

**Conclusions on very high frequency noise**  
**& its bearing on conventional hearing loss**

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## **Explanation of Frequency considerations**

There has been considerable discussion since the launch of a device called a Mosquito – a sound emitting device designed to only annoy teenagers – in relation to whether or not the level of sound it emits is harmful to human or animal hearing.

It is stated that the Mosquito device operates between the frequencies of 17 – 18 KHz with a volume range of 75 – 95 dB (A) at a distance from the unit of 1 meter.

The following information is provided in order to allow interested parties to understand the perceived issues surrounding this device and to clarify what the above stated figures actually mean and how they fair in relation to accepted government limits on noise.

The first area to be discussed is the frequency aspect of the device. In and of themselves, frequencies – figures stated above with the suffix KHZ (Kilohertz) – have NO health issues associated with them. Frequency is, simply put, the wavelength that a given sound is transmitted at.

High frequencies, very high frequencies and ultrasonic frequencies – note that anything over 10 KHz is considered to be a high frequency - have very short wavelengths. In the context of this report, this is only important in as much as short wavelengths do not effectively penetrate solid objects such as windows, walls, fences and dense foliage. Short wavelengths also have a shorter range than lower frequency sounds at a given volume.

Low frequencies on the other hand have very long wavelengths. These wavelengths have a significant range and penetrate solid objects extremely well. Low frequency transmissions are used by submarines as an effective method of communicating through vast amounts of ocean. It should be noted here that very low frequencies can be FELT as well as heard and have the potential to make people within the field feel extremely sick if the frequency

and volume are correct. Readers will have experienced such low frequency effects when exposed indirectly to heavy base music played by neighbours or in cars that are stationary at stop signs. One can FEEL the music as well as hear it.

The following paragraph has been taken from a recent HSE document and confirms the above statement:

*'The few reports dealing with this noise-and-loss option concentrate on Temporary Threshold Shift from VHF (very high frequency) and ultrasonic sounds with levels greater than 100 dB. No TTS (Temporary Threshold Shift) was observed. For tones of 8 kHz or less, or for broadband noise, such levels would be expected to result in a considerable dullness of hearing, even after only a few minutes exposure. It seems safe to conclude that, on a straight acoustic pressure or dB basis, VHF or ultrasonic sounds are less hazardous to the hearing than noises confined to the frequency range below 8-10 kHz.'*

*Source: Damage to human hearing by airborne sound of very high frequency or ultrasonic frequency (Ben Lawton) 2001, HSE*

It should be noted that sounds below 10 KHz as mentioned in the last sentence of the above extract, are sounds that make up our normal day to day environment, such as engine noise, music, TV, hairdryers etc. etc.

## **Explanation of Volume considerations**

Having discussed the frequency aspect of the Mosquito device output, we now turn to the volume output of the device.

The UK government have in accordance with the HSE – Health and Safety Executive – set a national limit for noise exposure that is considered safe, with little or no risk of hearing damage. Most other countries, certainly European countries, USA, Canada, Australia etc. have also set limits, all of which are very similar as they are all based on current research and accepted conventional wisdom. For UK purposes, this limit is set at 85 dB(A),

HOWEVER, it is not that simple. One cannot say that if a sound is higher than 85dB(A) it is necessarily dangerous. There are several further issues:

1. First of all, when the volume of a sound is expressed in dB or dB (A), it is usually as in the case with the Mosquito expressed as the volume measured at 1 meter distance from the source. If a person is standing 2 meters away from the source, the volume will be 50% less. If that person is 4 meters from the source, the volume will be 75% less. Example – volume at 1 meter = 85 dB. Volume at 2 meters will be 79 dB and at 4 meters, 73 dB. A decrease of 6 dB is in fact a 50% decrease in the Sound Pressure Level (SPL) or volume.
2. Whilst keeping in mind the minimum distance that a person will be from the source, the second consideration is that the HSE and UK Government limit of 85 dB is in relation to an 8 hour exposure. Simply put, this means that it is safe to be exposed constantly to 85 dB for 8 hours. Therefore when determining if exposure to a sound / noise is dangerous, one MUST relate it to the 85 dB for 8 hours limit. This results in converting the volume in question into a TWA figure (Time Weighted Average).

