

Damage limitation

For your ears only

Wearing earpieces and headphones is an everyday event for many people, whether it be as part of their job or worn recreationally to listen to music from MP3 players. Unfortunately, what many don't realise is that hearing loss can all too easily result from their use. The facts around this are potentially alarming for cameramen, who are frequent users, but there is a new product on the market that may help to reduce the danger. Engineer and noise monitoring expert Paul Rubens explains the nature of the problem and then introduces AdaptEar, an innovative solution that has already been trialled and welcomed by cameramen working on music productions, an area where this issue is a particular concern.



The threat to our ears

When we hear a noise we are receiving sound energy which vibrates hair cells in our inner ear. These hair cells convert the sound energy into electrical energy, which then travels to our brain. The problem is that when these hair cells are exposed to prolonged periods of high sound intensity or even short bursts of extremely high sound intensity they are damaged and, once damaged, they

of a sufferer committing suicide has made this headline news. Our general inability to detect hearing loss ourselves before it's too late, places greater emphasis on the need for the assessment and control of sound pressure levels.

It is now generally accepted among researchers into the environmental causes of deafness that the use of earpieces with MP3 players at high volumes will create permanent noise-

against due to the cumulative damage and inevitable noise-induced hearing loss, but unfortunately this message has either been largely ignored or just not communicated in an adequate way to many users.

There have been a number of campaigns from dedicated organisations highlighting the problem including the RNID (Don't Lose the Music), the Noise Abatement Society (Love Your Ears) and Deafness

earpieces are often substantially higher than those for MP3 players. While private individuals may be subjected to 'only' 105dB from their MP3 players, those who use earpieces in the course of their work (without limiters) with private mobile radios (also known as PMRs or walkie-talkies) and communication systems, risk subjecting themselves to sound pressure levels greater than 120dB.

This volume is substantially more than the 85dB action level specified in the Control of Noise at Work Regulations 2005. It is therefore crucially important that both the users and the employers of those who use earpieces at work are aware of the risks they run and the measures they should take to protect themselves and their staff.

Let us now consider the background to the problem, a number of common scenarios and how users may protect themselves against acoustic shocks and high levels of sound while continuing to operate efficiently in the workplace.

Our general inability to detect hearing loss ourselves before it's too late, places greater emphasis on the need for the assessment and control of sound pressure levels

can never grow back or be repaired.¹ To add to the problem, we don't normally know that our hearing has been damaged until many years after exposure. The damage sustained to hearing as a result of being subjected to excessive noise is generally termed 'noise-induced hearing loss' or NIHL.

One of the more common symptoms of NIHL is tinnitus, described as a continual ringing (or similar) in the ears and a recent case

induced hearing loss. Research has shown that the full volume sound pressure levels from MP3 players are around 100dB, with some player and earpiece combinations exceeding 105dB in the user's ears.² However, it must be borne in mind that dBs are a logarithmic scale, so an increase of 10dB is actually an increase of 10 times the sound pressure level. Prolonged use of MP3 players at these high volumes is strongly advised

Research (60% for 60 Minutes). These campaigns have been established specifically to make MP3 users aware that they run the risk of sustaining noise-induced hearing loss if they don't manage the volume of their MP3 player, but their impact has been patchy at best.

Using earpieces at work

Perhaps surprisingly, audio levels measured in professions that use

Using earpieces with PMRs and other high power sources

In the past, if you wanted to listen to communications without locally broadcasting them, the only solution

was to use manufacturer-supplied headsets or other brand alternatives. These function well but provide poor isolation if ambient noise levels rise, and they can be uncomfortable to wear for long periods.

Many former headset users have moved to using small high sensitivity earpieces or custom-fit 'in ear monitors' (IEMs) out of personal preference as they are lighter and more comfortable to wear. However, if these IEMs are incorrectly configured they may be putting their hearing at risk.

periods of time, especially in warm conditions. Ask any users of such heavy headphones and they'll tell you that they breathe a huge sigh of relief when they remove them at the end of the day. They are also far from ideal if using a hand-held camera as the size of the earpieces interferes with the positioning of the camera on the operator's shoulder.

