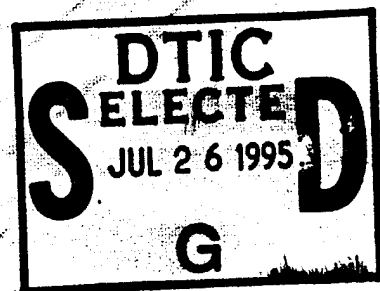




NAMRL Technical Memorandum 95-1

SOUND ATTENUATION EVALUATION OF THE NAVY'S HGU-84/P HELICOPTER HELMET

D. W. Maxwell and C. E. Williams



19950725 025

DTIC QUALITY INSPECTED 5

Naval Aerospace Medical Research Laboratory
51 Hovey Road
Pensacola, Florida 32508-1046

Approved for public release; distribution unlimited.

NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
51 HOVEY ROAD, PENSACOLA, FL 32508-1046

NAMRL Technical Memorandum 95-1

SOUND ATTENUATION
EVALUATION OF THE NAVY'S
HGU-84/P HELICOPTER
HELMET

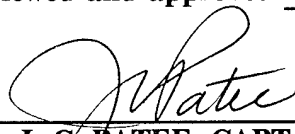
D. W. Maxwell and C. E. Williams

Accession For	
NTIS CRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification _____	
By _____	
Distribution /	
Availability Codes	
Dist	Avail and/or Special
A-1	



DTIC QUALITY INSPECTED 5

Reviewed and approved 12 Jan 95



J. C. PATEE, CAPT, MSC USN
Commanding Officer



This research was sponsored by the Naval Warfare Center, Aircraft Division, Warminster, PA, under Work Request N62269/94/WR00136.

The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government.

Volunteer subjects were recruited, evaluated, and employed in accordance with the procedures specified in the Department of Defense Directive 3216.2 and Secretary of the Navy Instruction 3900.39 series. These instructions are based upon voluntary informed consent and meet or exceed the provisions of prevailing national and international guidelines.

Trade names of materials and/or products of commercial or nongovernment organizations are cited as needed for precision. These citations do not constitute official endorsement or approval of the use of such commercial materials and/or products.

Reproduction in whole or in part is permitted for any purpose of the United States Government.

ABSTRACT

"First article" sound attenuation tests were conducted on samples of the HGU-84/P helicopter helmet, candidate replacement for the SPH-3C series of helmets, supplied for evaluation by the Naval Air Warfare Center Aircraft Division, Warminster, Pennsylvania. The tests were conducted in accordance with American National Standard ANSI S12.6-1984, "Method for the Measurement of Real-Ear Attenuation of Hearing Protectors." Objective measurements of attenuation, microphone-in-real-ear (MIRE), were also obtained. Ten Marine Corps student aviators served as volunteer test subjects. Real-ear attenuation values calculated from measurements made at the nine, one-third octave test frequencies met or exceeded the required minimum real-ear attenuation specifications for the newly developed helmet. This technical memorandum documents the results of the sound attenuation tests. The HGU-84/P helmet is currently being fielded as a replacement for the SPH-3C helmet.

INTRODUCTION

At the request of the Naval Air Systems Command and the Naval Air Warfare Center Aircraft Division, Warminster, Pennsylvania (1), "first article" sound attenuation tests were conducted on samples of the Navy's candidate replacement helmet for the SPH-3C series of helmets--the HGU-84/P. The tests were conducted to determine if the newly developed helmet met the required minimum real-ear attenuation specifications. Photographs of one of the sample helmets supplied for testing can be seen in Figs. 1 (visor up), 2 (visor down), and 3 (visor covered). While only real-ear attenuation test data were requested and required, we also obtained objective measurements of attenuation (microphone-in-real-ear or MIRE) for database and record purposes. This technical memorandum documents the results of the sound attenuation tests.

METHODS

Subjects. Ten Marine Corps student aviators in the Naval Aviation Flight Training Program served as volunteer test subjects for both the requested real-ear attenuation tests and the objective real-ear attenuation (MIRE) tests. All of the subjects had hearing threshold levels of 20 dB or less at the standard audiometric test frequencies.

Real-ear attenuation tests. The real-ear attenuation tests were conducted in NAMRL's Real Ear Attenuation Test Facility in accordance with American National Standard S12.6-1984 (2). Figure 4 shows one of the test subjects responding to auditory test signals (one-third octave bands of noise centered at each of the nine test frequencies) in the Real Ear Attenuation Test Facility.

Objective real-ear attenuation. The MIRE measurements were obtained in a semireverberant test chamber. A Knowles miniature microphone was placed at the outer end of a Silaflex earplug that was inserted into the subject's right ear. The wire to the microphone was small enough so as not to interfere with the seal of the helmet earcups, and the microphone and wire were secured so that the microphone remained fixed as the helmet was donned and doffed. Figure 5 shows one of the test subjects in the semireverberant test chamber with the miniature microphone inserted in his right ear.

