N-96-01
II-A-129

United States
Environmental Protection
Agency

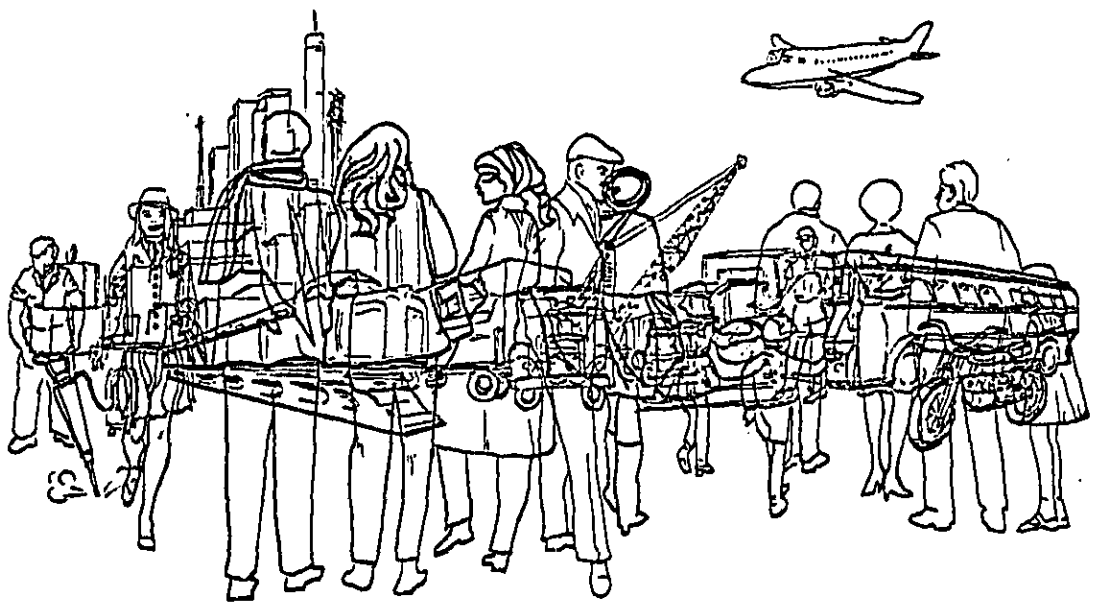
Office of Noise
Abatement & Control
Washington, D.C. 20460

December 1980
EPA 550/9-81-100

FEDERAL NOISE RESEARCH

IN HEALTH EFFECTS

1978 - 1980



TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA 550/9-81-100		

4. TITLE AND SUBTITLE	5. REPORT DATE
FEDERAL NOISE RESEARCH IN HEALTH EFFECTS, 1978-80	December 1980
	6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Carl Modig, John Moore (Informatics Inc.); Jack Shampan (Environmental Protection Agency).	

9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
Informatics Inc. 6011 Executive Blvd. Rockville, MD 20852	11. CONTRACT/GRANT NO. EPA 68-01-5015

12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
Office of Noise Abatement and Control Environmental Protection Agency Washington, DC 20460	Final 1978-80 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Updates "Federal Noise Research in Noise Effects" EPA 550/9-78-102, February 1978, which covered federal research for the period 1975-77.

16. ABSTRACT

This review of federally sponsored research on the effects of noise on health updates a previous survey, and compares present trends in research in each research category and by federal agency. The following categories of research are covered: Nonauditory Physiologic Responses; Noise Effects on Sleep; Individual and Community Response; Behavioral, Social, and Performance Effects; Communication Interference; Noise Environment Determination and Exposure Characterization; and Human Response to Noise Concomitant with Vibration. Over 250 research projects were sponsored by twenty Departments, Institutes, and Agencies during the 1978-80 period. The following information is provided for each project: title; objective; description; summary of findings; where findings are published; period of performance; name and address of investigator; name, address and telephone number of agency contact person; fiscal year funding data.

In comparing present research with previous recommendations made by an Interagency Panel, it was determined that overall expenditures had increased by about 15 percent (compared with the previous period) instead of the recommended 40 percent; and that in general, the Panel's recommendations have not been implemented in the priority areas.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Noise-induced hearing loss, nonauditory health effects, sleep disturbance, community response, environmental noise pollution, public health policy, * occupational safety and health, communication interference, speech disturbance, * industrial medicine, * noise pollution, * public health.	Interagency Noise Effects Research Panel	

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
	unclassified	458
	20. SECURITY CLASS *(This page)*	22. PRICE
	unclassified	

EPA Form 2220-1 (9-73)

FEDERAL NOISE RESEARCH

IN

HEALTH EFFECTS

1978-1980

Update for FY 1978-80 Period

December 1980

Office of Noise Abatement and Control
U.S. Environmental Protection Agency
Washington, D.C. 20460

EXECUTIVE SUMMARY

This report describes the federally sponsored research effort on the effects of noise on public health and welfare for the recent three-year period, Fiscal Years 1978-80. It updates surveys made for two previous three-year periods: FY 1973-75 and FY 1975-77. In the present report, general noise-related health effects research funding trends may be reliably identified by federal agency and research category. Three-year research funding averages are used to make data comparable with that of the two previous reports and assess overall funding trends. The extent to which previous recommendations for research have been implemented may also be assessed.

Overall Funding

The rate of increase of overall noise research funding has slowed. Funding in FY 1978 was actually below FY 1976 and 1977 levels, but has since increased to a new high of $7.9 million in 1980, the most recent reporting year.

Overall funding increased only 15.0 percent in current dollars, from a three-year average of $5.8 million per year in the FY 1975-77 period to $6.7 million in the FY 1978-80 period. Thus, after discounting for inflation, there has been little or no real recent increase in overall funding. In the two previous three-year periods, overall funding increased about 45 percent, from a three-year average of $4.0 million to approximately $5.8 million.

Funding by Category

As shown in Figure E-1, *Noise-Induced Hearing Loss and Hearing Conservation* has remained the largest single category of research, averaging $3.1 million annually over the last three years. This amounts to approximately 46 percent of the total federal noise-related health effects research budget. This compares with a similar annual average of $3.1 million for the FY 1975-77 period. Over 50 percent of the funding in this category is being spent investigating the mechanisms of hearing loss, conducting studies in support of new hearing loss criteria for impulse noise and intermittent noise, and developing more effective hearing conservation methods.

The next largest categories, are *Noise Environment Determination and Exposure Characterization* and *Individual and Community Response*, averaging nearly $1.5 million and slightly less than $1 million, respectively. Individual and Community Response has tripled and Noise Environment Determination and Exposure Characterization has quadrupled since the FY 1975-77 period. To some extent, these increases have been influenced by the more comprehensive and extensive data collection effort undertaken in this report.

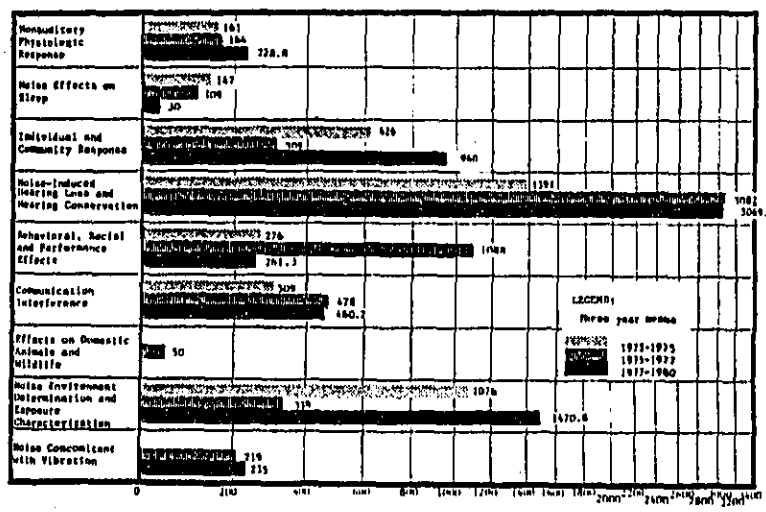
Nonauditory Physiologic Response research has increased significantly but remains at the relatively low average annual level of $228,000.

Behavioral, Social, and Performance Effects funding has declined to a three-year average of $261,300 per year.

Funding of research on *Effects of Noise on Sleep* and on *Effects of Noise on Domestic Animals and Wildlife* was small and has gotten smaller ($30,000 per year and 0, respectively.)

The other categories have remained more or less stable.