The favoured approach is to use custom-moulded attenuating earpieces (or IEMs). These fill the ear, extending into the ear canal and, if fitted correctly, typically attenuate

protected as above would be wise. If this arrangement is necessary, in moderate noise levels, wearing a custom-fit hearing attenuator with a flat frequency response diaphragm in the open ear will 'turn down' the ambient noise but allow full frequency response, thus allowing acoustic communication with colleagues.

However, in high noise environments, this setup is an almost impossible situation for our hearing to deal with. Listening to different things in each ear is difficult enough for the brain to process anyway, as our ears

hear communications at a safer level.

The sensitivity of these earpieces mandates the use of some form of limiting device and LimitEar has developed a device called AdaptEar®, which helps to address this. It is adjustable to the sensitivity parameters of the IEM in question to provide a safe listening level and contains a patent-applied-for 'peak limiting' device that not only protects you from acoustic shock, but illuminates to let you know that it is working.

It also addresses another issue



▲ An extensive range of interconnection cables are available



▲ AdaptEar can connect to most PMRs and comms systems



▲ AdaptEar

Most earpieces contain highly sensitive drivers (speakers) which require little power to produce very high sound pressure levels. The output of most PMRs and communications systems is very powerful (originally designed to power low efficiency headsets), and when used with a high sensitivity earpiece can create dangerously high levels of sound over long periods of time plus peak sound pressure levels in excess of 120dB.

Given this potential risk to hearing, it is essential that earpieces should only be used in conjunction with a device to limit both acoustic shock and volume peaks.

Using earpieces with PMRs in high ambient noise environments

If a user is operating in a high ambient noise environment, such as a live music event, then there is the added complication of hearing any communications above the ambient noise. With typical ambient noise levels well above 90dB the operator has to increase the volume in their earpieces to above 100dB just to hear anything.

Until recently, the only solution has been for users to wear heavy weight 'aviation style' headsets. These can be both cumbersome and uncomfortable to wear for long

ambient noise by around 25dB. They meet or exceed the protection afforded by aviation-style headsets and are both unobtrusive and more comfortable to wear for long periods of time.

Even having limited the impact of ambient noise, there remains another issue: controlling the level of communications into the ears of the users. As mentioned previously, small earpieces contain very sensitive drivers which can give rise to very high volumes at the ear. It is therefore recommended that these should only be used in conjunction with a volume limiter.

Listening to comms in one ear and acoustically with the other

Another technique, beloved of television presenters, is to have an earpiece or headphone for one ear and to have the other ear exposed to pick up local noise. This works well in low ambient noise environments but can rapidly become a hearing danger in more noisy environments.

Before accepting that a user in a noisy environment has to have one ear to monitor the radio communications with an earpiece (the closed ear), and the other open (the open ear) to listen to colleagues or members of the public, a trial with both ears

are designed to work as a pair, but adding to that the disparity in levels means that the brain will have trouble sorting out the required information from the 'noise'. The typical response from the user is to turn up the volume in the single earpiece to excessive levels, risking irreversible hearing damage. Reverting to listening to communications with both ears as described above is therefore the best path to follow.

So what's the answer?

Once the user has achieved good isolation from the ambient noise by using IEMs, it becomes possible to

commonly faced by IEM users – that of connectivity.

Most IEMs come fitted with a stereo 3.5mm (1/8") mini-jack connector and this is not compatible with professional communications systems. AdaptEar answers this by having a range of adapter leads available as accessories that will connect to most PMRs and other communications systems, allowing full two-way communication.

AdaptEar also features an auxiliary input socket which means that the user can connect an extra audio source and mix it with the primary signal. The user can therefore monitor,

USER VIEWS

"I am a cameraman who mostly works at live music events and have been using one of the prototype AdaptEar units (along with moulded earpiece) for the last two years on every job. I can honestly say I can't do without it. The thought of wearing heavy cans that who knows who has been wearing, that get in the way, squeeze your head, make you sweat and stand out in shot doesn't make sense to me. You can run talkback at much lower levels and my ears no longer ring at the end of the day, even after a full-on festival like Reading or Glastonbury."

