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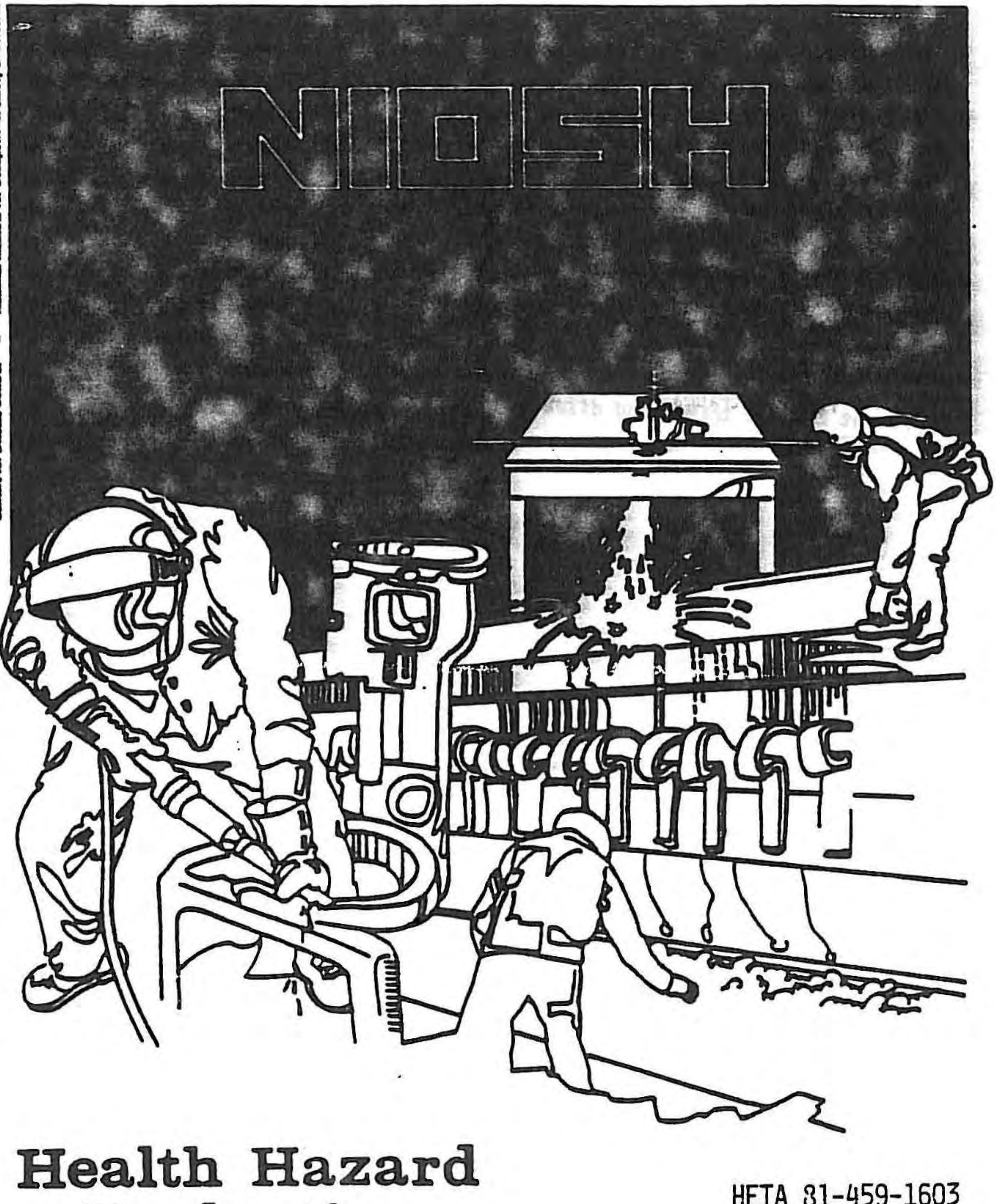

Health Hazard Evaluation Report

HETA 81-459-1603
THE CITY OF NEW YORK
FIRE DEPARTMENT
NEW YORK, 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.

