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14. ABSTRACT An acoustical assessment was performed on the Combat Arms Firing Range at Vance AFB in April 2014. It was determined that the noise in the firing range did not meet the definition of impulse noise in accordance with AFOSH Standard 48-20, due to acoustical reflections. Therefore, it was recommended that acoustical absorption be added to the side walls to reduce the reverberant field.					
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DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
WRIGHT-PATTERSON AFB OH

11 August 2014

MEMORANDUM FOR 71 MDG/SGOQB
ATTN: CAPT TREVOR SLEIGHT
527 Gott Rd, Bldg 810
VANCE AFB, OK 73705-5105

FROM: USAFSAM/OEC
2510 Fifth Street
Wright-Patterson AFB, OH 45433

SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2014-0013, Acoustical Evaluation of
Combat Arms Firing Range, Vance AFB, Oklahoma

1. INTRODUCTION:

a. *Purpose:* On 15-17 April 2014, the United States Air Force School of Aerospace Medicine, Consultative Services Division (USAFSAM/OEC), at the request of AETC/SGPB and 71 MDG/SGOQB, conducted an acoustical evaluation of the Combat Arms Firing Range at Vance AFB, Oklahoma. The process of assessing impulse noise at a firing range is a very complex task using specialized equipment to assess hazardous noise environments. USAFSAM/OEC is the only AF bioenvironmental engineering resource with both the skilled personnel and equipment to accomplish these risk management/mitigation surveys. The purpose of this assessment was to classify the measured noise exposure as continuous or impulse, explain how the classification pertains to Air Force Occupational Safety and Health (AFOSH) Standard 48-20, *Occupational Noise and Hearing Conservation Program*, and provide recommendations for mitigating exposure to hazardous noise.

b. *Survey Personnel:* Two Bioenvironmental Engineering Technicians, Consultative Services Division, USAFSAM/OEC.

c. *Personnel Contacted:*

- (1) Bioenvironmental Engineer, 71 MDG/SGOQB
- (2) Bioenvironmental Engineering Technician, 71 MDG/SGOQB
- (3) NCOIC, Combat Arms, 71 SFS/S4C
- (4) Combat Arms Instructor, 71 SFS/S4C

d. *Equipment:*

- (1) B&K PULSE Analyzer, Type 3052-A-030, SN: 3052-105153
- (2) B&K Microphone, Type 4128C 2530, SN: 2856097, 2856098
- (3) Quest Calibrator, Model # QC-20, SN QF8050050

2. BACKGROUND:

a. The Vance AFB Combat Arms Firing Range is a partially enclosed firing range with 14 total firing lanes (see Figure 1). The range is used to train personnel on M4, M9, and M870 weapons firing. A noise-reverberant field occurs during firing where the noise energy is reflected off the ceiling, walls, and floor surfaces, thereby increasing noise levels for a longer duration. Downrange of the firing line is a series of steel safety baffles covered with plywood on the ceiling that are designed to deflect stray bullets and prevent bullets from leaving the range. These panels are closely spaced, thereby reflecting acoustical energy and increasing the duration of noise levels.



Figure 1. Vance AFB Combat Arms Firing Range Lanes

b. During this assessment, data were not collected during the Combat Arms live-fire qualification training course.

c. According to AFOSH Standard 48-20, the maximum level of **continuous noise** that is allowed to reach the ear shall not exceed 115 dBA and the maximum level of **impulse noise** that is allowed to reach the ear shall not exceed 140 dB peak sound pressure level (SPL).

3. METHODOLOGY:

a. *Process Description:* The Combat Arms Firing Range is used to train and qualify base personnel on multiple weapons systems. The firing range has two distinct painted floor lines that are used for reference. The first point of reference is the yellow safety line. Students must stand behind this line while not actively firing a weapon. The second point of reference is the red firing line, which is located 8 feet forward of the yellow safety line. The red line is where each student actively fires a weapon at a downrange target. During live-fire weapons training classes, instructors are positioned along the yellow line to ensure the range is safe and to assist students when needed. During this assessment, Combat Arms Instructors were observed wearing dual hearing protection.

b. *Sample Procedure:* The SPL time histories corresponding to individual M4, M9, and M870 weapons firings were measured with 1/8-inch microphones placed 5 feet above ground level along the yellow safety line; see Figure 2 for microphone positions.

