Acoustical Evaluation of 35 SFS Indoor Firing Range, Misawa Air Base, Japan

June 24-25, 2004

Consultative Letter # AFIOH-DO-BR-CL-2004-0046

Prepared by:

Detachment 3, AFIOH/CD
Kadena AB, Okinawa, Japan

10 August 2004

DEPARTMENT OF THE AIR FORCE
DETACHMENT 3, AIR FORCE INSTITUTE FOR OPERATIONAL HEALTH
(AFIOH) (AFMC)
APO AP 96368-5213

10 August 2004

MEMORANDUM FOR 35 AMDS/SGPB
Attention: Capt Belser

FROM: Detachment 3, AFIOH/CD
Unit 5213
APO AP 96368-5213

SUBJECT: Consultative Letter, IOH-DO-BR-CL-2004-0046, Acoustical Evaluation of 35 SFS Indoor Firing Range, Misawa Air Base, Japan

1. Scope: At the request of your office, Detachment 3, of the Air Force Institute for Operational Health (AFIOH) completed an acoustical study at the 35 SFS Indoor Firing Range. The purpose of this study was to identify noise contours that could be utilized to select appropriate dampening materials and pinpoint dampening installation locations.

2. Background: The Security Forces indoor small arms range is located in the Security Hill sector of Misawa AB at building 1549. This recently opened range complex is poured concrete construction with a roughly finished interior. Much of the range, including all of the ceiling and most of the walls (see attachment 1) has been left as natural concrete. This creates significant reverberation inside the range during weapons firing. Couple this with a lack of noise dampening in the range and there are significant hazardous noise issues.

3. Personnel Contacted:
Capt William Belser, Bioenvironmental Engineering Flight Commander
TSgt Anthony Harris, 35 SFS Firing Range
SrA Nekia Mbaye, Bioenvironmental Engineering Technician
Ms. Christina Lane, Bioenvironmental Engineering Assistant

4. Process Description: The firing range was evaluated over a two day period. The initial visit involved a complete physical assessment of the range and development of an accurate facility drawing (see attachment 2). The facility is 8' 11½" tall from front to back. It has two entry doors in the walls behind the firing line. There is a control booth in one of the corners behind the firing line. The control booth is not enclosed. The back wall of the range is peg-hole wallboard. Besides functioning as a rear wall for the range, it also allows supply air from a ventilation system behind the wall to be blown into the firing area. This system captures lead dust created

during weapon firing and carries it down range. The ceiling is natural concrete with fluorescent lighting shielded by wooden bullet deflectors. The down range portion tapers 15'4" to a funnel where spent rounds are collected. They are captured on a tray behind the range where an auger operates to pull the rounds down the tray and into a 55-gallon drum. This area of the range also has a large exhaust system to capture airborne lead dust. There is no existing noise dampening in the range.

The noise assessment was completed on the second day. In order to accomplish this, a Quest Model 2900 Sound Level Meter with a Quest Model OB-300 Octave Filter was utilized. This instrument was calibrated with a Quest Model QC-10 Calibrator immediately prior to the start of the survey and the calibration was verified several times during the survey. Measurements were taken at two locations inside of the range under a variety of scenarios. The first measurement location was at ear level of the seated position in the operator's booth. The microphone was positioned downrange at an angle according to manufacturer recommendations. The second measurement location was at ear level for the weapon's operator. The weapon's operator fired a M4 in three round bursts using 5.56-mm ammunition. The M4 is the most common weapon used on the range. The weapon's operator was situated in the prone firing position in lane seven of the firing range. This lane was chosen due to its proximity to the operator's booth and to a range wall. This would maximize reverberation and thereby sound levels.

Four sets of measurements were collected at both measurement locations. These four sets included (1) background noise, (2) background noise + lead capture auger, (3) background noise + ventilation system, and (4) background noise + lead capture auger + ventilation system + weapons firing. In each case, the sound level meter captured linear decibel readings at all of the primary center frequencies (16Hz, 31.5Hz, 63Hz, 125Hz, 250Hz, 500Hz, 1000Hz, 2000Hz, 4000Hz, 8000Hz, and 16000Hz). For the first three sets, the meter was set to fast response and the highest stable reading was recorded. Due to the staccato nature of weapons firing, the meter was set to impact for the final measurement set and the highest reading was recorded.