HETA 81-459-1603
July, 1985
The City of New York
Fire Department
New York, New York

NIOSH Investigator:
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I. Summary

In August, 1981, the National Institute for Occupational Safety and Health (NIOSH) was requested by the Fire Department, City of New York (FDNY) to evaluate the noise levels found in the fire apparatus of the department. From November 9, through November 18, 1982, a noise survey was conducted on select fire apparatus during simulated response runs on the chauffeur's training road course at Randall's Island. Additionally, the noise levels found on shipboard were measured in one of the department's fire boats.

The noise survey results revealed that the noise levels emitted by sirens, air horns, and fire engines ranged from 81 dB(A) to 118 dB(A) during the simulated response runs. The noise levels found on the fire boat ranged from 81 dB(A) to 113 dB(A). NIOSH recommends 85 dB(A) for an eight-hour time-weighted average (TWA) noise exposure. The current OSHA standard limits noise to 90 dB(A) for an 8-hr TWA exposure.

On the basis of the noise survey, it is concluded that the potential for noise over-exposure does exist for the FDNY's personnel. Because of this potential for excess noise exposure, NIOSH is restating its recommendations on how to reduce noise in fire fighting operations which were first expressed in the Health Hazard Evaluation Report to the Newburgh, New York Fire Department.[1]

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

II. Introduction

In August, 1981, NIOSH was contacted by the FDNY to request that a noise survey be conducted on a select number of noise sources found at the fire scene or on vehicles used to get to and from a fire scene. This would include apparatus, pumping mechanisms, signaling and communication devices, power tools, etc.. The FDNY stated that they lacked these objective data on noise that were essential to assess their needs in this area of occupational safety and health. Also, previous work by NIOSH and others[1] has shown that fire fighters are likely to exhibit an appreciable amount of hearing loss, more so than found in the general population. On November 9-18, 1982, NIOSH investigators traveled to New York City to tape record the noise patterns found during simulated response runs on a number of the fire department's apparatus.

III. Background

The FDNY has a fleet inventory of over 350 engine and ladder vehicles which serve the five boroughs of the city. These vehicles are manned by a uniformed fire fighter roster of approximately 11,000 employees.

A large training facility for the FDNY is situated on Randall's Island. Located on the facility grounds is a chauffeurs' training road course which is used for training drivers. This approximately one-mile course contains several turns, curves, and slight hills and valleys. The course has a portion of it that travels under an elevated railroad trestle and another section that goes between two brick buildings. It was on this road course that the simulated response runs were conducted to evaluate the noise exposures.

IV. Methods and Materials

The noise levels emitted by several pieces of the FDNY's fire apparatus during simulated response runs were recorded during the two week period. The tested apparatus included 31 American LaFrance and Mack Pumpers, 23 Mack, Seagrave, and Sutphen Ladder Trucks, a Mack Rescue vehicle, a Chevrolet Suburban Battalion Chief's car, and the John D. McKean, one of the department's fire boats.

The procedure used to obtain the noise patterns for each vehicle was to have the officer and the chauffeur operate the vehicle while one of the NIOSH investigators made the noise measurements. A member of the FDNY's Department of Safety also accompanied the group. The chauffeur was instructed to drive through the training course at a safe and reasonable speed and to stop at each end of the course. The officer was to operate the siren, air horn, and radio as he would do if he were on an actual response run. The NIOSH investigator tape recorded the entire run from five or six different riding positions, depending on the make and model of the vehicle being tested. Usually, the positions consisted of two readings in the cab, two readings in the engine compartment, and one or two other positions. Additionally, noise recordings were made at the pump panel during pumping operations for the pumpers and at the ladder turntable for the ladder trucks.

