



**User Acceptability and Comfort
of the Communications Earplug (CEP)
When Used in the UH-1 Helicopter**

By

Ben T. Mozo

Barbara A. Murphy

John E. Ribera

Aircrew Protection Division

February 1995

Approved for public release; distribution unlimited.

**U.S. Army Aeromedical Research Laboratory
Fort Rucker, Alabama 36362-0577**

Notice

Qualified requesters

Qualified requesters may obtain copies from the Defense Technical Information Center (DTIC), Cameron Station, Alexandria, Virginia 22314. Orders will be expedited if placed through the librarian or other person designated to request documents from DTIC.

Change of address

Organizations receiving reports from the U.S. Army Aeromedical Research Laboratory on automatic mailing lists should confirm correct address when corresponding about laboratory reports.

Disposition

Destroy this document when it is no longer needed. Do not return it to the originator.

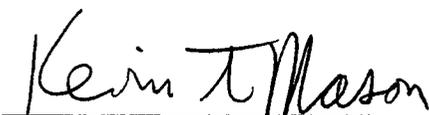
Disclaimer

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citation of trade names in this report does not constitute an official Department of the Army endorsement or approval of the use of such commercial items.

Human use

Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Reg 70-25 on Use of Volunteers in Research.

Reviewed:

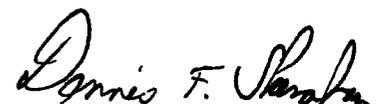


KEVIN T. MASON
LTC, MC, MFS
Director, Aircrew Protection
Division

Released for publication:



ROGER W. WILEY, O.D., Ph.D.
Chairman, Scientific
Review Committee



DENNIS F. SHANAHAN
Colonel, MC, MFS
Commanding

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified		1b. RESTRICTIVE MARKINGS	
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release, distribution unlimited	
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE		5. MONITORING ORGANIZATION REPORT NUMBER(S)	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) USAARL Report No. 95-17		7a. NAME OF MONITORING ORGANIZATION U.S. Army Medical Research and Materiel Command	
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Aeromedical Research Laboratory	6b. OFFICE SYMBOL (if applicable) MCMR-UAD	7b. ADDRESS (City, State, and ZIP Code) Fort Detrick Frederick, MD 21702-5012	
6c. ADDRESS (City, State, and ZIP Code) P.O. Box 620577 Fort Rucker, AL 36362-0577		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8a. NAME OF FUNDING / SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (if applicable)	10. SOURCE OF FUNDING NUMBERS	
8c. ADDRESS (City, State, and ZIP Code)		PROGRAM ELEMENT NO. 63787A	PROJECT NO. 3016287A878
		TASK NO. OF	WORK UNIT ACCESSION NO. 321
11. TITLE (Include Security Classification) User acceptability and comfort of the communication earplug (CEP) when use in the UH-1 helicopter			
12. PERSONAL AUTHOR(S) Ben T. Mozo, Barbara A. Murphy, and John E. Ribera			
13a. TYPE OF REPORT	13b. TIME COVERED FROM _____ TO _____	14. DATE OF REPORT (Year, Month, Day) 1995 February	15. PAGE COUNT 28
16. SUPPLEMENTARY NOTATION			
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	earplug, hearing protection, noise levels, communications capability, exposure level, noise reduction	
20	01		
23	04		
19. ABSTRACT (Continue on reverse if necessary and identify by block number) Aviators and crewmembers assigned to the crash rescue (FLATIRON) unit at Fort Rucker, Alabama, participated in an evaluation of the communications earplug (CEP) in the aviation environment. They were asked to wear the two CEP configurations in combination with their personal SPH-4 helmet for three flights of at least 1 hour duration. One CEP configuration included a foam tip and the other included a premolded triple flange tip. Comments and responses provided by the volunteers showed the CEP, with some modifications, is acceptable for use in the aviation environment. Speech clarity of the CEP was judged to be an improvement over normal helmet/ear protection by 85 percent of the respondents. The CEP with foam tip was judged to be more comfortable than CEP with the triple flange tip. Comfort was judged to be between comfortable and mildly uncomfortable for the CEP with foam earplug tip. The volunteers rated the CEP as being helpful in achieving their mission. The results of this study show the CEP is comfortable and acceptable to the aviation crewmember.			
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL Chief, Science Support Center		22b. TELEPHONE (Include Area Code) 334-255-6907	22c. OFFICE SYMBOL MCMR-UAX-SI

Contents

Page

List of figures	2
List of tables	2
Introduction	3
Background	3
Methods	5
Results and discussion	6
Earplug users	6
Volunteer flight time	7
Speech quality	8
Noise reduction	8
Helmet donning	8
Discomfort	8
Problem areas	9
Utility rating	9
Conclusions	9
Recommendations	10
References	11
Appendix A. User acceptability/comfort questionnaire for the communication earplug (CEP)	12
Appendix B. Results of user acceptability/comfort questionnaire for the communication earplug (CEP)	15

List of figures

Figure	Page
1. The CEP shown with foam and triple flange earplug tips	5

List of tables

1. Sound attenuation values in dB and EEL in dBA of various helmet and earplug combinations measured using ANSI S12.6. EEL is calculated, using noise of the UH-1H at 100-knot cruise	4
2. Number of flight hours flown by each volunteer while using each of the CEP earplug tips	7

Introduction

The objective of this study was to evaluate the communications earplug (CEP) in terms of user perception of capability, comfort, and acceptability when used in combination with the aviation helmet in the UH-1V flying environment. Volunteer flight crews from the crash rescue (FLATIRON) unit at Fort Rucker, Alabama, were used in the study.

