

NYO Guidelines on Hearing Protection

It is very important to protect your hearing, especially as a musician.

NYO is an enormous orchestra and makes a big and powerful sound. This is very exciting to listen to and be part of, but we all need to be responsible and look after our ears, as we only have one pair. NYO works hard to reduce exposure to noise as much as possible: ensuring that the rooms we perform and rehearse in are suitable; making acoustic adjustments where necessary; and using and researching specialist equipment. However, it's vital that you take responsibility for your own hearing and are doing all you can to protect yourself for the future. It's worth remembering too, while you're reading this, that you need to apply the same concern for your hearing when you're practising by yourself as when you're rehearsing with an orchestra.

We've created these guidelines to ensure you understand why this is an important consideration for your musical career and to help you establish what you can do to help protect yourself from dangers of regular noise exposure. The best thing you can do is to get regular hearing checks and to invest in good hearing protection. Both factors are crucial for

all musicians, but especially for NYO musicians, as you play in a large orchestra and are in the early stages of your musical journey. Playing your instrument for long periods of time at high volume will damage your hearing unless you wear the right earplugs. Playing your instrument without ear protection is like a footballer playing football without shin pads (not a good idea!).

We require you to bring your own ear protection for NYO activity. This is because the best ear protection for each person will vary according to your instrument, where you sit in the orchestra, and your personal preferences. We hope this document helps you make these choices. We've selected some useful information from expert sources, but it doesn't have to stop there for you: we've added some useful links and appendixes at the end for you to further explore.

“Personal Hearing protection will have to become a part of daily life for large numbers of musicians”

Extract from Association of British Orchestras report 'A Sound Ear II' 2008

MYTH BUSTING!

Orchestras are not loud

Yes they are. So far, attention has focused mainly on large ensembles, but early measurements on chamber orchestras indicate that they are not as quiet as we had hoped.

Music is NOT harmful

There are studies showing that music you enjoy causes less damage than noise of the same energy – it is thought to be related to the effect of stress on healing mechanisms. However, we know stress levels can be high in musicians, and the same studies also showed that music you do not enjoy causes more damage than plain noise.

Musicians do NOT go deaf

Yes they do. Possibly not as much as you would expect, but they suffer types of hearing damage that interfere with their ability to play accurately or to tolerate the wide dynamic range common in orchestras.

The occlusion effect

It's good to know about something called the occlusion effect. Ordinary compressible and disposable earplugs are generally unsuitable for players of reeded woodwind and brass instruments because of this effect.

Our ears emit vibrations that escape via the ear canal. If the ear canal is blocked, as with an earplug, these vibrations don't have a chance to escape and create a 'boomy' effect, which is particularly disconcerting for brass and wind players, as well as

singers. When blowing their instruments, wind and brass players experience their own sound both aurally and via the skull bones conducting the vibrations from the instrument to the ears. Using earplugs can affect this balance as the musician's ear hears less treble sound while experiencing more bass sound via bone conduction. The bass-treble distortion can be extreme. This will be strange for the player, can take some time to get used to and will vary from one individual to another. This is why it is important to invest in the right earplugs for you, and to acclimatise with patience.

There are two ways of dealing with the occlusion effect:

- Use deep fitting custom moulded earplugs which reach into the inner bony portion of the ear canal and so reduce potential vibration and jaw resonance
- Use earplugs with vents that allow the trapped low-frequency sound to escape.

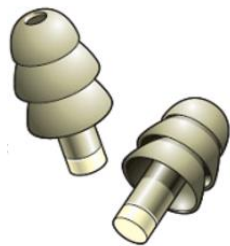
There is a misconception among some woodwind and brass players that it is not possible to wear earplugs due to the build up of pressure in the ear and the risk of further damage to the ear canal. This has no basis in fact. With the correct earplugs, with patience and sufficient acclimatisation, brass and woodwind players will find they are able to wear appropriate earplugs and have no need to worry that they will suffer further damage to their ears.