Procedure (MIRE measurements). A one-third octave band analysis of the microphone's output was first obtained without the helmet being worn as the subject was seated in a broadband noise environment (108 dB SPL). Following free-field (i.e., unattenuated) measurements, the subject donned the helmet, and one-third octave band analyses were obtained with the helmet on (attenuated measurements). The procedure was repeated three times, and the helmet was donned and doffed on each occasion.

Real-ear and MIRE measurements obtained with the helmet on were subtracted from the unattenuated (free-field) measurements to determine the amount of attenuation afforded by the helmet. Means and standard deviations were calculated from the various measurements.

RESULTS

Mean sound-attenuation values and standard deviations obtained via the real-ear attenuation measurements are shown in Table 1, together with the minimum acceptable real-ear attenuation values specified in the requirements for the new helmet. A graphic comparison of the "obtained" versus "required" real-ear attenuation values is shown in Fig. 6. Mean attenuation values, standard deviations, and noise-reduction ratings calculated from both the real-ear and objective real-ear attenuation measurements (MIRE) are shown together with individual subject data in Appendices A and B. A graphic comparison of the attenuation values obtained via the two types of measurements (real-ear and MIRE) is shown in Fig. 7. The MIRE values are shown for database and record purposes. It should be noted that subsequent to obtaining

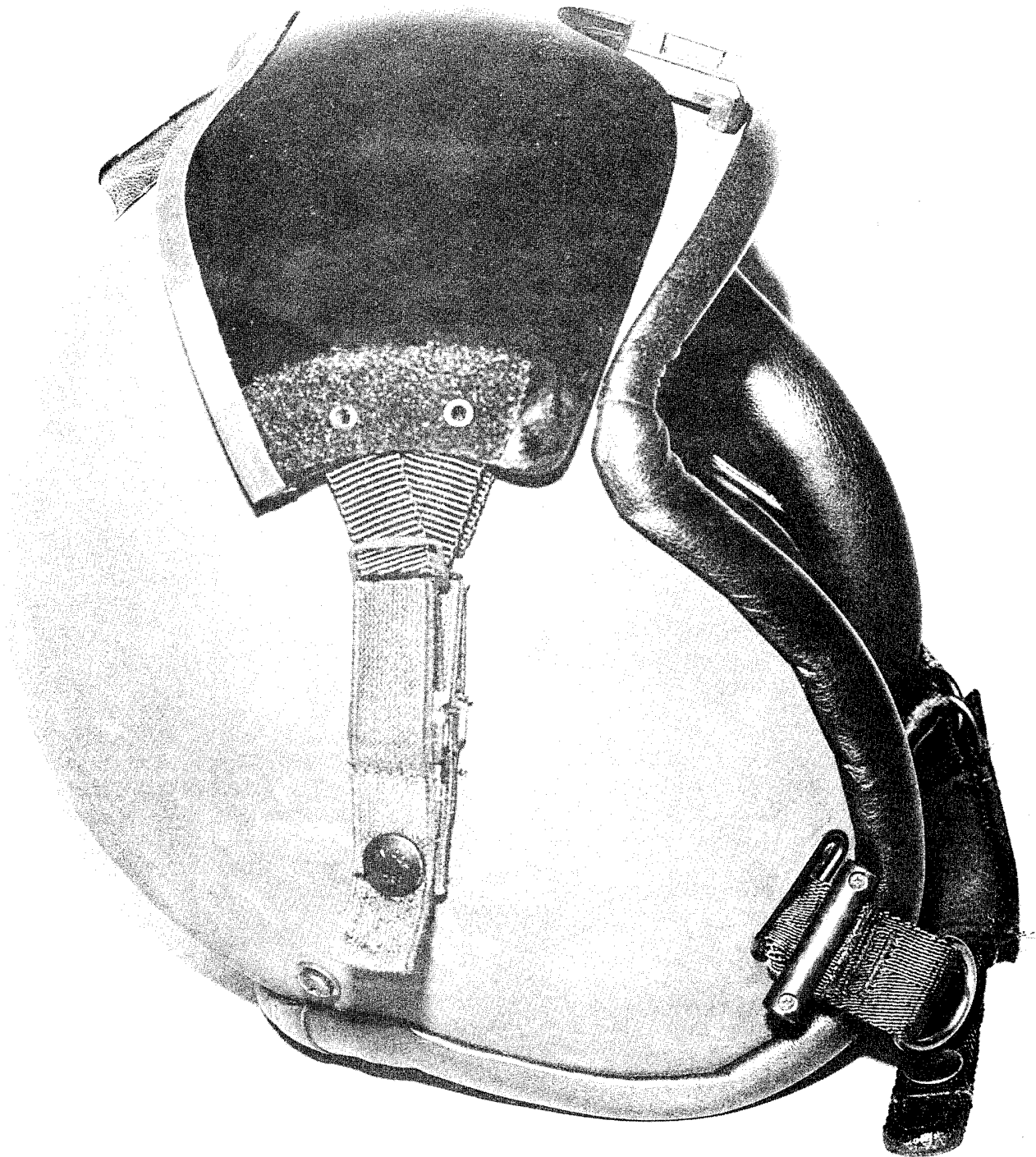


Figure 1. Side-view-of HGU-84/P helmet (visor up).