For example, we know that a person can be exposed to 85 dB for 8 hours with no ill effects. If they are exposed to 95 dB for 20 minutes, what is the TWA figure. Using standard conversion calculations, the TWA figure is 81.2 dB. This is less than the limit of 85dB which is safe for 8 hours of exposure.

The Mosquito it is advised should be mounted at least 3 meters above the ground in order to reduce the risk of vandalism. On this basis it would seem unlikely that any persons ear will be closer than 2 meters from the device. If one assumes that the device is set on maximum volume, 95 dB, the maximum volume at the ear of the person 2 meters away would be 89 dB. As a TWA, this figures is 75.2 dB for 20 minutes exposure. This is well within the HSE and UK guidelines for safety.

Note: A 20 minute period is used in these calculations because the Mosquito device has a built-in 20 minute auto-cut off system in it.

The following calculations confirm that even at maximum volume output, the Mosquito does not exceed the UK or HSE guidelines on noise exposure of 85 dB as an average over 8 hours.

Note: It should be noted for the sake of clarification that there are certain sound levels that can cause serious and permanent damage to human and animal hearing. Such levels are not discussed in this paper as they far exceed the volume that the Mosquito is capable of producing by at least 600%. At present in the UK, external security alarm sounders can generate a volume of 128 dB. Once levels of 130 dB at the ear are exceeded, there is a very real risk of hearing damage even after just few seconds.

## **Sound exposure levels**

The following converts the dB (A) of the Mosquito device - measured at 1 meter - into a TWA - Time Weighted Average - in order to ascertain how long an individual can be exposed to the device at various distances without any risk of hearing damage.

For UK purposes we use the HSE guidelines for maximum permitted exposure which is stated as Lex,8 85dB (A).

**Source volume 95 dB (A) at 1 meter**

	<b>1m</b>	<b>2m</b>	<b>4m</b>	<b>8m</b>	<b>16m</b>	
<b>Volume</b>	95	89	83	77	71	<b>For 20 minutes</b>
<b>TWA</b>	81.2	75.2	69.2	63.2	57.2	

**Source volume 90 dB (A) at 1 meter**

	<b>1m</b>	<b>2m</b>	<b>4m</b>	<b>8m</b>	<b>16m</b>	
<b>Volume</b>	90	84	78	72	66	<b>For 20 minutes</b>
<b>TWA</b>	76.2	70.2	64.2	58.2	52.2	

**Source volume 85 dB (A) at 1 meter**

	<b>1m</b>	<b>2m</b>	<b>4m</b>	<b>8m</b>	<b>16m</b>	
<b>Volume</b>	85	79	73	67	61	<b>For 20 minutes</b>
<b>TWA</b>	71.2	65.2	59.2	53.2	47.2	

**Source volume 80 dB (A) at 1 meter**

	<b>1m</b>	<b>2m</b>	<b>4m</b>	<b>8m</b>	<b>16m</b>	
<b>Volume</b>	80	74	68	62	56	<b>For 20 minutes</b>
<b>TWA</b>	66.2	60.2	54.2	48.2	42.2	

*Note. Doubling the distance reduces volume by 6 db(A) which is a 50% reduction in SPL (Sound Pressure Level)*

To reach max Lex,8 85 dB(A) equivalent, the following exposure times may be used.

	<b>Time Safely Allowed</b>
<b>Mosquito set to 95 dB (A) at ear</b>	48 minutes
<b>Mosquito set to 90 dB(A) at ear</b>	2.5 hours
<b>Mosquito set to 85 dB(A) at ear</b>	8 hours
<b>Mosquito set to 80 dB(A) at ear</b>	25 hours

*Note: If one doubles the distance of the Mosquito from the ear, one can double the exposure time.*

## **Conclusion**

Obviously there are some frequencies that are more likely to cause hearing damage and other physical effects than others. These are low frequencies and are therefore of no relevance in the context of this report.

There is also a level of volume that can even after very short exposure times, cause hearing damage, however, these volumes are in excess of 130 dB and again are of no relevance in the context of this report.

In order to understand whether the volume of the Mosquito is likely to cause any hearing damage either permanent or temporary (subjective), volume levels dB MUST be converted into TWA (Time Weighted Average) figures in

order to make any sense when comparing them to limits imposed by the UK government and the HSE (Health & Safety Executive).

The calculations above, which are based on the actual volumes that the Mosquito device is capable of producing, clearly demonstrate that there is no danger to hearing from exposure to the Mosquito device.

Signed

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