Double hearing protection

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In what situation is the use of double hearing protection required?

Double hearing protection is required when the attenuation of a single hearing protection device is no longer enough to ensure the hearing protection of its wearer.

Remember that hearing protection devices, as well as double hearing protection, are only recommended as a last resort when all other means to reduce noise at the source have been exhausted.

We shall see how to determine the sound level at which it becomes necessary to use double hearing protection.

We shall also see how to calculate the attenuation provided by this double protection and which hearing protection device is predominant in the calculation, the attenuation of each of the two combined systems being much lower than the sum of the combined attenuation.

Protection against noise
E-129.1

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1. When to use double hearing protection

Double hearing protection is necessary when the residual level at the ear is above the limit set by the European Directive on "Noise", which is 87dB (A) over a period of 8 hours, or 140dB (C) at peak sound pressure.

The residual level is calculated according to one of the four methods described in the EN458 standard:

1. Octave band method
2. HML method
3. HLM control
4. SNR method

These methods allow one to predict the level perceived in the ear by a person wearing personal hearing protectors.

A reduction must be made (Nexer, 2011) so that the personal hearing protector comes closer to its actual attenuation. Using the SAPAN method makes it possible to easily determine whether the HPD (Hearing Protection Device) is suitable or not.

Example 1
Sound exposure of an employee over eight hours is 98dB (A).
He wears an HPD, the attenuation of which (after reduction) gives him a hearing protection level of 25dB.
We get 98-25 = 73dB (A)
The residual level of 73dB (A) is less than the limit of 87dB (A).

Example 2
The sound exposure of an employee over eight hours is 115dB (A).
He wears an HPD, the attenuation of which (after reduction) gives him a hearing protection level of 26dB.
We get 115–26 = 89dB (A)
The residual level of 89dB (A) is greater than the limit of 87dB (A). We have three options:

1. Reduce the noise level at the source
2. Reduce the employee's exposure time
3. Provide the employee with double hearing protection that can bring the residual level to below 87dB (A)

2 What is double hearing protection?

Double hearing protection consists of two hearing protection devices:

1. An earplug-type protector (intra-aural) inserted in the ear canal
2. A headset type of protector with ear muffs that cover the outer ear

This combination of hearing protectors is relatively uncomfortable, especially in environments with high temperatures, as well as during a physical activity; therefore, it should be used only as a last resort.

3 How to calculate the attenuation of double hearing protection

To perform this calculation, it is necessary to have the attenuations of two hearing protectors, the earplugs and the ear muffs. Once the reduction has been applied to each hearing protector, we shall use the following formula: $33 \times \log((0.4 \times B) + (0.1 \times ST))$
This formula has been defined by INRS (Damongeot, Lataye, & Kusy, 1990), in which ***B*** SNR is the reduced SNR attenuation of the Earplug, and ***ST*** is the reduced SNR attenuation of the Earmuff.

A free calculator is available on the website hearingprotech.com under *Download* to easily perform calculations and simulations of double hearing protection.

Example 1

I have earplugs whose attenuation (SNR) is 28dB. I have ear muffs whose attenuation (SNR) is 30dB.

Type of hearing protector	Earplug	Ear muffs	Double hearing protection
Attenuation (SNR)	28	30	**38.0**

The estimate of the attenuation of the double hearing protection will be equal to **38.0dB**.

Example 2

Imagine that an attenuation as described in Example 1 is not sufficient. We lack two decibels to effectively protect an employee who is exposed to high noise levels. Which of the two hearing protectors should we modify to achieve the desired attenuation 40dB?

Simulation 1:

We decide to select **ear muffs** with a much higher attenuation, such as: I have earplugs whose attenuation (SNR) is 28dB.
I have ear muffs whose attenuation (SNR) is 34dB. The estimate of the attenuation of the double hearing protection will be equal to **38.4dB**.

Type of hearing protector	Earplug	Ear muffs	Double hearing protection
Attenuation (SNR)	28	34	**38.4**

Simulation 2:

We decide to select **earplugs** with a much higher attenuation, such as: I have earplugs whose attenuation (SNR) is 32dB.
I have ear muffs whose attenuation (SNR) is 30dB. The estimate of the attenuation of the double hearing protection will be equal to **39.6dB**.

Type of hearing protector	Earplug	Ear muffs	Double hearing protection
Attenuation (SNR)	32	30	**39.6**

We find that, in order to improve the attenuation of double hearing protection, it is beneficial to make a modification primarily on the intra-aural type of hearing protector, i.e. the earplug. The ear muff has little influence on the overall result. A simple glance at the formula proves this.

4 Conclusion

In extreme cases, implementation of double hearing protection can help to protect a user exposed to very high noise levels.
The calculation of a combination of two hearing protectors is not equal to the sum of their attenuations, but is the result of a more complex formula whose result improves the attenuation only by a few decibels.

Bibliography

Damongeot, Lataye, & Kusy. (1990). Sound attenuation provided by double hearing protection (ear muffs + earplugs). INRS.

NEXER, G. (2011). *Selecting a personal hearing protector* HearingProTech.

Appendix 1

Some examples of double hearing protection.

	Earplug	Ear muffs	**Double hearing protection**
Attenuation (SNR)	20	20	**33.0**
	21	20	**33.6**
	22	20	**34.1**
	23	20	**34.6**
	24	20	**35.1**
	25	25	**36.2**
	26	25	**36.6**
	27	25	**37.1**
	28	25	**37.5**
	29	25	**37.9**
	30	30	**38.8**
	31	30	**39.2**
	32	30	**39.6**
	33	30	**39.9**
	34	30	**40.3**
	34	35	**40.7**