Figure E-1. Trend in Annual Average Funding Levels by Category (Averaged over the 3-year period indicated) (In Thousands of Dollars)

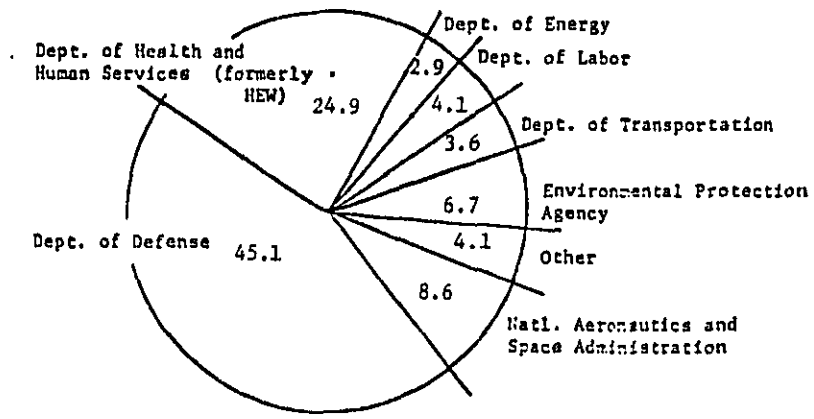


Funding by Agency

As seen in Figure E-2, by a wider margin than ever, the Department of Defense continues to be the leading sponsor, averaging 45 percent of total funding over the last three years. DOD funds are largely concentrated in the *Noise-Induced Hearing Loss and Hearing Conservation* and *Noise Environment Determination and Exposure Characterization* categories.

In second place, the Department of Health and Human Services programs have averaged $1.7 million per year over the last three years, a decline of 19 percent compared to the previous three-year period. This decline is predominately due to a significant decrease in the research funding levels of the National Institute of Neurological and Communicative Diseases and Stroke of the National Institutes of Health, although there has been a noticeable increase in research funding by the National Institute for Occupational Safety and Health.

Figure E-2. DISTRIBUTION OF FUNDING BY AGENCY
(Average Annual Expenditures, FY 1978-80)
(Percentages)



Other leading agencies include NASA ($579,000) and EPA ($450,000) Of these, the EPA program has increased significantly since the FY 1975-77 period (76 percent) while the programs of NASA have declined (19 percent).

Implementation of the 1978 Panel's Recommendations

Based on comparison of three-year averages, overall funding (in current dollars) has increased only about 15 percent instead of the 40 percent recommended by the Second Federal Interagency Noise Effects Research Panel.

Funding increased in the highest priority category identified by the Panel, *Nonauditory Physiologic Response*, by 40 percent, increasing its share from 2.0 percent to 3.4 percent of total funding. However, this is still a small share of total funding.

The other two priority categories identified by the 1978 Panel were *Effects of Noise on Sleep* and *Community or Collective Response*. While the latter category (now *Individual and Community Response*) has received increased emphasis, funding on sleep research has declined still further, averaging only 0.4 percent of total funding over the last few years.

The Panel also identified selected topics within all categories needing additional emphasis. Chapter IV describes in detail the work undertaken during the past three years in response to these needs. However, the adequacy of this research has not been evaluated in this report.

Continuing Research Needs

Both the 1975 and 1978 Panel recommendations and other more recent recommendations by groups of scientific experts reflect a longstanding consensus on areas of research needing more emphasis. When this pattern is compared to the largely static pattern of actual federal funding by the various agencies, it is clear that the overall recommendations have not been implemented in the highest priority categories. Although each federal agency must necessarily base its research on needs consonant with its particular mission, more attention must be placed on improved coordination and planning of research. This will maximize the opportunties for increasing emphasis on the recommended categories. It will also make it more possible to respond to potentially very serious health and welfare research issues with a well planned program. Positive steps along these lines that have been taken in the past three years include the development of a Five-Year Health Plan for EPA-sponsored research and the start of a number of jointly funded research projects. This report provides needed information for establishing a more coordinated noise-related health effects research program to develop criteria, standards, and guidelines in needed research areas to protect the public health and welfare against the adverse effects of noise.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

Background

The Quiet Communities Act of 1978 gives the Environmental Protection Agency the responsibility for coordinating the noise control research programs of all federal agencies. The Act also states that EPA shall periodically report to Congress on the status and recent developments of the federal noise abatement and control effort, including research into the health effects of noise.

EPA has, in the past, responded to this mandate by sponsoring interagency panels to review federal noise research in the following four areas:

- o Health effects of noise
- o Surface transportation noise
- o Machinery/construction noise
- o Aircraft noise

These panels were assembled for the first time in late 1973 and early 1974. Their results were presented as EPA's "First Report on the Status and Progress of Noise Research and Control Programs FY 73-75." In late 1976, the panels were again convened to report on the progress made since the first panels' reports were issued. The second Panels' findings were published in 1978 in a series of reports, each dealing with one of the four topic areas.

The present report is an update of the 1978 document "Federal Noise Research in Noise Effects" (EPA 550/9-78-102), which presented the findings of the Second Federal Interagency Noise Effects Research Panel. The report has been used most extensively in informing federal agencies, State and local governments, Congress, OMB and the scientific community concerning the specific

program initiatives of the federally sponsored, noise-related health effects research effort. While the formal Noise Effects Panel was not reconvened for the preparation of this report, the information presented here was gathered with the assistance of an ad hoc Interagency Health Effects Advisory Group. Many federal agencies, involved to varying degrees in noise research, have made significant contributions to this update by responding to EPA's request for project data. In some instances, individual researchers provided detailed descriptions of their ongoing research activities when clarification was needed.

Purpose of This Report

In continuing to report on the status of federal noise effects research, it is hoped that research efforts on the health effects of noise by the various departments and agencies will be increasingly coordinated and mutually supportive. Considering the small amount of available research funds in relation to the magnitude of existing noise-related health problems, it is mandatory that research be planned and conducted in a better coordinated and more unified manner, with the least duplication of effort and the maximum utilization of available expertise and resources.

The fundamental objective of this report is to assist federal officials in planning their overall research programs and specific research projects with better focus, direction and insight. In effect, this document should serve to provide a more detailed understanding and knowledge of the existing research effort and thus function as a valuable research reference source for planning purposes. Better knowledge on noise research activities and results will result in better planned research in the future.

Secondly, the body of information should assist in identifying gaps in the nation's noise-related health effects research program where increased

emphasis should be placed, and help foster the promotion of a more unified, integrated and supportive effort in research areas where there are mutual research interests.

Health effects information provides the foundation and support for almost all noise control efforts. Often the research results of one agency are incorporated into the research programs, program plans, and policies of another agency. Therefore, improved research planning and coordination will ultimately promote more unified noise control policies based upon the most comprehensive health and welfare data base and applicable human response criteria. Ultimately there should be one set of health criteria used by all agencies. Agencies would then develop noise policy under their respective authorities using those criteria based upon the health implications of noise.

In addition, the document will assist in informing federal policy makers, the scientific community and the public concerning emerging avenues of research on the health effects of noise such as cardiovascular research. An examination of these research efforts and expanding research horizons will assist in creating demands for increased research in these areas. Likewise, where recommendations for additional research have previously been made, the progress being made towards meeting such recommendations can be assessed.

To further progress in all of these areas, EPA has prepared this updated report as a comprehensive overview of noise effects research throughout the federal arena. Over 200 noise-related research projects from over 20 federal agencies are summarized in this document. It is the most comprehensive data base of its kind.

Report Organization

The various projects discussed in this report (which are detailed in Appendix A) involve research on a wide range of noise-related health effects and have been categorized as follows:

- *Nonauditory Physiologic Response*
- *Effects of Noise on Sleep*
- *Individual and Community Response*
- *Noise-Induced Hearing Loss and Hearing Conservation*
- *Behavioral, Social, and Performance Effects*
- *Communication Interference*
- *Effects of Noise on Domestic Animals and Wildlife*
- *Noise Environment Determination and Exposure Characterization*
- *Noise Concomitant with Vibration*

The categories are explained in some detail in the first part of Chapter III. The last part of Chapter III summarizes the noise concerns and research activities of individual agencies and presents funding data on their research activities in the various effects categories. Funding figures and charts summarizing the total federal effort are presented in Chapter IV. Also presented in this chapter is an analysis of research trends and the extent to which current research conforms to the priorities and recommendations for future research made in the 1978 Panel report, the progress made in these areas, and an assessment of the effort still required to meet the identified research needs.

As indicated, Appendix A contains summaries of the specific noise-related research projects of each federal agency. Readers of the previous report will note that the project summaries in this update are far more detailed, including technical references for the readers, a summary of findings of completed

research, and the identification of principal investigators and federal agency personnel to serve as points of contact for additional information. This information has been provided so that readers may obtain more detailed knowledge about projects of particular interest. The added detail is intended to increase the utility of this report.

To complement the federal project information, Appendix B presents project summaries on research sponsored and conducted by a few state, local, and private institutions. While this body of data is far from being a complete listing, it is representative of the nature and extent of research interest at the non-federal level.

Thus, the data collection presented here represents the most complete and up-to-date assessment and compilation of the current state of the nation's research effort to identify, understand and quantify the harmful health effects of noise. It should be noted, however, that because of the lengthy data collection phase required for this report, some recently-initiated projects may be absent. For these, the reader is advised to check the abstracts from recent technical society meetings and journals and cross reference these with the "SSIE"--Smithsonian Science Information Exchange.* Nevertheless, the information presented here should assist policy makers in the continuing development of a federal noise effects research program that is more unified, coordinated, and comprehensive.

---

*-Smithsonian Science Information Exchange
Rm. 300, 1730 M Street, N.W.
Washington, DC 20036
Tel.: 202/634-3933

CHAPTER II

SOURCES OF INFORMATION

The information was gathered through an exhaustive data gathering program in an effort to ensure maximum representation of all applicable research projects, to improve the level of their accuracy and detail and to reflect their current standing.

