

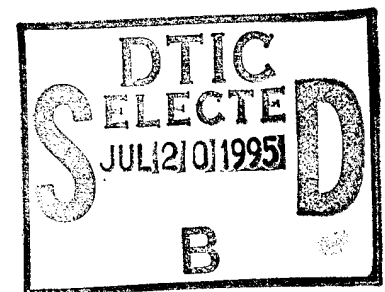


**Otoacoustic Emissions,  
A New Tool  
for Hearing Conservation Testing  
(Reprint)**

By

**Kevin T. Mason  
John E. Ribera**

**Aircrew Protection**



19950719 058

April 1995

DTIC QUALITY INSPECTED 5

Approved for public release; distribution unlimited.

**United States 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.

Reviewed:

*Kevin T. Mason*

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

Released for publication:

*Dennis F. Shanahan*

DENNIS F. SHANAHAN  
Colonel, MC, MFS  
Commanding

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

Accession For	
ERIC GRA&I	<input checked="" type="checkbox"/>
ERIC TAB	<input type="checkbox"/>
Unannounced Justification	<input type="checkbox"/>
By _____	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
<i>AK</i>	

<b>REPORT DOCUMENTATION PAGE</b>				<i>Form Approved OMB No. 0704-0188</i>		
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						
4. PERFORMING ORGANIZATION REPORT NUMBER(S) USAARL Report No. 95-22			5. MONITORING ORGANIZATION REPORT NUMBER(S)			
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Aeromedical Research Laboratory		6b. OFFICE SYMBOL <i>(If applicable)</i> MCMR-UAD	7a. NAME OF MONITORING ORGANIZATION U.S. Army Medical Research and Materiel Command			
6c. ADDRESS <i>(City, State, and ZIP Code)</i> P.O. Box 620577 Fort Rucker, AL 36362-0577			7b. ADDRESS <i>(City, State, and ZIP Code)</i> Fort Detrick Frederick, MD 21702-5012			
8a. NAME OF FUNDING / SPONSORING ORGANIZATION		8b. OFFICE SYMBOL <i>(If applicable)</i>	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER			
8c. ADDRESS <i>(City, State, and ZIP Code)</i>			10. SOURCE OF FUNDING NUMBERS			
			PROGRAM ELEMENT NO. 62787A	PROJECT NO. 30162787A878	TASK NO. HC	WORK UNIT ACCESSION NO. 144
11. TITLE <i>(Include Security Classification)</i> Otoacoustic emissions, a new tool for hearing conservation testing						
12. PERSONAL AUTHOR(S) Mason, Kevin T., and Ribera, John E.						
13a. TYPE OF REPORT Final		13b. TIME COVERED FROM TO		14. DATE OF REPORT <i>(Year, Month, Day)</i> 1995 April	15. PAGE COUNT 4	
16. SUPPLEMENTAL NOTATION Reprint from the U.S. Army Aviation Digest, March/April 1995, pp. 22-23.						
17. COSATI CODES			18. SUBJECT TERMS <i>(Continue on reverse if necessary and identify by block number)</i> otoacoustic emission, audiogram, hearing conservation			
FIELD	GROUP	SUB-GROUP				
06	04					
06	05					
19. ABSTRACT <i>(Continue on reverse if necessary and identify by block number)</i> Researchers at the U.S. Army Aeromedical Research Laboratory are investigating a revolutionary hearing test called otoacoustic emissions (OAEs). With OAE testing, an Army aircrew member's annual hearing test will be reduced to listening passively to a few tones for a few seconds. The paper describes the method of conducting OAE testing and presents figures to demonstrate findings. The advantages of OAE are tabulated.						
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 <i>(Include Area Code)</i> (334) 255-6907		22c. OFFICE SYMBOL MCMR-UAX-SS	

# Otoacoustic Emissions, a New Tool for Hearing Conservation Testing

Kevin T. Mason, M.D., M.P.H.  
LTC, MC, MFS  
Director, Aircrew Protection Division

and

John E. Ribera, Ph.D.  
MAJ, MS  
Research Audiologist, Acoustics Effects Branch  
U.S. Army Aeromedical Research Laboratory

