CEP introduction

During the past twenty plus years, the search for improved hearing protection and communications has been centered on the concept of active noise reduction (ANR). While this technique provides exceptional protection for frequencies below 800 Hertz, there are shortcomings, which make ANR a compromise solution to improve hearing protection and speech communications. Shortcomings include weight, power required for operation, source of electro/magnetic interference (EMI), susceptible to EMI, higher cost, and more.

An alternative solution that overcomes shortcomings of the ANR approach is the communications earplug (CEP). The CEP is a cost-effective device that provides the exceptional hearing protection of an expanding foam earplug while passing to the ear the clearest speech signal attainable. A miniature transducer and foam earplug are coupled in a unique arrangement to yield a light weight, high quality communications device that can be used alone or in combination with circumaural hearing protection.

The CEP was developed by the U.S. Army Aeromedical Research Laboratory (USAARL) at Fort Rucker, Alabama to meet the significant noise threat of Army helicopters. Tests conducted with aviation units fully demonstrated the capabilities of the CEP in actual operational environments found in all helicopters used in Army aviation.

Communications & Ear Protection was founded in January, 1999 and committed to provide the U.S. Army aviator with state-of-the-art personal communications equipment. This equipment enables the user to understand vocal messages, even in the highest noise environments of the Army helicopter. Since our start, C& EP have been successful in developing a manufacturing process that yields a very high quality device at a modest cost to the user.

Technical Performance of the Communications Earplug (CEP)

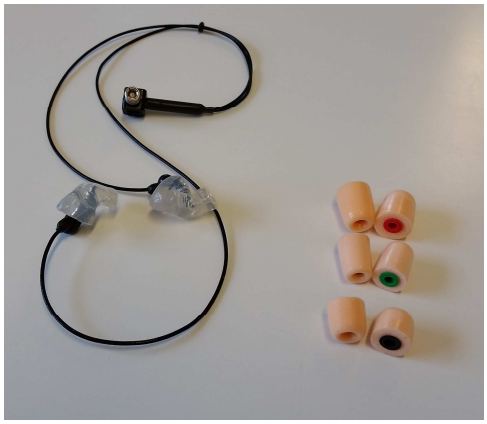
The following is a specification of the Communications Earplug (CEP) system designed for use with the Aviator's helmets. This product is currently manufactured and marketed by Communications & Ear Protection, Inc., Enterprise, AL.

General Description

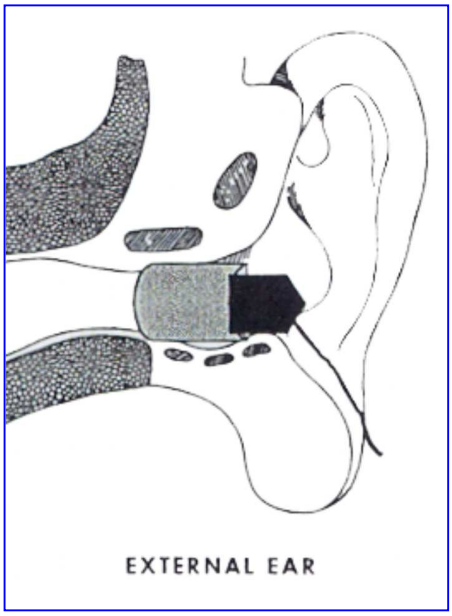
The CEP is a device that is used to provide hearing protection and high quality speech communications to the user.

- The CEP consist of a pair of mini-speaker elements combined with earplugs to provide a passive noise attenuating barrier between the users ear and the noise source and provide monaural voice communications signals to each ear.

- The elements can be standard CEP foam ear plugs or custom molded earplugs.



- Each element consists of a housing that contains a dynamic earphone transducer and a foam earplug tip.
- The transducer is directly connected into the communications system through a small, highly flexible coaxial wire with overall diameter of less than 1.6 mm (0.063 inches).
- Outer covering of the wire will be polyurethane to reduce hardening effects caused by contact with various chemicals.
- The construction of the wire uses an alloy that is designed to reduce flexure breaks, extending the life of the product.



• The foam earplug tip provides sound attenuation for the user when fit into the ear canals. The earplug tip has an internal threaded insert that extends through the center from the base to near the tip and mates with the threaded adapter on the transducer housing.
• The speech signal produced by the transducer is directly coupled into the occluded portion of the ear canal through the 1.3-mm (0.051-inch) channel in the threaded adapter and foam earplug tip.

