



DEPARTMENT OF THE AIR FORCE
INSTITUTE FOR ENVIRONMENT, SAFETY AND
OCCUPATIONAL HEALTH RISK ANALYSIS (AFMCI)
BROOKS AIR FORCE BASE, TEXAS

27 Sep 00

MEMORANDUM FOR 97 ADOS/SGGB

FROM: AFIERA/RSHI
2513 Kennedy Circle
Brooks AFB, TX 78235-5123

SUBJECT: Consultative Letter, IERA-RS-BR-CL-2000-0109, Peak Sound Pressure Level Measurements
of the M1 Rifle, Randolph AFB

1. INTRODUCTION

a. *Purpose:* On 7 Feb 00, the Industrial Hygiene (IH) Branch of the Air Force Institute for Environment, Safety, and Occupational Health Risk Analysis (AFIERA/RSHI), obtained peak sound pressure level measurements of the M1 rifle for our Firearm Noise Data Inventory and Capt Joseph Narrigan, Audiologist, Wright-Patterson AFB. This consultative letter summarizes our findings and provides recommendations to reduce noise exposures from the M1.

b. *Survey Personnel:*

Mr. Andrew Wells, Noise Consultant
MSgt Pete LaPorta, Superintendent Industrial Hygiene Section
SSgt Henry DeBose Jr, NCOIC Noise and Vibration Team

c. *Personnel Contacted:*

MSgt Traci Peck, Superintendent Honor Guard Flight
SSgt Duane Cruz, NCOIC Honor Guard Flight

d. *Equipment Used:*

High Techniques Digital Oscilloscope (Model FW 7633P, Serial #6293432)
Norsonic Front End Power Supply (Model 336, Serial #18511, 20567)
Norsonic Pre-amplifier (Model 1201, Serial #20083, 19978)
Larson Davis 1/4" Microphone (Type 2530, Serial #1030, 1118)

e. *Description of Operation:* Honor Guard personnel discharge .30 caliber blank cartridges in the M1 rifle during training sessions. The area where firing takes place is adjacent to a parking lot and approximately 200 feet from any surrounding buildings. Honor Guard personnel fire the M1 weapons at least once a week during practice and as needed for ceremonies. One to two weapon training classes can be conducted per day. During a class up to 12 rounds can be fired per member with seven members firing. The Honor Guard instructors work directly with the students when firing.

f. *Source of Exposure:* Honor Guard instructors and members of the team have potential of being exposed to hazardous noise during the firing of weapons.

2. SURVEY PROCEDURES

a. *Equipment Set-Up:* The best locations for the equipment such as microphones are selected based on the type of facility or area where the firing is taking place, the noise sources, and the type of assessment. For measurements of the M1, we placed the measurement microphone one foot behind the single shooter. This is the standard location at which we measure the shooter's noise exposure. The microphone was pointed upward, and the microphone diaphragm was in the same horizontal plane as the muzzle of the weapon [1]. For measurements of the seven shooters a microphone was placed between shooter 4 and 5. Parameters for the signal processors and other support equipment were established for measuring and storing the signals representing the pressure fluctuations due to weapon discharge.

b. *Data Collection:* A condenser microphone senses pressure fluctuations and converts them into an electrical signal. The electrical output feeds into a pre-amplifier, amplifying the signal to a front end. The front end provides microphone polarization voltage, frequency selective filters, and additional amplification for the signal. The signal goes into a digital storage oscilloscope, which digitizes the analog signal. The oscilloscope displays a voltage-time history signal that corresponds to the decaying, random pressure signal. From the voltage signal, we can determine the peak pressure level and decay time (B-duration) for each round fired.

c. *Data Storage:* The oscilloscope has the capability of collecting data at a maximum rate of 0.05 microsecond (μs) per point and can store up to two million data points. If all two million points were collected at the maximum rate, total data collection time would be limited to only 0.1 seconds. This amount of time may not be enough to record the entire event. Therefore, sampling rates of 0.5 to 1.0 μs per point (1 to 2 million samples per second) were chosen to enable the best evaluation of the entire event with sufficient detail.

d. *Peak Pressure and B-duration:* The peak pressure level is the maximum absolute sound pressure level achieved for any specified time interval [2]. The B-duration is the time interval during which the envelope of pressure fluctuations (positive and negative) is within 20 dB of the principal peak pressure level [2]. Peak pressure is determined by multiplying the magnitude of the greatest voltage deflection in the time history by a calibration constant. B-duration is determined by computing the voltage that is 20 dB below the peak voltage, and then finding the point on the time history where the voltage envelope decays to this lower voltage. The time from the start of the pulse to this -20 dB point is the B-duration. When weapons are fired outdoors, B-duration depends on the weapon and ammunition. When weapons are fired indoors, B-duration depends on the acoustical properties of the room more than the emissions of the weapons. Peak pressure, B-duration, and the number of impulse exposures were used to identify the required hearing protection.