## Annual hearing test

It is time for your annual hearing test. You sit in a booth. The air is stale and stuffy. You put on the familiar earphones. Make sure you have got the red one on the right ear. You grab a button in your hand and wait for tone pulses. You get the attention of the tester, "Wait, I'm tangled in these wires." There it is, a tone, and you press the button. Darn, somebody just moved . . . was that a tone? The tones get fainter and fainter. Click, click. You are straining to hear that very distant tone. Beep, beep, beep. Bang, somebody kicked the booth. Thinking to yourself, "I missed that tone. Boy, it is getting hot in here. I can not believe how loud that high-pitched whine is getting in the background. Is that the machine or me? This is not going so well." Minutes go by. Click, click. Finally, it is over. Okay, you passed!

## Introduction

U.S. Army Aeromedical Research Laboratory (USAARL) scientists are investigating a revolutionary hearing test called otoacoustic emissions (OAE). With

OAE testing, your annual hearing test will be reduced to listening passively to a few tones for a few seconds. And, no more button pressing!

## OAE method

An OAE ear piece is placed comfortably in the ear. It has a miniature sound source that emits two tone pulses of different frequencies ( $f_1$  and  $f_2$ ) into the ear canal. These are conducted to the inner ear (cochlea). The inner ear is stimulated by the tones and generates a third tone, called a distortion product. The distortion product tone is a biomechanical emission of acoustic energy from the inner ear; hence the name, otoacoustic emissions (ear sound emissions). With hearing loss, the inner ear loses its ability to produce the distortion product tone at affected frequencies.

A miniature microphone in the OAE ear piece detects the stimulation tones and the distortion product tone. In a few seconds, many stimulation tones of varying frequencies are sent into the ear, generating various distortion product tones. Aircrew members do

not have to actively listen for tones and push a button. They just relax, sit still, and the test is over in less than 2 minutes.

A computer measures the original stimulation tones and the distortion product tones. The computer makes a two-axis graph. Background noise is plotted on the graph by amplitude in decibels and by frequency in Hertz. The amplitude of the distortion product tone is plotted at the frequency of the second stimulation tone (f2) that caused the distortion tone. Audiologists examine the shape of the plotted curves. They measure the difference between the background noise and the distortion product amplitudes. Figure 1 shows an aircrew member with normal hearing. In contrast, Figure 2 shows an aircrew member with hearing loss. Note how the distortion product curve and the background noise curve approach each other above 3000 Hz in the patient with abnormal hearing. The inner ear is not responding properly to stimulation tones at and above 3000 Hz, producing OAE with reduced amplitudes compared to a patient with normal inner ear function.

### **Advantages**

Current pure tone testing stations can be upgraded readily to measure OAE. Table 1 shows the advantages of using OAE testing instead of the traditional pure tone testing.

### **Validation tests**

USAARL is conducting validation OAE tests. We are testing aircrew members of all ages and genders, with a broad range of hearing capabilities. Volunteers will undergo standard audiometric testing, speech

discrimination tests, and OAE tests during short sessions. Data will be examined to find out if new hearing conservation program standards can be based on OAE testing instead of pure tone testing. If you are interested in testing this new technology as a volunteer, contact MAJ Ribera at DSN 558-6823/6804 or COMM (205) 255-6823/6804.

### **Bibliography**

- Durrant, J. D. 1992. Distortion-product OAE analysis: Is it ready for broad clinical use?. The hearing journal. 45:42-45.
- Lonsbury-Martin, B., McCoy, M., Whitehead, M., and Martin, G. 1992. Otoacoustic emissions: future directions for research and clinical applications. The hearing journal. 45: 47-52.
- Probst, R. 1990. Otoacoustic emissions: An overview. Advanced otorhinolaryngology. 44:1-91.
- Probst, R., Lonsbury-Martin, B. L., and Martin, G. K. 1991. A review of otoacoustic emissions. Journal of the acoustic society of America. 89:2027-2067.