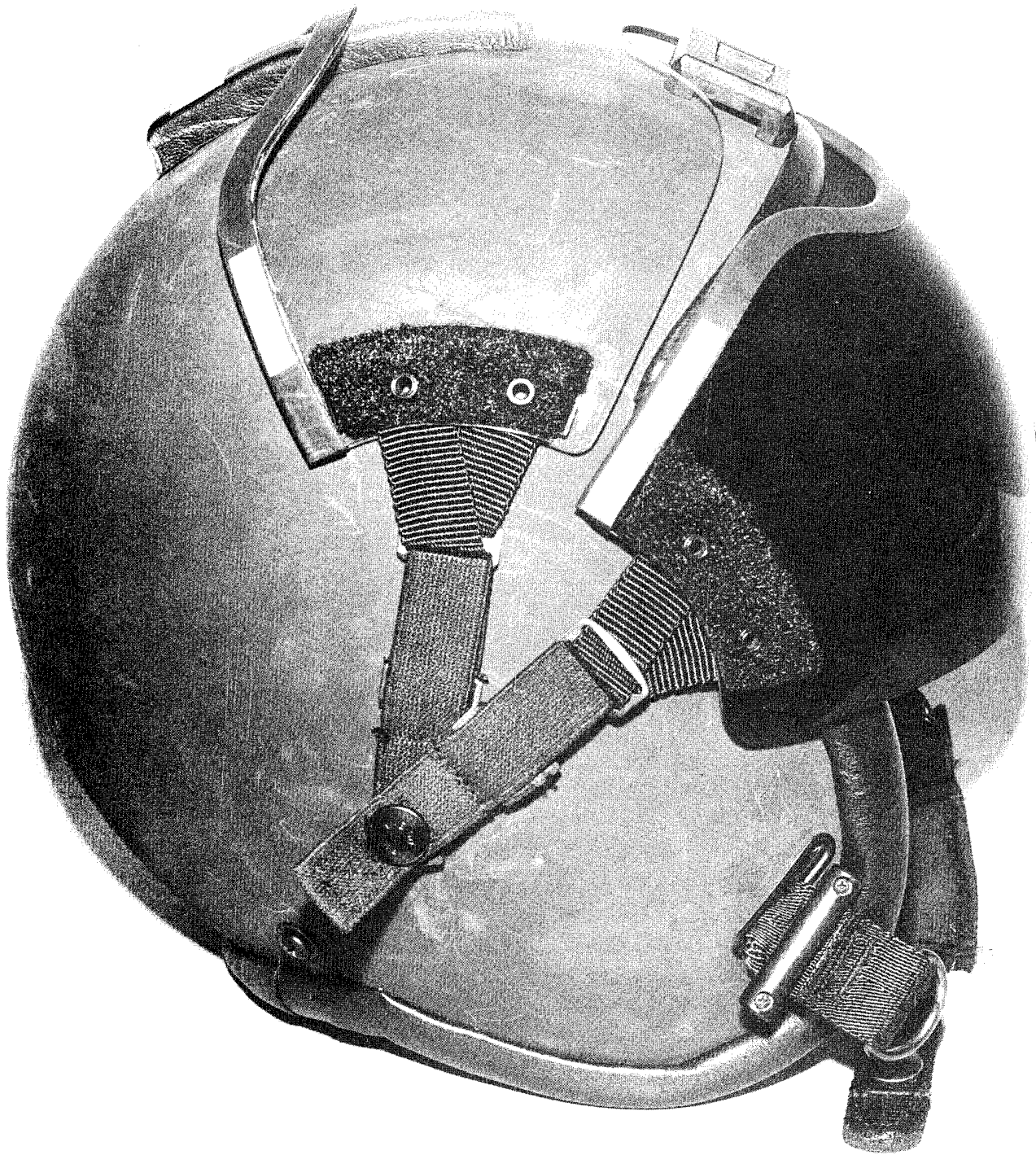


Figure 2. Side-view of HGU-84/P helmet (visor down).