The noise patterns were measured with a General Radio Precision Sound Level Meter (Model 1981), set on the dB(A)-slow scale. The ac signal from the sound level meter was fed to Nagra Tape Recorders (Models III and D35R) for permanent storage of the noise patterns and later analysis. Calibration signals from a General Radio Omnical Calibrator (Model 1986) were placed on the audio tape both before and after each simulated response run. The later analyses were frequency spectra plots of all of the recorded audio tapes. This was accomplished with a Nicolet Mini-Ubiquitous Spectrum Analyzer (Model 444) connected to a Tektronix Interactive Digital Plotter (Model 4662) which supplied hard copy of the noise survey results.

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, A-weighted scale (dB(A)), causes hearing loss in a portion of the exposed population.

OSHA's existing standard for occupational exposure to noise (29 CFR 1910.95) [2] specifies a maximum permissible noise exposure level of 90 dB(A) for a duration of 8 hours, with higher levels allowed for shorter durations. NIOSH, in its Criteria for a Recommended Standard,[3] proposed a limit of 85 dB(A), 5 dB less than the OSHA standard.

Time-weighted average (TWA) noise limits as a function of exposure duration are shown below:

Duration of Exposure (hrs/day)	Sound Level, dB(A) 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 dB(A)

** 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 the levels to permissible limits.

VI. Results

The data collected during the simulated response runs are presented both as dB(A) and dB Sound Pressure Levels (SPL) in all of the analyses. The dB(A) levels were taken directly from both the sound level meter and from the Fast Fourier Transform (FFT) analyzer. Because the data were stored on the audio tapes in a dB(A) format, the conversion to dB(SPL) was done mathematically rather than by a separate FFT analysis. Specifically, the A-weighting correction values[4] for each of the octave bands analyzed were added to the recorded dB(A) value so that the SPL values could be approximated. Additionally, each of the SPL octave bands were combined according to the correct mathematical formula[4] to determine the overall SPL of the sound.

Generally, a total of 64 samples were used in each of the FFT analyses. This represents sound sampling over a 48-sec time period. Therefore, the sound levels reported here are average intensities, rather than peak intensity levels. The values read-out to the person from the Safety Division following each run down the chauffeur's training road course are more representative of peak intensities measured during the run. There were a few instances where less than 64 samples were used in the analysis. The times associated with these fewer number of samples are given in Table 1.

The spectral data are contained in a rather large appendix which accompanies this report. The figures represent the uncorrected sound levels in dB(A) for the octave bands 31.5 Hz through 16 kHz. The octave band sound levels were corrected by taking the difference between the recorded calibration tones at the beginning and end of each tape and the standard dB(A) relative weighting values[4] and adding this difference to each octave band sound level. The tables which are included for each figure give the vehicle being tested, the riding position, and the corrected sound levels in both dB(A) and dB(SPL), as well as other relevant information.

The overall sound levels found for the pumpers and ladder trucks in both dB(A) and dB(SPL) are shown in Tables 2-5. Inspection of these tables reveals that there was little difference in the overall dB(A) values measured for the pumpers and for the ladder trucks. All of the riding positions had a mean dB(A) value in the middle 90's with the exception of the "2 Left" riding position on the ladder trucks. This exception can be explained by the fact that the "2 Left" position is an open riding position, usually just behind the air horns mounted on the cab's roof. One additional point concerning the dB(A) values found for ladder trucks should be pointed out. The two Sutphen Ladder Trucks tested during the simulated response runs were usually the most intense vehicles measured at all of the riding positions.

The sound levels found during the noise survey on the fire boat are included in the spectral data appendix. The dB(A) values measured above deck ranged from 81 dB(A) (pilot house) to 113 dB(A) (horn). The noise measured in the engine room was quite consistent and was more intense. The dB(A) values for the engine room ranged from 102 dB(A) to 111 dB(A).