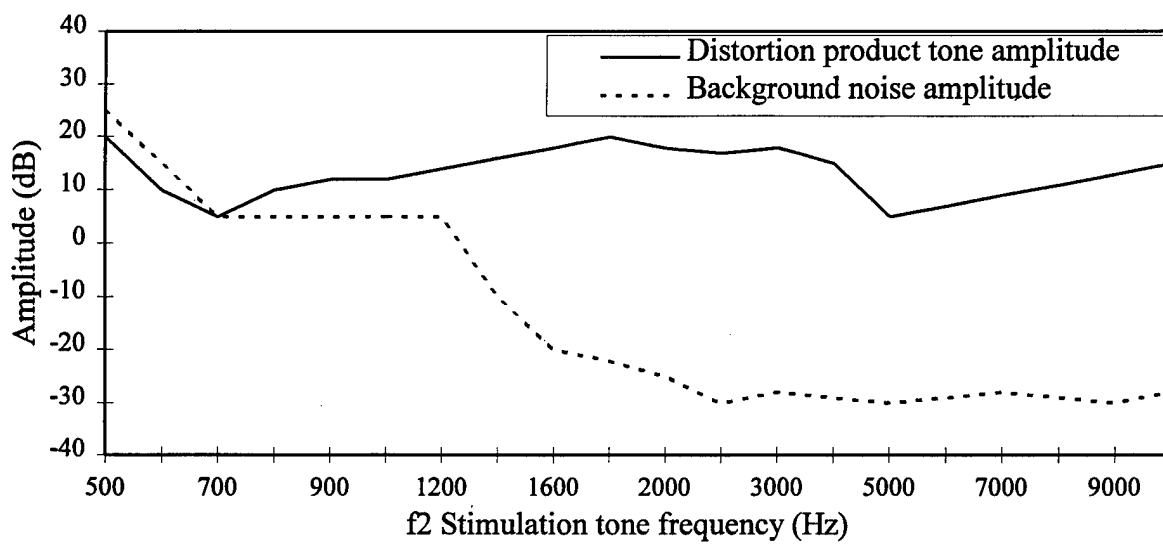


Figure 1. Otoacoustic emissions plot in an aviator with normal hearing.

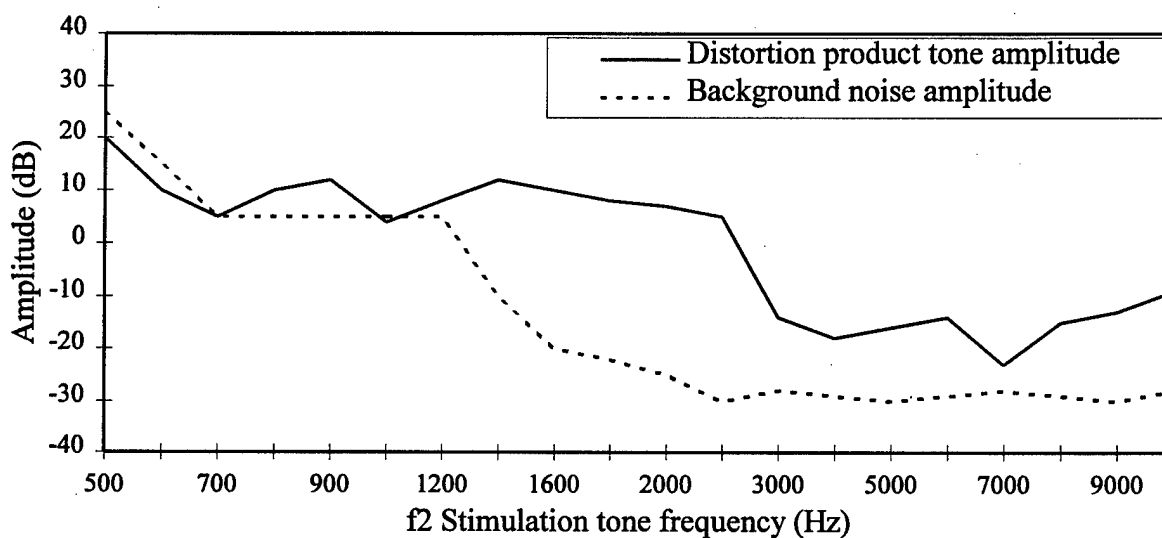


Figure 2. Otoacoustic emissions plot in an aviator with abnormal hearing at and above 3000 Hz.

