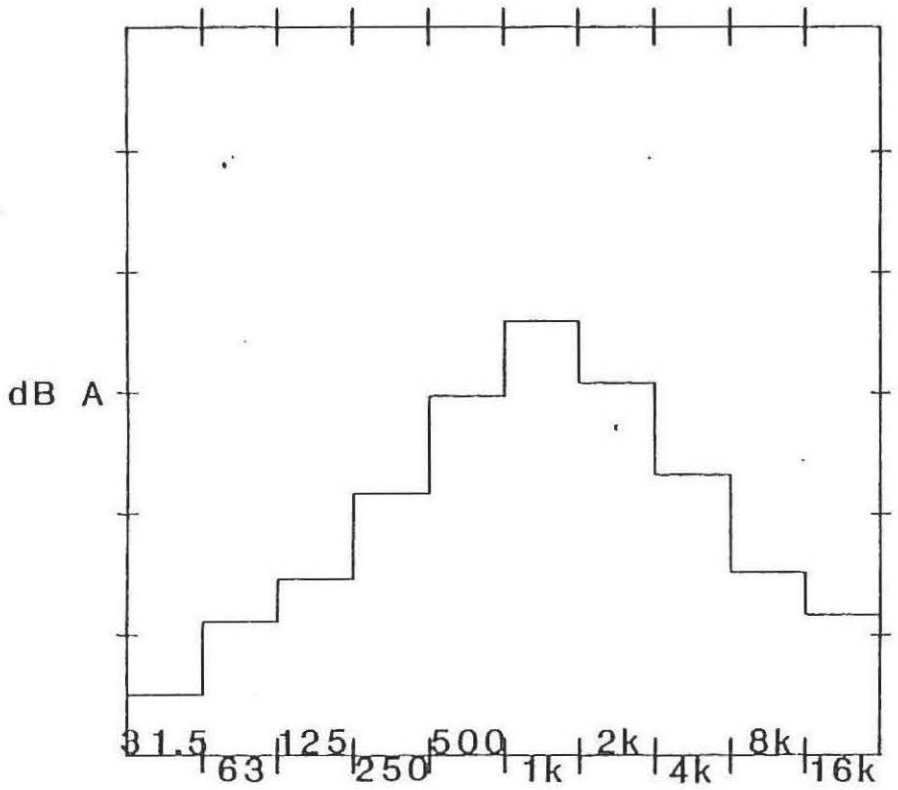
1975 Mack Aerial Ladder

Truck — Jumpseat

Hz	dB A	dB SPL
31.5	66	106
63	78	104
125	81	97
250	88	97
500	94	98
1 k	103	103
2 k	99	98
4 k	94	93
8 k	86	88
16 k	76	83
overall	105	110