5. Findings & Observations:

The results for the background sound level measurements inside the firing range are listed in Table 1. These levels are normal for this type of building construction.

Table 1: Background Sound Levels (dB_{LIN})

	Frequency (Hz)										
	16	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**16000**
Operator's Booth	48	53	55	47	43	34	30	30	30	30	30
Shooter	49	51	57	54	50	38	30	30	30	30	30

*Note that 30dB was the lower limit of the machine.

The sound levels listed in Table 2 were measured when the lead capture auger was turned on. The table also indicates the difference between these values and the background level. When examining these values, it is important to realize that the decibel scale is logarithmic, not linear. Therefore a one decibel increase in sound level equates roughly to a 20% increase in noise exposure.

Table 2: Background + Lead Capture Auger Sound Levels (dB_{LIN})

	Frequency (Hz)										
	16	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**16000**
Operator's Booth	76	80	68	66	58	53	54	62	64	64	47
Difference from Background	+28	+27	+13	+19	+15	+19	+24	+32	+34	+34	+17
Shooter	69	78	71	71	66	56	56	62	66	66	49
Difference from Background	+20	+27	+14	+17	+16	+18	+26	+32	+36	+36	+19

The lead capture auger adds a significant sound burden to the room, but none of the values approach levels of regulatory or occupational health concern. The sound seems to be spread evenly across the entire spectrum, but with the highest levels still concentrated in the lower frequencies. Table 3 illustrates the change to the background level when the ventilation fan was turned on.

Table 3: Background + Ventilation Sound Levels (dB_{LIN})

	Frequency (Hz)										
	16	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**16000**
Operator's Booth	46	51	62	69	67	65	65	62	58	52	43
Difference from Background	-2	-2	+7	+22	+24	+31	+35	+32	+28	+22	+13
Shooter	47	52	63	69	66	66	67	63	57	49	44
Difference from Background	-2	-1	+6	+15	+16	+28	+37	+33	+27	+19	+14

As with the lead capture auger, the ventilation system adds a significant sound burden to the firing range, but the resulting levels are not considered significant with regard to regulatory or occupational health concerns. This sound seems to be concentrated more in the mid-frequency area, with a slight tendency toward the high frequencies. The small negative numbers on the low frequency end of the spectrum can be considered within the normal variability associated with the instrument be utilized. They should not be interpreted to indicate that it was quieter with the ventilation turned on than with it off.

It is also interesting to note that levels for both the operator's booth and the shooter are nearly identical, even though the supply ventilation is entering the range directly behind the operator's booth. This can most likely be attributed to the reverberation acoustics of the room which tend to even out the sound levels throughout. The final chart (Table 4) shows the measurements during weapons firing with all other sound sources operating.

Table 4: Background + Lead Auger + Ventilation + Weapons Sound Levels (dB_{LIN})

	Frequency (Hz)										
	16	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**16000**
Operator's Booth	84	88	91	115	126	129	132	131	127	120	108
Difference from Background	+36	+35	+36	+68	+83	+85	+102	+101	+97	+90	+78
Shooter	98	104	107	117	127	133	132	129	126	119	107
Difference from Background	+49	+53	+50	+63	+77	+95	+102	+99	+96	+89	+77

It is readily apparent from Table 4 that the sound level associated with the weapon completely dominates all other sources. Although this is true across all frequencies, the highest increases in sound pressure are between 250-4000 Hertz. Another note of interest is the apparent lack of significant sound level difference between the two measurement locations. This can likely be attributed to reverberation in the firing range. All of this information is valuable in determining the proper control of noise in this environment.

6. Discussion:

It is clear from the measurements above that the sound pressure levels being generated by gunfire in the firing range need to be reduced. Since it is unacceptable to replace the current weapons or modify the training classes, the most feasible solution is to dampen the sound. There are two sources to the sound (direct and reverberation), so an effective solution will address both. Based upon this, there are a couple of options available when considering dampening.

1. Quilted Fiberglass: A reliable method used at many indoor firing ranges is quilted fiberglass panels. Typically, these 1" thick panels, with a 1" air gap, are mounted to the range walls and ceiling behind the firing line. The panels must be covered on both sides to facilitate cleaning and prevent lead impregnation. These panels are an excellent choice for reducing reverberation, but provide minimal direct sound absorption.

