CHAPTER 31

CONTROL OF NOISE FROM SA RANGES

INTRODUCTION

3101. **Aim.** This Chapter provides advice on environmental noise related issues as they relate to small arms ranges. The Chapter is primarily aimed at those producing justifications for works related to noise reduction around ranges and Range Administration Units (RAU) so they have some insight into the issues and more particularly the control measures available and covers:

a. Introduction.

b. Noise at Work.

c. Environnemental Noise from ranges.

d. Engineering controls for environmental noise from ranges.

HEARING PROTECTION.

3102. **Control Measures.** Noise in relation to small arms ranges involves protection for those exposed to muzzle blast peak noise levels dealt with under the Control of Noise at Work Regs 2005 (CNWR). MOD policy covering hearing protection on ranges is covered in PAM21.

3103. **Indoor Ranges**. Engineering solutions to minimise the effect of noise are only possible in indoor ranges or where there are enclosed firing points. When analysing the acoustic properties of a room, the sound arriving at the ears, can be considered under 3 headings:

a. **Direct Sound**. This is the sound which travels directly from the source to the listener. It is the first sound to reach the listener, having travelled by the shortest route at a velocity of approximately 340 m/s. Hearing protection is the only means of providing protection from direct sound.

b. **Early Sound Reflections**. Shortly after the direct sound arrives, the listener receives a series of sound wave fronts which have been reflected one or more times from the walls, ceiling and any other reflective surfaces in the room. These wave fronts have taken a longer path than the direct sound and therefore arrive later. The later they arrive, the greater their potential for interfering with speech intelligibility. Angled baffles such as those used on the old 94 HEAT range firing points (see Chapter 24) deflect noise away from the firing point. Open texture materials can absorb noise and there are many proprietary noise reduction surface finishes that are suitable for use in ranges – i.e. they do not absorb dust

c. **Reverberation.** Sound wave fronts are repeatedly reflected from the room surfaces and, as a result of absorption, gradually grow weaker and weaker. Acoustic surfaces in a firing room will ensure reverberation is minimised.

3104. Spare

ENVIRONNEMENTAL NOISE

[Noise nuisance.]

BACKGROUND

3105. **The Environmental Issue**. Noise is a particular issue for the MOD. Training requires realistic battlefield conditions which include live and blank firing on ranges and training areas, tank exercises, blast vibrations from firing and battle simulation effects, and the use of weapon firing simulators and other similar operations. Low altitude flying and night flying are also essential training activities that must be carried out regularly if the Armed Forces are to remain effective, and this may be intrusive, especially at night. Noise, can also be generated from non-training activities at MOD barracks, offices and establishments. Road vehicles are a very pervasive source of noise (and vibration) in the environment, and MOD heavy vehicle movements may be intrusive, again, especially at night.

3106. **The Nugent Rule (Historical Reference).** Distance is the most cost effective reduction measure available as well argued in the Report extracted below.

Report of the Defence Lands Committee 1971-73 by The right Hon. Lord Nugent of Guilford.

Report of the Defence Lands Committee 1971 – 73

Extract

Noise

8.33 We first examined the measures the Services are already taking to mitigate the effects of noisy activities. We learned that steps have been taken, at an airfield where noise problems are particularly severe, to buy surrounding land to ensure that the areas most affected are not developed. This policy of sterilization can, in special cases, make a worthwhile contribution to the reduction of noise nuisance to the public; though it involves the acquisition of more defence land, this land can usually be productively used for agricultural purposes.

Buffer Zones

8.34 We considered whether this policy might have wider applications. In particular, we had in mind the fact that the noise problem which already exists at firing ranges and training areas close to urban areas is likely to get worse as housing and other developments advance closer to the Service sites, even though the volume of noise may not increase. We hold very strongly that this is a matter which needs to be tackled now, and consider that if 'buffer zones' were introduced between Army sites where firing takes place and civilian developments, the worst features of this noise problem could be contained, and in some measure mitigated. We recognize that this poses problems for local authorities as well as the Ministry of Defence; we recommend that it should be tackled jointly, with give and take on both sides. Existing dispositions and problems of land acquisition make it unlikely that this policy can be universally applied, but we would propose its adoption wherever practicable.

NOISE SOURCE

3107. **Sound in the Open Air.** As an observer moves away from a sound source, the sound pressure level diminishes. The rate which this occurs depends on the nature of the source itself and this principle is true as long as the observer is not too close. Most practical situations may be described in terms of two 'ideal' sources: point sources and line sources.

a. **Point Source**. The sound source is represented by a point and sound is radiated equally from it in all directions. Every time the distance from a point source is doubled, the level decreases by 6dB. A point source, such as a weapon, which produces a level of 130dB at 10m will produce a level of 124dB at 20m. At a distance of 30m, the level will have fallen by 10dB. In other words, when the distance is trebled, the loudness is halved.

b. **Line Source**. A line source, such as a military convoy, which produces a level of 70dB at 10m, will produce 67dB at 20m. For a 10dB reduction, half as loud as the level at 10m, the observer must retreat to a distance of approximately 100m from the source or ten times the original distance.

