



Just the Facts...

The Combat Arms Earplug

The Problem. For the dismounted soldier or marine, conventional hearing protection can interfere with communication requirements when hearing protection is needed the most, i.e., when firing weapons away from fixed firing points with loudspeaker systems. In steady-state noise over 85 dBA (e.g., in armored vehicles, aircraft or watercraft), conventional hearing protectors can improve communication ability. They function like sunglasses that cut down glare reducing the noise to a level where the ear is not "overloaded". In relative quiet, however, conventional (linear) hearing protectors interfere with speech communication and the detection of environmental (combat) sounds such as vehicle noise, steps in leaves, operation of a rifle bolt, etc.

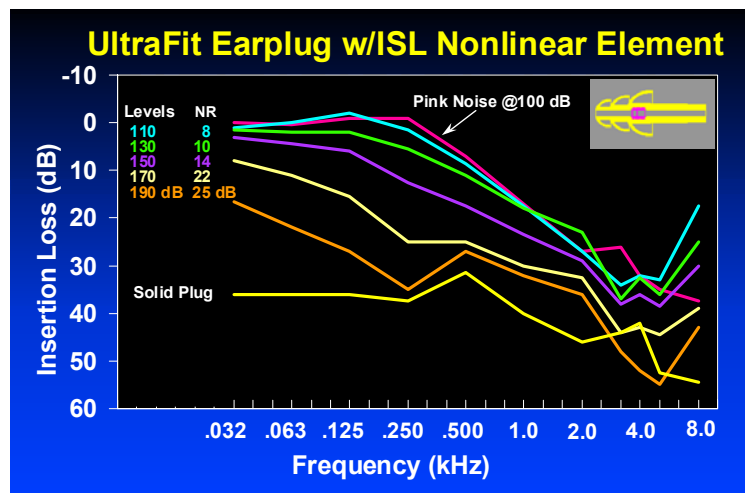
The Solution. The dismounted soldier or marine requires a non-linear hearing protector that mitigates the hazard from weapons fire (impulse noise) over a desired intensity range, but marginally interferes with required verbal communications and detection of combat sounds. One solution has been to exploit the acoustic impedance of impulse noise through small orifices that was reported almost 70 years ago.¹ Researchers at the French-German Institute in Saint Louis have dramatically improved this low tech and inexpensive solution to a long-standing problem. A small "filter" is inserted into the center (stem) of a one-sized, preformed earplug. This filter is a cylindrical device of a specified length (3.7 mm) with holes (0.30 mm) in each end.² French ergonomic designers proposed a two-ended earplug configuration which adapted the earplug for steady state noise use while eliminating wind noise over the plug opening.

Protection Available. The calibrated holes in the non-linear earplug significantly dampen the more hazardous high-frequency component of the impulse noise signature. Noise reduction capability increases with the noise level of weapons fire, hence the term, non-linear, i.e. level dependent. The non-linearity begins at about 110 dBp and increases with increasing peak pressure level. At 190 dBp there is an overall peak reduction of 25 dB.³ See attached graph. Testing at a U.S. military facility found this non-linear earplug protective up to 190 dBp.^{4,5}

Color Coding. The yellow color of the non-linear earplug assists in the requirement to keep the hole clean and free of ear wax, sand, etc. The solid (linear) end of the earplug, which shows when the non-linear yellow plug is inserted, is colored olive drab for compatibility with the stealth mode associated with dismounted operations. The yellow non-linear end of the earplug, which shows when the linear olive drab plug is inserted, should assist in the enforcement and monitoring of the correct device to be used for steady state noise.

Communication and Detection Capabilities. While high-frequency impulse noise is significantly reduced, most speech energy is passed. In addition, a detection model developed at the Army Research Lab predicts a normal-hearing soldier (H-1 profile) can detect a truck with a low-frequency noise signature at the same distance (800 meters) with or without the non-linear plug. That detection capability is cut in half with conventional foam plugs. Note that the detection and localization of sounds with a high-frequency emphasis are only slightly better than with conventional hearing protectors.