Hearing protection options

At NYO, we recommend that the best thing you can do to protect your hearing is to get hearing checks regularly and to invest in good earplugs! There are many different types of hearing protection available, and all are suited to different scenarios: what instrument you play, where you sit in the orchestra, and so on.

Premoulded earplugs (reusable)

Premoulded earplugs are generic fit earplugs shaped for the average user's ear canal. Most have a triple-flanged plug that fits inside the ear canal. These plugs are generally reusable but require regular cleaning. Various types are available, including uniform attenuation and amplitude sensitive (see later in document for further explanation of these types).



Useful for:

- Musicians and vocalists who want a relatively inexpensive earplug with relatively uniform attenuation for practice and rehearsals.

Advantages

- Cheaper than custom moulded earplugs.
- Last longer than compressible earplugs; they are reusable if kept clean.
- Easy to insert.
- Available 'off-the-shelf'.

Disadvantages

- More expensive than compressible earplugs (but not by much, and can be found relatively cheaply).

There are four main types of hearing protection:

- premoulded (reusable) earplugs
- compressible (disposable) earplugs
- custom moulded (permanent) earplugs
- earmuffs

Have a look at these options to see which earplugs might be right for you.

- Uniform attenuation types generally not as 'flat' as custom moulded uniform attenuation earplugs.

NYO Summary: we advise that you purchase a pair of these so you don't need to rely on less effective disposable options. You can get a reasonable pair for about £20. This will make a huge difference to your experience and can be used for a good couple of years. These are particularly worth investing in for wind and brass players, as the flange effect is good at counteracting issues of the occlusion effect (we talk more about this later). Since these are not custom-made they cannot completely protect you, but they are great value compared to the disposable ones and should be purchased by every NYO musician unless you are investing in a more advanced option.

The most recommended models for musicians are the high-fidelity ER 20 earplug. These can be bought online from various places for under £20. You can purchase a BabyBlue model from the USA, which is smaller and therefore more appropriate for young people/smaller ears. They have also been reported to be more comfortable for adult years.

Compressible earplugs (disposable)

Useful for:

- Crew, venue staff, and other workers in situations in which sound quality and speech communication are not issues (especially non-musical applications).
- Emergency applications (such as forgetting or losing custom moulded earplugs).



Advantages

- Inexpensive and simple to use.
- Effectively protect against high sound levels.
- More comfortable than earmuffs in hot environments.

Disadvantages

- Provide uneven frequency attenuation; remove more high frequencies than low.
- Occlusion effect distorts sound perception for reeded woodwind and brass musicians.
- Interfere with speech communication.
- Require careful insertion to ensure effective protection.
- Risk of infection from dirty hands.

NYO Summary: we advise that you use these for emergency cases only on NYO Activity. We always provide these earplugs, but you should bring your own personal, permanent earplugs suited to you. It is important for you to understand that these foam earplugs are particularly problematic for wind and brass players because of the occlusion effect.

Custom moulded earplugs

These are made of silicon and are moulded to the shape of the user's ear canal. They are typically made by a laboratory supplying local audiologists and hearing clinics. They can come in **filtered or vented/tuned varieties**. This means each plug is bored out and then either fitted with an adjustable vent or capped with a button sized filter attached to its outer end.



Vented or tuned earplugs

These earplugs have a vent in the earmould, which reduces the amount of low frequency gain that the user receives. A vent allows low frequency sound to leak out and in doing so, tends to improve voice quality. The

vented/tuned earplug that is completely open is ideal for some brass woodwind musicians (and, interestingly, dentists - dentists can still hear their patients, hygienist, and talk on the phone, while receiving protection from the annoying dental drill and other office clattering noises).

Typically, vented/tuned earplugs attenuate higher frequencies by about 20 dB when the adjustable vent is wide open. Closing the vent increases higher frequency attenuation to as much as 28 dB (performance similar to compressible earplugs). Most ear mould laboratories can make custom moulded vented/tuned earplugs.

Useful for:

- Musicians playing bass and lower frequency instruments (for example, lower strings, reeded woodwinds, and low brasses) who wish to shield themselves against high frequency sounds from percussion or trumpet sections.