NATURAL DISSIPATION

3108. **Attenuation In Open Air**. Attenuation due to distance has already been discussed. Wind and temperature gradients also effect sound. Sound travels faster in air as the temperature increases. The absolute speed also increases with wind speed (downwind propagation).

3109. **Attenuation from existing Screens and Barriers**. In addition to the effect climate has on sound, there are often buildings or similar objects which lie between the source and the observer and prevent line of sight between them. When a sound wave meets an obstacle like a fence or a building, a proportion of it is reflected, and the rest of the wave carries on past the edge of the obstacle. However, the 'bare' edge of a sound wave cannot sustain itself in free space - the vibrating air molecules at the end start themselves to act like sources and radiate in all directions. The result is, that a sound wave which has passed the obstacle, bends or diffracts round it into the shadow zone behind the obstacle.

NATURAL & ENGINEERING CONTROLS

3110. **Distance**. This is a simple inverse square law relationship, which at frequencies between 300-600 Hz, would give attenuations of 66 dB and 68 dB at 1500 metres and 1650 metres respectively.

3111. **Ground Absorption**. Sound travelling close to grass covered ground is attenuated as follows:

Distance from sound source in metres	Frequency (Hz)				
	37-75	75-150	150-300	300-600	600-1200
	Attenuation (dB)				
1500	4-5	15-0	34-0	45-0	34-0
1650	5-0	16-5	38-0	50-0	38-0

Ground Absorption

3112. **Trees**. When trees are sufficiently dense, so as to mask a highly visible object at 60 metres, the following attenuations apply:

Frequency (Hz)	37-75	75-150	150-300	300-600	600-1200
Attenuation (dB)	2	3	5	6	7

Attenuation from trees

3113. **Earth Banks**. Although these block the direct path of sound between weapon and complaint area, earth banks have a complicated effect:

a. For example, the attenuation due to banks at 3 metres and 30 metres from the weapon would be 18dB and 9dB respectively. Should the side of the bank nearest the weapon be vertical the above attenuation would be reduced.

b. A bank may however cut out, or reduce, the sound travelling close to the ground and hence reduce the ground absorption by about half. To gain 18dB attenuation by means of a bank 3 metres from the weapon, one could therefore lose between 22-5 and 25dB attenuation in lost ground absorption. This effect is uncertain, especially where the ground cover is bushy rather than grassy.

c. The effect of a bank and its likely effect on ground absorption may be summarised as follows:

Bank sited at 3m from weapon	Frequency (Hz)				
	37-75	75-150	150-300	300-600	600-1200
Attenuation due To bank (dB)	9	12	15	18	21
Loss of ground absorption, in dB, due to bank:					
at 1500 m	2.3	7.5	17	22.5	17
at 1650 m	2.5	8.3	19	25	19

Attenuation from earth banks.

3114. **Wind and Turbulence**. Turbulence at the top of a wall may assist the sound to diffract over the wall and reduce the dBs of attenuation as follows:

Wind Speed	Frequency (Hz)				
	37.75	75-150	150-300	300-600	600-1200
8 kph	0 dB	0 dB	0 dB	0 dB	0 dB
16 kph	0 dB	0 dB	1 dB	2 dB	4dB
32 kph	1 dB	3 dB	6 dB	8 dB	10 dB

Attenuation from wind.

3115. **Temperature and Humidity**. A figure of 3 dB attenuation has been taken as typical for temperate summer climatic conditions. The figure represents atmospheric absorption at low frequencies. At high frequencies absorption will be much higher, so much so that high frequency nuisance over these sample distances can be ignored.

3116. **Temperature Gradients**. These have effects like those of wind gradients and, similarly, are not as yet capable of prediction. An inversion may increase sound transmission but it is not known how often this condition may obtain in any given locale. However at least it could not be combined with the adverse wind direction mentioned above.

3117. **Theoretical Prediction.** An example is given below of a theoretical prediction of sound attenuation, at distances of 1500 metres and 1650 metres from an SLR. As high frequencies, i.e. above 1000 Hz, will be unimportant in the case of small arms, the octave 300-600 Hz is used in the example.