*Pink Noise- equal energy across standard bands

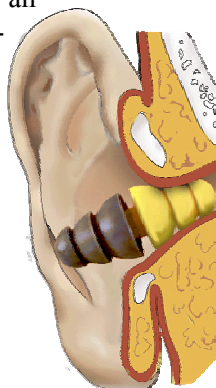


Ordering. A National Stock Number (NSN) 6515-01-466-2710 has been issued for the double-ended earplug. The one size that is available will fit most of the adult population. A single-sided non-linear version will soon be available that will better accommodate smaller ear canals (NSN 6515-01-512-6072). Since the Defense Logistics Agency has added such a substantial handling fee, the most cost effective source currently available is a private distributor, Brock Sales Co., 1155 Providence Rd., Suite C, Brandon, FL 33511, 813-662-2251. The double-ended plug is available in lots of 50 pairs at approximately \$5.75 a pair from this distributor and the single-side version will be distributed in lots of 100 pairs at approximately \$3.25 a pair.

User Tips.

- Commanders should know that the non-linear earplug contributes to realism in training. Even though the non-linear plug is protective, weapons fire sounds louder than with conventional hearing protection.
- Like any earplug, it is essential that the Combat Arms Earplug be properly inserted. This is more difficult with this plug because there aren't readily available landmarks of the plug to the ear to verify proper insertion. Gently tug on the plug. If there is tension, that's a good indication of proper insertion. Also, the voice of the individual wearing the plug will sound more low-toned and slightly muffled to that wearer.
- For exceptionally large ear canals, fold the opposing plug back to enhance proper insertion.
- The seating device for the triple-flange earplug on the lid of the standard carrying case will accommodate the single-sided plug and assist in proper insertion.
- Keep these earplugs clean with soap and water. Immersion in water will not block the filter holes. Return them dry to the earplug carrying case.
- Restrict the non-linear earplug to impulse noise exposures (weapons fire).

• Wind noise may be an issue with the single-sided version.

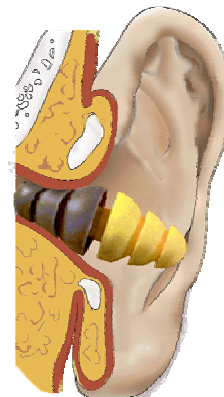


COMBAT ARMS EARPLUG

← Insert **YELLOW** plugs for weapons fire.



→ Insert **OLIVE DRAB** plugs for steady state noise.



References

¹Sivian, L. J. "Acoustic Impedance of Small Orifices," *Journal of the Acoustical Society of America*, 7 (2), 94-101, 1935.

²Dancer, A. and Hamery P., "Nonlinear Hearing Protection Devices," Proceedings of 27nd Annual Conference of the National Hearing Conservation Association, Albuquerque, New Mexico, 19-21 Feb 1998.

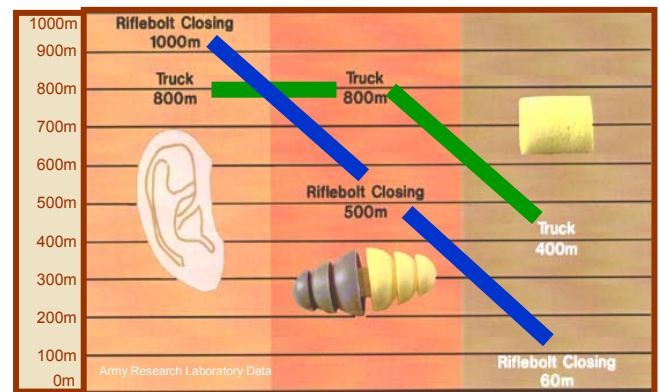
³Ibid.

⁴Johnson, D., "Nonlinear Earplug Study," Research Project Conducted by EG&G Management Systems, Inc., under Contract DAMD-17-93-C-3101 to the U.S. Army Medical Research and Material Command, June 1995.

⁵Testing standards for Noise Reduction Ratings (NRR's) were not designed to evaluate non-linear devices or impulse noise reduction and do not apply.

DETECTION OF SOUND BY

Open Normal Ear Combat Arms Earplug Foam Earplug



Low Suburban Environmental Noise with Acceptable (H+1 Profile) Hearing Ability