For federally sponsored research, requests for project information were made on an agency-to-agency basis in the Fall of 1979, utilizing as contact persons, where possible, the panel members who participated in preparing the previous report. In other cases, research and environmental officers were contacted in an effort to gain their participation in this large data gathering program. Furthermore, the assistance of the Interagency Health Effects Advisory Group was invaluable in reestablishing a network of agency contacts. This advisory group assisted EPA in the review and final drafting of the "EPA Five-Year Health Effects Research Plan for Noise" prepared for submission to Congress. For some agencies or departments, several contact persons were required because of the decentralized nature of the organization's activities. All federal agency contacts who helped EPA prepare research abstracts for their respective organizations are listed at the end of this chapter.

Relevant noise effects research project descriptions were also obtained from a computer search on the Smithsonian Science Information Exchange (SSIE) data base. SSIE is an institution which collects information from federal agencies on research being sponsored by them. However, the SSIE descriptions were for the most part limited in project detail, and therefore had to be supplemented. These inputs were provided to the agency contacts to aid them

in their work of identifying all relevant projects in their organizations. Copies of model project descriptions were also distributed to the agency contacts for their use as format samples.

After initial project descriptions were received by EPA, draft project abstracts were prepared. The project descriptions were then reviewed by well known noise effects research experts to assess their technical content and clarity of presentation. The abstracts were then returned to the agencies in order to obtain any missing or clarifying information and check on their accuracy and completeness. Numerous telephone follow-ups were also made to agency contacts, or in some cases to the principal investigators, to fill in information gaps and finalize the abstracts. This process of refining the data continued through the month of July 1980, when a cut-off was finally imposed.

This collection mechanism insured that practically all of the information presented in this report was received directly from either the sponsoring agencies or principal investigators, and that it is comprehensive. For some projects, SSIE data and agency-supplied data were merged to create new project descriptions.

For State, local, or privately sponsored research, information was gathered directly from each sponsor and/or investigator. These were identified in several ways: from the previous 1978 "Federal Noise Research in Noise Effects" report; by questioning numerous experts in the field; by leads supplied by EPA/ONAC's State and Local Programs Division; through the Committee on Hearing, Bioacoustics and Biomechanics of the National Academy of Sciences; and by publicizing in noise-related journals and newsletters the need for such information. This collection of project descriptions is believed to include a representative sample of the type of nonfederally supported noise-related health effects research projects currently being undertaken.

AGENCY CONTACTS FOR PROJECT INFORMATION

(Alphabetically by Agency)

Department of Agriculture	George Miller Department of Agriculture Forest Environmental Research Staff United States Forest Service Headquarters P.O. Box 2417 Washington, DC 20013 202/235-1071
	Barry R. Flamm, Director Office of Environmental Quality U.S. Department of Agriculture Room 412-A Administration Building 14th and Independence Avenue, S.W. Washington, DC 20250 202/492-6415
Department of Commerce	Simone L. Yaniv Department of Commerce National Bureau of Standards Building and Community Acoustics Washington, DC 20234 301/921-3783
Consumer Product Safety Commission	Albert Esch Medical Director Consumer Product Safety Commission Washington, DC 20007 202/492-6428, 492-6639
Department of Defense Air Force	*Henning von Gierke Department of the Air Force HQ6570 AMRL/BB Wright-Patterson AFB, OH 45433 513/255-3602
	Colonel Dewey V. Sturges, USAF Chief, Technical Plans Office Biodynamics and Bioengineering Division Air Force Aerospace Medical Research Laboratory Wright-Patterson AFB, OH 45433 513/255-3602

* Members of Ad-Hoc Interagency Health Effects Advisory Group.

Department of Defense (cont'd)	
Army	Brian Walden Walter Reed Army Medical Center Army Audiology and Speech Center Washington, DC 20012 202/576-3721
	Paul Schomer U.S. Army Corps of Engineers Construction Engineering Research Lab. P.O. Box 4005 Champaign, IL 61820 217/352-6511
	Major Jerod L. Goldstein, MSC Acting Director, HTS US AARL P.O. Box 577 Fort Rucker, AL 36362 205/255-4408
	Georges Garinther Human Engineering Lab Aberdeen Proving Grounds, MD 21005 301/278-3265
Navy	Meyer Lepor Airborne Acoustics Branch Naval Ocean Systems Center San Diego, CA 92152 714/225-7916
	W.M. Parsons Naval Medical Research and Development Command National Naval Medical Center Bethesda, MD 301/295-1028
Department of Education Bureau of Education for the Handicapped	Alan Dittman Department of Education Bureau of Education for the Handicapped 400 Maryland Ave., S.W. Washington, DC 20202 202/245-9836
Environmental Protection Agency	*Rudolph M. Marrazzo Office of Noise Abatement and Control U.S. Environmental Protection Agency ANR-471 Arlington, VA 22202 703/557-0592

* Members of Ad-Hoc Interagency Health Effects Advisory Group.

Environmental Protection Agency (cont'd)	Jack Shampan Office of Noise Abatement and Control U.S. Environmental Protection Agency ANR-471 Arlington, VA 22202 703/557-0592
Department of Health and Human Services	
NIMH	*George E. Renaud National Institute of Mental Health Parklawn Building, Room 10C09 5600 Fishers Lane Rockville, MD 20857 301/443-3942
NIOSH	*Alex Cohen National Institute for Occupational Safety and Health Cincinnati, OH 45226 513/684-8291
	Randy Tubbs National Institute for Occupational Safety and Health Physical Agents Branch 4676 Columbia Parkway Cincinnati, OH 45226 513/634-8281
NHLBI	*Helen Hubert National Institutes of Health National Heart, Lung, and Blood Institute Bethesda, MD 20205 301/496-4333
NICHHD	*Charlotte Catz National Institutes of Health National Institute of Child Health and Human Development CNED-Room 7C08, Landow Building 7910 Woodmont Avenue Bethesda, MD 20205 301/496-5575
NIEHS	*Reginald Cook National Institutes of Health National Institute of Environmental Health Services Research Triangle Park, NC 27709 919/541-3247

* Members of Ad-Hoc Interagency Health Effects Advisory Group.

Department of Health and Human Services (cont'd)

NINCDS

*Earleen Elkins
National Institutes of Health
National Institute of Neurological
and Communicative Disorders and Stroke
7550 Wisconsin Avenue
Bethesda, MD 20014
301/496-5061

FDA

Bruce Herman
Food and Drug Administration
Bureau of Radiological Health
Division of Electronic Products
Acoustics Branch
HFX-210
5600 Fishers Lane
Rockville, MD 20857
301/443-6113

Department of Housing and Urban Development

George Winzer
Chief, Environment and Land Use Research
Office of Policy Development and Research
Department of Housing and Urban Development
Washington, DC 20410
202/755-7340

Department of Interior

Bureau of Mines

Harrison Daniel
Department of Interior
Bureau of Mines
Mining Research Health and Safety
2401 E Street, N.W.
Washington, DC 20241
202/634-1251

Department of Labor

OSHA

*Alice Suter
Department of Labor
Occupational Safety and Health Administration
2000 Constitution Ave., N.W.
Washington, DC 20210
202/523-7151

ESA

James Brown
Deputy Director
Office of Program Development &
Accountability
Employment Standards Administration
U.S. Department of Labor
Washington, DC 20210
202/523-6579

*Members of Ad-Hoc Interagency Health Effects Advisory Group.

Department of Labor (cont'd) MSHA	Jerry Brasch Department of Labor Mine Safety and Health Administration Coal Mine Safety and Health 4015 Wilson Blvd. Arlington, VA 22203 703/235-1358
National Aeronautics and Space Administration	*David G. Stephens National Aeronautics and Space Administration Langley Research Center Hampton, VA 23665 804/827-3561
	Homer G. Morgan National Aeronautics and Space Administration Langley Research Center Acoustics and Noise Reduction Division Hampton, VA 23665 804/827-3577
National Science Foundation	*Terrence R. Dolan National Science Foundation 1800 G St., N.W. Washington, DC 20550 202/634-1624
Tennessee Valley Authority	E. A. Belvin Manager, Office of Health and Safety Tennessee Valley Authority River Oaks Building Muscle Shoals, AL 35660 205/383-4631
Department of Transportation FRA	Donald Levine Federal Railroad Administration Office of Rail Safety Research RRD 33 Washington, DC 20590 202/426-1227
FAA	*Bill Shepherd Federal Aviation Administration 800 Independence Ave., S.W. Washington, DC 20591 202/755-9027

* Members of Ad-Hoc Interagency Health Effects Advisory Group.

Department of Transportation (cont'd)	
FHWA	Harter Rupert Chief, Noise and Air Quality Branch Environmental Quality Division Office of Environmental Policy Federal Highway Administration Department of Transportation 400 7th Street, S.W. Washington, DC 20590 202/426-4836
Veterans Administration	G. Donald Causey Audiology and Speech Pathology Service (126) Veterans Administration Medical Center 50 Irving St., N.W. Washington, DC 20422 202/389-7268

* Members of Ad-Hoc Interagency Health Effects Advisory Group.