The study was designed to evaluate the relative merits of CEP on the crewmember's comfort, and whether this mode of providing speech communication input to the individual through an earplug would be acceptable for use in aviation. The rationale for this device being acceptable to the aviation crewmember is that the CEP reduces the noise level at the ear and improves speech intelligibility (SI) while not increasing the discomfort. This study will show that the benefits of reduced noise and improved SI outweigh the potential discomfort of the aviator.

Background

Aviators use the SPH-4 series helmet to provide hearing protection and communications capability. Many aviators routinely use earplugs in combination with the helmet to provide an added margin of protection for some aircraft noise environments. However, use of combination protection can impair the aviator's ability to communicate since earphone output must overcome attenuation of the earplug to provide speech signals to the ear. Using the CEP reduces noise exposure and improves SI in high noise environments. Table 1 shows that when the CEP is worn in combination with the SPH-4 or HGU-56/P, the attenuation of noise is increased for all frequencies, which will result in improved speech-to-noise ratio. Noise exposure of individuals wearing the CEP compared with passive helmets worn alone and in combination with earplugs also are shown in Table 1. The effective exposure level (EEL) is the calculated A-weighted level at the ear of an individual wearing the hearing protector in a particular noise environment, i.e., a UH-1H at 100-knot cruise.

The CEP, shown in Figure 1, is a miniature dynamic earphone which may be used with either a urethane foam tip or a polyvinyl chloride triple flange tip. The CEP has a ¼-inch hollow plastic screw attached to the acoustic output port. The CEP/FOAM has a foam tip which is internally threaded to match the plastic screw on the CEP. A 2.5-mm hole through the center of the earplug provides a sound path from the CEP into the occluded portion of the ear canal. The CEP/TF is based on the triple flange earplug design which has been modified with a built-in pouch used to contain the CEP. Also, it has a hole from the CEP to the earplug tip providing a sound path to the ear. The CEP, with either earplug tip worn in combination with the SPH-4, yields significant improvements in speech signal-to-noise ratio, and provides additional sound attenuation that reduces noise exposure of aviators in the UH-1H noise environment.

Hearing protection afforded by the aviator's helmet can be compromised significantly when ancillary devices are worn in combination with it. For example: eyeglass frames break the earseal creating a leak, producing a sound path from outside to inside the earcup. Protective masks and cold weather hoods also provide leakage paths and decrease the hearing protection capability of the helmet. Loss of sound attenuation due to compatibility with other clothing or equipment is true for both passive and active noise reduction hearing protectors. The CEP is less susceptible to sound attenuation losses because none of the clothing or protective ensembles worn by the aviator break the seal within the ear canal.

Table 1.
Sound attenuation values in dB and EEL in dBA of various helmet and earplug combinations measured using ANSI S12.6. EEL is calculated, using noise of the UH-1H at 100-knot cruise.

		Frequency in hertz									
		125	250	500	1000	2000	3150	4000	6300	8000	EEL
SPH4*	MEAN	17.7	15.9	23.3	28.8	33.7	40.0	42.9	46.5	44.1	79
	S.D.	3.2	2.5	2.7	3.2	3.9	3.3	3.4	3.7	3.8	
SPH4* W/E-A-R	MEAN	32.7	36.9	42.4	37.2	37.5	50.7	52.7	55.5	54.8	67
	S.D.	7.2	7.2	7.9	7.6	4.1	5.9	6.1	5.2	4.5	
SPH4* W/TF	MEAN	30.6	33.3	36.2	32.0	38.6	49.0	52.2	53.6	53.7	69
	S.D.	6.6	5.9	6.8	4.0	4.3	4.0	3.8	4.5	3.6	
HGU-56**	MEAN	17.6	19.2	22.5	33.8	31.9	40.3	41.8	44.2	44.9	79
	S.D.	4.2	4.1	3.9	3.2	4.5	4.4	5.1	5.7	4.1	
HGU-56** W/E-A-R	MEAN	32.2	32.5	38.7	37.3	41.9	49.6	53.8	53.1	53.8	67
	S.D.	3.8	6.6	6.2	5.5	3.8	3.4	4.0	3.6	3.5	
HGU-56** W/CEP	MEAN	30.4	27.2	35.8	36.7	42.2	52.2	51.9	52.4	53.1	70
	S.D.	6.4	3.2	7.9	6.7	4.6	4.6	6.2	4.8	4.9	
CEP/ FOAM	MEAN	20.2	23.0	27.5	29.8	32.7	36.2	35.3	36.4	38.0	76
	S.D.	5.2	4.5	4.7	4.9	3.8	5.4	6.0	5.1	6.1	
CEP/ TF	MEAN	23.4	23.2	23.3	20.0	26.9	28.0	24.5	32.2	33.5	83
	S.D.	8.7	8.2	8.9	6.0	6.5	6.2	5.9	10.6	8.9	