3. RESULTS

a. *Noise Levels:* Several B-durations were measured and the average value, in milliseconds (msec), is reported in Table 1. The measured peak pressure level is also shown in Table 1.

Table 1. Firing Range Noise Exposure Summary

Weapon	M1
B-Duration (average, msec)	57
Peak Pressure Level (dB)	158

b. *Applicability of Impulse Noise Standard:* The pressure-time history for the M1 and its ammunition is shown in Attachment 1. From the pressure-time history, we determined that the average time required for the noise from a fired M1 to decay to background level is 0.5 seconds. All of the rounds fired from the M1 decayed to background in less than a second. Therefore, the impulse noise standard applies when the M1 is fired.

4. DISCUSSION

a. Impulse noise is defined as a short burst of acoustic energy consisting of either a single burst or a series of bursts. The pressure-time history of a single burst includes a rapid rise to a peak pressure followed by a somewhat slower decay of the pressure envelope to ambient pressure, both occurring within 1 second [2]. If noise can be defined as impulse, then impulse standards are applied. Otherwise, the continuous noise standard is used. When the M1 was fired, the pressure-time history consistently decayed within one second, so the impulse noise standard can be applied.

b. Assuming the number of exposures equals the number of rounds fired in a class, the required hearing protection is determined from AFOSH Std 48-19 [2]. When we plot the B-duration versus the peak pressure level on the graph in Attachment 2, the X curve is selected since it is the lowest curve above the data point for the M1. Table A2.1 of Attachment 2 indicates that single hearing protection (either plugs or muffs) is considered adequate if the definition of impulse noise is met and the number of exposures is less than 1000. Since there is no guidance on what hearing protection is needed to protect personnel from more than 1000 exposures per day, an individual's number of exposures should be limited to 1000 or less whenever possible. If exposures cannot be limited to 1000 or less per day, double protection should always be used.

c. Instructors are routinely exposed M1 noise. It is particularly important to ensure that adequate hearing protection and guidance for use are provided to instructors. Instructors may participate in multiple classes if the total number of exposures is less than 1000 per day.

5. RECOMMENDATIONS

a. During M1 classes, single hearing protection is adequate for students. Single hearing protection is also adequate for instructors unless they receive more than 1000 exposures per day. Use of double hearing protection, however, provides more protection and is encouraged.

b. Whenever possible, limit instructors to less than 1000 exposures per day.

6. We greatly appreciate the cooperation of the Randolph AFB Honor Guard and Bioenvironmental Engineering personnel during this M1 impulse noise survey. If you have any questions concerning this report, please contact Mr. Wells at DSN 240-2455 or myself at DSN 240-8441.



JEREMY M. SLAGLEY, Capt, USAF, BSC
Industrial Hygiene Consultant

3 Atchs

1. Pressure-Time History for an M1 Rifle
2. Excerpt from AFOSH Standard 48-19
3. References

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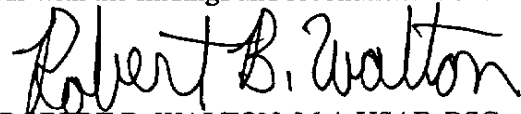
HQ AETC/SGPB

1st Ind, AFIERA/RSHI

27 Sep 00

MEMORANDUM FOR 97 ADOS/SGGB

I have reviewed this report for technical content and concur with the findings and recommendations.