Advantages

- Allow musicians playing lower frequency instruments to hear themselves while screening out surrounding higher-frequency sounds.
- Very little occlusion effect.
- Right and left earplugs can be adjusted separately to compensate for right ear hearing loss in flute and piccolo players.
- Small 500 Hz resonance improves vocalists' ability to monitor voice.

Disadvantages

- Expensive.
- Need custom fitting by a qualified professional.

Filtered

- In filtered silicone earplugs the filter, in conjunction with the air inside the bored out section, offsets the loss of high frequencies that normally occurs when an object is inserted into the ear. Not only can the frequency attenuation of the fitting be specifically tuned to the user's needs, but also the plugs themselves will be comfortable and highly effective and are

readily reusable. Filters are available which reduce overall noise levels by 9, 15, and 25dB (among others).

Useful for:

- Musicians playing or seated nearby to instruments that produce higher frequency sounds (for example violins, trumpets, piccolos, and pianos).
- Anyone who needs sound reduction with minimal distortion or colouration.

Advantages

- Can provide even attenuation of frequencies up to about 6000 Hz.
- Can be modified to adjust high frequency attenuation.
- May be flesh coloured and unobtrusive.

Disadvantages

- Expensive.
- Need custom-fitting by a qualified professional.

NYO Summary: custom made earplugs are the best option for musicians who want to have a long career in music. They are worth looking into and considering, but it may be appropriate to wait for the musician's role to be more clearly defined before investing in these as they are expensive. They are highly recommended for anyone already having hearing problems.

Additional earplug features

Uniform attenuation

Flat/uniform attenuation is an equal reduction in sound across frequency. In hearing protection, it used to be the case that the earplug would stop vibrations in the canal. This prevents damage to hearing but also makes everything seem quieter and more

muffled. Fortunately, hearing protection technology has developed to the point where specialised products can reduce sound levels almost equally across a broad range of frequencies. This means that the user perceives the sound as being far

more natural than with ordinary earplugs.

'Amplitude sensitive' or 'Level dependant'

This is an earplug that is adjusted to protect against different amplitudes. Some instruments, such as brass, percussion and much woodwind, have a particularly large dynamic range. In these situations 'amplitude

sensitive' or 'level dependent' hearing protection can be suitable. Mostly, these use mechanical or electronic mechanisms to allow lower level sounds to pass relatively unhindered, but 'clip' very high energy noise. Those with mechanical mechanisms often use acoustic properties of carefully designed air ducts to give different protection at different noise levels.

Instrument specific information

Instrument	Typical issues	Possible hearing protection
Flutes and piccolos	<p>Loud peak levels, intense high frequencies.</p> <p>Existing right-ear hearing loss results in perceived distortion.</p>	<p>Generally:</p> <ul style="list-style-type: none"> • Uniform attenuation or amplitude sensitive earplugs. <p>Right-ear hearing loss:</p> <ul style="list-style-type: none"> • Asymmetrical vented/tuned earplugs.
Reeded woodwinds	<p>Proximity to brass or percussion sections.</p> <p>Jaw resonance (occlusion effect) makes it difficult to monitor instrument while using conventional earplugs.</p>	<ul style="list-style-type: none"> • Near trumpet or percussion sections: • Vented/tuned earplugs. • Uniform attenuation or amplitude sensitive earplugs.
Brass	<p>Jaw resonance (occlusion effect) makes it difficult to monitor instrument while using conventional earplugs.</p>	<ul style="list-style-type: none"> • Near percussion or other brass instruments: • Vented/tuned or amplitude sensitive earplugs. • Earmuffs.
Violins and violas	<p>Conventional earplugs remove higher-frequency sounds.</p>	<ul style="list-style-type: none"> • Uniform attenuation earplugs. • Some prefer amplitude sensitive – particularly if near loud neighbours.
Double basses, cellos, harps	<p>Proximity to brass section.</p>	<ul style="list-style-type: none"> • Vented/tuned earplugs.
Drums and percussion	<p>High sound levels, intense higher frequency sounds such as cymbals.</p> <p>Conventional earplugs reduce sound levels too much and may result in over hitting to compensate.</p>	<ul style="list-style-type: none"> • Uniform attenuation or amplitude sensitive earplugs. • Earmuffs.