CHAPTER III

AGENCY NOISE RESEARCH PROGRAMS

The purpose of the many research projects discussed in this report is highly dependent upon the sponsoring agency's mission. In most cases the agencies' research activities are concerned with 1) establishing information on the prevalence and severity of various noise related health effects, 2) developing human response criteria to quantify the effects and health consequences of noise, and 3) ascertaining a cause-effect relationship due to specific source environments. The quantification of the health effects caused by noise is necessary for the development of noise related legislation and the setting of noise exposure limits, since it is the explicit purpose of such regulations to protect the public health and welfare. A comprehensive understanding of the health consequences of noise will enable public officials to make rational, efficient and cost effective decisions to secure a healthy environment.

This chapter will present 1) short descriptions of the health effects categories under which all of the project descriptions are listed, and 2) summary overviews of the noise related health effects research programs of each federal agency.

Research Category Definitions

The various health related effects of noise were categorized by the first and second Federal Interagency Noise Effects Research Panels, and for the sake of consistency, the same categories have been essentially maintained in this report. These categories serve as the foundation for existing criteria or have the potential for being incorporated into new health effects criteria.

In some cases, however, slight changes have been made in categories to reflect new knowledge of the effects that noise can have on the body, and to conform to the terminology currently used by EPA in the formulation of its "Five-Year Health Effects Research Plan for Noise."

The following paragraphs provide summary descriptions of the categories as they are used in the current update. The order of their appearance coincides with the priority EPA has given its own research interests as presented in its "Five-Year Health Effects Research Plan for Noise." The most important factors in the establishment of these priorities were the severity or potential severity of the particular health problem, scientific recommendations, and EPA program needs. The priorities of other federal agencies may be somewhat different depending on their specific programmatic needs. However, the assignment of the highest priority to the *Nonauditory Physiologic Response* category does reflect the principal recommendation of the 1978 Federal Interagency Noise Effects Research Panel.

The project descriptions in Appendix A are organized by agency. But, to aid the reader with a particular listed research interest, there is an index of projects by research category at the back of Appendix A, starting on page A-313. Each listing consists of investigator, sponsoring agency, project title, and page location of the complete project description in Appendix A.

1. Nonauditory Physiologic Response

This category, referred to as *Non-Auditory Health Effects* in the last report, consists of research investigations into the physiological effects of noise (other than hearing damage) on bodily systems and on general health. The largest body of nonauditory physiologic response research exists on the relationship between long term noise exposure and hypertension and other cardiovascular problems. Other principal areas of research include effects on the fetus and on general health.

A listing of projects in this category may be found starting on page A-315.

2. Effects of Noise on Sleep

Research in this category consists of investigations quantifying the relationship between sleep disturbance and noise exposure, including determining the acoustic parameters which contribute most to the disruption of sleep; and determining general health implications of chronic sleep disruption.

A listing of projects in this category may be found on page A-316.

3. Individual and Community Response

This category was formerly entitled *Community or Collective Response*. Research in this category includes assessments of the subjective reactions of individuals and residential populations to noise environments in general, to specific acoustic attributes, and to certain noise sources in particular. Overall community noise studies and environmental impact assessments are also integral areas of research under this topic.

A listing of projects in this category may be found on page A-317.

4. Noise-Induced Hearing Loss and Hearing Conservation

Formerly called *Noise Induced Hearing Loss,* this category has been expanded to encompass the protection and rehabilitation of hearing ability. This category consists of research 1) quantifying the relationship between hearing loss and different levels and durations of noise exposure, 2) laboratory investigations of the basic physiologic mechanisms of noise induced hearing loss, 3) the development of hearing conservation methods and programs for the prevention of noise induced hearing loss, and 4) determining the communicative problems of the hearing impaired and developing effective rehabilitative methods.

A listing of projects in this category may be found on page A-319.

5. Behavioral, Social and Performance Effects

This category is a very broad category encompassing most aspects of personal and social adjustment and performance. Included are effects on job performance and productivity, absenteeism, effects on learning, cognitive and social development of children, mental health, and social problems.

A listing of projects in this category may be found on page A-326.

6. Communication Interference

This category is primarily concerned with the interfering aspects of noise on the speech discrimination abilities of the hearing impaired as well as on normal hearing individuals. Other research components include the development of speech materials for diagnostic assessments, determination of the requirements for adequate verbal communication, and the masking by noise of warning signals and other acoustic cues.

A listing of projects in this category may be found on page A-327.

7. Effects of Noise on Domestic Animals and Wildlife

Research in this category includes investigations of the possible effects of noise on farm animals (e.g., changes in reproductivity) and effects on wild animals (e.g., changes in mating behavior). Since laboratory animals (such as rats, chinchillas, and monkeys) are almost always used as human surrogates, projects to study the effects of noise on these animals are discussed under the various preceding categories and are not included under this category.

There have been no projects in this category during the update period.

8. Noise Environment Determination and Exposure Characterization

This category, previously entitled *Noise Environment Determination* in the last report, now encompasses the quantification of both the noise levels in various environments as well as the noise exposure patterns of individuals or groups within those environments. Research efforts under this category also include the assessment of noise monitoring systems, the development of improved measurement techniques, and the design and institution of noise modeling for predicting community response.

A listing of projects in this category may be found on page A-329.

9. Human Response to Noise Concomitant with Vibration

This category represents a small but growing body of research on the combined effects of noise and vibration generated by certain noise sources, such as aircraft, military (artillery) and mining (blasting) operations.

A listing of projects in this category may be found on page A-332.

Agency Noise Research Programs

In order to present information on the perspectives of the various agencies on noise research, the following sections briefly summarize for each agency the general agency mission, the role of noise related health effects research in that mission, and current emphases in health effects research. These narratives are followed by tables providing at-a-glance information on research funding in each health effects research category and a summary discussion of the general project areas of concern. In some cases, one research project may encompass more than one category. For example, this may well be the case in an industrial noise study where hearing level information and nonauditory physiologic response findings are being investigated in relation to the measured noise exposure of workers. For the sake of simplicity, these projects are "force-fit" into the category where the major emphasis seems to be. Thus there are many instances in which specific research projects, assigned to one research category, are in fact benefiting the ongoing research effort in another category. Only a thorough review of the actual project descriptions will provide the reader with this level of detail.

Agencies

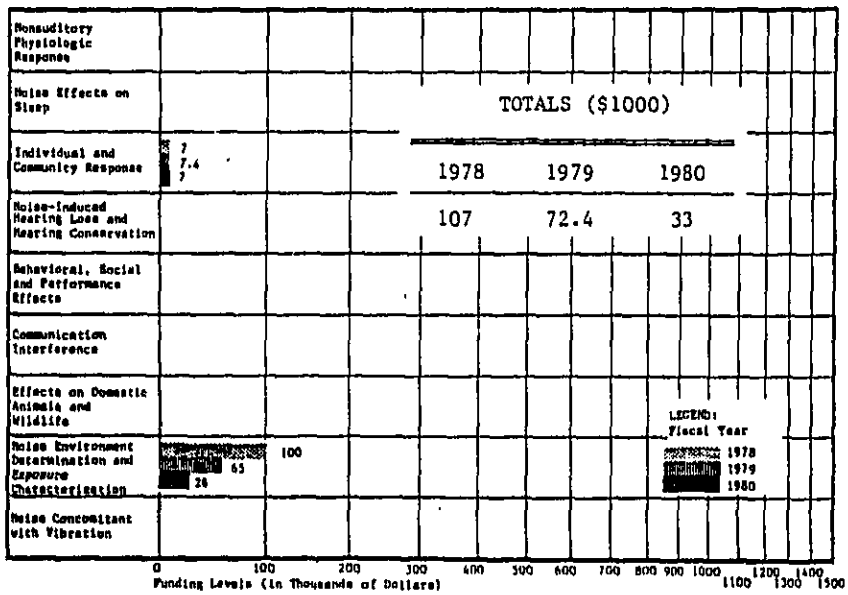
The noise related health effects research efforts of the following agencies are represented in this document, and will be summarized in this chapter.

- Department of Agriculture
  - U.S. Forest Service
- Department of Commerce
  - National Bureau of Standards
- Department of Defense
  - Air Force
  - Army
  - Navy
- Environmental Protection Agency (Office of Noise Abatement and Control)
- Department of Education
  - Bureau of Education for the Handicapped
- Department of Energy
- Department of Health and Human Services
  - National Institute of Mental Health
  - National Institute for Occupational Safety and Health
  - National Heart, Lung and Blood Institute
  - National Institute of Child Health and Human Development
  - National Institute of Environmental Health Sciences
  - National Institute of Neurological, and Communicative Diseases and Stroke
  - Food and Drug Administration
  - Health Services Administration
- Department of Interior
  - Bureau of Mines
- Department of Labor
  - Mine Safety and Health Administration
  - Employment Standards Administration
- National Aeronautics and Space Administration
- National Science Foundation
- Department of Transportation
  - Federal Railroad Administration
  - Federal Aviation Administration
  - Federal Highway Administration
- Veterans Administration

DEPARTMENT OF AGRICULTURE

U.S. Forest Service

The Department of Agriculture is directed by law to acquire and disseminate information on agricultural matters and also to engage in research, conservation, and regulation of agricultural areas. Within the Department of Agriculture, the U.S. Forest Service is responsible both for managing the Federal forest reserves, and for national leadership in forestry. The Forest Service is concerned with identifying and reducing noise sources in forested areas and other natural settings. The noise related health effects research effort of this agency includes investigations of the attenuation of forest vegetation, influence of vegetation on human response, and noise impact modeling.