Table 1.

Advantages of using otoacoustic emissions compared to standard pure tone testing.

- 
- 
1. Simple, passive, automated measure of hearing.
  2. Provides objective results.
  3. Provides frequency-specific measure of inner ear function.
  4. Results are highly reproducible between examinations.
  5. Reliable indicator of noise-induced hearing loss.
- 
-

Initial distribution

Commander, U.S. Army Natick Research,  
Development and Engineering Center  
ATTN: SATNC-MIL (Documents  
Librarian)  
Natick, MA 01760-5040

Chairman  
National Transportation Safety Board  
800 Independence Avenue, S.W.  
Washington, DC 20594

Commander  
10th Medical Laboratory  
ATTN: Audiologist  
APO New York 09180

Naval Air Development Center  
Technical Information Division  
Technical Support Detachment  
Warminster, PA 18974

Commanding Officer, Naval Medical  
Research and Development Command  
National Naval Medical Center  
Bethesda, MD 20814-5044

Deputy Director, Defense Research  
and Engineering  
ATTN: Military Assistant  
for Medical and Life Sciences  
Washington, DC 20301-3080

Commander, U.S. Army Research  
Institute of Environmental Medicine  
Natick, MA 01760

Library  
Naval Submarine Medical Research Lab  
Box 900, Naval Sub Base  
Groton, CT 06349-5900

Executive Director, U.S. Army Human  
Research and Engineering Directorate  
ATTN: Technical Library  
Aberdeen Proving Ground, MD 21005

Commander  
Man-Machine Integration System  
Code 602  
Naval Air Development Center  
Warminster, PA 18974

Commander  
Naval Air Development Center  
ATTN: Code 602-B  
Warminster, PA 18974

Commanding Officer  
Armstrong Laboratory  
Wright-Patterson  
Air Force Base, OH 45433-6573

Director  
Army Audiology and Speech Center  
Walter Reed Army Medical Center  
Washington, DC 20307-5001

Commander/Director  
U.S. Army Combat Surveillance  
and Target Acquisition Lab  
ATTN: SFAE-IEW-JS  
Fort Monmouth, NJ 07703-5305

Director  
Federal Aviation Administration  
FAA Technical Center  
Atlantic City, NJ 08405

Director  
Walter Reed Army Institute of Research  
Washington, DC 20307-5100

Commander, U.S. Army Test  
and Evaluation Command  
Directorate for Test and Evaluation  
ATTN: AMSTE-TA-M (Human Factors  
Group)  
Aberdeen Proving Ground,  
MD 21005-5055

Naval Air Systems Command  
Technical Air Library 950D  
Room 278, Jefferson Plaza II  
Department of the Navy  
Washington, DC 20361

Director  
U.S. Army Ballistic  
Research Laboratory  
ATTN: DRXBR-OD-ST Tech Reports  
Aberdeen Proving Ground, MD 21005

Commander  
U.S. Army Medical Research  
Institute of Chemical Defense  
ATTN: SGRD-UV-AO  
Aberdeen Proving Ground,  
MD 21010-5425

Commander  
USAMRMC  
ATTN: SGRD-RMS  
Fort Detrick, Frederick, MD 21702-5012

HQ DA (DASG-PSP-O)  
5109 Leesburg Pike  
Falls Church, VA 22041-3258

Harry Diamond Laboratories  
ATTN: Technical Information Branch  
2800 Powder Mill Road  
Adelphi, MD 20783-1197

U.S. Army Materiel Systems  
Analysis Agency  
ATTN: AMXSY-PA (Reports Processing)  
Aberdeen Proving Ground  
MD 21005-5071

U.S. Army Ordnance Center  
and School Library  
Simpson Hall, Building 3071  
Aberdeen Proving Ground, MD 21005

U.S. Army Environmental  
Hygiene Agency  
ATTN: HSHB-MO-A  
Aberdeen Proving Ground, MD 21010