VII. Discussion and Conclusions

The measured dB(A) values obtained from this noise survey show that the potential for noise overexposure does exist for the FDNY personnel. Most of the examined riding positions on the vehicles tested exceeded a 90 dB(A) level. Also, only a few of the routine fire fighting operations (e.g., pumping, ladder operations, chain saw usage) were surveyed in this study. The fact that the possibility for intense, impulsive-type noises (e.g., explosions, crashing timbers, chopping) exist at the actual fire scene points out that fire fighters are most likely overexposed to noise.

The results from this study, while being quite extensive, are really only informational to the FDNY. The data were collected from a representative sample of the department's motor vehicle inventory. However, these data only show the noise levels found during a very short-term simulated fire fighting condition. Additionally, long-term noise information from actual fire fighting operations is needed before definitive statements concerning the amount of fire fighters' noise overexposure can be made. Also, the environmental measurements must eventually be correlated with the medical hearing loss data before the impact of this noise exposure can be assessed.

VIII. Recommendations

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. Sirens can be moved to 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 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 percep_ually 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 nose 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. 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 stero 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.

II. References

1. Tubbs, R. L. and Flesch, J. P. Health Hazard Evaluation: Newburgh Fire Department. HHE Report No. 81-059-1045. National Institute for Occupational Safety and Health, Cincinnati, Ohio, 1982.

2. U.S. Department of Labor, Occupational Safety and Health Administration. Occupational safety and health standards. Federal Register, Vol. 36, No. 105, Part II, May 29, 1971.

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

4. American National Standards Institute S1.4-1971, American National Standard Specification for Sound-Level Meters.

Table 1

Number of Samples	Analysis Time
4	4 sec
8	6 sec
16	12 sec
32	24 sec
64	48 sec

Table II

PUMPERS - A-WEIGHTED dB LEVELS

Vehicle	Pump Panel 150 psi	Pump Panel 200 psi	Chauffeur's Position	Officer's Position	1 Right	1 Left	Backstep
AP 8003	88.8	97.0	107.8	103.6	100.8	101.0	99.2
AP 8020	91.4	93.0	108.0	100.9	102.8	103.6	98.6
AP 8024	91.8	97.5	91.8	93.0	92.6	92.7	90.4
AP 8058	91.6	93.7	97.1	95.9	94.1	96.6	86.6
AP 8069	91.6	98.7	102.6	101.7	96.8	100.7	97.1
AP 8074	92.6	98.1	101.6	97.8	99.1	100.6	101.2
AP 8080	92.6	94.1	99.4	95.2	92.9	93.4	87.9
MP 7201	87.8	93.5	100.6	99.7	97.2	97.2	94.3
MP 7202	--	--	94.3	97.7	95.9	94.0	99.2
MP 7231	91.0	93.8	93.9	92.0	95.6	95.0	88.2
MP 7528	93.8	102.5	97.0	97.3	96.5	97.3	93.4
MP 7530	--	--	92.6	98.2	99.4	99.1	93.8
MP 7810	90.0	91.2	95.4	94.3	91.2	95.1	87.3
MP 7812	88.2	97.2	103.0	98.9	92.4	93.6	94.2
MP 7815	88.9	91.9	90.1	94.0	93.8	95.1	91.8
MP 7816	--	91.7	98.5	93.6	95.9	97.6	95.9
MP 7834	92.2	--	95.2	94.5	97.0	97.6	100.6
MP 7838	88.8	90.0	92.0	94.7	93.0	93.6	92.1
MP 7840	91.1	92.8	96.1	97.2	98.0	97.4	98.3
MP 7905	85.0	--	90.8	92.2	93.6	92.8	92.1
MP 7907	87.2	88.9	97.3	98.6	93.9	93.5	97.8
MP 7914	88.9	--	100.3	96.9	95.1	94.4	98.0
MP 7918	88.1	--	93.5	91.5	93.8	93.6	87.0
MP 7927	86.4	--	94.2	93.7	93.6	94.0	93.0
MP 7928	92.0	94.3	98.6	99.8	95.4	95.9	94.3
MP 7946	87.2	--	88.0	93.7	96.0	93.9	88.9
MP 7955	85.4	88.8	91.1	90.7	92.1	90.6	86.7
MP 7966	88.7	90.3	94.2	93.9	101.8	97.7	93.4
MP 7973	87.1	--	101.6	101.6	98.2	99.6	103.9
MP 7976	84.8	88.8	93.8	94.3	93.2	94.8	90.3
MP 8106	86.0	87.6	90.3	89.8	90.2	89.7	89.9
Mean	89.2	93.4	96.5	96.0	95.5	95.9	93.7