* Reference USAARL Report No. 93-10

** Reference Mozo and Murphy, 1995 (draft).

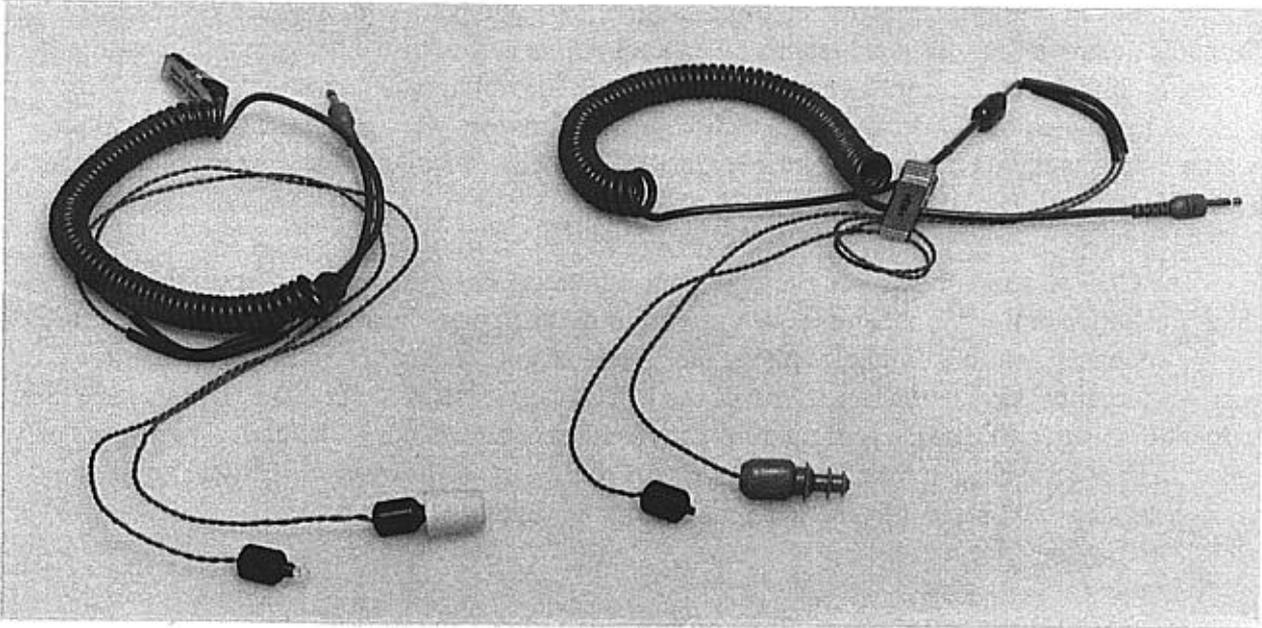


Figure 1. The CEP shown with foam and triple flange earplug tips.

Results of sound attenuation evaluations conducted at this laboratory, shown in Table 1, demonstrated the CEP provides adequate hearing protection for a typical noise found in Army helicopters. The EEL is a calculation that combines hearing protector attenuation less one standard deviation at each test frequency and A-weighted octave band noise levels in the helicopter to estimate the dBA level at the ear. Up to 8 hours exposure is allowed for noise levels less than 85 dBA in accordance with DoDI 6055.12, "Hearing conservation."

Methods

Aviators and crewmembers assigned to the FLATIRON unit at Fort Rucker were participants in this study. They were asked to wear the two CEP configurations, shown in Figure 1, in combination with their personal SPH-4 helmet for three flights of at least 1 hour duration. At the end of the last flight for that earplug tip condition, the volunteer was asked to complete the questionnaire shown in Appendix A.

Twenty human subjects were used in the comparison of the CEP/TF plus SPH-4 and CEP/FOAM plus SPH-4. The CEP devices were counterbalanced with half of the volunteers using CEP/TF first and the other half using the CEP/FOAM first. Otherwise, the volunteers performed their normal activities and wore ancillary equipment as they normally do. Hearing loss was not a controlled factor for this study.

A training session was provided to familiarize the volunteers with the CEP devices. Volunteers were given otoscopic exams by an audiologist or a certified occupational hearing conservation technician prior to beginning the study. The volunteers then were fitted with the CEP and instructed on proper insertion techniques. Volunteers were protected fully with their own helmet plus the CEP device. Noise exposure was below 85 dBA which is considered safe, in accordance with DODI 6055.12.

The CEP was integrated into the aircraft communications system with a special adapter which fits between the helmet and the aircraft communication connectors. The CEP connected into the adapter through a miniature phone jack. The adapter included circuitry to adjust the CEP sensitivity to approximate the sensitivity of the SPH-4 helmet at 1000 Hz. The CEP used in this evaluation was in a "Y" cord configuration with each ear's transducer at the end of two wires of approximately 18 inches in length. The other part of the "Y" cord was a coiled wire approximately 18 inches resting length and terminated with a miniature phone plug.