Technical Library Chemical Research  
and Development Center  
Aberdeen Proving Ground, MD  
21010-5423

Commander  
U.S. Army Medical Research  
Institute of Infectious Disease  
ATTN: SGRD-UIZ-C  
Fort Detrick, Frederick, MD 21702

Director, Biological  
Sciences Division  
Office of Naval Research  
600 North Quincy Street  
Arlington, VA 22217

Commandant  
U.S. Army Aviation  
Logistics School ATTN: ATSQ-TDN  
Fort Eustis, VA 23604

Headquarters (ATMD)  
U.S. Army Training  
and Doctrine Command  
ATTN: ATBO-M  
Fort Monroe, VA 23651

IAF Liaison Officer for Safety  
USAF Safety Agency/SEFF  
9750 Avenue G, SE  
Kirtland Air Force Base  
NM 87117-5671

Naval Aerospace Medical  
Institute Library  
Building 1953, Code 03L  
Pensacola, FL 32508-5600

Command Surgeon  
HQ USCENCOM (CCSG)  
U.S. Central Command  
MacDill Air Force Base, FL 33608

Director  
Directorate of Combat Developments  
ATTN: ATZQ-CD  
Building 515  
Fort Rucker, AL 36362

U.S. Air Force Institute  
of Technology (AFIT/LDEE)  
Building 640, Area B  
Wright-Patterson  
Air Force Base, OH 45433

Henry L. Taylor  
Director, Institute of Aviation  
University of Illinois-Willard Airport  
Savoy, IL 61874

Chief, National Guard Bureau  
ATTN: NGB-ARS  
Arlington Hall Station  
111 South George Mason Drive  
Arlington, VA 22204-1382

AAMRL/HEX  
Wright-Patterson  
Air Force Base, OH 45433

Commander  
U.S. Army Aviation and Troop Command  
ATTN: AMSAT-R-ES  
4300 Goodfellow Bouvelard  
St. Louis, MO 63120-1798

U.S. Army Aviation and Troop Command  
Library and Information Center Branch  
ATTN: AMSAV-DIL  
4300 Goodfellow Boulevard  
St. Louis, MO 63120

Federal Aviation Administration  
Civil Aeromedical Institute  
Library AAM-400A  
P.O. Box 25082  
Oklahoma City, OK 73125

Commander  
U.S. Army Medical Department  
and School  
ATTN: Library  
Fort Sam Houston, TX 78234

Commander  
U.S. Army Institute of Surgical Research  
ATTN: SGRD-USM  
Fort Sam Houston, TX 78234-6200

Air University Library  
(AUL/LSE)  
Maxwell Air Force Base, AL 36112

Product Manager  
Aviation Life Support Equipment  
ATTN: SFAE-AV-LSE  
4300 Goodfellow Boulevard  
St. Louis, MO 63120-1798

Commander and Director  
USAE Waterways Experiment Station  
ATTN: CEWES-IM-MI-R,  
CD Department  
3909 Halls Ferry Road  
Vicksburg, MS 39180-6199

Commanding Officer  
Naval Biodynamics Laboratory  
P.O. Box 24907  
New Orleans, LA 70189-0407

Assistant Commandant  
U.S. Army Field Artillery School  
ATTN: Morris Swott Technical Library  
Fort Sill, OK 73503-0312

Mr. Peter Seib  
Human Engineering Crew Station  
Box 266  
Westland Helicopters Limited  
Yeovil, Somerset BA20 2YB UK

U.S. Army Dugway Proving Ground  
Technical Library, Building 5330  
Dugway, UT 84022

U.S. Army Yuma Proving Ground  
Technical Library  
Yuma, AZ 85364

AFFTC Technical Library  
6510 TW/TSTL  
Edwards Air Force Base,  
CA 93523-5000

Commander  
Code 3431  
Naval Weapons Center  
China Lake, CA 93555

Aeromechanics Laboratory  
U.S. Army Research and Technical Labs  
Ames Research Center, M/S 215-1  
Moffett Field, CA 94035