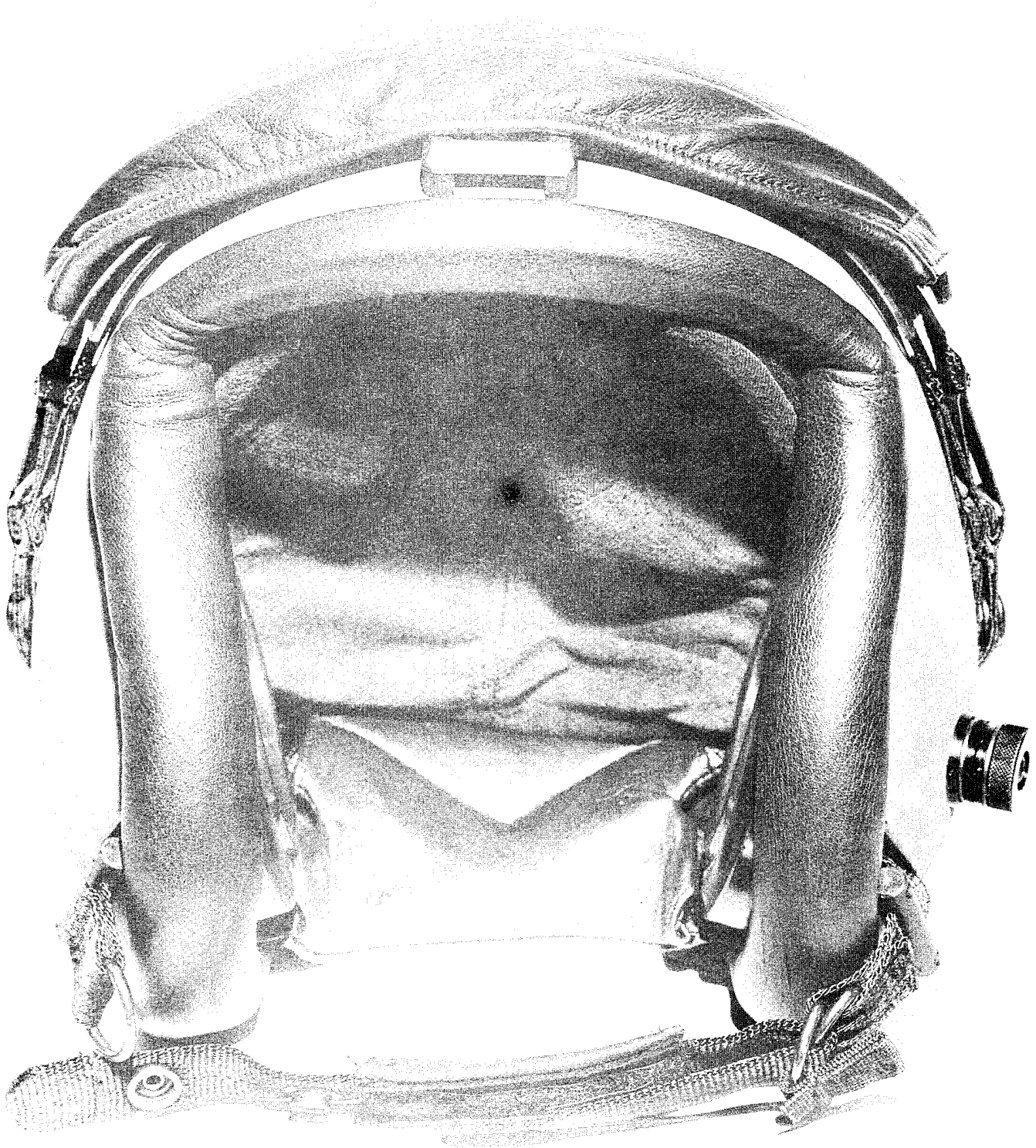


Figure 3. Front view of HGU-84/P helmet (visor covered).



Figure 4. Test subject responding to auditory test signals in Real Ear Attenuation Test Facility.



Figure 5. Test subject with miniature microphone inserted in right ear.

