3M Science. Applied to Life.™

3M Technical Bulletin

Regulatory updates - EN 352:2020 Further Explained

Understanding the acoustic performance of hearing protectors

More About EN 352:

All hearing protectors sold in Europe with the purpose of protecting the wearer against harmful noise must be CE approved. This is typically done by testing the product against the relevant parts of the Harmonised European family of standards, EN 352.

When certifying hearing protectors against the Harmonised European standard (whether passive or electronic), they must meet the requirements of one of the following three standards as appropriate for a given device.

- EN 352-1 Hearing protectors - General requirements – Part 1: Earmuffs
- EN 352-2 Hearing protectors - General requirements – Part 2: Earplugs
- EN 352-3 Hearing protectors - General requirements – Part 3: Earmuffs attached to head protection and/or face protection devices

The EN 352 family of standards were published in 2020 after a recent periodic revision. For more information on this update please refer to the 3M Technical Bulletin 'Regulatory updates - EN 352:2020'.

When certifying electronic hearing protectors against the Harmonised European Standard, they must meet the standard passive requirements of one of the above-mentioned standards, whilst also fulfilling additional requirements. For more information on the electronic standards please refer to the 'EN 352 Technical Bulletin - Electronic hearing protection devices'.

Passive Performance Testing:

There are two parts to the passive performance testing requirements.

- EN 13819-1 Hearing Protectors – Testing – Part 1: Physical test methods
- EN 13819-2 Hearing Protectors – Testing – Part 2: Acoustic test methods

Part 1 Physical testing, what is entailed?

The physical test method assesses all the necessary physical properties of the type of hearing protector as follows.

Earplugs:

- Sizing and adjustability – nominal size range for aural earplugs and adjustability for banded earplugs when worn in multiple positions (under-the-chin, behind-the-head or over-the-head).
- Resistance to damage when dropped
- Ignitability
- Cleaning

Earmuffs:

- Sizing and adjustability
- Headband force
- Cushion pressure
- Headband flexing
- Cup rotation
- Change in headband force
- Resistance to damage when dropped
- Ignitability
- Resistance to Leakage of liquid-filled cushions

Part 2 Acoustic test methods

The acoustic performance must be ascertained for all certified hearing protection, no matter if it is an earplug, earmuff, passive or electronic.

How is acoustic performance or attenuation tested?

The test, described in EN ISO 4869-1, aims to determine the 'Real Ear Attenuation at Threshold' of a hearing protector and is also referred to as REAT testing.

Determined by human test subjects, a panel of sixteen people of any gender, head shape and size, are selected to represent the general populace and their 'real ears'. Only those who have specific abnormalities which would affect hearing protectors fit are excluded.

Test subjects used in testing must not show hearing threshold level of greater than 15 dB for frequencies of 2000 Hz and below, and no more than 25 dB for frequencies above 2000 Hz.

Before the testing starts, the subjects must be fully trained on the correct fitting technique of hearing protectors, with due consideration of the available product sizes.

The testing is performed in a special room called an anechoic chamber. It is specially designed to prevent any reflection of sound or electromagnetic waves or energy entering from external surroundings. They are typically lined with fibreglass wedges covering the entire floors, walls and ceilings. The floor on which the test subject and loudspeakers are positioned is normally suspended.

Test signals

The test signal consists of pink noise filtered through one-third octave band centre frequencies and testing is carried out at the following centre frequencies:

125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz and 8000 Hz.

The hearing threshold is measured un-occluded (without wearing hearing protectors) and then repeated with hearing protectors across the various test frequencies. The attenuation provided by the hearing protector is the difference between the occluded and un-occluded measurements at each frequency.

How is the Data reported?

Full attenuation data includes the following:

- Octave Band
- High (H): average attenuation between 2 and 8 kHz
- Medium (M): average attenuation between 0.5 and 2 kHz
- Low (L): average attenuation at less than 0.5 kHz
- Single Number Rating (SNR)
- Standard deviations for all of the above data sets

Here is an example of new attenuation data for the 3M™ Classic™ Earplugs tested against the revised standard EN 352-2:2020.

Test frequency (Hz) f	63	125	250	500	1000	2000	4000	8000
Mean attenuation (dB)	28.7	29.0	30.4	33.1	32.4	33.6	43.1	38.3
Standard deviation (sf)	3.8	4.8	6.0	5.9	6.4	3.4	2.3	3.3
APV_{f84}, α=1	24.9	24.2	24.4	27.2	26.0	30.2	40.8	35.0
APV_{f98}, α=2	21.1	19.4	18.4	21.3	19.6	26.8	38.5	31.7

H	31	M	27	L	26	SNR	31
H_m	34.3	M_m	32.1	L_m	30.8	SNR_m	34.3
H_s	2.9	M_s	4.8	L_s	4.9	SNR_s	3.8

The H, M, L and SNR values are calculated for protection performance at the 84% confidence level (one standard deviation).