Results and discussion

Appendix B lists volunteer responses along with questions contained in the questionnaire for the convenience of the reader. Comments are shown verbatim and numerical rating responses are summarized. The yes/no type questions show the average value calculated using numerical assignments of yes=1 and no=0. The numerical rating responses of multiple interval questions use the value indicated by the respondents to calculate the average.

Measures of the perception of the volunteers relative to noise, speech and comfort were assessed to determine if the CEP was acceptable to the aviator/crewmember. It is important to keep in mind that perceptions should not replace the measurements conducted under controlled conditions in the laboratory. The perceptions are indicators of the subjective feelings and, therefore, the acceptability of a device to the respondent. Responses to questions about the two different earplug tips are separated into columns for easier comparisons by the reader.

Earplug users

Responses indicate that 70 percent of the volunteers normally wear earplugs during the performance of their flying duties while 40 percent wear glasses. The SPH-4 helmet was worn by 19 of the volunteers while 1 indicated he wore the SPH-3 helmet.

Volunteer flight time

Table 2 shows the length of time flown by each volunteer while wearing each CEP tip. The mean flight time for the 20 volunteers was 7.2 hours for each earplug tip which is above the 3-hour requirement in the protocol. In one case, the volunteer indicated he had flown only .8 hours while wearing the CEP/triple flange (TF) due to an ear canal irritation. The remaining volunteers indicated flight times of 3 hours or more.

Table 2.
Number of flight hours flown by each volunteer
while using each of the CEP earplug tips.

Vol	Foam	TF
1	3.0	3.2
2	8.0	.8
3	4.5	8.0
5	9.0	3.0
6	9.0	5.5
7	6.0	3.0
8	4.5	18.1
9	7.0	20.0
10	5.0	6.5
11	5.0	5.0
13	10.0	4.0
15	5.4	4.0
16	6.0	4.0
18	14.0	8.0
20	6.0	5.0
21	12.5	10.0
22	3.0	3.0
23	4.0	5.0
24	10.0	10.0
25	15.0	9.0
	146.9	135.1

Speech quality

Eighty percent of the volunteers said the CEP improved speech quality. The comments suggest the effect was to increase clarity and improve their ability to understand speech over the intercommunication system (ICS). Only one individual commented there was no difference. Several respondents said the volume level of the speech signal could be reduced while maintaining satisfactory SI. Comments from several volunteers indicated speech clarity was improved significantly and they were able to understand speech over the communications system better.

Noise reduction

Thirty-nine of the forty responses (one no-response) indicated noise levels at the ear were reduced. The scaled response average was very near "great reduction" for both tips. The hoist operators indicated the CEP was excellent for communications and hearing protection during hoist operations. Table 1 shows results of laboratory measurements which examined the sound attenuating qualities of the CEP with foam tip, TF tip when worn alone and worn in combination with the HGU-56/P helmet. The SPH-4 helmet also is shown in Table 1 to provide a reference for attenuation characteristics of devices commonly used in Army aviation. The sound attenuation of the HGU-56/P when worn in combination with the CEP far exceeds that of any hearing protector in the inventory.

Helmet donning

Helmet donning procedures were reported to be more difficult while wearing the CEP by 90 percent of the volunteers. As described earlier, the CEP requires a significant amount of wire management for the configuration used in this evaluation. As expected, the volunteers pointed out that additional time and planning was required to put on the helmet due to the length of the wires with the CEP. There were several comments relating to the CEP being pulled out of the ear during helmet donning. This shortcoming is corrected by routing the wire to the CEP from a point above the ear canal. This laboratory is currently developing a headband communication unit which includes the CEP and a state-of-the-art noise cancelling microphone. It is expected that this device will alleviate most of the donning problems encountered during this study.

Discomfort

Determining discomfort caused by the CEP device was the central objective of this study. Fifty percent of the foam users and 85 percent of the TF users reported some degree of discomfort. The respondents reported an average level of discomfort of 2.25 which is between no discomfort and mild discomfort for the foam tip while the TF tip average level was 1.65 which is

between mild and moderate discomfort. Seventy-five percent of the responses indicated discomfort was mild or less for the foam tip while 66 percent TF tip users indicated discomfort was mild or less. When asked the length of time when discomfort was first noticed, 18 volunteers wearing the CEP/foam indicated mild discomfort occurred within the first hour while only 10 using the CEP/TF indicated discomfort within that period. Some of the respondents indicated the foam tip plastic insert caused some discomfort. After review, we think this is due to improper insertion of the earplug. If the tip is forced into the canal, the foam will be forced back and away from the plastic insert. The proper insertion technique is to roll the foam into a smaller cylinder before insertion into the canal which will prevent exposing the plastic insert. Volunteer #2 reported that the CEP/TF caused a "blood blister" on his eardrum. Subsequent otoscopic examination by the audiometric technician revealed unidentified debris near the tympanic membrane that appeared dark red in color. This may have been dried blood from an irritation in the canal, or dark colored cerumen (ear wax). After consultation with the research audiologist, it has been determined that the likelihood of inserting the CEP, whether foam or triple flange, deep enough to cause damage to the eardrum itself is remote. These findings do not rule out the discomfort sensed by the aviator, nor the possibility that an irritation occurred on the canal walls due to repeated insertions and extractions of the CEP over time. The volunteer discontinued his evaluation of the CEP/TF, but continued the protocol with an additional 8 hours of flight time using the CEP/FOAM.