2. Foam Panels: A variety of manufacturers produce panels composed of noise-absorbent foam. The primary advantage of these panels is their ability to limit reverberation and absorb sound energy. A typical panel can absorb between 70-90% of the acoustical energy for the 500 Hz and 1000 Hz frequencies. These panels also have the advantage of easy cleaning to prevent lead dust build-up. Finally, these panels can be manufactured with fire retardant materials making them significantly less flammable than the quilted fiberglass.

7. Recommendation:

Based upon the above discussion, the most appropriate method to control sound levels in the indoor firing range is through the use of foam panels. The following items should be considered when purchasing the appropriate panels.

- Panels should be 2" thick and have a Class I fire rating.

- Based upon the size of the range, 3800ft^2 of foam will be necessary to properly dampen the range. Foam should be split with 2/3 applied to the ceiling and 1/3 applied to the walls. The ceiling foam should be applied starting at 6' behind the firing line and moving forward down the range. The foam should cover the ceiling from side wall to side wall. The wall foam should start at the firing line and extend down range. Foam should be applied to each side evenly with a 1' gap left between the bottom of the foam and the floor.

- Panels should be cut as little as possible. It will be necessary to modify the panels to avoid lights and deflectors, but the more intact the panels remain, the better they will function.

- Panels should have a Hypalon® coating to facilitate cleaning.

- Panels should be attached directly to the concrete walls -- no air gap is necessary. Special adhesives are unnecessary; a standard water-based or spray adhesive will work fine.

8. If you have any questions concerning this survey, please contact me at DSN 634-2638 or e-mail me at gregory.frick@kadena.af.mil. I appreciate the opportunity to provide assistance on this project and would like to extend my gratitude to all of the professionals in your shop for their cooperation and support.