Because of the nature of human subjective testing, there is inherent variability factored into the REAT measurement and repeat testing often produces differing results. Therefore, attenuation figures should not be treated as absolute values.

When re-testing the same model, results that are within +/- 3dB of the previous results derived from laboratory testing under specified conditions are considered to be "within the uncertainty limits of the test method", meaning there is no significant change in product performance and reviewing the risk assessment may not be necessary.

Acceptable Variability, why +/-3dB?

The standards acknowledge there is inherent variability in these test methods and account for this by stipulating the level of variance allowed.

Uncertainty in the measurement of mean attenuation of hearing protectors in accordance with EN ISO 4861-1:2018 arises from several sources.

For convenience they can be grouped as follows:

1. Uncertainty of the mean individual attenuation of sixteen test subjects
2. Uncertainty of the test signal generation equipment
3. Uncertainty of deviation from- ideal test environment

EN ISO 4869-1 provides uncertainty limits specific to repeat testing for earplugs and earmuffs across the frequency range 250 Hz to 4 kHz. For earplugs it is +/- 3dB, while for earmuffs it is +/-2, rounded to the nearest whole number.

The measured uncertainty is included when reporting attenuation data including octave band, H, M, L and SNR values for each hearing protector and when carrying out conformity assessment against minimum H, M, L values of 12, 11 and 9 respectively.

In conclusion, for repeat testing of earplugs, a sound attenuation difference of up to +/- 3dB does not indicate a statistically significant change in product performance. However, regardless of the test results being within +/- 3dB, the user may wish to review their risk assessment.

What if my product has been retested and has a bigger performance change then +/- 3dB?

If the difference is more than +/- 3dB, 3M recommends the customer review their risk assessment in line with the European Physical Agents (Noise) Directive 2003/10/EC to help ensure any control measures implemented in the workplace, including hearing protection, are still adequate for the noise hazard.

Additionally, employers can consult 'EN 458:2016 Hearing protectors - Recommendations for selection, use, care and maintenance – Guidance document', which provides information on selection based on sound attenuation and many other factors such as situational awareness, communication, compatibility, and comfort, for example.

This European guidance document suggests that a hearing protector providing effective attenuation in the range of 70 dB and 80 dB may be suitable – not withstanding any additional factors of consideration as outlined above when selecting hearing protectors.

To illustrate this point, a hearing protector was 32dB and after retesting has a new SNR rating of 28dB. If this hearing protector was used by a worker with noise exposure of 98dB(A) for 30 minutes per day, the effective protected exposure level would be 70dB. This is still within the 70dB(A) to 80dB(A) protected exposure range as explained in the EN 458:2016 guidance document. If the effective level falls outside the 70 dB(A) to 80 dB(A) range, employers should revisit their risk assessment.

Is this all the testing?

The REAT testing under the harmonised standard is mandatory, standardised and a good benchmark for hearing protector performance. It is also important to understand that REAT measurements are derived from laboratory testing under controlled conditions and may not be an accurate indicator of the actual field performance of the hearing protection device.

To validate the protection an individual worker can achieve from a particular model of hearing protectors, 3M recommends individual fit testing.

Fit testing can play a key role in the training and motivation of the wearer in understanding the pitfalls of poor fitting. It can also play a valuable role in achieving and documenting an effective hearing conservation programme in the workplace.

For more information from 3M on fit testing, visit 3M Hearing Protection Fit Testing

3M strongly recommends personal fit testing of hearing protectors. Research suggests that users may receive less noise reduction than indicated by the attenuation label value(s) on the packaging due to variation in hearing protector fit, fitting skill and motivation of the user. Refer to your applicable regulations for guidance on how to adjust label values and estimate attenuation. In addition, 3M™ E-A-Rfit™ Dual-Ear Validation System can support your fit testing needs for improved wear and compliance.

Summary

- EN 352 is a Harmonised European family of standards
- The European Standard EN 13819-2 Hearing Protectors – Testing – Part 2: Acoustic test methods is referenced in the EN 352 family of standards, methods', and is a requirement for both passive as well as electronic hearing protectors
- REAT stands for the 'Real Ear Attenuation at Threshold' and is measured on a test panel of sixteen subjects
- There is inherent variability built into REAT measurement and as such the reported data should not be viewed as absolute
- Attenuation difference of +/- 3dB is within the norm for repeatability and reproducibility
- Customers can check the performance ratings of a product by consulting the user instructions contained within each product and by checking the Declaration of conformity published on each manufacturers site
- Fit testing can be a good indicator of the field performance of hearing protection and an important part of an effective hearing conservation program, for example, it can create a training conversation and ensure appropriate product selection and protection

Who do I speak to if I want to learn more?

3M has a team of dedicated hearing technical and regulatory specialist around Europe ready to assist you. Please contact your local 3M representative for more information.

3M United Kingdom PLC
3M Centre, Cain Road,
Bracknell
Berkshire RG12 8HT
Tel: 0870 60 800 60

3M Ireland
The Iveagh Building
Carrickmines Park
Carrickmines
Dublin 18