Problem areas

When asked to predict problems areas for the CEP within the operational environment, the majority of the respondents concluded that wire management was the primary problem. Increased donning time and inconvenience were classified as shortcomings of the CEP system used in this evaluation, due primarily to wire length.

Utility rating

Volunteers were asked to rate the utility for helping to achieve their mission. The average rating was 2.97 for foam tip and 3.15 for TF tip (3 is classified as helpful). Finally, they were asked if the CEP was acceptable for the operational environment. The response average was .85 for the foam tip and .80 for the TF tip. Comments indicated the CEP is not ready for fielding yet, but possesses potential to significantly improve communications and hearing protection.

Conclusions

Comments and responses provided by the volunteers indicate the CEP, with some modifications, is acceptable for use in the aviation environment. As expected, the long wires which must be managed by the user were identified as a problem area. The development of the communications headband will be directed at improving the areas of long wires and donning of the CEP and helmet.

Eighty-five percent of the respondents judged speech clarity of the CEP to be a significant improvement over their normal helmet/ear protection. Noise reduction at the ear was judged to be significantly improved by 95 percent of the volunteers. As a result of these improvements, most of the participants in this study expressed a desire to keep the test items after completion of the test.

The results show the CEP is acceptable to the aviation crewmembers used in this study. Laboratory evaluations show the CEP provides excellent sound attenuating properties, reducing the threat of noise induced hearing loss of the aviator and significant improvements in speech intelligibility. The CEP is a cost effective means to provide the aviator with increased hearing protection while improving their ability to understand speech through the communications system. The enhancement of speech communication should provide for better overall performance and cockpit coordination.

Recommendations

The positive responses from volunteers used in this study show the CEP is a viable technique to provide the aviator with improved hearing protection and communications capability. This laboratory recommends continued development of the CEP into a communications device for U.S. Army Aviation.

References

- Department of Defense. 1991. Hearing conservation. Washington, DC: Department of the Defense: DoDI 6055.12.
- Mozo, Ben T., Barlow, Linda S., and Murphy, Barbara A. 1993. Sound attenuation characteristics of the standard DH-132A and SPH-4 helmets worn in combination with standard issue earplugs. Fort Rucker, AL: U.S. Army Aeromedical Research Laboratory. USAARL Report No. 93-10.
- Mozo, Ben T., and Murphy, Barbara A. 1995. Speech intelligibility characteristics of the active noise reduction hearing protectors, passive hearing protectors, and communications earplug hearing protector for use in aviation noise environments. Fort Rucker, AL: U.S. Army Aeromedical Research Laboratory. Draft USAARL Report.

Appendix A.

User acceptability/comfort questionnaire
for the communication earplug (CEP).

You have been asked to fly with a Communication Earplug (CEP) utilized with your flight helmet in order to evaluate its acceptance and comfort. We would be grateful if you would complete the following questionnaire:

Instructions:

Most questions are self explanatory, requiring a Yes/No response and leaving room for comment. Please try to be as precise as possible when making comments. Some questions will require you to make a mark on a continuum between extremes. Your response should be indicative of the strength of your feeling.

Thank you for your cooperation.

General details:

Name _____

Date _____

Type of helmet you normally use. _____

Type of helmet used with CEP. _____

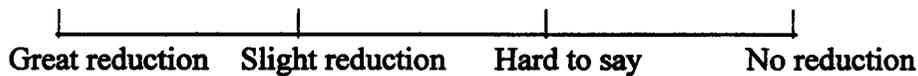
Aircraft type. _____

Approximate number of hours flown with the CEP. _____

1. Do you normally wear earplugs in conjunction with the flight helmet? Yes/No
2. Do you normally wear glasses when flying? Yes/No
 - a. Did you wear glasses on this flight? Yes/No
3. Compared to your normal helmet/ear protection, did CEP effect speech quality? Yes/No
 - a. How was speech quality effected?

Comments:

4. Did the CEP reduce noise levels at the ear? Yes/No



Comments:

5. Did the addition of CEP result in differences in the helmet donning procedure? Yes/No

Comments:

a. Did you have any trouble with the wiring tangling with the helmet? Yes/No

Comments:

6. Did the CEP cause any discomfort in your ears? Yes/No

Comments:

a. When did you first notice the discomfort? Please circle the appropriate time below.