Sixth U.S. Army  
ATTN: SMA  
Presidio of San Francisco, CA 94129

Commander  
U.S. Army Aeromedical Center  
Fort Rucker, AL 36362

Strughold Aeromedical Library  
Document Service Section  
2511 Kennedy Circle  
Brooks Air Force Base, TX 78235-5122

Dr. Diane Damos  
Department of Human Factors  
ISSM, USC  
Los Angeles, CA 90089-0021

U.S. Army White Sands  
Missile Range  
ATTN: STEWS-IM-ST  
White Sands Missile Range, NM 88002

Director, Airworthiness Qualification Test  
Directorate (ATTC)  
ATTN: STEAT-AQ-O-TR (Tech Lib)  
75 North Flightline Road  
Edwards Air Force Base, CA 93523-6100

Ms. Sandra G. Hart  
Ames Research Center  
MS 262-3  
Moffett Field, CA 94035

Commander  
USAMRMC  
ATTN: SGRD-UMZ  
Fort Detrick, Frederick, MD 21702-5009

Commander  
U.S. Army Health Services Command  
ATTN: HSOP-SO  
Fort Sam Houston, TX 78234-6000

U. S. Army Research Institute  
Aviation R&D Activity  
ATTN: PERI-IR  
Fort Rucker, AL 36362

Commander  
U.S. Army Safety Center  
Fort Rucker, AL 36362

U.S. Army Aircraft Development  
Test Activity  
ATTN: STEBG-MP-P  
Cairns Army Air Field  
Fort Rucker, AL 36362

Commander  
USAMRMC  
ATTN: SGRD-PLC (COL R. Gifford)  
Fort Detrick, Frederick, MD 21702

TRADOC Aviation LO  
Unit 21551, Box A-209-A  
APO AE 09777

Netherlands Army Liaison Office  
Building 602  
Fort Rucker, AL 36362

British Army Liaison Office  
Building 602  
Fort Rucker, AL 36362

Italian Army Liaison Office  
Building 602  
Fort Rucker, AL 36362

Directorate of Training Development  
Building 502  
Fort Rucker, AL 36362

Chief  
USAHEL/USAAVNC Field Office  
P. O. Box 716  
Fort Rucker, AL 36362-5349

Commander, U.S. Army Aviation Center  
and Fort Rucker  
ATTN: ATZQ-CG  
Fort Rucker, AL 36362

Dr. Sehchang Hah  
Dept. of Behavior Sciences and  
Leadership, Building 601, Room 281  
U. S. Military Academy  
West Point, NY 10996-1784

Canadian Army Liaison Office  
Building 602  
Fort Rucker, AL 36362

German Army Liaison Office  
Building 602  
Fort Rucker, AL 36362

French Army Liaison Office  
USAAVNC (Building 602)  
Fort Rucker, AL 36362-5021

Australian Army Liaison Office  
Building 602  
Fort Rucker, AL 36362

Dr. Garrison Rapmund  
6 Burning Tree Court  
Bethesda, MD 20817

Commandant, Royal Air Force  
Institute of Aviation Medicine  
Farnborough, Hampshire GU14 6SZ UK

Defense Technical Information  
Cameron Station, Building 5  
Alexandra, VA 22304-6145

Commander, U.S. Army Foreign Science  
and Technology Center  
AIFRTA (Davis)  
220 7th Street, NE  
Charlottesville, VA 22901-5396

Commander  
Applied Technology Laboratory  
USARTL-ATCOM  
ATTN: Library, Building 401  
Fort Eustis, VA 23604

Commander, U.S. Air Force  
Development Test Center  
101 West D Avenue, Suite 117  
Eglin Air Force Base, FL 32542-5495

Aviation Medicine Clinic  
TMC #22, SAAF  
Fort Bragg, NC 28305

Dr. H. Dix Christensen  
Bio-Medical Science Building, Room 753  
Post Office Box 26901  
Oklahoma City, OK 73190

Commander, U.S. Army Missile  
Command  
Redstone Scientific Information Center  
ATTN: AMSMI-RD-CS-R  
/ILL Documents  
Redstone Arsenal, AL 35898

Aerospace Medicine Team  
HQ ACC/SGST3  
162 Dodd Boulevard, Suite 100  
Langley Air Force Base,  
VA 23665-1995