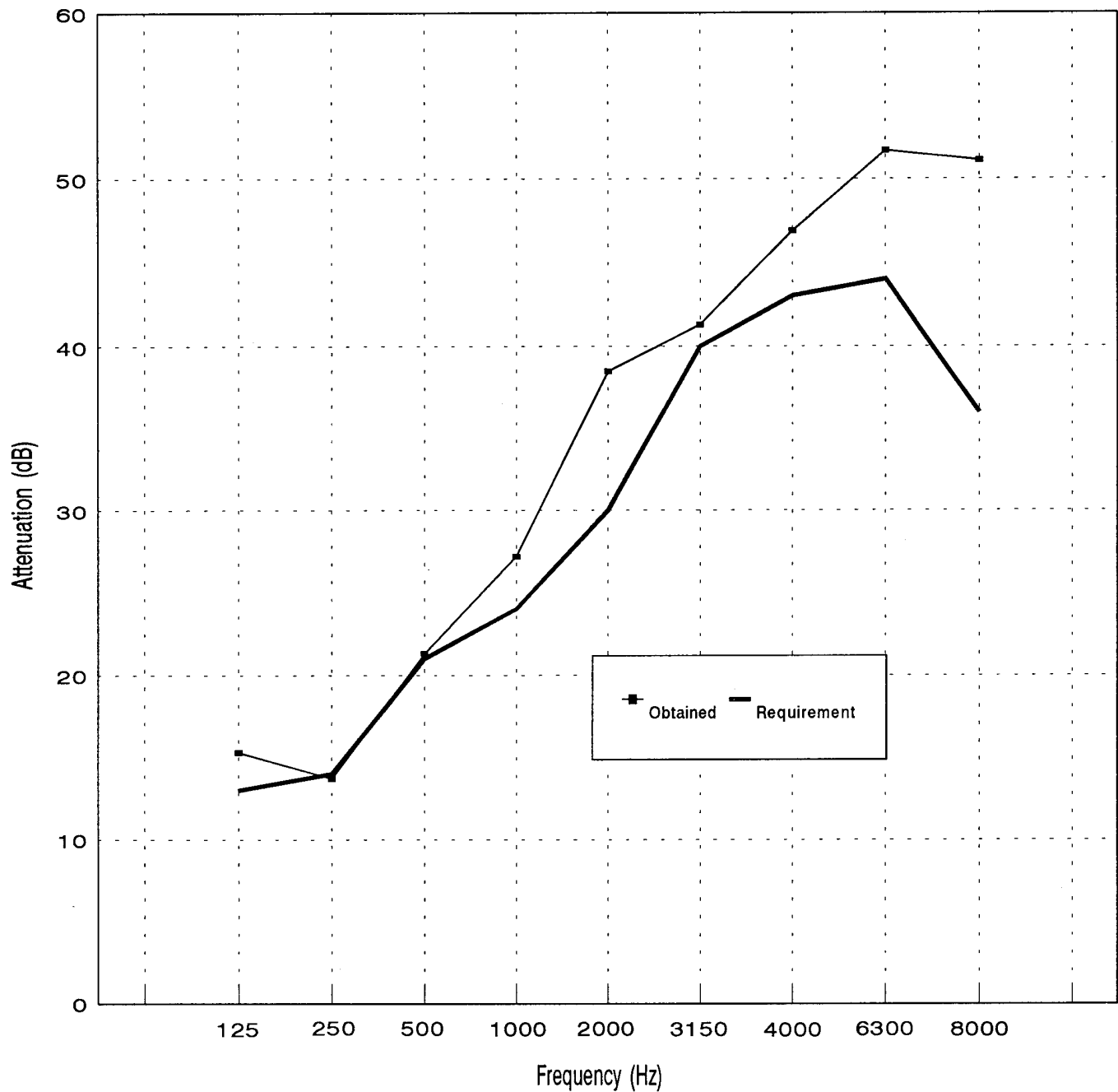


Figure 6. Graphic comparison of real-ear attenuation values obtained with the HGU-84/P helmet and the minimum acceptable attenuation values specified in the requirement.