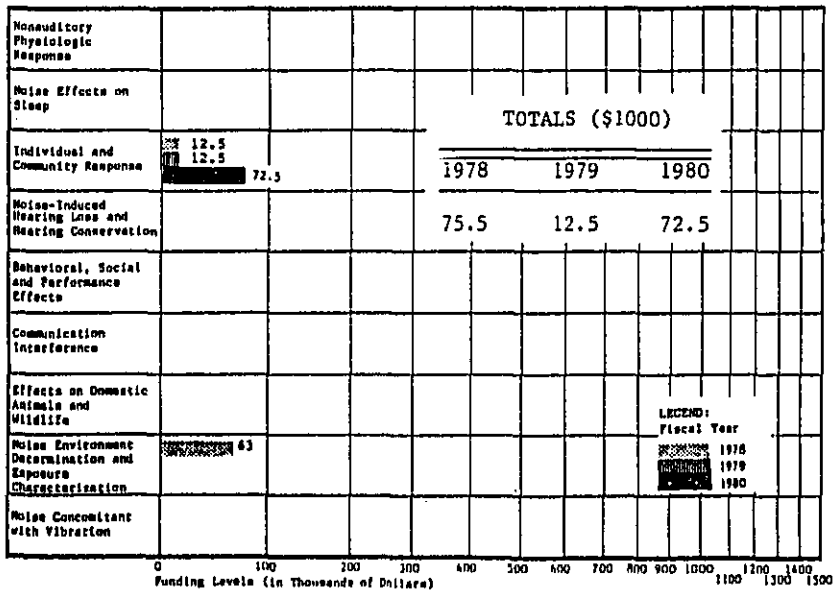


DEPARTMENT OF COMMERCE

The National Bureau of Standards

The mission of the National Bureau of Standards is to advance the nation's science and technology and promote their effective application for the public benefit. NBS is responsible for the standardization of physical measurement systems, and conducts research to improve materials for technological application.

The main objective of the Bureau's noise related health effects research is to establish a psychoacoustical basis for noise measurement by identifying and quantifying human adverse response to noise. Current areas of emphasis are the development of design criteria for buildings, and noise isolation requirements for building partitions and exterior walls. In addition to its



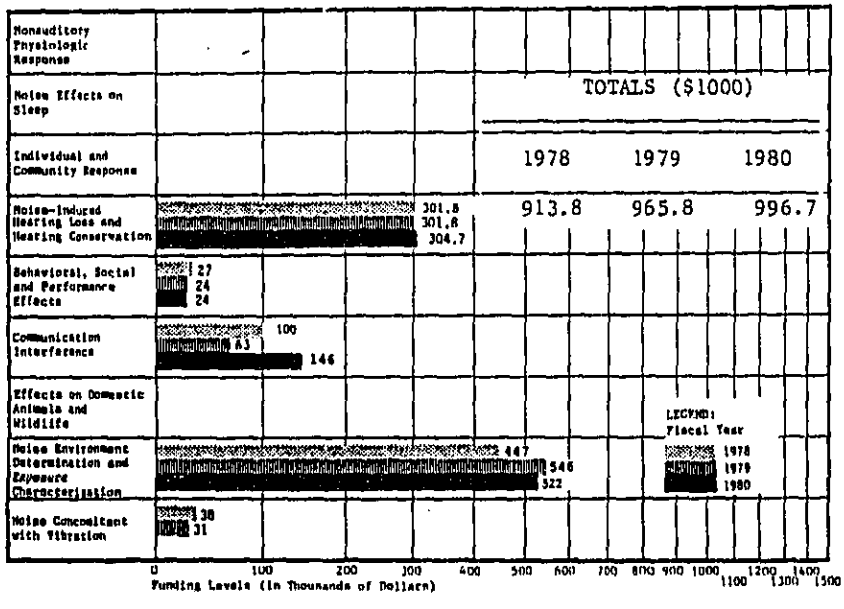
own program, NBS has also undertaken the following research projects for other government agencies: a study on highway noise criteria for DOT (Federal Highway Administration), a criteria study of transmission line noise for DOE, development of an automated noise-exposure measurement system for HUD, and an assessment of locomotive crew in-cab occupational noise exposure for DOT (Federal Railroad Administration).

DEPARTMENT OF DEFENSE: Air Force, Army, Navy

The noise related health effects research of DOD is directed to support mission needs including protecting the hearing and health of military personnel, insuring the performance capability and mission effectiveness of personnel in noise and combined noise and stress environments, and reducing the impact of peacetime military operations on the surrounding communities.

Air Force

Air Force biological acoustics research is primarily conducted in the research facilities of the Aerospace Medical Research Laboratory,

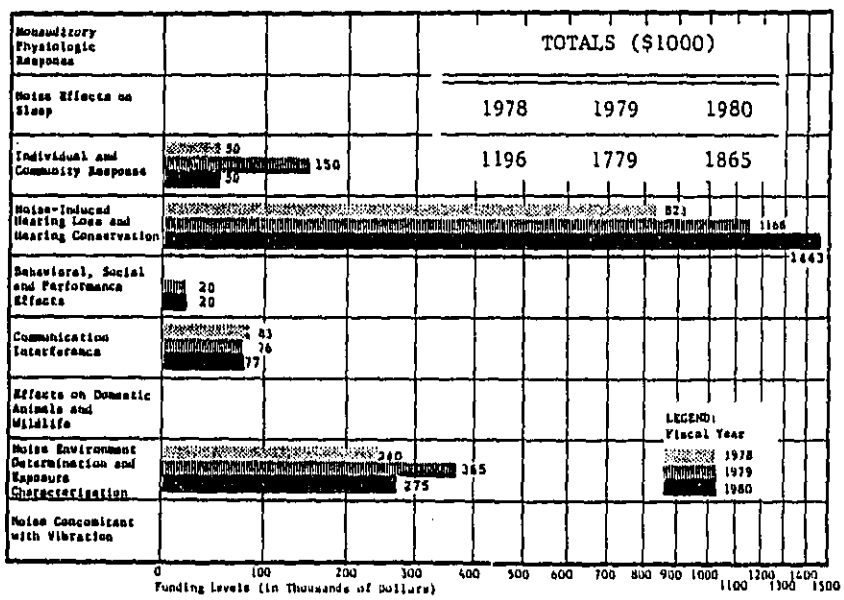


Wright-Patterson AFB, Ohio. The Air Force hearing conservation program and related studies are the responsibility of the School of Aerospace Medicine, Brooks AFB, Texas. Both laboratories are under the Aerospace Medical Division, Air Force Systems Command.

Particular noise related research emphases of the Air Force include studies investigating the following: the auditory effects of long-duration continuous noise exposure, infrasound exposure, and combined effects of continuous and impulse noise; effects of noise on the hearing of children; fetal effects of noise; assessment of hearing conservation programs; evaluations of personal hearing protector performance; effects of aircraft noise on communications; combined noise and vibration effects on performance; performance effects of low frequency noise; the application of noise dosimetry and determination of individual noise exposures of Air Force personnel; and assessments of aircraft noise prediction models for monitoring aircraft noise and determining noise impact around Air Force installations.

Army

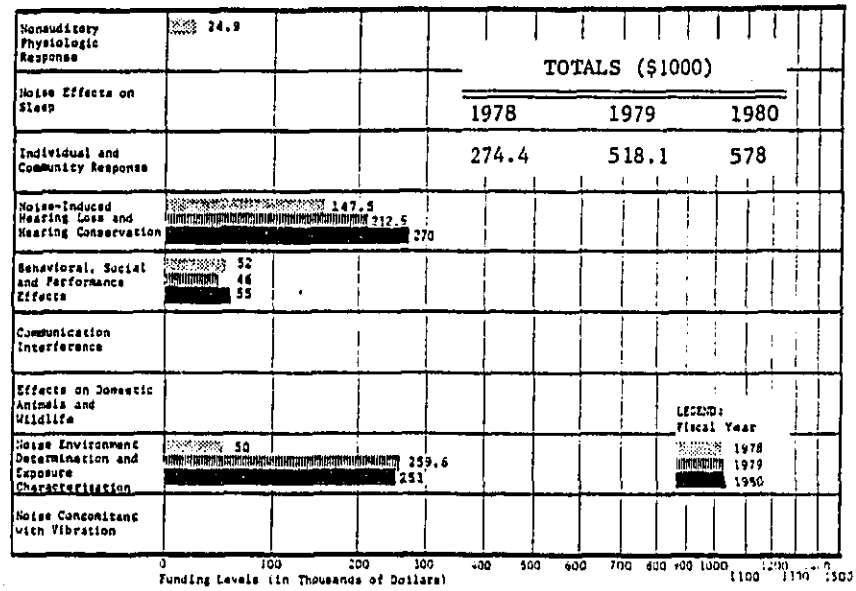
Research on the effects of noise is being performed at the Human Engineering Research Laboratory (HERL) at Aberdeen Proving Grounds, Maryland; the Construction Engineering Research Laboratory (CERL), Champaign, Illinois; the Army Aeromedical Research Laboratory (AMRL), Fort Rucker, Alabama; and the Walter Reed Army Medical Center (WRAMC), Washington, D.C. Research at the HERL and the AMRL is directed at 1) investigations of the physiologic effects of impulse noise on the auditory system in order to develop improved damage risk criteria to prevent hearing loss from impulse noise, and 2) assessments of hearing protective devices and design requirements to meet Army hearing conservation and noise control needs. The CERL is primarily concerned with the prediction of noise emissions and noise impact around Army bases and the



assessment of community response to impulse and helicopter noise. Research activities at the WRAMC center on studies to improve the communicative abilities of military personnel suffering from noise induced hearing loss through improved hearing aid designs and evaluations, and aural rehabilitation training.