Table III

PUMPERS - dB SOUND PRESSURE LEVELS

Vehicle	Pump Panel 150 psi	Pump Panel 200 psi	Chauffeur's Position	Officer's Position	1 Right	1 Left	Backstep
AP 8003	101.3	103.0	109.0	106.1	105.2	104.7	102.7
AP 8020	99.7	101.0	108.8	103.5	104.8	105.0	101.6
AP 8024	100.1	102.0	100.4	100.8	101.3	101.5	99.1
AP 8058	100.2	101.8	101.9	101.8	102.5	102.6	99.3
AP 8069	99.9	104.9	104.6	103.9	102.6	103.9	101.2
AP 8074	101.3	103.3	106.6	104.8	106.3	106.6	104.2
AP 8080	100.4	101.0	102.6	100.9	102.1	102.1	98.5
MP 7201	101.6	102.6	105.2	107.0	103.6	103.6	104.5
MP 7202	--	--	102.7	103.9	103.8	103.1	111.4
MP 7231	100.1	104.3	101.4	102.1	108.9	105.4	105.6
MP 7528	104.2	106.4	104.5	104.0	112.0	106.2	105.2
MP 7530	--	--	103.4	104.2	108.2	107.9	106.3
MP 7810	100.1	100.3	101.0	100.9	102.0	103.2	99.1
MP 7812	99.5	102.3	104.8	102.5	106.8	102.6	100.3
MP 7815	101.2	103.2	101.7	102.1	102.5	102.4	101.1
MP 7816	--	102.1	103.7	103.0	103.9	104.6	107.2
MP 7834	102.8	--	105.5	106.1	107.0	105.8	105.7
MP 7838	99.4	100.3	100.6	101.1	103.8	102.7	100.0
MP 7840	101.7	103.8	103.7	104.3	104.1	104.4	103.4
MP 7905	99.0	--	100.0	100.6	105.1	104.7	100.1
MP 7907	101.2	102.3	103.2	103.6	103.6	103.8	103.3
MP 7914	101.4	--	104.7	103.5	103.3	103.1	102.9
MP 7918	101.4	--	103.2	103.5	103.2	103.4	101.5
MP 7927	99.3	--	100.8	100.9	103.3	103.2	100.1
MP 7928	101.0	100.9	103.2	103.0	104.3	103.2	100.8
MP 7946	100.8	--	105.6	102.6	104.3	103.8	101.2
MP 7955	99.4	100.6	101.0	104.8	103.8	103.1	99.6
MP 7966	100.2	101.2	102.8	103.3	106.7	104.0	101.2
MP 7973	100.5	—	105.6	105.8	104.5	105.4	106.3
MP 7976	101.0	101.2	102.0	102.3	102.9	103.0	101.4
MP 8106	101.8	102.9	100.8	101.1	104.8	104.4	100.9
Mean	100.7	102.3	103.4	103.2	104.6	104.0	102.4