½-hr 1 hr 1½ hrs 2½ hrs 3 hrs 3½ hrs 4 hrs

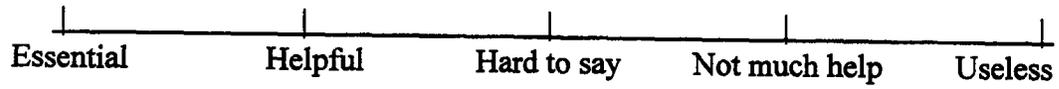
7. Were there any other adverse effects of CEP performance? Yes/No

Comments:

8. Can you foresee any problems within the operational environment for the CEP system?
Yes/No

Comments:

9. Based on your flying experience, rate the utility of CEP for helping you achieve your mission.



Do you think the system is acceptable for the operational environment? Yes/No

Comments:

Appendix B.

Results of user acceptability/comfort questionnaire for the communication earplug (CEP).

You have been asked to fly with a Communication Earplug (CEP) utilized with your flight helmet in order to evaluate its acceptance and comfort. We would be grateful if you would complete the following questionnaire:

Instructions:

Most questions are self explanatory, requiring a Yes/No response and leaving room for comment. Please try to be as precise as possible when making comments. Some questions will require you to make a mark on a continuum between extremes. Your response should be indicative of the strength of your feeling.

Type of helmet you normally use.	RESULTS:	SPH-4	SPH-3
		19	1

Type of helmet used with CEP.	RESULTS:	SPH-4	SPH-3
		19	1

Aircraft type.	RESULTS:	UH-1V
		20

Approximate number of hours flown with the CEP.	RESULTS:	FOAM	TF
	TOTAL	146.9	135.1
	MIN	3.0	.8
	MAX	15.0	20.0
	MEAN	7.3	6.8
	S.D.	3.5	4.8

1. Do you normally wear earplugs in conjunction with the flight helmet?	Yes/No
RESULTS:	Yes-14 No-6
Percent:	70

2. Do you normally wear glasses when flying?	Yes/No
RESULTS:	Yes-8 No-12
Percent:	40

Did you wear glasses on this flight?	Yes/No
RESULTS:	YES-8 NO-12
Percent:	40

3. Compared to your normal helmet/ear protection, did CEP effect speech quality? Yes/No

RESULTS: Yes-16 No-4
Percent: 80

How was speech quality effected?

Comments:

Vol	CEP/FOAM	CEP/TF
1	Able to discern cockpit and radio calls better, better clarity	Quality was better
2	Clarity, lower volume setting	Clarity with a lower volume setting
3	The plugs increased clarity while also providing noise attenuation	Speech was louder and clearly understood. Extraneous aircraft noise was reduced
5	It made everybody's speech more clear and easier to understand	More clear and easier to understand
6	No response	Could understand better
7	None	No response
8	Improved	Significant improvement in clarity
9	No response	No response
10	Greatly improved	Much improved
11	No response	No response
13	Clear	Clear
15	A lot clearer with less outside noise, cleared out static	Helped it out
16	Improved drastically	Much better
18	Very clear	Very clear
20	Clearer	Better
21	I could hear other crew members a lot clearer	A lot clearer and less background noise
22	Clearer	Clearer and less aircraft noise, I like them although I did have minor wire problems

- | | | |
|----|--|--|
| 23 | Tremendously, I was able to relax more because aircraft noise was eliminated and actually communicated in a softer voice tone than I do in normal conversation | As with the foam plugs, I was able to relax more because of reduced background noise; this enabled me to speak in a softer tone voice than I normally do when away from the aircraft |
| 24 | No response | No response |
| 25 | I was able to hear all radios and crew conversations extremely well. I was able to turn my volume down and was finding myself speaking softer than before | I wasn't forcing my speech. Speech was calmer and softer. Didn't have to concentrate on enunciating each word |
-

4. Did the CEP reduce noise levels at the ear? Yes/No

	FOAM	TF
RESULTS:	Yes-19	Yes-20
	No- 0	No- 0
	NR-1	NR- 0
Percent:	95	

	*F			
3	T	2	1	0
I	^	I	I	I
<hr/>				
Great		Slight	Hard	No
reduction		reduction	to say	reduction

*F=CEP/FOAM
T=CEP/TF

	FOAM	TF
RESULTS:	3-14	3- 14
	2-2	2- 5
	2.5-3	2.5-1
	1-1	1-0
	0-0	0-0
Average:	2.73	2.7

Comments:

Vol	CEP/FOAM	CEP/TF
1	Great reduction	Great reduction
2	Slight reduction	Slight reduction
3	Great reduction	Great reduction, this was the second phase of the study for me, using the triple flange rubber. Comfort level was significantly less for TF than the soft sponges
5	Great reduction, excellent for use with our hoist	Great reduction, excellent for use with our hoist
6	Great reduction	Slight reduction, did not hear as much outside noise
7	Great reduction, would like to keep this system, it really cut down on the overall noise level	Great reduction, I could actually hear the conversation over the ICS versus every other noise
8	Slight reduction, not as great as triple flange	Slight reduction in noise, normally wear TF anyway, but seemed to be an improvement in noise levels
9	Between slight reduction and great reduction	Great reduction