Figure 12

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



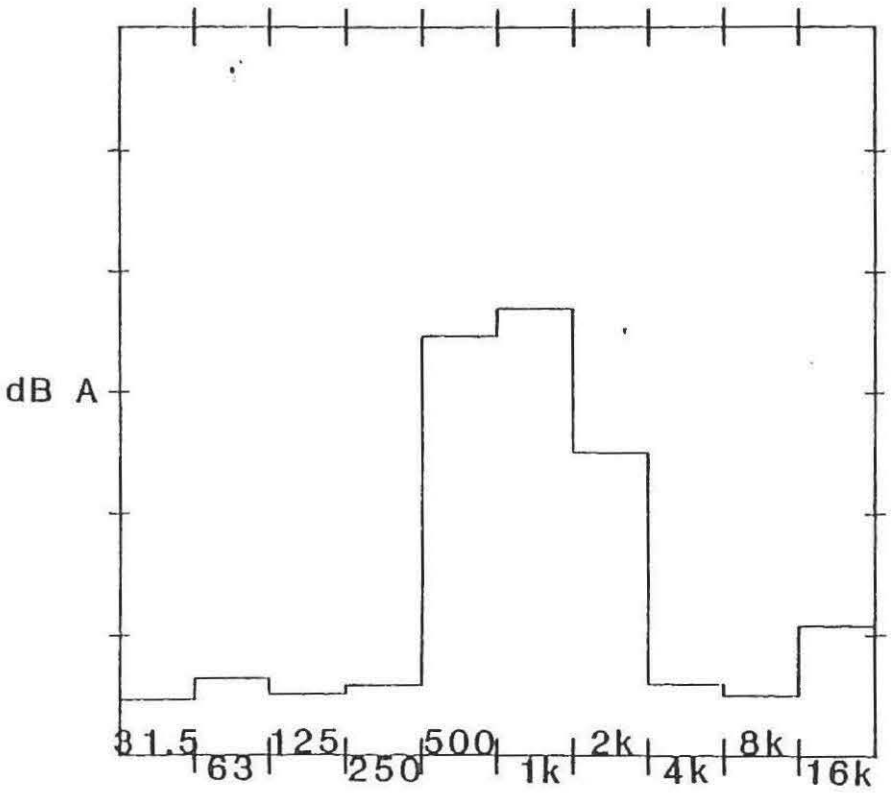
1975 Mack Aerial Ladder

Truck — Cab

Hz	dB A	dB SPL
31.5	67	106
63	73	99
125	76	92
250	83	92
500	91	94
1 k	98	98
2 k	92	91
4 k	85	84
8 k	77	78
16 k	73	80
overall	100	108

Figure 13

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



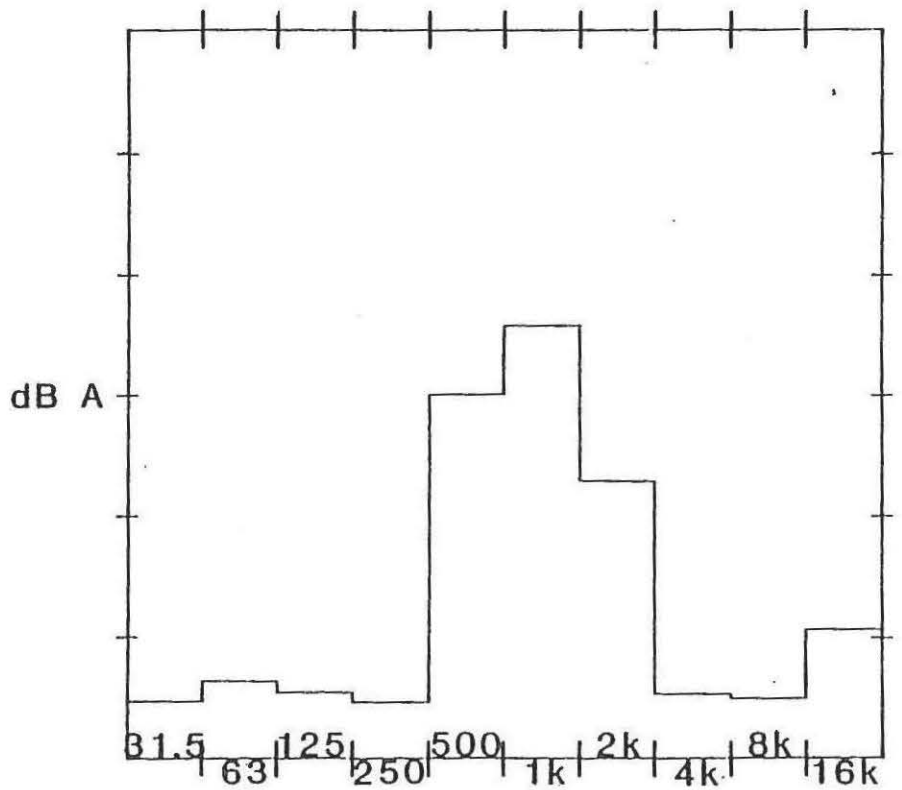
1977 Pontiac

Windows up — yelp

Hz	dB A	dB SPL
31.5	67	106
63	68	95
125	67	83
250	68	77
500	97	100
1 k	99	99
2 k	87	86
4 k	68	67
8 k	67	68
16 k	73	80
overall	101	108