Navy

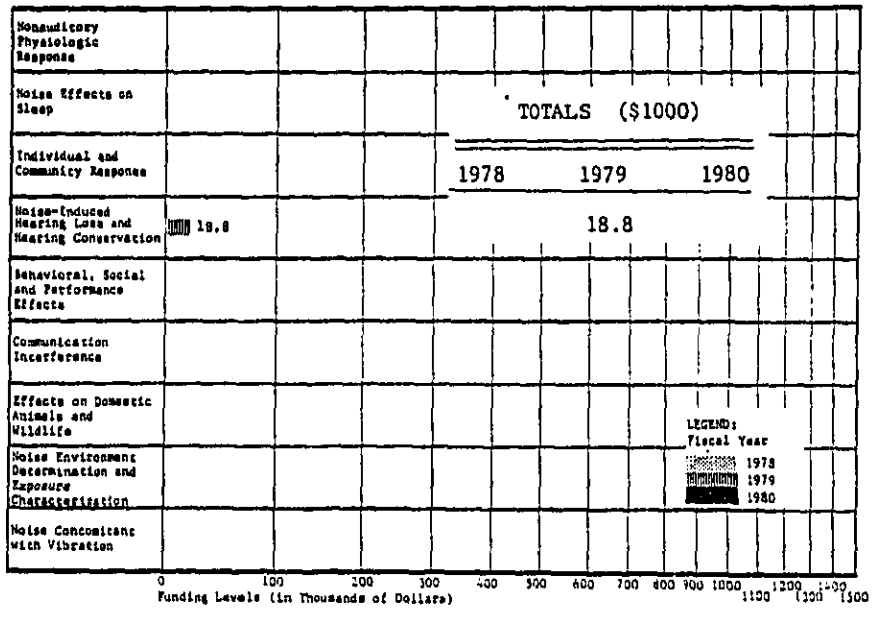
Naval noise related health effects research is conducted primarily at the Naval Submarine Medical Research Laboratory (NSMRL), Groton, Connecticut; the Naval Aerospace Medical Research Laboratory (NAMRL), Pensacola, Florida; and the Naval Ocean Systems Center (NOSC), San Diego, California. The research efforts of the Navy center on: 1) the assessment and quantification of auditory and nonauditory risks associated with noise exposure in naval environments; 2) measures of susceptibility for early identification of noise induced hearing loss; 3) development of improved hearing conservation programs--automated hearing test systems, a hearing assessment data base and management system, and prototype hearing protectors; and 4) shipboard noise exposure measurements and assessments, and naval installation noise monitoring.



DEPARTMENT OF EDUCATION

Bureau of Education for the Handicapped

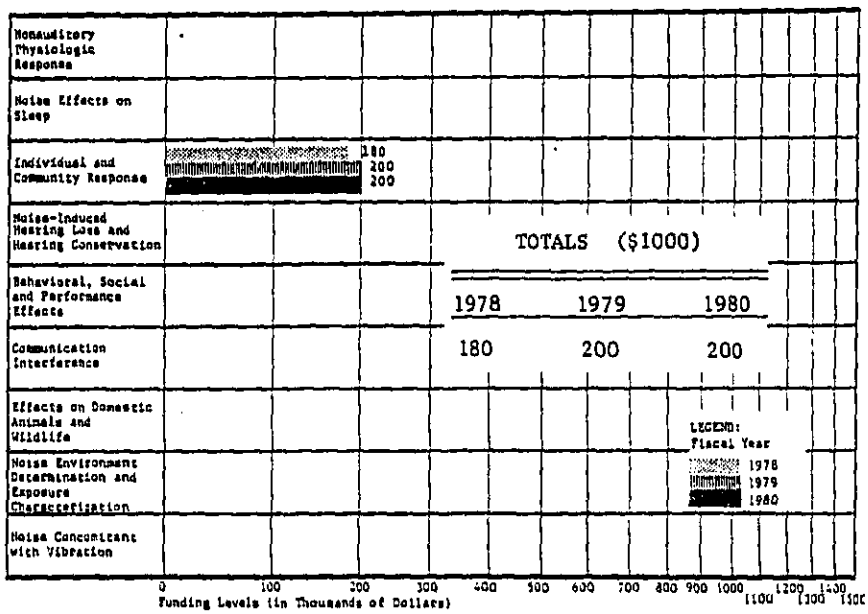
The main goals of the Department of Education (formerly a part of the Department of Health, Education and Welfare), are to insure equal educational opportunties for all citizens; and to promote improvement in the quality of education through research, program evaluation, and information dissemination. The Bureau of Education for the Handicapped (now called The Office of Special Education and Rehabilitative Services) formulates policy, and directs and coordinates the administration of programs for special education services to meet the needs and develop the full potential of handicapped children; and to provide vocational rehabilitation services to reduce human



dependency and restore the productive capabilities of handicapped people. The Office's noise related health effects research is concerned with investigating the amplification system needs of the hearing-impaired, particularly in classroom situations.

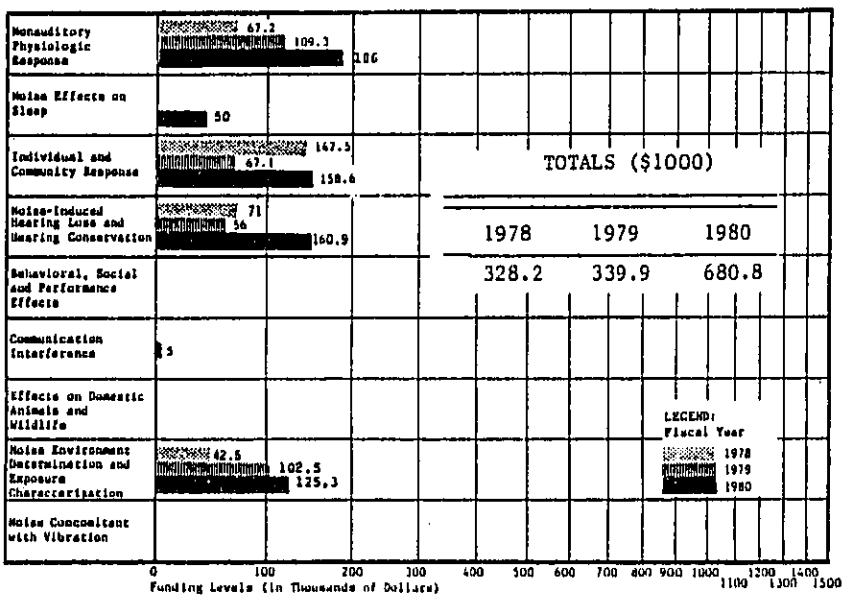
DEPARTMENT OF ENERGY

The Department of Energy provides the framework for a comprehensive and balanced national energy plan through the coordination and administration of the energy functions of the Federal Government. The noise related health effects research activities of the agency involve measuring human response to the noise propagated by energy generating and transmitting equipment.



ENVIRONMENTAL PROTECTION AGENCY

The Noise Control Act of 1972 and the Quiet Communities Act of 1978 mandate the Environmental Protection Agency to conduct and financially support research on noise, including investigations of the psychological and physiological effects of noise on humans and animals, in order to determine dose/response relationships suitable for use in decision making. In this mandate, special emphasis is placed on the nonauditory effects of noise. The overall goal of the EPA/ONAC research program is to "improve the noise related health and welfare data base, refine existing criteria and develop quantified dose-response criteria where they are lacking." The health effects research program supports EPA's noise regulatory program, state and local technical assistance



programs and public information efforts in order to collectively meet the nation's noise control needs. The highest priority in EPA's research program is to verify as soon as possible the extent to which a cause-effect relationship exists between noise and stress related diseases such as cardiovascular disease, since the potential public health problem is great.