Getting used to your earplugs

All hearing protection alters the listening experience, and it can take a long time to get used to it. You should manage your acclimatisation carefully and avoid wearing hearing protection for the first time in a performance.

A typical sequence for a musician acclimatising to earplugs might be:

- wear them at home and get used to speaking while wearing them;
- wear them around and about and get used to conversation;
- wear them while practising;
- wear them at rehearsal;
- wear them in performance.

With enough time to acclimatise to using the right hearing protection, communication with other people should not be a major problem.

Thanks for reading!

We hope this document has been useful in helping you decide what kind of earplugs to buy. Please make sure you purchase these and bring them with you to NYO activity. NYO cannot supply you with good quality ear protection as you will need specific types depending on the instrument you play.

Please note: if you lose your earplugs on an NYO activity please let a member of staff know immediately so we can order some more for you.

If you have any further questions about hearing protection or any problems with your hearing please get in touch

Useful links

Please see below for further links for information on noise risks that might be useful:

Musicians Hearing Service

Unique and established organisation offering advice on hearing protection, on site noise assessments, and specialist technology for all musicians and those affected by hearing loss.

<http://www.musicianshearingservices.co.uk/>

Music, Noise and hearing: How to play your part

A guide for musicians made by the BBC with support from leading music organisations

http://www.laplaya.co.uk/knowledgebank/Musicians_guide_to_noise_and_hearing.pdf

Hearing Review

Useful articles on earplugs for musicians

<http://www.hearingreview.com/2014/07/high-notes-musicians-earplugs/>
<http://www.hearingreview.com/2007/03/uniform-attenuation-hearing-protection-devices/>

Sound advice

Expert advice on and practical guidelines on the control of noise in music and entertainment. This is aimed at working environments in a professional contexts but has some useful and interesting information, including information on hearing protection

<http://www.soundadvice.info/thewholestory/san5.html>

<http://www.soundadvice.info/>

A Sound Ear II

The Control Of Noise At Work Regulations 2005

And Their Impact On Orchestras

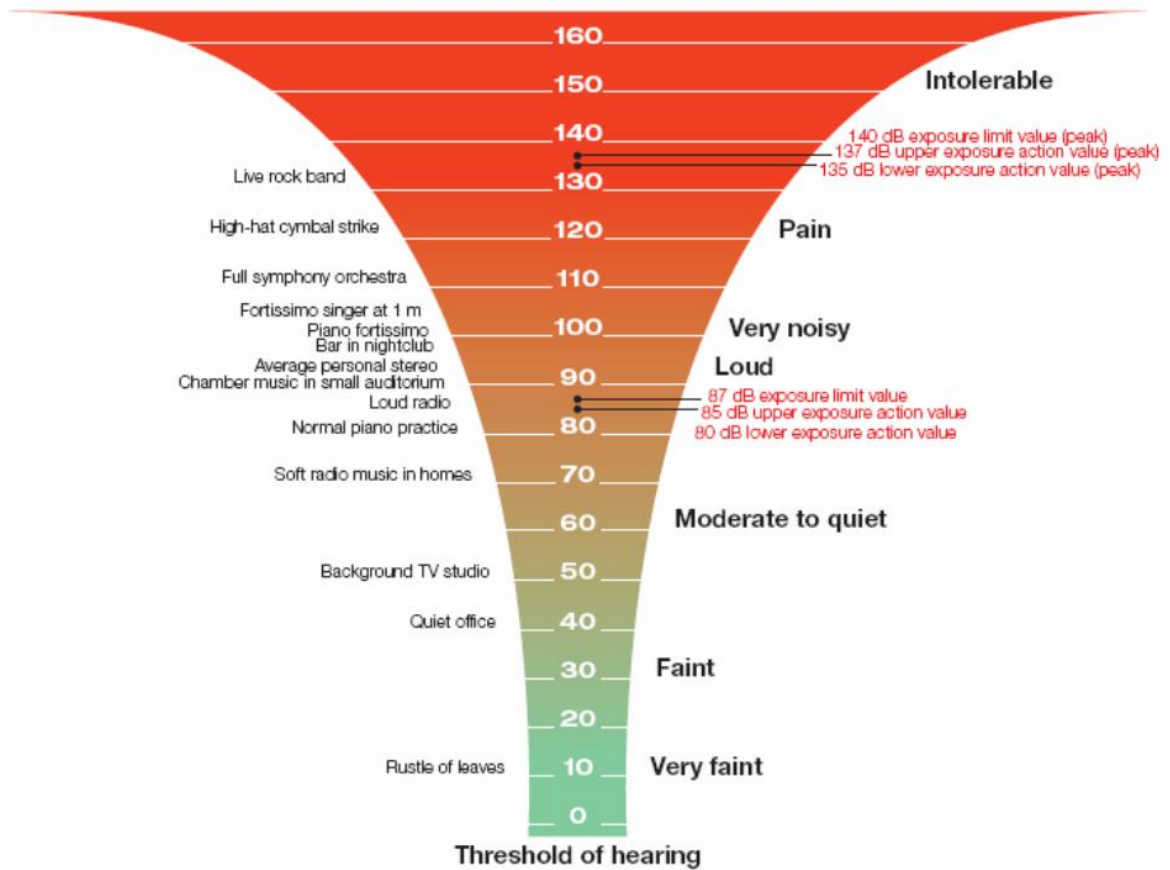
Published report by the Association of British Orchestras, February 2008 commissioned to

