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Mr David Howell
Occupational Health
N. Staffs Police Headquarters
Cannock Road
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Dear Mr Howell,

Compound Security Systems 'Mosquito' sonic deterrent
Report on acoustic tests performed 6th April 2006

Thank you for your invitation to examine an example of the Mosquito deterrent device, and for the opportunity for my colleague Emma Conein and myself to make some measurements under reasonably controlled conditions.

Emma's report on the measurements we made in the gymnasium shows that the device performs broadly as the manufacturer describes, with a measurable output around 16 to 20 kHz, pulsing regularly at about 2 Hz. The overall sound intensity was close to that claimed by the manufacturer and measured independently by standards laboratories, though the measurement conditions were not ideal, and would not be representative of a free-field shop-front installation position some 3 m from the ground. On the other hand, these conditions might be more like an installation in a more resonant shopping mall, with concrete and brick walls in a similar configuration to the gymnasium.

Subjectively, the presbycusis effect was evident, since I was unable to detect the intended output from the loudspeaker, but Emma (just short of 24 years of age) was able to hear it, and found it disagreeable. I was able to detect that the unit was powered up and running from the small amount of amplifier or mechanical noise generated by the device, but only from a distance of about a metre or less, so in practical situations this would be completely inaudible to most people in their late 20s or older.

We cannot say if there was any generated output above 20 kHz, since the IVIE spectrum analyzer with 1/3 rd octave band-pass display was not capable of displaying beyond 20 kHz (and presumably, by design, unable to record or measure it either). If any output above 20 kHz exists in the Mosquito's output, it would be inaudible to virtually all humans of any age. On the other hand, it is not possible to state categorically that supersonic components are irrelevant to any possible hazards associated with Mosquito, since there may be effects on human hearing at lower frequencies which are unknown.

Examining the device, it was clear that the electrical power required to run it was low, since it was powered simply by a 12V 'power brick', of the sort used to recharge torches or mobile phones, or to power fax machines or answer phones in the home and office. The visible cable runs were of small capacity, so the power consumed is small, and less than that required to run a domestic audio system of any quality. However, the small amount of power consumed was all being directed towards the production of intense high frequency sound, which was reported as being reasonably loud by those who can hear it, and attention-flagging, because of the cyclic nature of the sound being generated. Emma

The evaluation of a Mosquito teenager deterrent at Staffordshire Police Headquarters

A Mosquito teenager deterrent (manufactured by Compound Security Ltd) was tested on the 6th April 2006 using an IE30A 1/3 octave spectrum analyser. The spectrum analyser was calibrated the day before the measurement of the Mosquito device, using a piston sound generator (1 kHz, 92.0 dB) which was calibrated by the National Physical Laboratory (NPL).

The device was mounted approximately 80 cm from the floor in a large gymnasium. The device was measured at a variety of distances and at different angles to the front face of the device.

The measurements were made with no weighting (units: dB) and with an A-weighted filter (units: dBA) to allow comparison with previous measurements of the device and with noise legislation and guidelines. The A-weighting filter is used to represent subjective loudness of the human ear.

Due to the measurement conditions these measurements cannot be said to be "free field" measurements and as such the measurements are a combination of the sound coming directly from the device and reflections from the walls of the gymnasium. Ambient noise was measured to be of the order of 55 dB (49 dBA) during the course of the measurements. No correction for ambient noise was made, since the noise from the source was over 10 dB greater than the ambient noise.

The NPL measurements of this device, as found on the Compound Security website, found that the Mosquito had an unweighted sound pressure level at 3 m of 83.2 dB and an A-weighted level of 76 dBA. Our corresponding measurement fluctuated between 85.2-86.2 dB and 73.1-77.4 dBA respectively. The fluctuations noted here are due to the cyclical nature of the noise produced by the Mosquito. We conclude that our measurements are in agreement to those carried out by NPL.