The noise related health effects research studies of EPA are concentrated in the following areas:

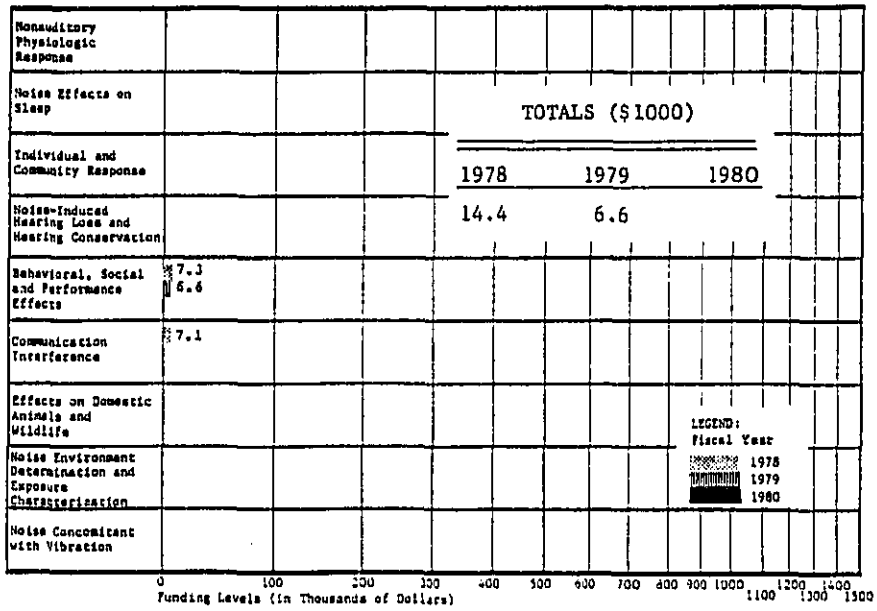
- o Cardiovascular effects of noise
- o Effects of chronic sleep disturbance on general health and performance
- o Effects of noise on the hearing of children; fetal effects of noise; prevalence of noise induced hearing loss in U.S.; social handicap of hearing loss; and workers compensation programs and provisions for noise induced hearing loss.
- o Human response to intrusiveness, impulse noise and construction noise; community noise survey assessments
- o Measurement and modeling of noise exposures in the community and workplace.

DEPARTMENT OF HEALTH AND HUMAN SERVICES

The Department of Health and Human Services (formerly a portion of the Department of Health, Education and Welfare) is the primary U.S. agency responsible for furthering the good health of Americans and providing them with essential human services.

Center for Disease Control: National Institute of Mental Health (NIMH)

The Institute serves as the principal agency for the study of behavioral science and the cultural and social problems related to mental health. NIMH has been involved in the study of short term effects and level of adjustment of community residents to highway construction noise and the problems of communication in the presence of competing auditory messages.

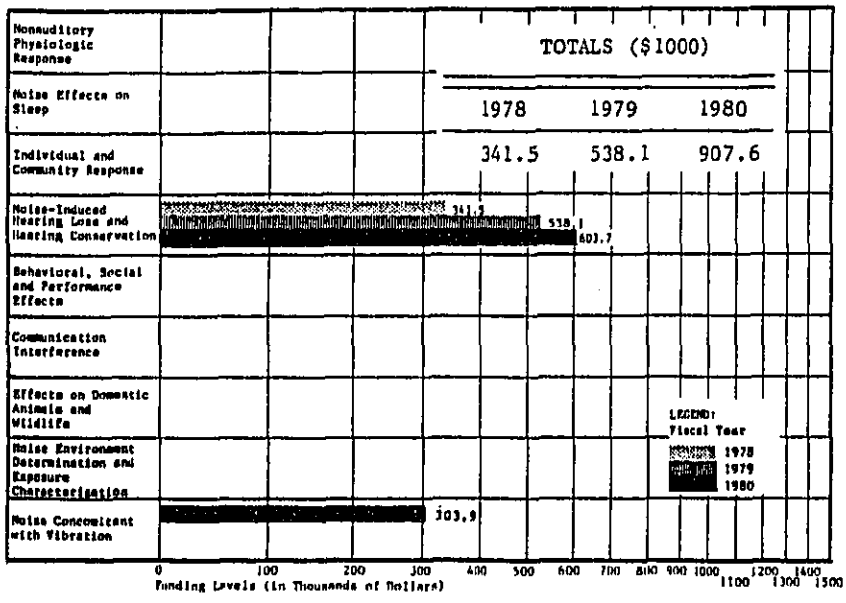


Center for Disease Control:

National Institute for Occupational Safety and Health (NIOSH)

The National Institute for Occupational Safety and Health is directed to perform research leading to criteria for safe and healthful workplace conditions by authority of the Occupational Safety and Health Act of 1970 and the Federal Coal Mine Safety and Health Act of 1969. Noise is one of the many agents investigated for deleterious effects on health and safety.

Current noise related health effects research emphasizes animal experimental laboratory studies and industrial field investigations of the long term effects of impulse noise, intermittent noise and segmental vibration. These studies will help establish the mechanisms of loss, determine the prevalency of these problems, identify differences from steady state noise exposure effects, and

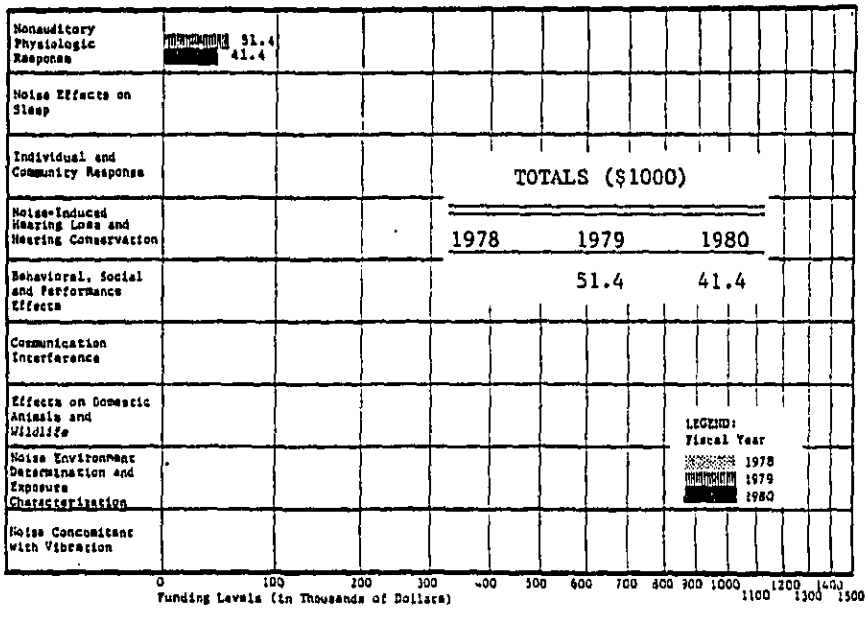


provide a basis for revised damage risk criterion. Other research efforts include an investigation of the interactive effects of noise and chemical agents on hearing and field assessments of the effectiveness of hearing protectors.

National Institutes of Health:

National Heart, Lung, and Blood Institute (NHLBI)

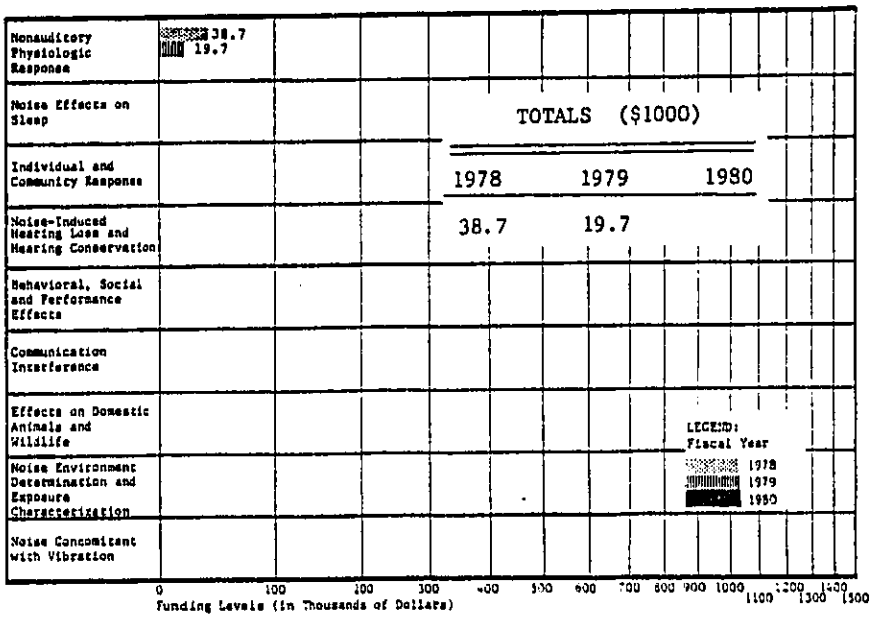
The Institute plans, conducts and supports research investigations into the causes, prevention, diagnosis and treatment of disorders related to the cardiovascular system. NHLBI has been investigating the effects of psychological stress on the etiology of adolescent hypertension and differences in the orienting responses of adolescents with elevated blood pressure to noise stimuli.