Figure 14

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



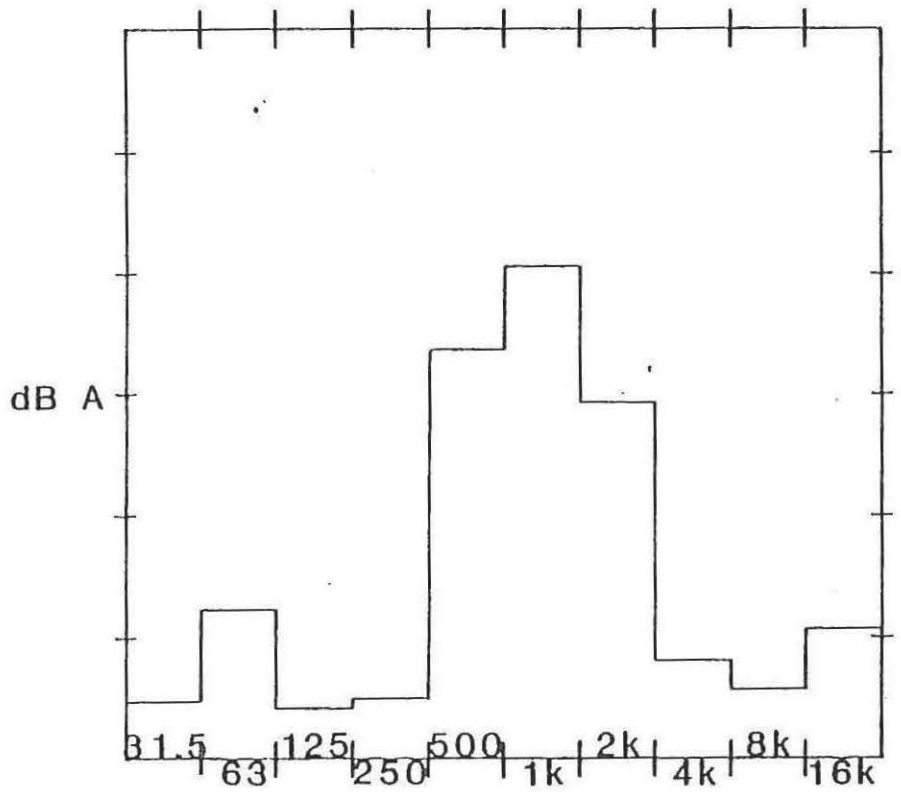
1977 Pontiac

Windows up — Siren

Hz	dB A	dB SPL
31.5	67	106
63	69	95
125	68	84
250	67	75
500	92	95
1 k	98	98
2 k	85	84
4 k	67	66
8 k	67	68
16 k	73	80
overall	99	107

Figure 15

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



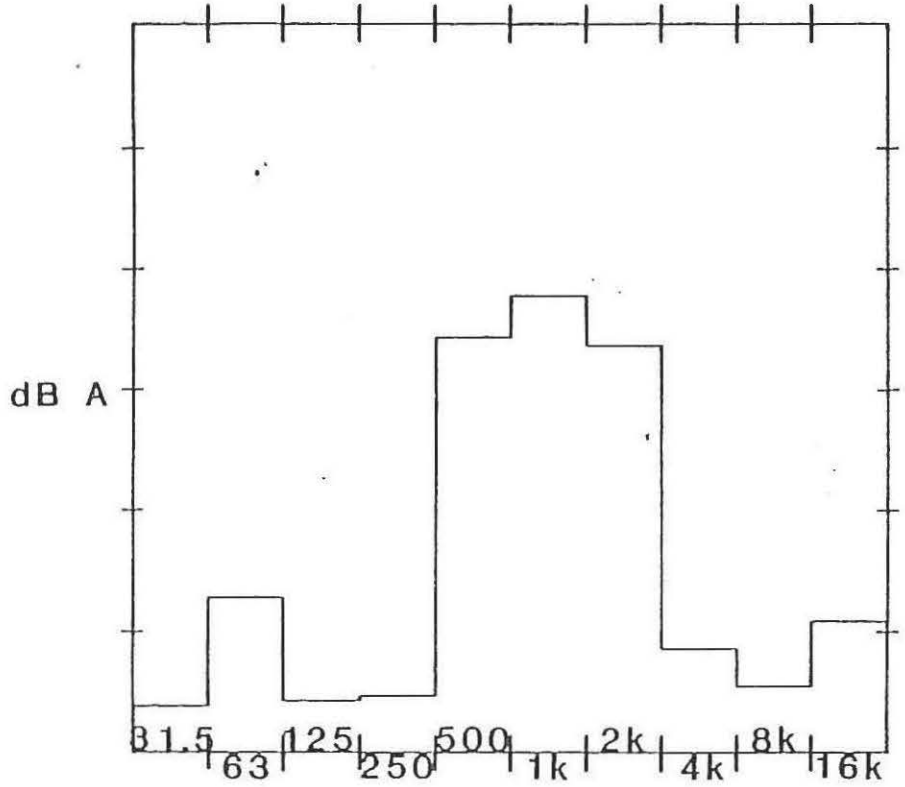
1977 Pontiac

Windows down — Siren

Hz	dB A	dB SPL
31.5	67	106
63	74	101
125	66	82
250	67	76
500	96	99
1 k	103	103
2 k	91	90
4 k	70	69
8 k	68	69
16 k	73	80
overall	104	109