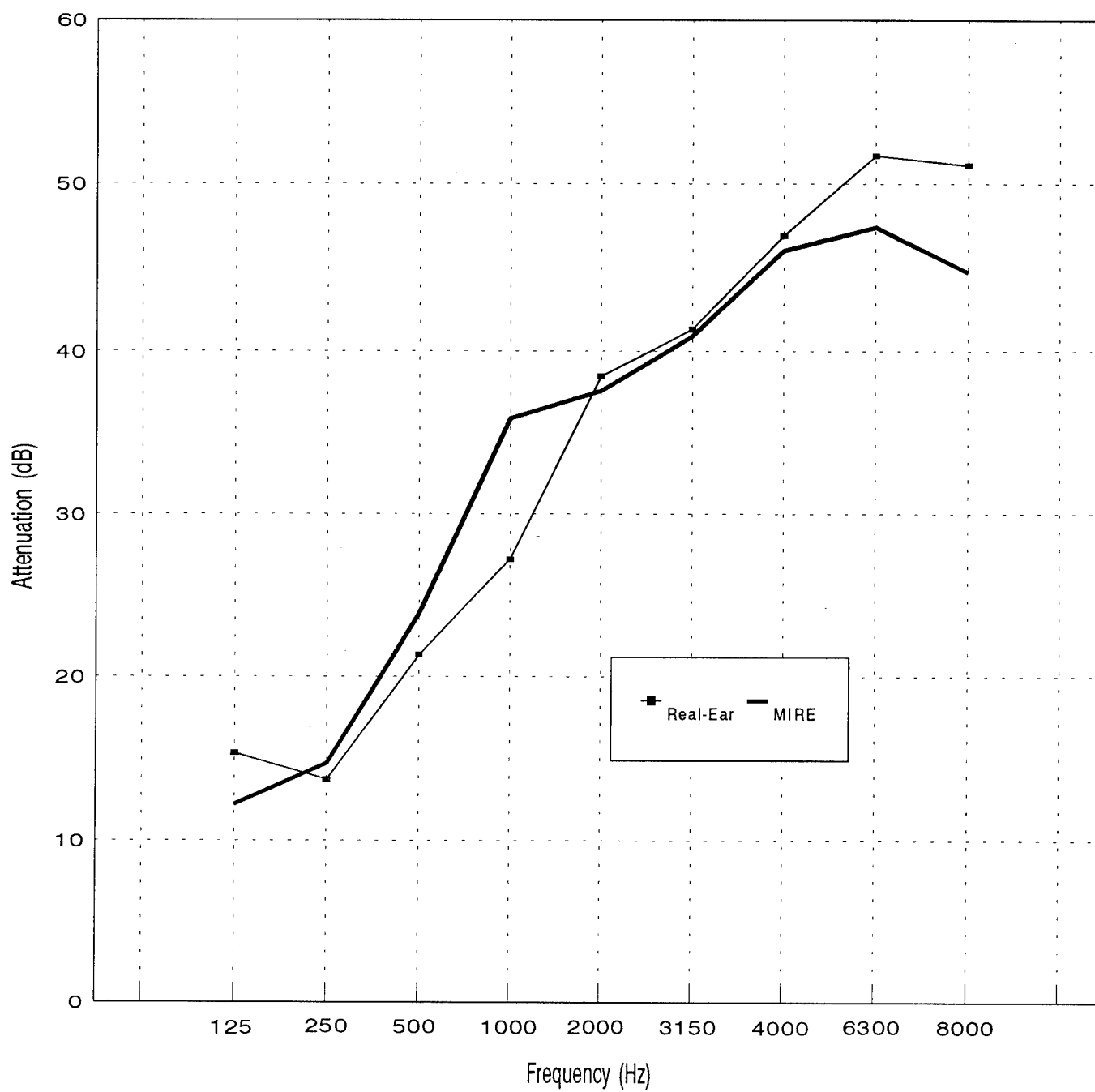


Figure 7. Graphic comparison of real-ear attenuation values and microphone-in-real-ear (MIRE) attenuation values obtained with the HGU-84/P helmet.

and reporting the attenuation measurements just described, additional MIRE attenuation measurements were obtained on 10 additional flight students (right and left ears). The results of these MIRE measurements are shown in Appendix C.

Table 1. Mean real-ear attenuation values and standard deviations (in dB).
Minimum required attenuation values are shown for comparison.

		One-third octave band center frequency (Hz)								
		125	250	500	1000	2000	3150	4000	6300	8000
Obtained										
Mean		15.3	13.7	21.3	27.2	38.5	41.3	46.9	51.7	51.1
S.D.		3.6	3.5	2.7	4.7	6.2	6.0	5.2	6.7	6.3
Minimum required										
Mean		13.0	14.0	21.0	24.0	30.0	40.0	43.0	44.0	36.0

As can be seen in Table 1 and Fig. 5, real-ear attenuation values calculated from measurements made at the nine, one-third octave test frequencies (125, 250, 500, 1000, 2000, 3150, 4000, 6300, and 8000 Hz) met or exceeded the minimum required real-ear attenuation specifications for the new helmet.

CONCLUSIONS

The results of the real-ear attenuation evaluation demonstrated that the HGU-84/P helmet met or exceeded the minimum required real-ear attenuation specifications. The real-ear attenuation test data, in conjunction with the results of other first article tests conducted elsewhere, were instrumental in a subsequent Navy recommendation to implement fielding of the HGU-84/P helmet as a replacement for the SPH-3C series of helmets. Field implementation of the new helmet is currently underway.

REFERENCES

1. Work Request N62269/94/WR00136, Naval Air Warfare Center Aircraft Division, Warminster, PA, February 1994.
2. American National Standards Institute, American National Standard ANSI S12.6-1984, Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors, 1984.

APPENDIX A

PROTECTOR: HGU-84/P "REAL-EAR"