GREGORY A. FRICK, Maj, USAF, BSC, CIH
Chief, Occupational Health Division

2 Attachments:
1. Firing Range Photos
2. Firing Range Drawing

Figure 1: Firing Line -- Stations 1-3

Figure 2: Firing Line -- Stations 5-7

Figure 3: Control Booth -- Measurement Location #1

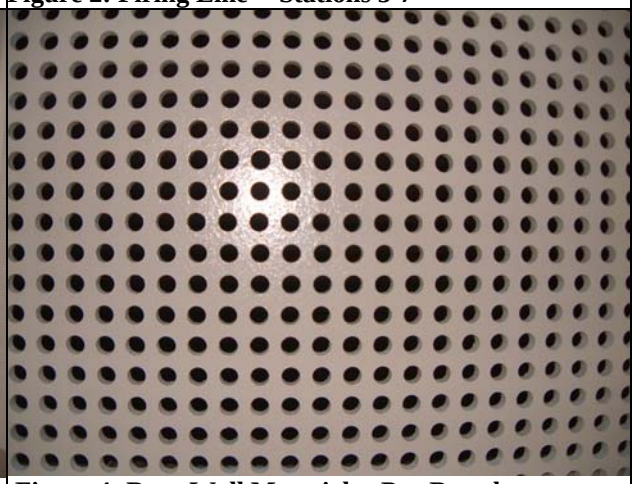


Figure 4: Rear Wall Material -- Peg Board

Figure 5: Firing Range Side Wall

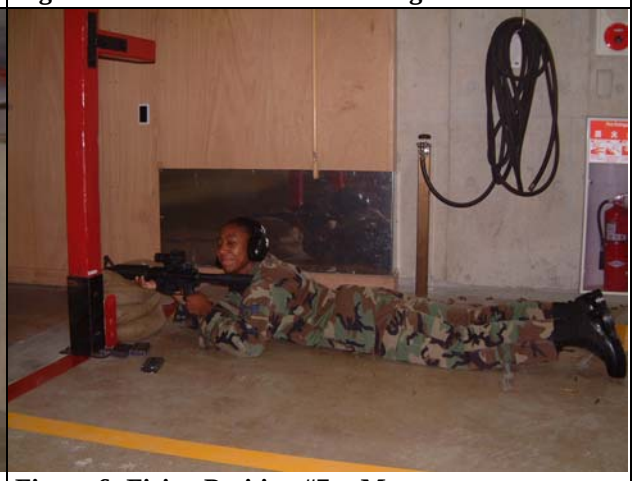
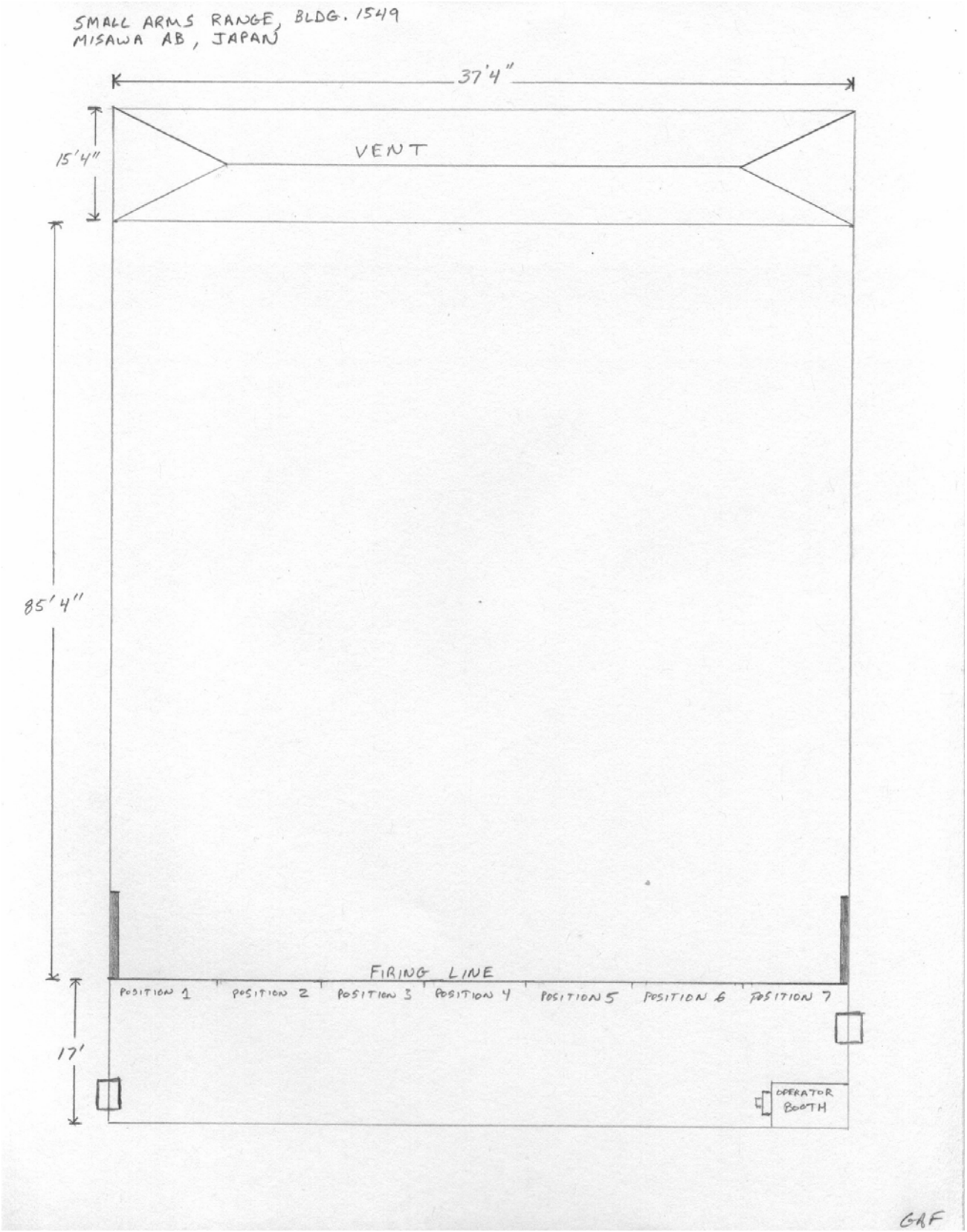


Figure 6: Firing Position #7 -- Measurement Location #2



Attachment 2
Firing Range Drawing
2-1