Figure 16

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



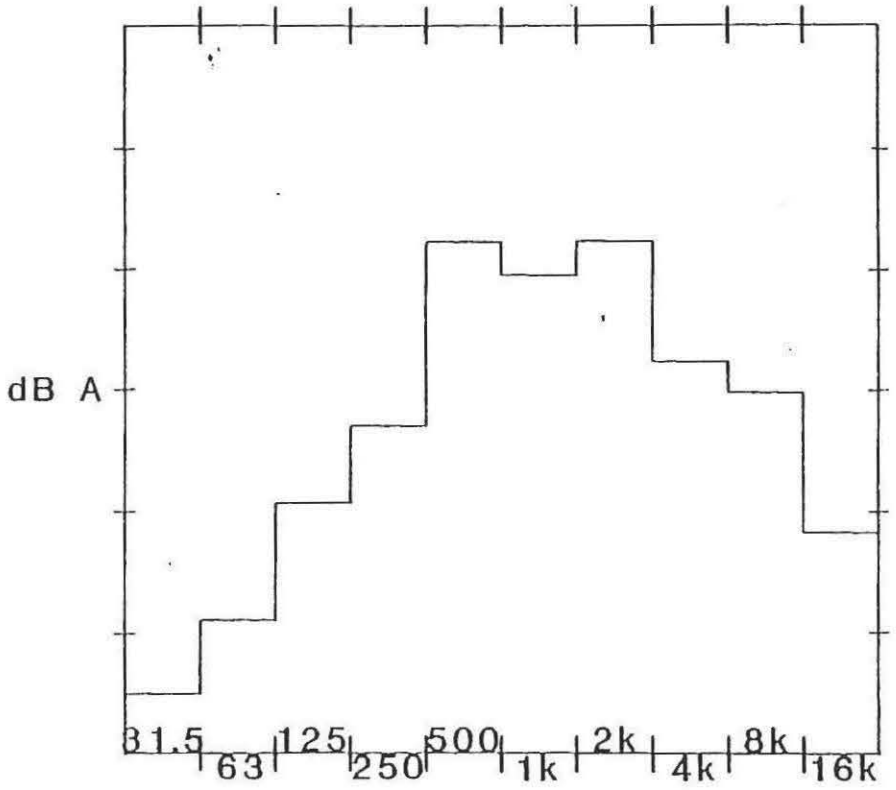
1977 Pontiac

Windows down — yelp

Hz	dB A	dB SPL
31.5	66	106
63	75	101
125	66	82
250	67	76
500	96	100
1 k	100	100
2 k	96	95
4 k	71	70
8 k	68	69
16 k	73	80
overall	102	108

Figure 17

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



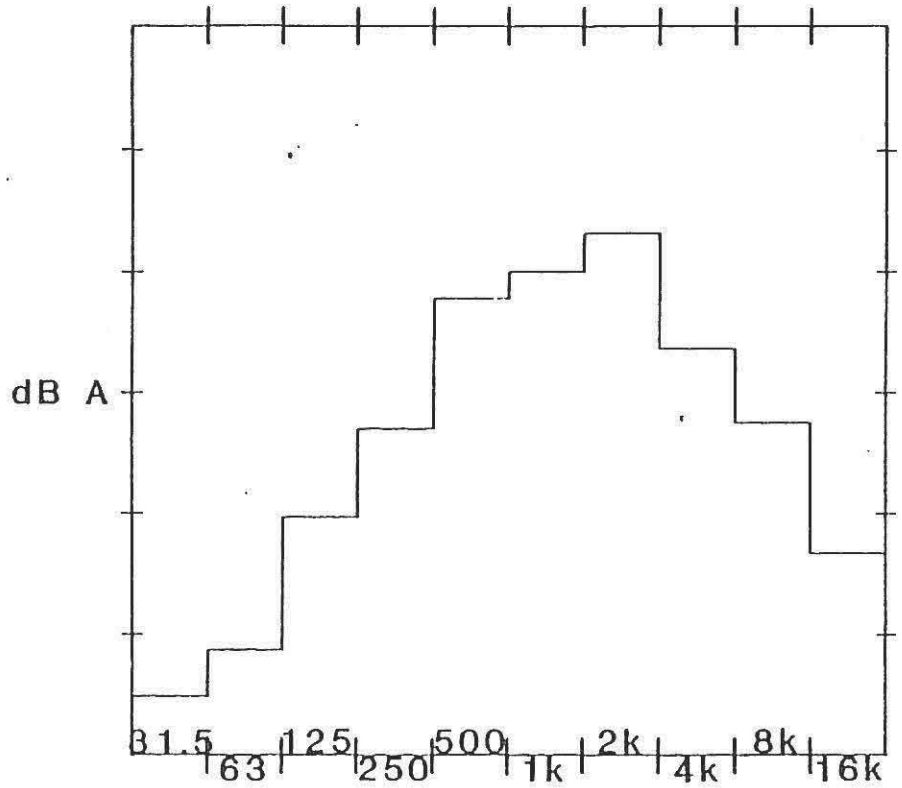
1963 American LaFrance

Ladder Truck — Cab

Hz	dB A	dB SPL
31.5	66	106
63	72	99
125	82	98
250	88	97
500	104	107
1 k	101	101
2 k	104	102
4 k	94	93
8 k	91	92
16 k	80	86
overall	108	111