DATES: 02/01/94 / 02/09/94

SUBJECT	125	250	500	1K	2K	3.15K	4K	6.3K	8K
M - 22	16	14	26	24	36	36	44	52	54
K.G.	14	16	22	24	36	34	40	50	48
"L" 1	16	14	18	20	36	40	46	48	48
M - 27	12	14	22	22	30	36	46	48	48
M.W.	16	18	30	20	26	32	44	44	48
"L" 2	8	16	22	20	30	32	40	42	46
M - 23	10	12	20	26	32	44	46	52	40
C.B.	16	14	20	26	30	36	40	52	52
"L" 3	16	18	18	28	36	40	42	50	50
M - 22	14	12	20	22	34	40	42	48	46
M.D.	16	6	18	24	28	34	40	48	50
"XL" 4	10	18	24	24	36	36	40	46	48
M - 23	22	20	24	30	40	40	44	56	62
S.Q.	24	20	18	28	42	40	46	60	58
"XL" 5	16	14	22	30	46	38	48	56	62
M - 24	12	10	24	38	44	48	52	62	54
J.P.	16	10	20	36	44	50	56	58	58
"XL" 6	12	12	20	36	48	50	56	58	54
M - 22	18	12	24	30	44	44	52	60	52
T.R.	18	14	18	32	46	48	54	64	60
"XL" 7	18	10	22	30	48	48	56	62	54
M - 22	12	10	20	28	46	42	54	54	50
T.B.	18	6	20	24	42	36	50	56	54
"XL" 8	14	12	22	34	40	40	52	44	56
M - 26	18	14	20	28	40	46	50	54	56
M.D.	18	14	20	28	44	48	48	52	50
"XL" 9	20	18	24	26	44	56	48	52	56
M - 24	10	14	20	26	36	46	44	38	40
K.K.	16	16	20	24	36	40	46	42	38
"L" 10	14	12	20	28	36	40	42	44	42
MEAN	15.3	13.7	21.3	27.2	38.5	41.3	46.9	51.7	51.1
STANDARD DEVIATION	3.6	3.5	2.7	4.7	6.2	6.0	5.2	6.7	6.3

NRR= 16.6

APPENDIX B

PROTECTOR: HGU-84/P "OBJECTIVE REAL-EAR" DATES: 02/01/94 / 02/09/94

SUBJECT	125	250	500	1K	2K	3.15K	4K	6.3K	8K
M - 22	15	16	29	36	39	43	51	48	44
K.G.	12	14	27	36	40	41	46	48	43
"L" 1	10	13	25	31	36	35	45	46	41
M - 27	10	17	24	35	35	38	46	49	44
M.W.	8	15	25	32	33	37	44	47	40
"L" 2	10	15	27	31	26	37	46	45	42
M - 23	17	17	28	37	31	41	48	48	48
C.B.	17	18	27	36	32	38	41	45	45
"L" 3	15	17	27	31	29	38	42	41	47
M - 22	7	13	25	31	33	35	37	43	49
M.D.	8	15	26	32	32	35	40	42	44
"XL" 4	8	10	23	33	30	35	41	40	47
M - 23	13	16	24	37	40	41	42	46	45
S.Q.	14	15	25	37	40	40	41	47	48
"XL" 5	15	15	24	37	40	40	43	41	45
M - 24	13	16	20	37	44	45	50	53	51
J.P.	13	18	20	36	42	46	52	52	51
"XL" 6	11	15	22	36	42	45	51	50	47
M - 22	16	15	22	40	44	44	48	48	41
T.R.	14	14	22	39	42	47	49	49	41
"XL" 7	14	12	22	43	45	45	50	46	43
M - 22	11	14	23	39	40	44	49	49	41
T.B.	10	15	22	36	41	43	49	52	45
"XL" 8	11	14	21	37	41	45	50	50	42
M - 26	12	14	21	37	42	46	51	54	47
M.D.	13	15	22	38	41	45	50	54	50
"XL" 9	13	12	18	39	41	47	53	53	49
M - 24	13	15	26	36	38	37	42	45	40
K.K.	12	14	24	35	34	38	41	45	41
"L" 10	11	13	23	37	34	37	43	45	39
MEAN	12.2	14.7	23.8	35.9	37.6	40.9	46.0	47.4	44.7
STANDARD DEVIATION	2.6	1.8	2.6	2.9	5.1	4.0	4.3	3.9	3.5

NRR= 20.7

APPENDIX C

PROTECTOR: HGU-84/P (L)

DATES: 03/01/94 / 03/07/94

SUBJECT	125	250	500	1K	2K	3.15K	4K	6.3K	8K
M - 23	15	12	22	38	37	44	45	41	41
M.D.	17	13	23	39	37	45	41	43	47
1	13	14	22	37	38	41	44	48	46
M - 22	16	17	23	37	33	39	48	46	42
J.B.	11	12	18	34	29	37	43	47	40
2	15	14	22	36	29	37	49	45	36
M - 27	13	13	19	31	33	41	44	44	46
M.W.	14	15	19	29	35	41	45	43	44
3	14	15	15	29	35	40	43	43	43
M - 23	18	15	22	38	43	45	51	45	42
E.F.	16	13	20	38	41	43	51	46	40
4	15	12	16	37	39	41	49	46	38
M - 22	17	12	21	28	36	45	50	42	44
C.M.	13	12	22	30	39	45	45	42	43
5	16	12	20	29	38	46	46	41	42
M - 23	17	12	22	34	28	35	38	42	41
J.T.	15	10	22	35	33	41	41	41	42
6	14	9	23	33	31	41	40	41	42
M - 27	13	12	21	34	38	45	46	49	41
T.D.	14	12	21	32	37	44	47	51	45
7	14	12	20	32	39	45	47	50	42
M - 26	19	13	22	38	44	45	52	41	38
M.D.	21	14	22	39	41	49	50	40	37
8	16	11	25	39	42	48	54	46	43
M - 24	18	15	22	40	34	44	49	51	44
G.A.	14	12	21	38	34	43	48	52	48
9	19	12	20	39	34	44	48	47	41
M - 25	18	13	22	38	39	53	52	51	47
M.M.	21	11	22	40	40	53	54	47	42
10	21	9	21	40	39	52	52	49	55
MEAN	15.9	12.6	21.0	35.4	36.5	43.7	47.1	45.3	42.7
STANDARD DEVIATION	2.6	1.8	2.1	3.8	4.1	4.4	4.2	3.6	3.7