give the orchestral sector the tools to implement the regulations as is reasonably practicable, ensuring that the breadth of repertoire demanded by players and audiences alike survives and thrives.

<http://www.abo.org.uk/media/20101/a-sound-ear-ii.pdf>

Appendices

1. Typical noise levels in decibels



2. Representative noise levels per instrument

Noise source	dB	Peak
Single musicians		
Violin/viola (near left ear)	85–105	116
Violin/viola	80–90*	104
Cello	80–104*	112
Acoustic bass	70–94*	98
Clarinet	68–82*	112
Oboe	74–102*	116
Saxophone	75–110*	113
Flute	92–105*	109
Flute (near right ear)	98–114	118
Piccolo	96–112*	120
Piccolo (near right ear)	102–118*	126
French horn	92–104*	107
Trombone	90–106*	109
Trumpet	88–108*	113
Harp	90	111
Timpani and bass drum	74–94*	106
Percussion (high-hat near left ear)	68–94	125
Percussion	90–105	123–134
Singer	70–85*	94
Soprano	105–110	118
Choir	86	No data
Normal piano practice	60–90*	105
Loud piano	70–105*	110
Keyboards (electric)	60–110*	118
Several musicians		
Chamber music (classical)	70–92*	99
Symphonic music	86–102*	120–137
* at 3 m		
<p>Note: These representative noise levels are collated from a range of sources. They give an indication of the variety of noise levels and noise peaks that musicians and other workers can receive from the instruments concerned. This information may be helpful with estimating noise exposure and in identifying potential noise 'hot spots'. However, as shown, many of the instruments can exhibit a range of noise levels depending on how loudly they are played, for how long and under what circumstances (eg repertoire, venue, number of instruments concerned). Do not only use this information for a risk assessment but look at 'Risk assessment and planning' in Part 1 and any other relevant sector guide(s).</p>		

3. Examples of how long it might take for a player to be exposed to the upper exposure action value of 85 dB if playing at the level of a typical symphony performance

dB		
82	16 hours	eg violin
85	8 hours	eg harp
88	4 hours	eg trumpet
91	2 hours	eg trombone/French horn
94	1 hour	eg loud piano
97	30 minutes	eg loud soprano
100	15 minutes	
103	7.5 minutes	
137 dB (peak)	Maximum instantaneous peak noise when wearing hearing protection	Note that the peak noise from percussion, eg snare drum or cymbal clash, may exceed the 137 dB upper exposure action value.