Figure 18

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



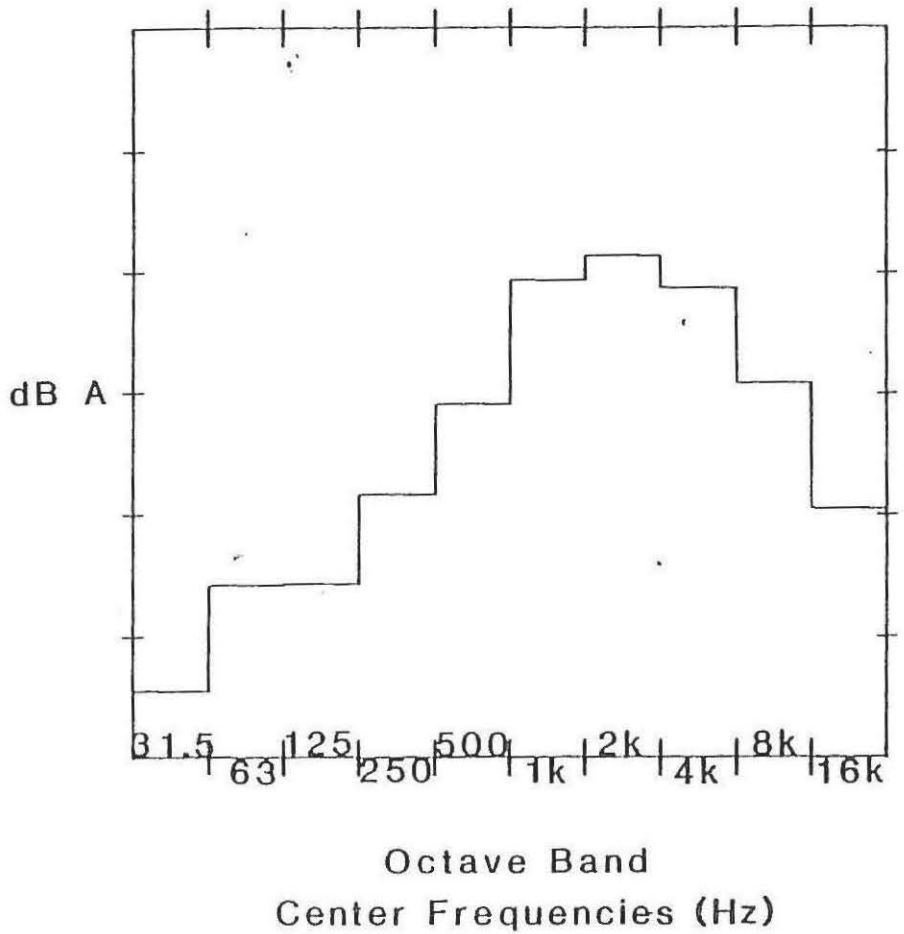
1963 American LaFrance Ladder

Truck — Jumpseat

Hz	dB A	dB SPL
31.5	66	106
63	70	96
125	81	97
250	88	97
500	99	102
1 k	101	101
2 k	104	103
4 k	95	94
8 k	89	90
16 k	78	85
overall	107	110