- The CEP unit is connected into the helmet communications circuit through an SMB type connector.
- The CEP-helmet-interface consist of a mating SMB coaxial recessed bulkhead jack receptacle that is connected, via 254 mm (8 inch) length of RG-174 coaxial cable, to the communications circuit inside the right earcup.
- The CEP-helmet-interface connection to the communications circuit includes a voltage divider network that adjust the speech output sound level at the ear to similar levels produced by the HGU-56/P helmet.
- Modifications will not reduce the sound attenuation characteristics of the helmet when worn alone or affect the speech output level of the helmet earphone earcup system.
- The CEP system can be retrofitted to any Gentex helicopter helmet also already in operation

Physical Characteristics standard CEP

(Note: To describe the basic concept and characteristics, the data for the earlier standard CEP module is used)
A newer CEP-module has been developed with smaller size and better noise attenuation characteristics. The CEP unit will consist of two transducers; each contained in a nonconductive housing. The transducer will be directly attached to a screw tip, compatible with Comply foam tips manufactured by Hearing Components, Inc. The screw tip exposed length will provide for at least 3/4 turn of the foam tip for attachment. Wire from the transducers will extend from the housing and will be combined at the SMB coaxial connector, right angle plug. Wire lengths of 305 mm (12 inches) and 482 mm (17 inches) for the right and left transducer housings will be used. Dimensions of the housing shall be no more than 9 mm (0.35 inch) in diameter and 20 mm (0.79-inch) length from screw tip to end of housing. Total weight of the CEP unit shall not exceed 10 grams. Material used for constructing the housing shall not cause a reaction or skin irritation of the user.

The CEP helmet-interface cable consist of a mating SMB coaxial recessed bulkhead jack receptacle which is wired into the communications circuit inside the right earcup via a 203 mm (8 inch) RG-1 74 coaxial cable. The resistive network will be encapsulated with greatest diameter to be less than ¼ inch. Wire will enter the earcup through a suitable size grommet to maintain integrity of the earcup.

Electrical Characteristics standard CEP

Acoustic output of the standard CEP shall not exceed 85 dBA with a pink noise input of 500 mV RMS. Measurement will be made using the Bruel & Kjaer Head and Torso Simulator (HATS) or equivalent. The output level shall remain within a range of 10 dB for frequencies between 200 Hertz and 4000 Hertz. The sensitivity of the CEP shall be adjusted to provide 85 dBA acoustic output to the ear when driven by an input of 400 milivolts at 1000 Hertz.

Sound Attenuation Characteristics standard CEP

Mean sound attenuation characteristics of the standard CEP will be no less than values for each frequency band as shown in the following table. The attenuation characteristics will be determined using ANSI S12.6 Method for the measurement of real ear attenuation of hearing protectors.

Table 1.
Minimum required sound attenuation in dB for CEP, fitted with standard foam tips, measured using ANSI S12.6

Frequency in Hertz

125	250	500	1000	2000	3150	4000	6300	8000
20	23	27	30	33	36	35	36	38

New Mini-CEP system CEP508-C15 improvements vs standard CEP

In the pictures above the newer CEP508-C15 is displayed. The new CEP508-C15, reduces the overall size of the housing that is used to keep and protect the transducer, and provides the threaded coupling tube that is used to attach the Comply™ expanding foam ear tip. The diameter of the housing is 0.25 inch which allows for greater comfort in limited space provided in the external ear even when wearing ear cups in order to improve hearing protection. The CEP508-C15 is fully compatible with the interface that is used with the CEP199-C01. It is the intention of CEP, Inc. to replace the earlier Standard CEP, CEP199-C01, and the mini-CEP, CEP402-C05 with this latest product. It provides performance that is equivalent to or better than the earlier versions of the CEP. Cost of this latest development is less than the mini-CEP and the same as the Standard CEP. The connector body is over-molded with a plastic cover to improve the user grip to connect and disconnect the CEP into the comm. system. The over-molding also improves the strain relief for the cable extending from the connector and the transducer housing. A number 4 ‘O’ ring is included over the cable to keep the cord for a wide range of head and neck size of the individual users.

