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Mr Simon Morris  
Compound Security Systems  
Unit 7  
Glynmil Close  
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Merthyr Tydfil  
CF47 0GE

Dear Mr Morris

### **Mosquito**

You have asked me to consider whether your Mosquito device might be harmful to hearing. I understand that this acoustic device is intended to disperse unwelcome gatherings of youths and teenagers in shopping malls and around shops. The Mosquito emits a very high-frequency tone which is heard by young people, but which may be inaudible to older individuals. The tone is intended to be irritating to those who hear it, but without harmful effects. You wish me to comment on the possibility of hearing injury to young people or children who might be exposed to the Mosquito tone.

I have read the National Physical Laboratory Test Report S 5341, dated 8 December 2005, which deals with the acoustic output of the Mosquito sound source 1050. The frequency of the Mosquito tone was 16 800 hertz (16.8 kHz). The Sound Pressure Level was measured 1 metre from the unit and found to be 92.8 decibels (dB) for a drive voltage of 11.9 V; at 2 m, the level had dropped to 87.0 dB. The NPL report gives no information on the directivity of the sound source, so my analysis assumes that the SPLs are greatest directly in front of the unit (on axis).

Your recommendation is that the unit be mounted at least 3 m above ground level to reduce the risk of vandalism. The sound 'beam' is to be directed downward from the horizontal at an angle of 30° to 45°.

For a tall person, the ear(s) could be 1.5 m (on axis) from the Mosquito unit. At this distance from the unit, the SPL would be 89 dB. I shall use this value as a 'worst case' level. For off-axis listening, the level should be lower. At any greater distances from the unit, the level should be lower; the ears of younger listeners, even toddlers in push-chairs, would be more than 1.5 m from the Mosquito unit.

The worst-case Mosquito signal, 16.8 kHz at 89 dB, should definitely be audible to young people. Data from the literature supports this conclusion: Table 1 below gives lowest audible levels (thresholds) at 16 kHz and 18 kHz for healthy ears, aged 18 to 30 years. I have interpolated between these frequencies to estimate the threshold at 17 kHz; overall, 57.5 dB seems a reasonable estimate. The Mosquito signal should be quite audible to a young person 1.5 m from the unit; the sound would be approximately 30 dB above threshold.

Would such a worst-case sound, 16.8 kHz at 89 dB, be potentially harmful to hearing? I do not believe so. In the occupational context, A-weighted Sound Level is used to assess whether a noise is potentially harmful to hearing. An 8 hour daily exposure to a sound of 85 dB(A) is likely to produce a small-but-measurable hearing loss after decades of occupational exposure. However, the worst-case Mosquito signal is 81.5 dB(A): this level would not be recognised as injurious to hearing, especially for any likely brief exposure.

There is another aspect to consider. In the 1960s, a number of Maximum Permissible Levels were recommended for very high-frequency sounds, in the range 10 kHz to 20 kHz. Over this range, the frequency-dependent limit values were between 75 dB and 110 dB; such limits were intended to avoid unpleasant, short-lived subjective effects in exposed persons. In sensitive individuals, higher noise levels had been found to cause annoyance, tinnitus, headaches, fatigue and even nausea. These sensations/feelings subsided after cessation of the high-frequency sounds. The Maximum Permissible Levels were subsequently adopted by a number of national and international bodies; see Table 2. I believe the spread of the limit values of Table 2 indicates differing degrees of caution in the interpretation of the underlying research.

From the limits of the Table, it seems possible that the worst-case Mosquito signal 16.8 kHz at 89 dB might produce some subjective effect in sensitive individuals. Indeed, the tone is *intended* to be irritating to those who hear it.

I trust these considerations will answer your question. It is our policy not to endorse individual products; however, we are able to comment on the acoustic safety of particular items.

Sincerely



B W Lawton MIOA  
*Senior Consultant*

Table 1. Estimated threshold for the Mosquito signal, approximately 17 kHz, by free-field listening

source	threshold, dB SPL		
	16 kHz	17 kHz ( <i>interpolated</i> )	18 kHz
Henry, Fast (1984) 18-20 y	45	56	67.5
Takeshima et al. (2001)	44.5	57.6	70.7
ISO (2004)	40	56.5	73
Ashihari et al. (2006)	42	60	78
central tendency		57.5	

Table 2. Limit values for very high-frequency sounds.

one-third-octave band centre frequency (kHz)	8	10	12.5	16	20
source:					
International Labour Office (1977)	–	–	75	85	110
WHO (1982)					
Japan	90	90	90	90	110
USSR	–	–	75	85	110
US Air Force	–	–	85	85	85
Canada	80	80	80	80	80
Sweden	–	–	–	–	105
INRC/IRPA (1984)					
occupational exposure	–	–	–	–	75
general public	–	–	–	–	70
Health Canada (1991)	–	–	–	75	75
ACGIH (2002) 8 hour average maximum, no regard to duration	–	88 105	89 105	92 105	94 105

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