Figure 19

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



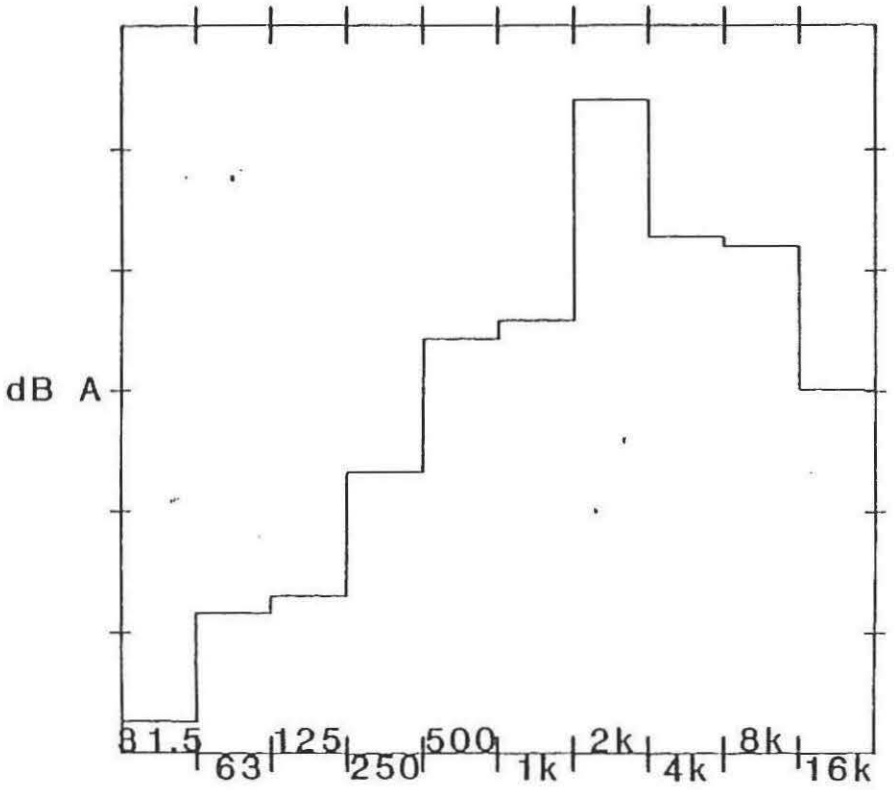
1963 American LaFrance Ladder Truck — Back Step

Hz	dB A	dB SPL
31.5	67	106
63	76	102
125	76	92
250	83	92
500	90	94
1 k	101	101
2 k	103	102
4 k	100	99
8 k	92	93
16 k	82	88
overall	106	110

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981

1963 American LaFrance Ladder

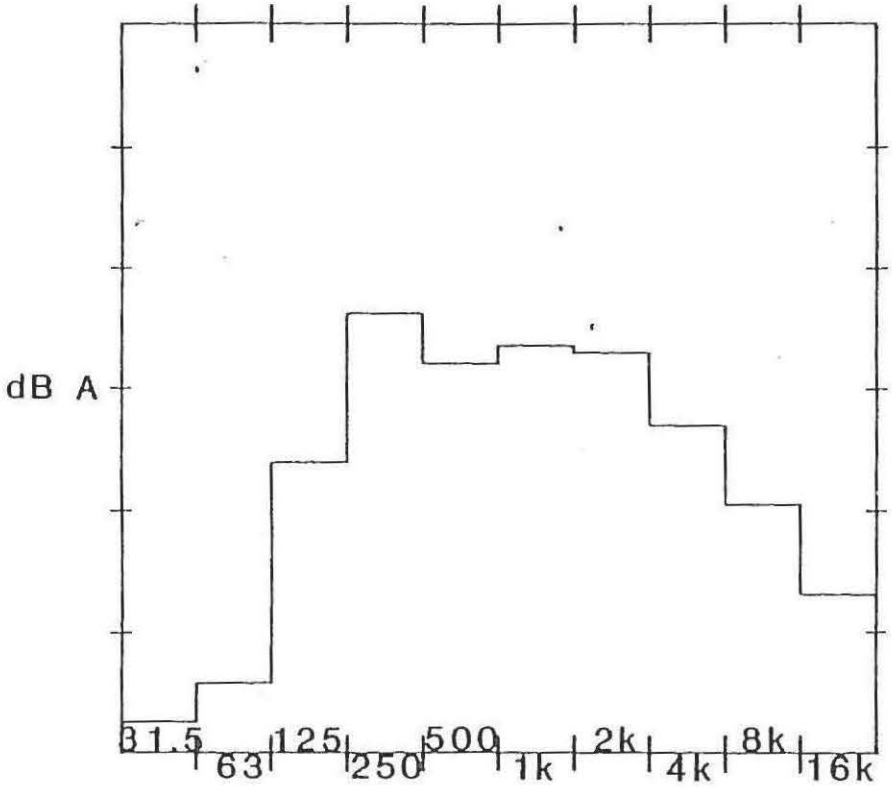
Truck — Cab, Left



Hz	dB A	dB SPL
31.5	64	103
63	73	99
125	74	90
250	85	93
500	96	99
1 k	97	97
2 k	115	114
4 k	104	103
8 k	103	104
16 k	91	98
overall	116	116