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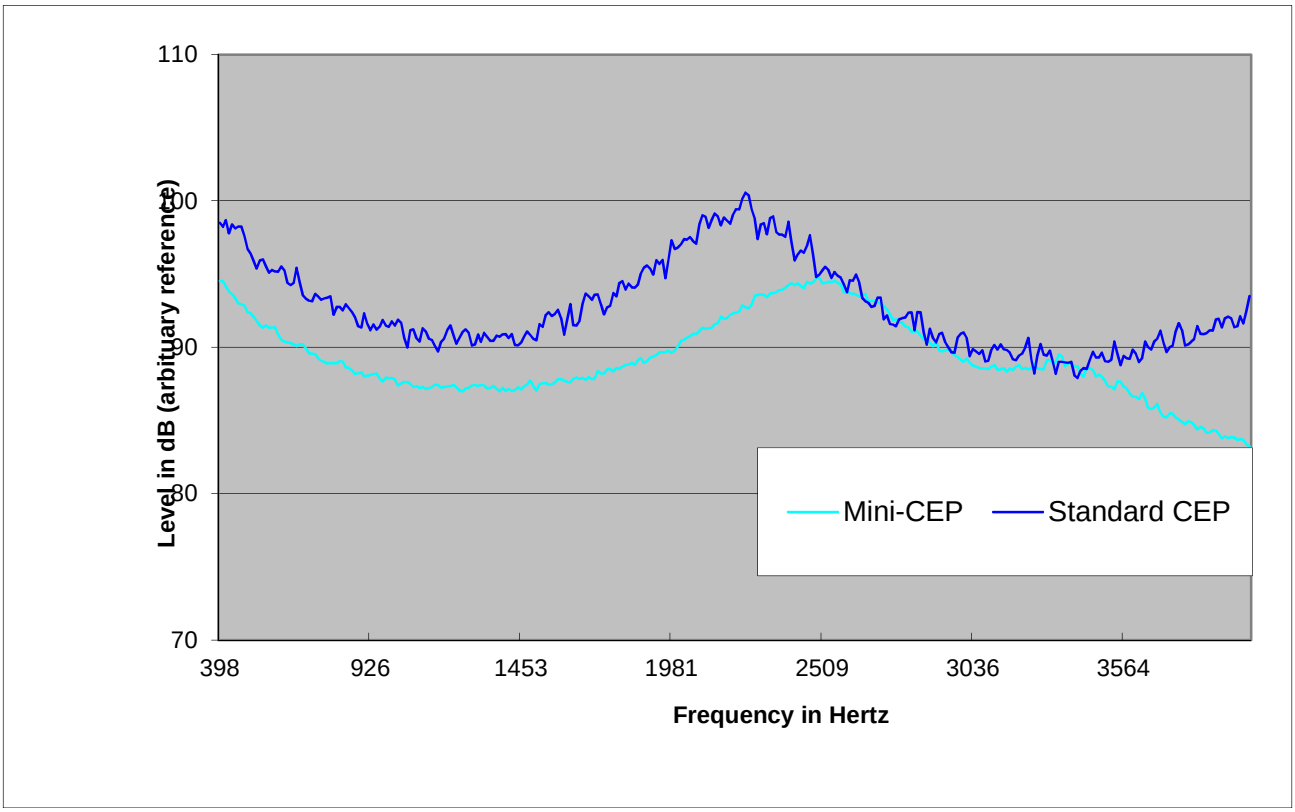

Item Descriptions

CEP unit with screw-on tip is compatible with the Comply foam eartip. The transducer is directly connected to the communications system through a small, highly flexible coaxial wire with overall diameter of less than 1.6 mm (0.063 inch). Outer covering of the wire will be polyurethane to reduce hardening effects caused by contact with various chemicals. Wire will be terminated into a SMB coaxial connector, right angle plug.

CEP-helmet-interface cable will consist of a mating SMB coaxial recessed bulkhead jack receptacle, resistive divider network, RG- 174 coaxial cable, solder tab compatible with SMB connector, and suitable sized grommet. The cable will be terminated with the resistive network that will reduce the speech signal by approximately 20 dB with the connecting leads extending approximately 51 mm (2 inches) from the network. The connector, solder tab washer, and mounting nut are provided with the CEP-helmet-interface cable. The finished length will be approximately 254 mm (10 inches).

Extension cable. The extension cable is 610 mm (24 inches) in length, with mating SMB connectors, and is used between the CEP unit and the CEP-helmet-interface connector. The extension cable includes a small clothing clip attached to the end of the extension cable that includes the jack connector. The extension cable is generally used in conjunction with the CB mask ensemble.

Foam earplug tip, manufactured by HEARING COMPONENTS; 420 Hayward Ave. North Oakdale, MN 55128 (800) 872-8986. Eartips are available in three sizes, standard, short, and slim. Eartips may be purchased in same sizes packages of 12 eartips, or by a case of 60 eartips.