Attenuation for sounds in the 300-600 Hz octave:

	See paragraph as under	Distances from Weapon			
		1500 metres		1650 metres	
		Without Bank	With Bank	Without Bank	With Bank
Distance	3110	dB 66	dB 66	dB 68	dB 68
Ground absorption	3111	45	22.5	50	25
Trees	3112	6	6	6	6
Earth bank 3 m from weapon	3113	-	18	-	18
Wind and Turbulence (assumed 32 kph)	3114	-8	-8	-8	-8
Temperate and Relative Humidity	3115	3	3	3	3
TOTAL Attenuation		112dB	107.5dB	119dB	112dB

Attenuation for sounds in the 300-600 Hz octave

a. The sound peak pressure, at the weapon, for the SLR is 159dB. From the table above, it can be seen that at 1500 metres from the weapon the sound peak pressure would be:

a. With Bank (159 -107.5) = 51.5dB.

b. Without Bank (159 -112) = 47dB.

b. These levels would be barely detectable in an average room and certainly not outside in a normal urban environment. It is emphasised that while these figures are theoretical, they were found to agree, within plus or minus 10%, with sound measurements taken in a similar situation.

3118 – 3119. Spare

GERMAN RANGE NOISE BAFFLE SOLUTIONS

3120. In 1991 the German, US and UK combined to develop means of reducing noise from tank test facilities, armoured and artillery ranges with fixed firing points and fixed small arms ranges. The methods included absorbing noise walls, barriers, both vertical and earth banks and for the first time open box units mounted above the firing points and in some cases, ranges. These measures achieved considerable reductions in audible noise beyond the firing points.

ANNEX A

To Chapter 31

**MEASUREMENTS OF PEAK PRESSURE LEVELS (dB)
AND PULSE DURATION (milliseconds) FOR TYPICAL
INFANTRY WEAPON SYSTEMS**

SER	WEAPON/AMMUNITION	EAR POSITION									
		FIRER		LOADER		INSTRUCTOR OR ADJACENT PERSONNEL					
						0.3m to Side		1.2m Side		3.0m Side	
		dB	ms	dB	ms	dB	ms	dB	ms	dB	ms
(a)	(b)	I	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
1	SLR/7.62mm Live 0.3M above Ground 1.5M above Ground SLR/7.62 Blank	 160 151 150	 5.0 0.9 10.0	 - - -	 - - -	 - 169 -	 - 0.5 -	 - 160 -	 - 0.5 -	 - 155 -	 - 0.5 -
2	SA80/5.56mm Live	158	-	-	-	-	-	-	-	-	-
3	Colt Armalite/5.56mm Live	151	1.0	-	-	165	1.0	155	0.5	153	0.5
4	SMG/9mm Live	157	1.0	-	-	162	1.0	154	0.5	151	0.5
5	GPMG/7.62mm Live	162	-	-	-	-	-	-	-	-	-
6	Shotgun/12 bore	155	5.0	-	-	-	-	-	-	-	-
7	Pistol/0.38 inch	157	5.0	-	-	-	-	-	-	-	-
8	Pistol/9mm Live	157	1.0	-	-	-	-	-	-	-	-
9	Rifle/0.22 inch	138	2.5	-	-	-	-	132	2.5	-	-
10	Mortar 81mm, QE45° L16/Charge 5 QE45° L16/Charge 5 QE45°	183 187 183	11.0 3.0 2.7	186 - -	8.0 - -	- - -	- - -	- 182 183	- 3.6 2.9	- 173 170	- 4.0 4.4
11	Mortar 2 inch QE45° MK2/2	170	0.9	-	-	-	-	161	0.9	153	0.7
12	LAW 80/94mm Practice A1T	183	-	-	-	-	-	184	-	-	-
13	Carl Gustav/84mm Practice AT	183	8.0	187	8.0	-	-	-	-	182	8.0

Note:

1. The pulse duration is the total time taken for the pressure fluctuations to decay by 20 dB from the peak pressure level.

ANNEX B

To Chapter 31

NOISE SURVEY RESULTS FOR A TYPICAL

CENTREFIRE INDOOR TUBE RANGE

1. Frequency Analysis - SA 80 5.56mm Ball.

Hz	63	125	250	500	1000	2000	4000	8000
dB	127	138	140	145	151	144	147	145

2. SA80 5 Rounds Single Shot.

Max Peak	158	157	157	156	157
IEL	-	143	143	143	144

3. SA80 Rapid Fire.

Max Peak	158	158	158	157	158
IEL	145	144	144	144	145

4. Frequency Analysis - GPMG 7.62mm Ball.

Hz	63	125	250	500	1000	2000	4000	8000
dB	129	140	148	148	148	150	150	150

5. GPMG 5 rounds Single Shot.

Max Peak	159	160	161	160	161
IEL	144	144	141	142	144

6. GPMG Rapid Fire.

Max Peak	162	160	160	160	158
IEL	149	145	144	141	142

7. Reverberation Time of Range Tested = 1.016 seconds.

Note:

IEL - Impulse Exposure Level.