Figure 21

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



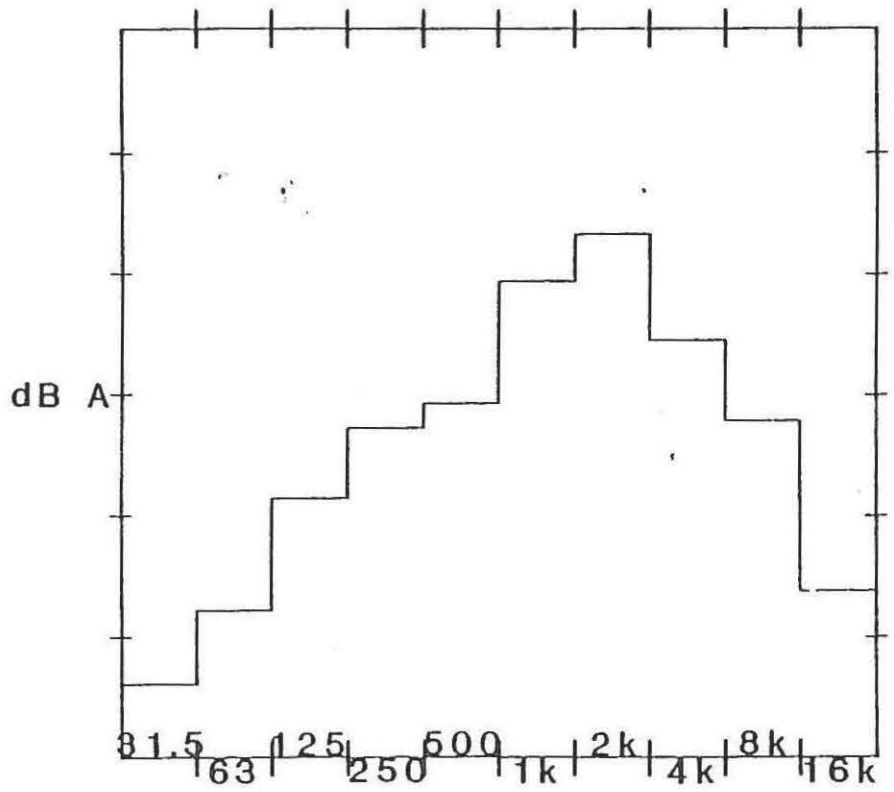
1963 American LaFrance

Pump Position

Hz	dB A	dB SPL
31.5	64	103
63	67	93
125	85	101
250	97	106
500	93	96
1 k	95	95
2 k	94	93
4 k	88	87
8 k	82	83
16 k	74	81
overall	101	109

Figu 2

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981



1955 American LaFrance

Pumper — Cab

Hz	dB A	dB SPL
31.5	68	108
63	74	100
125	84	100
250	89	98
500	91	95
1 k	102	102
2 k	105	104
4 k	97	96
8 k	90	91
16 k	76	84
overall	107	111

Figure 23

Sample of Dosimeter Readout Showing
Minute by Minute dBA Values During a
False Alarm Response

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981

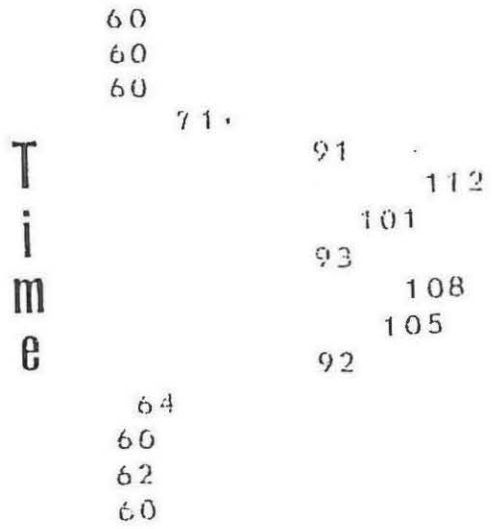


TABLE 1

8-hr TWA Dosimeter Readings (dBA) for Different Riding Positions on the Day Tour (A.M.) and Afternoon Tour (P.M.)

Newburgh Fire Department
Newburgh, New York
February 25-26, 1981

A.M.		P.M.
	Driver	
84.2		68.1
78.1		71.7
76.0		76.8
80.7		80.7
	Officer	
dosimeter failed		62.8
	Jumpseat-Truck	
85.3		80.8
	Backstep-Pumper	
81.9		81.2
79.1		83.3
76.6		73.5

TABLE 2

Percent of Fire Fighters Having Significant Non-Occupational Noise Exposures or Medical Abnormalities.