Table IV

LADDERS - A-WEIGHTED dB LEVELS

Vehicle	Ladder Maneuvers	Chauffeur's Position	Officer's Position	1 Right	1 Left	2 Left	Tiller
MT 7301	94.3	92.0	92.3	97.3	--	98.4	--
MT 7315	85.6	101.9	96.1	98.6	--	102.4	--
MT 7409	84.8	92.3	94.4	98.5	--	101.8	--
MT 7411	87.3	101.1	98.7	102.0	--	109.5	--
MT 7902	81.3	96.0	93.9	101.4	--	101.2	--
MT 7909	82.2	91.1	89.1	95.6	--	100.8	--
MT 8003	85.1	95.1	95.6	101.1	101.5	--	--
MT 8019	86.1	91.3	90.8	94.4	--	102.7	--
MT 8101	83.7	98.2	96.0	106.4	106.4	--	--
SL 7101	88.0	97.8	102.6	100.2	97.1	--	--
SL 7210	92.2	96.3	97.4	98.5	98.1	--	--
SL 7424	88.6	100.6	100.2	100.2	100.4	--	--
SL 7802	87.2	93.9	96.4	101.1	94.8	--	--
SL 7803	87.6	96.8	95.9	99.3	101.1	--	--
SL 7813	92.5	92.1	93.5	92.4	92.0	--	76.2
SL 7906	87.0	95.9	95.9	99.0	*	--	--
SL 7907	93.0	97.5	96.4	96.4	97.2	--	--
SL 8032	92.2	91.1	92.2	95.1	92.4	--	77.1
SL 8038	87.8	*	93.7	92.5	91.4	--	77.0
SL 8101	84.6	103.1	100.8	95.2	94.0	--	--
SL 8203	95.5	101.8	103.7	94.6	96.0	--	--
ST 8001	90.7	103.0	104.4	111.1	--	110.4	--
ST 8101	--	98.6	103.4	102.3	--	117.8	--
Mean	88.0	96.7	96.7	98.8	97.1	105.0	76.8

* Tape Recorder Malfunction

Table V

LADDERS - dB SOUND PRESSURE LEVELS

Vehicle	Ladder Maneuvers	Chauffeur's Position	Officer's Position	1 Right	1 Left	2 Left	Tiller
MT 7301	99.8	101.8	101.8	107.1	--	104.8	--
MT 7315	98.8	106.2	104.8	106.3	--	103.5	--
MT 7409	98.7	101.9	102.0	105.6	--	105.1	--
MT 7411	103.9	104.6	103.0	109.2	--	111.8	--
MT 7902	98.2	101.6	101.4	104.3	--	104.2	--
MT 7909	100.7	100.2	100.0	102.9	--	105.4	--
MT 8003	97.8	100.7	100.2	104.1	105.3	--	--
MT 8019	102.0	99.6	99.3	102.8	--	107.8	--
MT 8101	103.5	101.7	100.2	107.4	107.8	--	--
SL 7101	100.8	102.8	106.7	106.4	104.0	--	--
SL 7210	101.0	104.1	103.8	107.1	105.4	--	--
SL 7424	102.4	104.6	104.6	109.3	105.8	--	--
SL 7802	99.4	101.1	101.9	104.1	103.4	--	--
SL 7803	99.4	103.7	102.5	103.8	105.1	--	--
SL 7813	99.9	101.1	102.0	104.2	103.3	--	99.6
SL 7906	99.8	102.0	101.4	104.8	*	--	--
SL 7907	99.7	103.0	102.7	104.2	103.7	--	--
SL 8032	101.2	100.2	101.4	104.0	104.2	--	99.1
SL 8038	101.0	*	101.3	103.3	102.4	--	98.5
SL 8101	100.8	104.3	102.9	101.8	102.6	--	--
SL 8203	101.4	104.2	105.3	103.5	104.3	--	--
ST 8001	102.1	105.6	106.5	112.8	--	112.3	--
ST 8101	--	102.9	106.2	108.0	--	119.1	--
Mean	100.6	102.6	102.7	105.5	104.4	108.2	99.1

* Tape Recorder Malfunction

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