ROBERT B. WALTON, Maj, USAF, BSC
Chief, Industrial Hygiene Branch

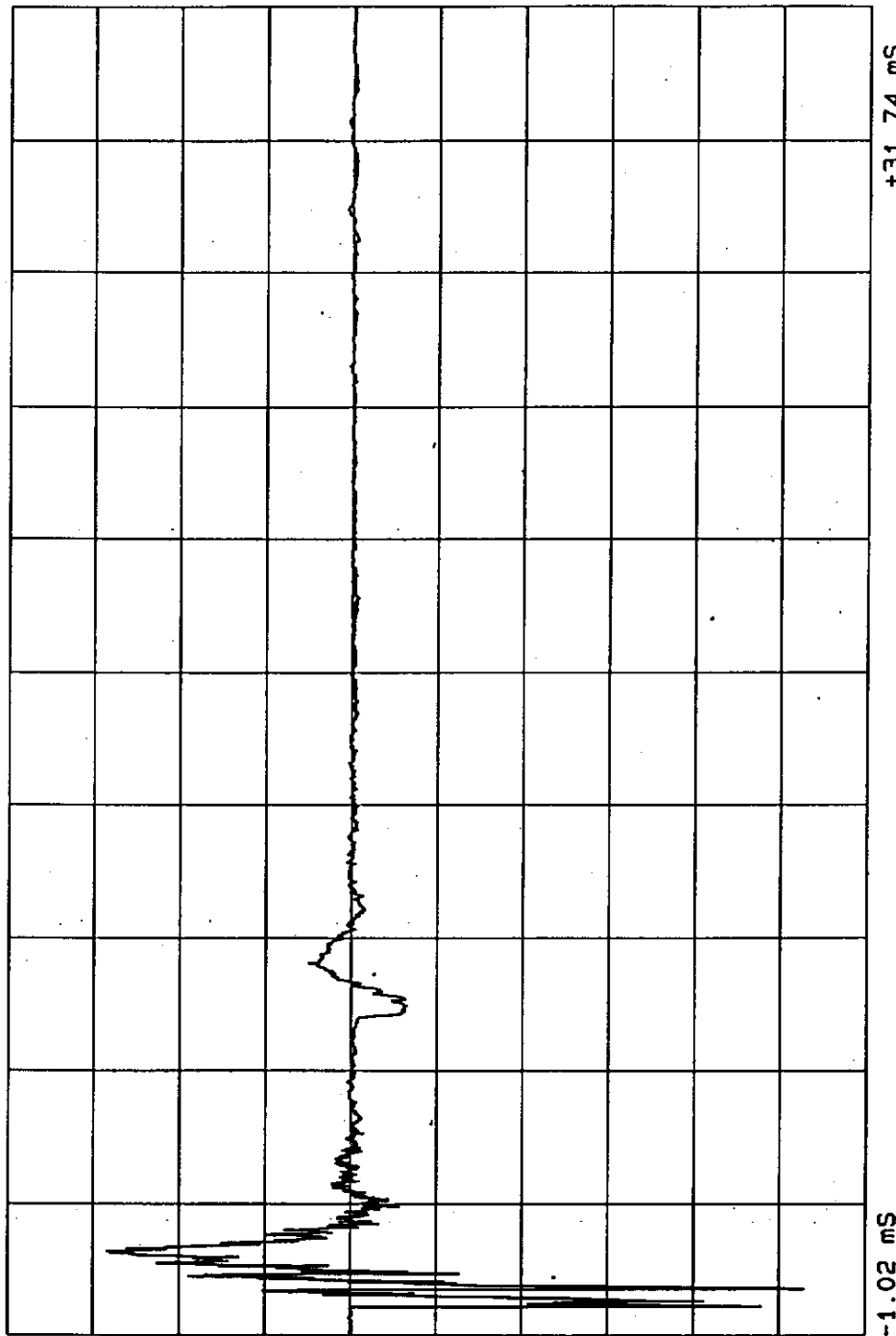
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Single Shooter