Technical Performance Parameters standard CEP

Sound attenuation and speech intelligibility tests were conducted by the USAARL to determine how the CEP compares to state-of-the-art (1997) ANR systems. The data are limited to U.S. Government official use only because of the nature of the Cooperative Research and Development Agreement. The results of the sound attenuation assessment of the CEP and HGU-56/P helmet are provided for your information.

One of the objectives of the assessment was to determine the effects of ancillary devices such as spectacles and CB mask, on the performance of the test device. The sound attenuation was measured, using ANSI S12.6, on 18 student aviators while wearing the CEP in combination with the HGU-56/P helmet. The combination was worn alone, with spectacles and with CB mask. Results of the measurements are shown in the following table. The attenuation of the yellow foam earplug worn with the HGU-56/P was also measured using the same procedures.

The results clearly show that the use of ancillary equipment degrades the helmet sound attenuation while causing minimal reduction for the conditions where the earplug or CEP is used. This is a practical advantage provided by the earplug when the aviator may use other equipment that interrupts the earseal of the earcup. The degradation of the HGU-56/P shown here is consistent with ANR systems using circumaural configurations.
Table 2.
Real-ear attenuation characteristics, mean and standard deviation, of the HGU-56/P with CEP, HGU-56/P with E-A-R and the HGU-56/P worn alone, with spectacles and with CB mask, 18 subjects, using ANSI S12.6 subject fit procedures.

Frequency in Hertz

Device	Ancillary Device		125	250	500	1000	2000	3150	4000	6300	8000
CEP+HGU56	1	Mean	29.1	26.0	33.0	30.6	40.1	50.2	55.6	54.1	53.5
		S.D.	6.2	6.6	6.4	3.9	3.9	4.4	6.7	5.7	5.7
	2	Mean	25.6	25.0	31.0	32.5	40.6	54.1	57.4	56.5	55.6
		S.D.	8.6	8.2	9.8	8.3	5.2	4.1	4.1	5.5	5.8
	3	Mean	25.5	26.1	35.2	29.8	39.4	49.0	52.3	51.8	53.7
		S.D.	9.0	7.2	8.1	5.0	2.6	4.4	4.5	7.2	6.2
EAR+HGU56	1	Mean	30.0	29.6	36.2	31.7	40.5	51.0	54.2	54.1	53.9
		S.D.	6.5	4.3	6.7	5.8	3.9	5.6	5.0	5.6	5.4
	2	Mean	26.0	25.2	32.6	31.1	40.0	53.4	57.3	59.1	56.9

		S.D.	7.7	7.8	5.6	5.8	4.4	3.4	5.1	5.1	4.5
	3	Mean	24.4	25.3	32.7	31.0	39.1	49.4	53.7	52.4	52.1
		S.D.	8.5	8.2	8.7	5.6	4.1	4.4	3.9	5.8	5.0
HGU-56	1	Mean	15.7	14.7	20.0	23.9	27.8	37.2	40.6	43.2	43.4
		S.D.	3.9	3.3	3.6	4.9	3.7	4.3	2.8	7.1	9.6
	2	Mean	9.1	9.5	14.6	17.3	25.6	34.5	35.9	35.0	33.3
		S.D.	6.5	6.5	5.8	8.4	7.8	6.2	7.5	7.2	6.8
	3	Mean	10.6	12.6	19.2	24.0	25.9	35.2	37.7	28.2	27.4
		S.D.	6.6	5.1	6.8	6.5	3.9	5.0	5.3	8.2	8.3

Ancillary device: 1=Alone, 2=CB Mask, 3=Spectacles

The CEP includes a high quality receiver to generate the speech signal that is provided to the aviator. The additional reduction of ambient noise of the cockpit reaching the ear also complements the speech intelligibility that is achieved with the CEP. During the CRDA tests, the CEP demonstrated significantly higher levels of speech intelligibility for the CB mask condition than was found with the ANR systems however, the alone and spectacle conditions were not found to be statistically significantly.

Weight and Center of Gravity

The weight of the CEP headset is less than 5 grams total weight and the interface cable adds about 5 grams. The CEP, placed in the earcanal, is located at about the CG of the head in the vertical and front/back planes and at approximate equal distance from the head center.

Conclusion

We are convinced the CEP approach for providing hearing protection and speech intelligibility performance is the optimum solution for many areas where voice communications and hearing protection are required. The CEP is a low cost device that may be added to an existing helmet or hearing protector with minimally impact on weight and CG while providing significant improvement in hearing protection and speech performance of the total system.