10	Great reduction	Great reduction
11	Great reduction	Great reduction
13	Great reduction	Great reduction
15	Great reduction	Great reduction
16	Great reduction	Great reduction
18	Great reduction	Slight reduction
20	Hard to say	Slight reduction
21	Great reduction, aircraft noise was reduced and speech and radio transmission was increased	Great reduction, background engine noise greatly reduced
22	Great reduction	Great reduction
23	Great reduction	Great reduction
24	Great reduction	Great reduction
25	Great reduction	Great reduction, aircraft and outside noise was greatly reduced

5. Did the addition of CEP result in differences in the helmet donning procedure? Yes/No

	FOAM	TF
RESULTS:	Yes-18	Yes-18
	No-2	No-2
Percent:	90	90

Comments:

Vol	CEP/FOAM	CEP/TF
1	More time required to ensure wires did not tug when moving head from side to side	A little more prep time to ensure wires did not tug at earcup or become tangled with shoulder harness
2	Care has to be taken not to pull the CEP out	Care has to be taken not to pull the CEP out

3	No response	Had to pull helmet apart so as not to knock plug from ear
5	Took more time and wires were easily snagged	Took more time and things got tangled
6	Required more time due to wire sticking from under helmet	Slows the time
7	Only slightly because of all the wires	No response
8	Slows things down	Slowed down the process slightly, careful not to tangle wires or pull plugs out of ears when sliding earcup over ears
9	It took a little more time to don	The earplug, if not seated good, usually fell out
10	Very complicated, not appropriate for crash duty	Cumbersome wires
11	No response	No response
13	More difficult	More difficult
15	No response	No response
16	Have to open helmet more forcefully to fit helmet without loosening CEP fit	Definitely added to my helmet donning time
18	Took about 1 minute longer	Took about 30 seconds longer to put helmet on
20	Wires very cumbersome	Wires gotta go!!
21	I had to be careful of the CEP cords and plugs	Due to wires and plugs
22	Took extra time to put equipment on	Made a little longer prep time
23	A little cumbersome but well worth it	A little more time is required
24	No response	No response
25	No more than any other time with glasses	No response

5a. Did you have any trouble with CEP wiring tangling with the helmet? Yes/No

	FOAM		
RESULTS:	Yes-9	No-10	NR-1
Percent:	45		
	TF		
RESULTS:	Yes-11	No-8	NR-1
Percent:	55		

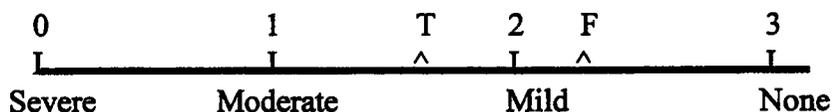
Comments:

Vol	CEP/FOAM	CEP/TF
1	No response	No response
2	No response	No response
3	I clip the CEP on the back of the seat and clip the wires above so they are ready to go	No response
5	Easily gets tangled with ALSE vest and helmet	No response
6	No response	No response
7	Wires need to be shortened going to the earplug	Sometimes the cord would tangle
8	No response	Too long, all three should be coiled
9	During hoist mission	During hoist operation your head is constantly moving from front to rear thus causing a tugging action in which the plug would come out of your ear
10	No response	No response
11	No response	No response
13	No response	No response
15	No response	No response
16	Minimal	No response
18	No response	No response
20	No response	No response
21	No response	No response
22	No response	No response
23	No response	A small amount of difficulty was found trying to move in and out of the aircraft but that was expected

24	No response	No response
25	I was aware of the possibility and was more careful	I was just more careful donning the helmet. The adapter was a bit cumbersome at first - falling down between my back and seat

6. Did the CEP cause any discomfort in your ears? Yes/No

	FOAM	TF
RESULTS:	Yes-10	YES-17
	No-10	No-3
Percent:	50	85



	FOAM	TF
RESULTS:	3-10	3-3
	2.5-1	2.5-0
	2-4	2-9
	1-4	1-5
	.5-1	.5-2
	0-0	0-1
Average:	2.25	1.65

Comments:

Vol	CEP/FOAM	CEP/TF
1	Plastic insert in earplug caused some discomfort especially if wires were not slack under earcup	Discomfort when taking them out, more w/left ear, could feel indention caused by the ridges
2	No response	Caused a blood blister on right eardrum
3	No response	TF are uncomfortable and cause sores in my ear
5	Very comfortable	Rubber ones are a little uncomfortable

6	Foam is easier on ear canal than flange	Some pressure to ear canal
7	I was not used to having them in and they were uncomfortable	Only with the triple flange I noticed it was harder to keep them seated in place
8	Foam plugs are of insufficient thickness to protect ear canal from sharp points on transducers	None while wearing CEP, only on removal felt some soreness where contacted outer part of canal and rubbed as they were bent forward by friction between wire and earcup
9	Very little	Very little, noted with the flange
10	Some pain due to "softies" being too small	Pain when removing helmet
11	No response	No response
13	No response	No response
15	No response	No response
16	No response	Triple flange caused slight discomfort on a few occasions
18	No response	After about an hour started hurting my ear
20	No response	No response
21	After long periods of flight, the CEP begins to cause discomfort in the ear and around it	After long periods of time the hard flange creates greater discomfort than the soft plugs
22	No response	Not used to wearing them
23	No response	The triple flange plugs cause moderate discomfort after approximately thirty minutes of flight time
24	No response	No response
25	No response	The triple flange was painful in the ear canal after about one hour of wear

6a. When did you first notice the discomfort? Please circle the appropriate time below.