NRR= 19.7

PROTECTOR: HGU-84/P (R)

DATES: 03/01/94 / 03/07/94

SUBJECT	125	250	500	1K	2K	3.15K	4K	6.3K	8K
M - 23	14	14	24	39	36	39	49	46	44
M.D.	11	15	23	39	37	41	46	42	40
1	12	15	23	40	34	43	49	48	43
M - 22	14	15	24	33	35	40	41	43	45
J.B.	12	15	23	33	36	40	42	43	43
2	11	13	24	31	33	39	41	42	46
M - 27	14	15	24	39	37	43	47	41	44
M.W.	7	17	22	38	34	41	46	49	47
3	10	14	24	41	37	45	48	50	45
M - 23	15	15	26	34	39	38	39	37	43
E.F.	12	13	17	32	35	35	40	42	43
4	14	13	23	37	36	39	46	49	49
M - 22	14	15	22	29	31	34	39	44	38
C.M.	13	16	22	28	30	33	35	48	42
5	13	13	21	33	39	40	45	41	40
M - 23	16	13	25	38	32	41	43	44	44
J.T.	14	12	25	37	34	43	43	43	40
6	16	14	28	38	31	45	44	43	43
M - 27	10	14	20	33	35	38	44	51	45
T.D.	10	14	22	32	37	37	45	48	40
7	14	13	22	34	38	36	46	46	39
M - 26	16	15	22	37	39	43	48	42	35
M.D.	18	16	20	36	38	42	48	43	36
8	13	14	25	36	40	44	48	46	41
M - 24	18	14	26	39	39	42	44	43	39
G.A.	18	14	22	40	41	46	49	42	39
9	15	15	28	40	38	43	47	50	42
M - 25	14	12	26	37	37	45	48	44	42
M.M.	16	16	26	40	37	47	47	39	43
10	20	16	23	40	37	44	49	47	47
MEAN	13.8	14.3	23.4	36.1	36.1	40.9	44.9	44.5	42.2
STANDARD DEVIATION	2.8	1.2	2.4	3.6	2.8	3.6	3.6	3.5	3.2

NRR= 21.4

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE January 1995	3. REPORT TYPE AND DATES COVERED		
4. TITLE AND SUBTITLE Sound Attenuation Evaluation of the Navy's HGU-84/P Helicopter Helmet		5. FUNDING NUMBERS WRN62269/94/ WR00136		
6. AUTHOR(S) D. W. Maxwell and C. E. Williams				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Aerospace Medical Research Laboratory 51 Hovey Road Pensacola FL 32508-1046		8. PERFORMING ORGANIZATION REPORT NUMBER Technical Memorandum 95-1		
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Air Warfare Center Aircraft Division Warminster, PA 18974-0591		10. SPONSORING / MONITORING AGENCY REPORT NUMBER		
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution unlimited.		12b. DISTRIBUTION CODE		
13. ABSTRACT (Maximum 200 words) "First article" sound attenuation tests were conducted on samples of the HGU-84/P helicopter helmet, candidate replacement for the SPH-3C series of helmets, supplied for evaluation by the Naval Air Warfare Center Aircraft Division, Warminster, Pennsylvania. The tests were conducted in accordance with American National Standard ANSI S12.6-1984, "Method for the Measurement of Real-Ear Attenuation of Hearing Protectors." Objective measurements of attenuation, microphone-in-real-ear (MIRE), were also obtained for database and record purposes. Ten Marine Corps student aviators in the Naval Aviation Flight Training Program served as volunteer test subjects. Real-ear attenuation values calculated from measurements made at the nine, one-third octave test frequencies met or exceeded the required minimum real-ear attenuation specifications for the newly developed helmet. This technical memorandum documents the results of the sound attenuation tests. The HGU-84/P helmet is currently being fielded as a replacement for the SPH-3C helmet.				
14. SUBJECT TERMS Sound attenuation, Flight helmets, Real-ear attenuation		15. NUMBER OF PAGES 16		
		16. PRICE CODE		
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT SAR	