c. Time histories are measured SPLs over a duration of approximately 10 seconds. This duration provided sufficient time to characterize the decay of the acoustical energy to background levels. These time histories were then used to compute acoustical decay characteristics.

d. The linear SPL decay rates, in decibels per second, were computed by selecting the linear decay phase of each time history and performing a sound level versus time analysis through the decay phase. Decay times are calculated from the linear slope from 150 dB down to 80 dB. The slope of this curve is the decay rate.

e. SPL time history data were collected in three phases to represent the spectrum of exposure scenarios typical at this range.

(1) During the first phase, one Combat Arms Instructor fired an M870 from firing lanes 3, 7, and 10. SPL time histories were collected at each microphone position.

(2) For the second phase, one Combat Arms Instructor fired an M9 from firing lanes 3, 7, and 10. SPL time histories were collected at each microphone position.

(3) The third phase of data collection was accomplished while one Combat Arms Instructor shot the M4 from firing lanes 3, 7, and 10. SPL time histories were collected at each microphone position.

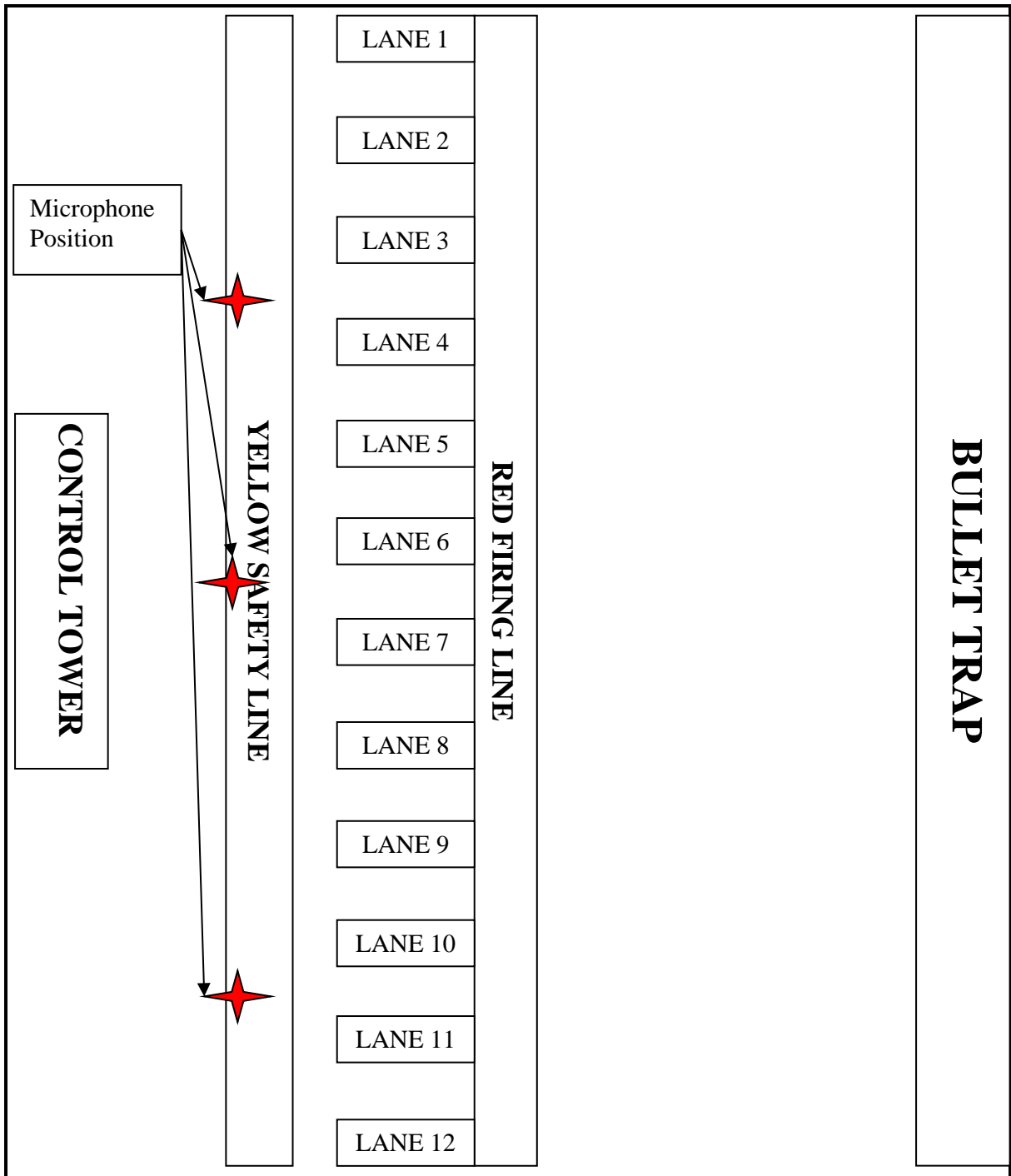


Figure 2. Vance AFB Combat Arms Firing Range Layout and Microphone Positions

4. RESULTS:

a. Under the monitored conditions of this assessment, the average noise decay time for each of the weapons fired was greater than 1 second with peak SPLs greater than 115 dB; therefore, the noise is classified as continuous. According to AFOSH Standard 48-20, Table 3, there is no allowed exposure time above 115 dBA.

b. The average decay time and noise characterization of the five different types of weapons are summarized in Table 1.

Table 1: Noise Characterization by Decay Time

Weapon System/Class Type	Average Decay Time (s)	Peak Sound Pressure Level (dB)	Noise Characterization	Maximum Unprotected Continuous Noise Level (dB)	Exceeds Continuous Noise Std. (Yes/No)
M9 single shooter	1.7	139			
M4 single shooter	1.9	145	Continuous	115	Yes
M870 single shooter	2.1	147			

5. CONCLUSION:

a. Based on the average decay times, the noise in the range is classified as continuous noise. According to AFOSH Standard 48-20, there is no allowed exposure time above 115 dBA.

b. Speech intelligibility is poor due to the strong reverberant sound field of the range. This condition increases safety risks.

6. RECOMMENDATIONS:

a. Install sound-absorbing material to reduce the reverberant field. The reverberant field in the range should be minimized to reduce the noise level to protect instructors and students from hazardous noise exposure and to improve speech intelligibility.

(1) Treat the firing area's first overhead baffle, the ceiling, and side walls from the red line back to the rear wall, the wall areas between the roll-up doors, as well as the the rear wall with acoustical absorption material. Quilted fiberglass, or other fiberglass panels wrapped in a manner allowing easy cleaning, is one option. There are also more fixed installation materials available, such as products offered by Pyrok or Troy Acoustics. The ideal goal of engineering controls is to reduce decay time to less than 1 second and peak SPLs to below 140 dB in accordance with AFOSH Standard 48-20, para 2.11.3.1. Controls to reduce the peak levels have been deemed operationally unacceptable. The goal of the sound-absorbing material is to change the noise classification from continuous to impulse noise by reducing the noise decay time to less than 1 second.

- b. Both Combat Arms Instructors and students should continue to wear dual hearing protection during all live firing at the range.
- c. Until effective engineering controls can be implemented, consider close scrutiny (frequent) audiograms as defined in AFOSH Standard 48-20 for all Combat Arms Instructors. The frequency of the audiograms will need to be determined locally by the Hearing Conservation Program Manager or through the Occupational and Environmental Health Working Group.
- d. Combat Arms Instructors should provide just-in-time training to students on proper use of hearing protection devices as part of classroom instruction. The National Institute for Occupational Safety and Health has a short video, as well as a printable brochure, on proper insertion of foam ear plugs available for download at <http://www.cdc.gov/niosh/mining/works/coversheet1840.html>.
- e. Request a USAFSAM follow-up noise assessment after acoustical treatment of the range is complete.
7. If you have any further questions regarding this report, please contact TSgt Jerimiah Jackson at DSN 798-3312 or jerimiah.jackson@us.af.mil. Please direct any questions or comments regarding Industrial Hygiene Consultative support to Maj Marc Sylvander at DSN 798-3855 or marc.sylvander@us.af.mil. To improve our services, please complete the critique located at <https://www.surveymonkey.com/s/OECUSTOMERSURVEY>.



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