.5 hr 1 hr 1.5 hrs 2 hrs 2.5 hrs 3 hrs 3.5 hrs 4 hrs

RESULTS:

	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	No response
FOAM	7	1	0	1	0	0	0	0	11
TF	4	6	6	2	1	0	0	1	4

7. Were there any other adverse effects of CEP performance? Yes/No

	FOAM	TF
RESULTS:	YES-3	YES-4
	NO-17	NO-16
Percent:	15	20

Comments:

Vol	CEP/FOAM	CEP/TF
1	No response	No response
2	No response	No response
3	No response	No response
5	Speech was more clear and easily heard	No response
6	No response	No response
7	No response	No response
8	No response	Impedance did not match non-CEP pilot ICS system, battle for radio volume harmony distracted from mission
9	No response	No response
10	No response	No response
11	No response	No response

13	No response	No response
15	No response	No response
16	No response	No response
18	No response	The adapter cut out a lot (intermittent signal)
20	No response	No response
21	No response	No response
22	No response	No response
23	Explained earlier	No response
24	No response	No response
25	I was less tense. Being able to hear all comms clearly made flying less stressful. I was not at all fatigued after flying long hours with the CEP. I was very fatigued after flights without CEP.	I was physically relaxed using the CEP. I <u>wasn't</u> tense and emotionally frustrated because I could hear all the radios and conversations.

8. Can you foresee any problems within the operational environment for the CEP system?

Yes/No

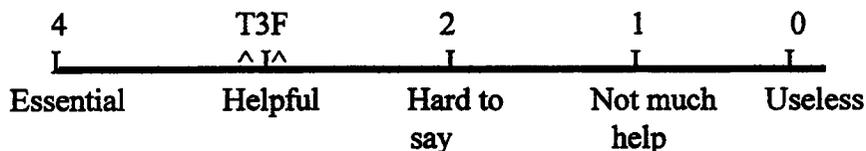
	FOAM	TF
RESULTS:	Yes-10	Yes-5
	No-10	No-15
Percent:	50	25

Comments:

Vol	CEP/FOAM	CEP/TF
1	No response	No response
2	The amount of external wires can cause the wires to pull out	Amount of external wires can cause the wires to pull out
3	Possibly technique	Increased donning time. Only affects MEDEVAC since we are rushing
5	Needs to be built into the helmet itself	No response
6	Need to modify wiring of CEP	No response

7	No response	No response
8	Wires tangling	No response
9	No response	No response
10	Need to be easier to don, especially for MEDEVAC	No response
11	No response	No response
13	No response	No response
15	No response	Pain in ears
16	Great piece of equipment	No response
18	Takes longer to put in when in a fast mode like to an accident	As long as the adapter keeps working
20	No response	No response
21	It needs to be easier to fit and wear the CEP	Tangling with wires and ear discomfort on long missions
22	Wires or connections were broken twice	No response
23	No response	No response
24	No response	No response
25	Only minor maintenance of the thin wire and possible breakage of the wire harness	No response

9. Based on your flying experience, rate the utility of CEP for helping you achieve your mission.



	FOAM	TF
RESULTS:	4-3	4-3
	3.5-3	3.5-2
	3-12	3-14
	2-0	2-1
	1-1	1-0
	0-1	0-0

Average:	2.97	3.15

Do you think the system is acceptable for the operational environment? Yes/No

	FOAM	TF
RESULTS:	Yes-17	Yes-16
	No-3	No-4
Percent:	85	80

Comments:

Vol	CEP/FOAM	CEP/TF
1	No response	No response
2	Great system when using foam plugs, system became inoperable after about 8 hrs	If the system can be incorporated into the helmet it would be better
3	No response	Takes some work in getting used to. Does improve communication
5	Being on the crew in the back, you move around more. Again easily gets tangled and excellent for use with our hoist	No response
6	With slight modification	Will work well with some modifications

7	I think this system helps me get information better than just using the regular earplugs and the information comes through clearly	No response
8	Foam plugs and wiring needs to be redesigned	Not just yet, great idea, terrific potential, needs some bugs worked out. Thank you for helping us
9	No response	On numerous hoist training mission, it greatly improved the communication between pilot and hoist operator, the only problem is noted in #5
10	With appropriate modification	No response
11	No response	No response
13	No response	No response
15	No response	No response
16	No response	With some modifications to facilitate ease in donning, they are phenomenal
18	No response	Cut down on a/c noise, clearer voices and radio calls
20	Not as configured (wires)	Not with the wires
21	No response	Less wires would make it easier
22	No response	As long as the wire set holds up
23	No response	No response
24	Will be very useful if wiring system is changed	Useful if wiring system is changed
25	It could be fielded now for pilots experiencing hearing difficulty. Packaging a smaller (less wires) system in the near future will be seen better	Completely