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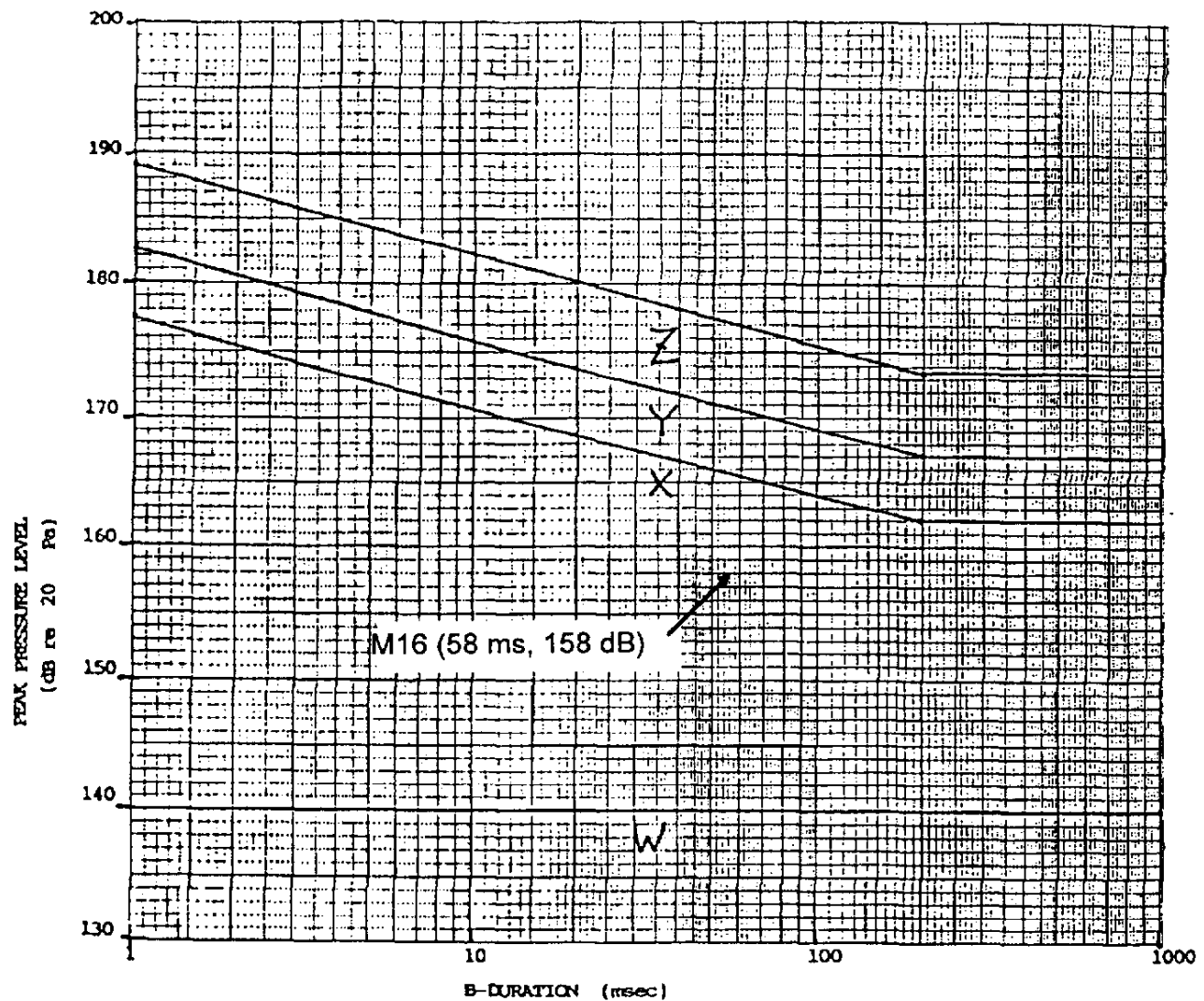
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-3.00 V



Time

Attachment 1. Pressure-time History for an M1 Rifle
at Randolph AFB Honor Guard Practice



(See table A2.1 to select curve for safe use. NOTE: Exposure to levels in excess of limit W requires mandatory hearing protection.)

Table A2.1. Impulse Noise Personal Protection Selection Criteria.

Maximum Expected Number of Exposures in a Single Day *	No Protection	Either Plugs Or Muffs	Both Plugs and Muffs
1000	W	X	Y
100	W	Y	Z
5	W	Z	Z **

* A single exposure consists of either (a) a single pulse for non-repetitive systems (systems producing not more than one impulse per second, such as semi-automatic weapons), or (b) a burst for repetitive systems (systems normally producing more than one impulse per second, such as automatic weapons).

** Higher levels than curve Z are not permitted since other, non-auditory physiological injury may occur.

Attachment 3 – References

1. American National Standard (ANSI) S12.7-1986: Methods for Measurement of Impulse Noise (1986).
2. Air Force Occupational Safety and Health Standard (AFOSH) 48-19, Hazardous Noise Program (31 March 1994).