U.S. Army Research and Technology  
Laboratories (AVSCOM)  
Propulsion Laboratory MS 302-2  
NASA Lewis Research Center  
Cleveland, OH 44135

Commander  
USAMRMC  
ATTN: SGRD-ZC (COL John F. Glenn)  
Fort Detrick, Frederick, MD 21702-5012

Dr. Eugene S. Channing  
166 Baughman's Lane  
Frederick, MD 21702-4083

U.S. Army Medical Department  
and School  
USAMRDALC Liaison  
ATTN: HSMC-FR  
Fort Sam Houston, TX 78234

NVESD  
AMSEL-RD-NV-ASID-PST  
(Attn: Trang Bui)  
10221 Burbeck Road  
Fort Belvoir, VA 22060-5806

CA Av Med  
HQ DAAC  
Middle Wallop  
Stockbridge, Hants S020 8DY UK

Dr. Christine Schlichting  
Behavioral Sciences Department  
Box 900, NAVUBASE NLON  
Groton, CT 06349-5900

Commander  
Aviation Applied Technology Directorate  
ATTN: AMSAT-R-TV  
Fort Eustis, VA 23604-5577

COL Yehezkel G. Caine, MD  
Surgeon General, Israel Air Force  
Aeromedical Center Library  
P. O. Box 02166 I.D.F.  
Israel

HQ ACC/DOHP  
205 Dodd Boulevard, Suite 101  
Langley Air Force Base,  
VA 23665-2789

41st Rescue Squadron  
41st RQS/SG  
940 Range Road  
Patrick Air Force Base,  
FL 32925-5001

48th Rescue Squadron  
48th RQS/SG  
801 Dezonias Road  
Holloman Air Force Base,  
NM 88330-7715

HQ, AFOMA  
ATTN: SGPA (Aerospace Medicine)  
Bolling Air Force Base,  
Washington, DC 20332-6128

ARNG Readiness Center  
ATTN: NGB-AVN-OP  
Arlington Hall Station  
111 South George Mason Drive  
Arlington, VA 22204-1382

35th Fighter Wing  
35th FW/SG  
PSC 1013  
APO AE 09725-2055

66th Rescue Squadron  
66th RQS/SG  
4345 Tyndall Avenue  
Nellis Air Force Base, NV 89191-6076

71st Rescue Squadron  
71st RQS/SG  
1139 Redstone Road  
Patrick Air Force Base,  
FL 32925-5000

Director  
Aviation Research, Development  
and Engineering Center  
ATTN: AMSAT-R-Z  
4300 Goodfellow Boulevard  
St. Louis, MO 63120-1798

Commander  
USAMRMC  
ATTN: SGRD-ZB (COL C. Fred Tyner)  
Fort Detrick, Frederick, MD 21702-5012

Commandant  
U.S. Army Command and General Staff  
College  
ATTN: ATZL-SWS-L  
Fort Leavenworth, KS 66027-6900

Director  
Army Personnel Research Establishment  
Farnborough, Hants GU14 6SZ UK

Dr. A. Kornfield  
895 Head Street  
San Francisco, CA 94132-2813

Mr. George T. Singley, III  
Deputy Assistant Secretary of the Army  
for Research and Technology  
and Chief Scientist  
ATTN: Room 3E374  
103 Army Pentagon  
Washington, DC 20310-0103

The Honorable Gilbert F. Decker  
Assistant Secretary of the Army  
for Research, Development,  
and Acquisition  
ATTN: Room 2E672  
103 Army Pentagon  
Washington, DC 20310-0103

Dr. Craig Dorman  
Office of the Deputy Director,  
Defense Research and Engineering  
ATTN: Room 3D129LM  
103 Army Pentagon  
Washington, DC 20310-0103

HQ, AFOMA  
ATTN; SGPA (Aerospace Medicine)  
Bolling Air Force Base,  
Washington, DC 20332-6188

Cdr, PERSCOM  
ATTN: TAPC-PLA  
200 Stovall Street, Rm 3N25  
Alexandria, VA 22332-0413