Newburgh Fire Department
Newburgh, New York
HETA 81-059
February 25-26, 1981

Category	%
1. Noise	
other jobs	20.0
military combat	7.3
military job	10.9
military weapon use	12.7
non-military weapon use	38.2
hobby	36.4
2. Medical	
severe blow to head	34.5
tinnitus	14.5
medical treatment	10.9
fluid from ears	9.1
chronic earaches	5.4
hearing aid use	0.0
ototoxic medication	7.3
hereditary deafness	3.6
otoscopic abnormalities	23.6

Mean Hearing Loss (dB) and Standard Deviation (S.D.)by Frequency (kHz)
for the Seven Age Groupings

Newburgh Fire Department
Newburgh, New York
HETA 81-059
June 3-5, 1981

Age	Fire Years	N	Frequency, kHz						
			0.5k	1k	2k	3k	4k	6k	8k
			(S.D.)	(S.D.)	(S.D.)	(S.D.)	(S.D.)	(S.D.)	(S.D.)
20-29	3.2	10	7.8 (5.5)	4.4 (5.7)	-0.6 (4.7)	2.0 (5.1)	5.4 (8.6)	5.2 (4.8)	5.3 (6.9)
30-34	8.1	11	15.6 (7.3)	10.5 (7.6)	7.4 (6.2)	9.6 (7.0)	11.4 (9.7)	19.0 (14.2)	12.5 (13.3)
35-39	11.9	11	11.3 (6.0)	6.8 (3.9)	4.1 (5.8)	11.3 (14.8)	14.9 (14.1)	18.7 (13.0)	12.4 (6.4)
40-44	17.2	12	12.0 (10.1)	11.0 (11.8)	9.0 (16.1)	14.0 (15.4)	20.2 (11.1)	23.7 (17.6)	19.2 (13.9)
45-49	21.2	5	6.2 (2.8)	5.9 (4.2)	7.6 (4.6)	14.5 (10.6)	29.0 (11.4)	29.6 (12.5)	18.2 (12.4)
50-up	29.4	5	18.3 (9.3)	22.5 (13.3)	25.5 (6.2)	40.7 (7.9)	49.9 (7.7)	61.8 (7.0)	61.2 (10.5)

TABLE 4

Median Hearing Losses by Frequency and Age and Ear for the Newburgh Fire Department (NFD) and 1960-1962 National Health Survey (NHS)

Newburgh Fire Department
Newburgh, New York
HETA 81-059
June 3-5, 1981

		NFD		NHS	
		Left	Right	Left	Right
500Hz					
	25-34	13.1	11.2	7.8	10.1
	35-44	12.4	8.7	10.8	12.2
	45-54	9.5	4.5	12.6	14.2
	55-64	9.5	14.5	15.3	15.6
1000Hz					
	25-34	8.2	4.0	2.2	2.0
	35-44	9.0	5.9	5.5	4.7
	45-54	8.8	5.5	7.9	8.4
	55-64	15.5	15.5	9.9	10.0
2000Hz					
	25-34	4.8	-0.5	4.6	3.7
	35-44	4.0	1.0	8.0	6.9
	45-54	9.5	13.5	12.2	10.4
	55-64	13.5	33.5	19.6	14.8
3000Hz					
	25-34	6.5	2.2	11.2	10.2
	35-44	7.7	7.0	18.8	15.8
	45-54	13.5	18.1	24.6	22.6
	55-64	43.5	43.5	41.9	36.2
4000Hz					
	25-34	8.5	6.5	15.1	13.2
	35-44	15.0	12.2	24.0	21.6
	45-54	31.5	31.5	34.0	30.6
	55-64	51.5	51.5	47.5	43.2
6000Hz					
	25-34	11.9	8.4	24.3	23.8
	35-44	21.0	14.8	32.6	30.8
	45-54	35.5	28.8	39.8	37.3
	55-64	65.5	58.8	55.4	53.5

TABLE 5

Gamma Values* relating age and hearing loss for NFD and NHS at Each Frequency and Ear Tested

Newburgh Fire Department
Newburgh, New York
HETA 81-059
June 3-5, 1981

	NFD		NHS	
	Left	Right	Left	Right
500Hz	-0.07	-0.09	0.33**	0.27**
1000Hz	0.25	0.18	0.31**	0.33**
2000Hz	0.34	0.58**	0.45**	0.41**
3000Hz	0.36**	0.58**	0.50**	0.47**
4000Hz	0.57**	0.64**	0.49**	0.43**
6000Hz	0.58**	0.62**	0.50**	0.48**

*Note: Gamma values can range from -1.00 to +1.00

** Probability that gamma = 0 is <0.01