The device claimed to change to a lower output after 15 minutes and this claim was tested. After 22 minutes of the device being on, the output changed from fluctuating between 57.0-61.0 dBA to 53.4-57.0 dBA (measured 6 m away at 90° to the device). As a general rule sound intensity must be increased by a factor of ten for sound to be perceived as twice as loud so a 4 dB drop is not going to sound very different.

Directly in front of the device, at a distance of 1.5 m, the spectral composition of the sound from the device was measured as follows:

1/3 octave band middle frequency in kHz (pass band)	Measured sound pressure level dBA	Measured sound pressure level dB
12.5 (11.2-14.1)	66	72
16 (14.1-17.8)	96	92
20 (17.8-22.4)	74	80

The angular dependence of the device as measured in the gymnasium is shown in figures 1 and 2. The angular dependence will be strongly affected by the environment of the device and may be quite different in situ.

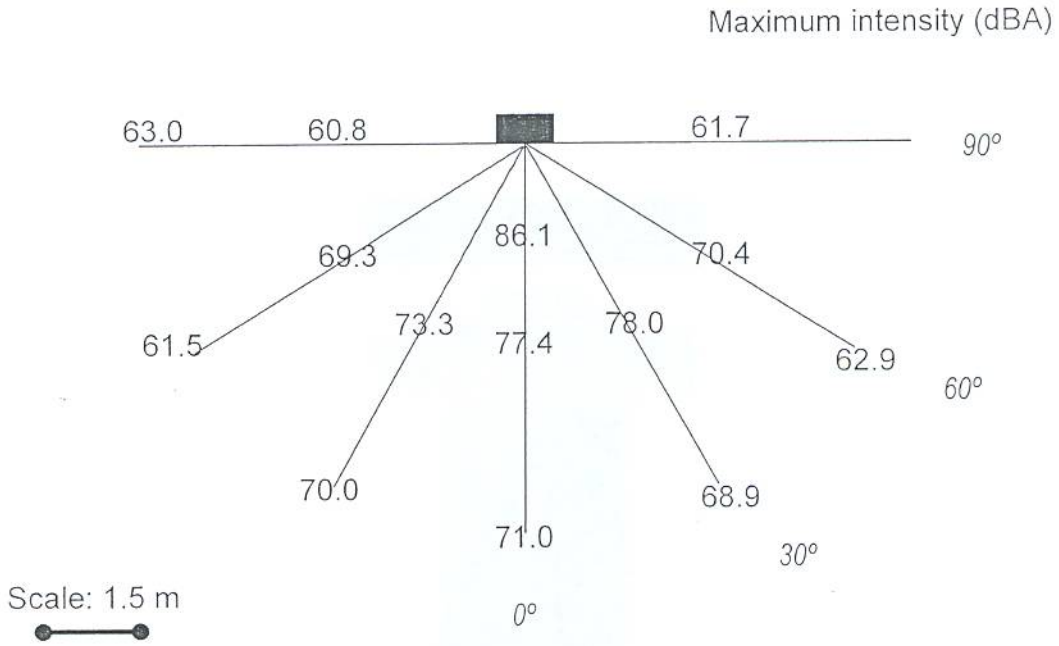

Figure 1: the maximum intensity measured at the locations indicated in dBA

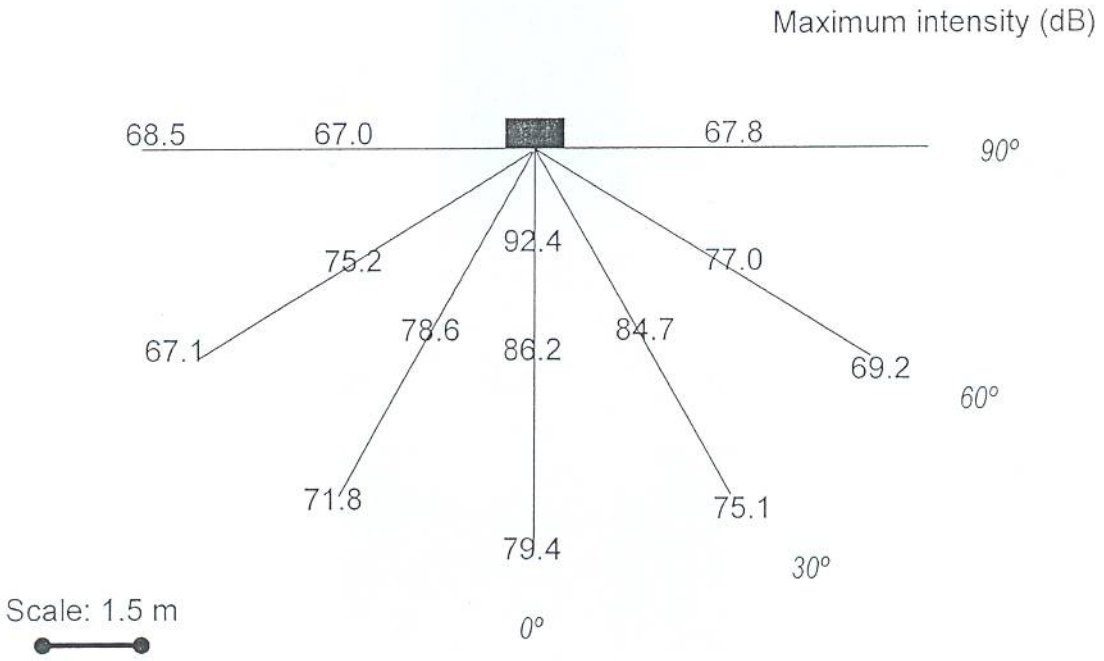

Figure 2: the maximum intensity measured at the location indicated in dB

Current legislation

The Control of Noise at Work Regulations 2005 became law in this country on 6th April 2006 and cover the minimum health and safety requirements regarding the exposure of workers to risks arising from noise. The aim of the Noise Regulations is to ensure that workers' hearing is protected from excessive noise at their place of work, which could cause them to lose their hearing and/or to suffer from tinnitus (permanent ringing in the ears).

The action levels are reproduced here:

(1) The lower exposure action values are—

(a) a daily or weekly personal noise exposure of 80 dB (A-weighted); and

(b) a peak sound pressure of 135 dB (C-weighted).

(2) The upper exposure action values are—

(a) a daily or weekly personal noise exposure of 85 dB (A-weighted); and