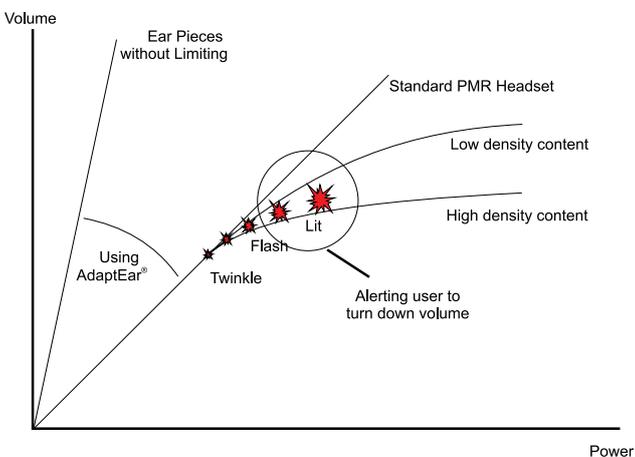
James Carroll, Cameraman



▲ In use at the Barclays ATP Tennis Tour Finals

for example, an extra radio channel, a mobile phone or even an MP3 player. If a Smartphone (e.g. iPhone, HTC, Blackberry) is connected with a suitable lead, then remote control of the phone is also possible through AdaptEar.

The diagram below illustrates the effect of AdaptEar.



1. With a standard PMR headset the volume received in the ear of the user rises smoothly and steadily as the user turns up the volume control at the source.
2. With sensitive earpieces (such as those commonly used with MP3 players) the response to turning up the volume occurs more quickly and can reach excessive volumes at low levels of power. This is potentially dangerous as well as making comfortable volume setting very tricky.
3. With AdaptEar in place the earpiece response is slowed to make the volume received in the ear of the user proportional to the power from the source.
4. AdaptEar helps prevent acoustic

shock by significantly restricting the maximum level sent to the earpieces. It also helps reduce excessive average levels, as shown by the slope of the graph.

5. An indicator light shows that it is functioning and signals to the user if they should turn down the volume.

So do technical advances allow small earpieces to be used safely?

The good news is yes, they do, and earpieces offer many significant benefits over cumbersome headsets. However, for the reasons mentioned, it is essential that noise levels at the ear are managed effectively and automatically to protect the user against the potential onset of noise-induced hearing loss. A high quality volume limiter such as AdaptEar® is an extremely effective solution to this problem. The product has been tested by various cameramen working on music productions – see testimonials, including one from GTC member Andy Pellett.

USER VIEWS

"As a multi-camera cameraman working in music and entertainment, I have to wear a headset all day long to hear the director, script supervisor and vision mixer's instructions. Being freelance, I work in many different locations with equipment, including a headset, supplied by the facilities company. These headsets are often in poor condition, having been worn by many different cameramen during the course of their life. Working in a high ambient background noise area means I have to turn the talkback up, just to be able to hear my instructions. I am often subject to poorly set up talkback systems with feedback, distortion and overload in my headset. Over time this would permanently damage my hearing. AdaptEar from LimitEar has changed my working life, as it eliminates many of the potential health risks associated with wearing a headset all day. AdaptEar allows me to use Personal In-ear monitors (PEIMs), which are far more comfortable and hygienic to wear all day long, enabling me to connect them to a walkie-talkie or directly into my camera's talkback system with the supplied connectors, whilst being sure in the knowledge that I can monitor the volume level to ensure my hearing will not suffer permanent loss."

Andy Pellett, Camera Supervisor



▲ Continuously protecting the cameraman



▲ AdaptEar connected directly to the camera

Footnotes

1. Griffiths TD, et al. (2001) Approaches to the cortical analysis of auditory objects. http://www.staff.ncl.ac.uk/t.d.griffiths/griffiths_Hearing_Research_2007.pdf.
2. Fligor BJ, Cox LC (2004) Output levels of commercially available portable compact disc players and the potential risk to hearing. *Ear and Hearing* 25(6):513-27.

For an exclusive LimitEar offer for Zerb readers turn to page 59.

Fact File

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Paul Rubens is an engineer and physicist who spent 10 years managing Casella, one of the world's largest designers and manufacturers of noise monitoring instrumentation. He currently works with a number of companies in the environmental technology field including LimitEar.