4. Information on personal hearing protection from ABO

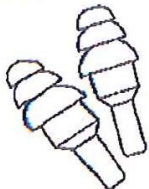
PERSONAL HEARING PROTECTION

With the upper exposure action value at a daily personal noise exposure of 85dB(A) or a peak of 135dB, not many players will be able to entirely avoid personal hearing protection.

In factories, the main problem with ear plugs is social isolation, and some discomfort. In orchestras the problems are much more immediate.

- Players need to hear themselves and their colleagues, so isolation can affect quality and exacerbate performance stress. This is minimised by using no more protection than is necessary.
- Skull conduction creates significant treble loss for some players, so eliminating the tones they need in order to play accurately
- Where there are sudden changes in dynamic, players may be in hearing protection during extremely quiet passages and so hear almost nothing.
- During rehearsal, players in hearing protection may struggle to understand the conductor

It is important to avoid over-protection. When properly fitted (which is rare), the yellow roll-up style of plug provides far too much reduction – it is good for sleeping in a noisy environment, but not for most orchestral work.

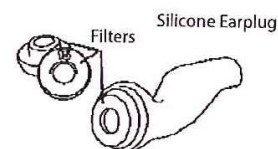


Flanged industrial plugs also over-protect when properly fitted, but the flanged design means they can be partially inserted to give less reduction. The problem is that you do not know how little, and it may be too little.

Bass players and cellists may prefer a style of plug that allows them to hear their own instrument, but reduces the treble from neighbours eg. Guymark Blue. Bespoke (custom-moulded) ear plugs can be 'vented' to give a similar transparency to lower frequency noise.

Strings may prefer uniform attenuation protection such as the EAR Ultratech, or the ER 9, 15 or 25. These plugs introduce a controlled amount of treble amplification so that the noise reduction is fairly even across all frequencies. The Ultratech is an off-the-shelf flanged plug, whereas the ER series are built into bespoke ear plugs. The advantage of bespoke ear plugs is that you can get a purer protection because the plug can be made to fill the whole ear canal (thereby eliminating resonance in the gap between the ear drum and an ear plug).

Bespoke ear plugs depend on getting a good mould of the ear canal. Some suggest as the mould sets, the player should move their jaw as though they were playing. The ER range of plugs can be constructed with swappable filters.



Players who have significant skull contact with their instrument (mainly brass and double-reeded woodwind) experience noise from both the ear drum and the skull. Skull noise is bass rich because the thick bone around the ears eliminates much treble.

You have probably failed to recognise a recording of your own voice because it was so tinny - unfortunately that is the real version: the rich noise you hear is because of the skull-conducted element. When an ear plug reduces noise reaching the ear drum, the skull noise remains constant. As a result, the bass/treble balance changes and this is exacerbated because bass noise interferes with your ability to hear treble. Thus some players hear remarkably little useful noise when they wear ear plugs. The distortion is minimised if the ear plug offers the minimum protection necessary, and if the ear plug fills as much of the ear canal as is possible.

Where a full-depth light-protection ear plug proves unusable, a different style of protection may work. Note that this style of protection is only effective if exposure is sufficiently spiky. Level-dependent or amplitude-sensitive protection is designed to offer negligible protection at moderate noise levels, but to almost eliminate very loud noise (usually above something like 105/110dB). The effect can be weird – a player may see percussionists working, but not hear the side drum – but creates less interference for most of the playing period. Level-dependent protection is normally the best option for percussionists, may be the best option for brass, and may work for some woodwind. It will rarely be suitable for strings players.

Level dependent protection is available in off-the-shelf flanged plugs, bespoke plugs and ear muffs.

Ear muffs may also be an option, and do not involve the problem of resonance in a blocked-up ear canal. There is a style of ear muff that supplies a controlled electronic version of the external sound field. When these were trialled, players were happy enough with the sound, but discovered that the electronics introduced a time delay. The delay was slight, but enough to put the players constantly behind the beat. So, currently not a solution unless all the players wear them.