(b) a peak sound pressure of 137 dB (C-weighted).

(3) The exposure limit values are—

(a) a daily or weekly personal noise exposure of 87 dB (A-weighted); and

(b) a peak sound pressure of 140 dB (C-weighted).

For frequencies above 1 kHz the C-weighting curve either keeps the unweighted sound pressure level the same or makes it lower. So even though we did not make measurements with the C-weighting we can say that directly in front of the device at a distance of 1.5 m this device is well below the peak sound pressure action level.

At a distance of 3 m away from the device the measured output from this device is below the lowest action level for daily exposure. Daily exposure, $L_{ex,d}$, is calculated by considering the level of the noise, $L_{Aeq,Te}$ (dBA), and the duration at that level, T_e (seconds) as shown by the following relation:

Equation 1: $$L_{ex,d} = L_{Aeq,Te} + 10\log_{10}\left(\frac{T_e}{28{,}800}\right)$$

The unit is advised by the manufacturer to be placed 3 m up to avoid vandalism. A person standing directly in line with the device could have their ears 1.5 m or closer to the device.

At a distance of 1.5 m it would be possible to exceed this action level if someone were to spend long periods of time in front of the device. At a sound pressure level of 86 dBA (as measured 1.5 m directly in front of the device) the following daily exposures would result from the following periods of exposure:

Time exposed to 86 dBA	Daily exposure dBA
½ hour	74
1 hour	77
2 hours	80
4 hours	83

This table is calculated from equation 1 above and ignores the reduction in output after 22 minutes.

Caution must be exhibited in interpreting these results in the context of the Control of Noise at Work Regulations 2005; this legislation does not extend to the general public. This legislation is also not designed specifically for the protection of children and other possible vulnerable groups since they are not expected to work.

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