National Institutes of Health:

National Institute of Child Health and Human Development (NICHD)

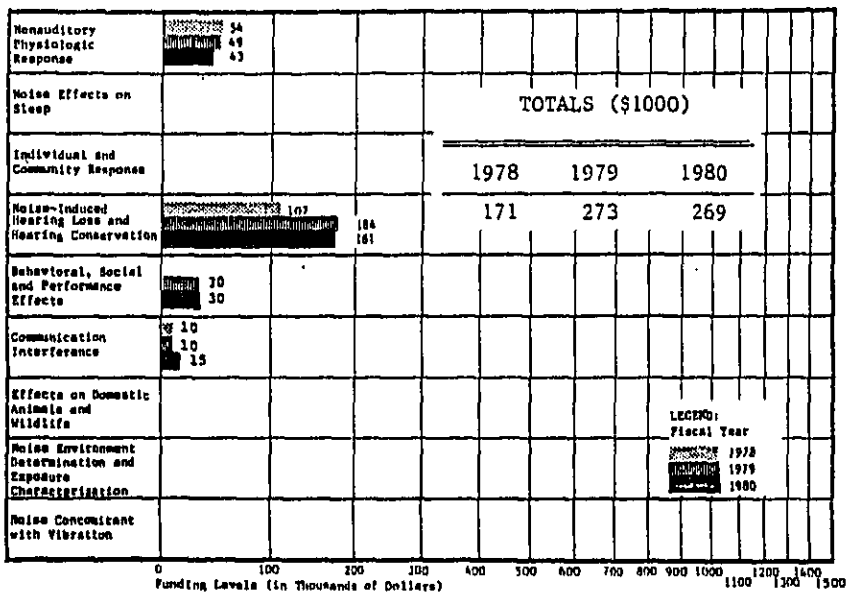
The Institute conducts and supports biomedical and behavioral research on child and maternal health. In the area of noise related health effects research, NICHD has funded one study concerning the relation between exposure to environmental noise (primarily aircraft noise) and the physical growth of children.



National Institutes of Health:

National Institute of Environmental Health Sciences (NIEHS)

The Institute conducts and supports fundamental research concerned with defining, measuring, and understanding the effects of chemical, biological, and physical factors in the environment on human health and well-being. The general objectives of the NIEHS noise effects program are to increase understanding of the process by which noise damages the physiological,



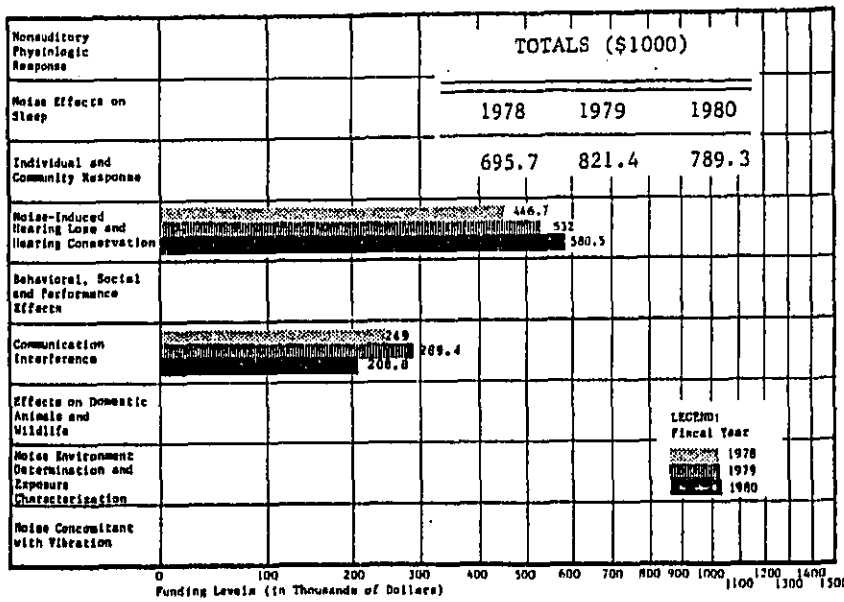
mechanical, biochemical and electroneural mechanisms of the ear and other parts of the body. The program also includes the identification of environmental agents that produce this damage, and the quantification of expected amounts of damage.

The areas of noise related health effects research currently being investigated are: 1) determining the nonauditory (cardiovascular, teratogenic) effects of noise exposure; 2) increasing the understanding of noise and ototoxic agent effect(s) on the physiology and biochemistry of the inner ear; 3) determining the auditory effects and mechanisms underlying combined exposures to impulse and continuous noise; and 4) investigations of the physiological, motivational and cognitive effects of aircraft noise on children, and the (cochlear) developmental consequences of early noise exposure.

National Institutes of Health:

National Institute of Neurological and Communicative Diseases and Stroke (NINCDS)

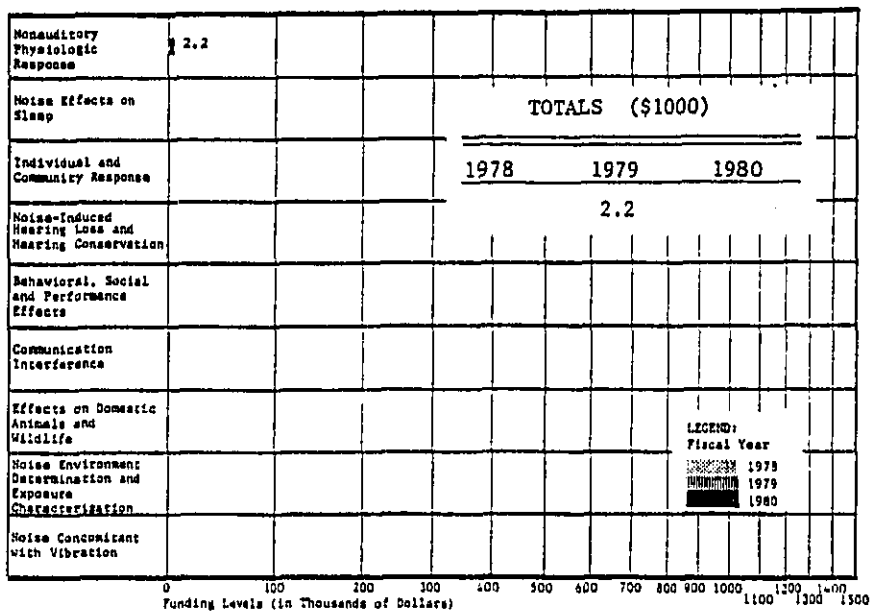
NINCDS conducts and supports research on neurological and sensory disorders, including Parkinson's disease, epilepsy, multiple sclerosis, muscular dystrophy, head and spinal cord injuries, stroke, deafness and other communicative disorders. Its noise related health effects research focuses on the effects of noise on the auditory system. Current research covers a wide range of topics such as: 1) investigations of the electrophysiologic, biochemical, neural and anatomical changes in the auditory system due to varying noise exposure patterns; 2) mechanisms responsible for such changes; 3) correlation between



behavioral measures of hearing impairment and anatomical damage; 4) changes in audibility function due to noise; 5) speech discrimination problems in noise; 6) effects of hearing aid amplification on children; and 7) studies of binaural hearing.

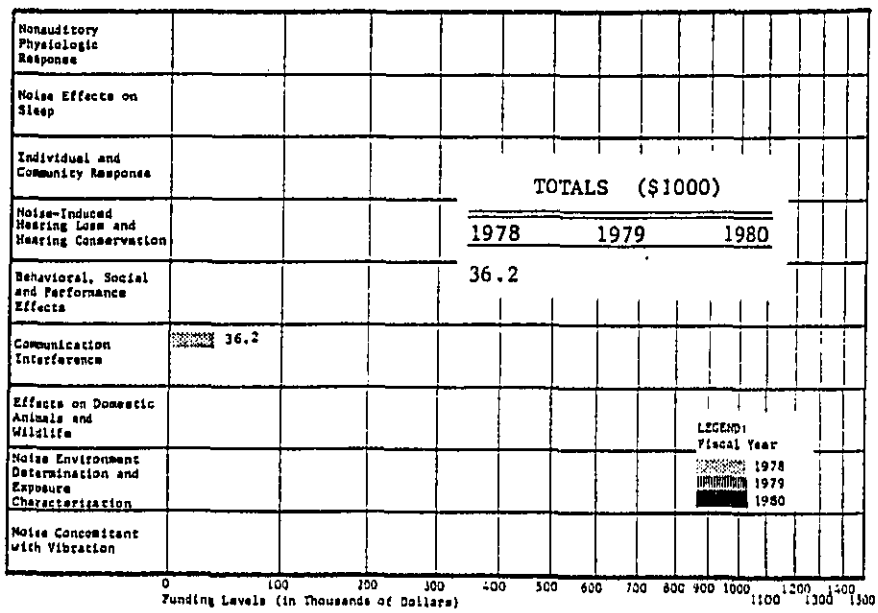
Food and Drug Administration

The Food and Drug Administration (FDA) conducts research and develops standards on the composition, quality and safety of drugs, cosmetics, and other products, food additives and foods; develops labeling and packaging standards; and enforces rulings and recommends actions to the Justice Department. FDA has been involved in ascertaining the potential hazards of ultrasonic devices and the effect that noise (and other stressors) may have on the metabolization of pharmaceuticals.



Health Services Administration

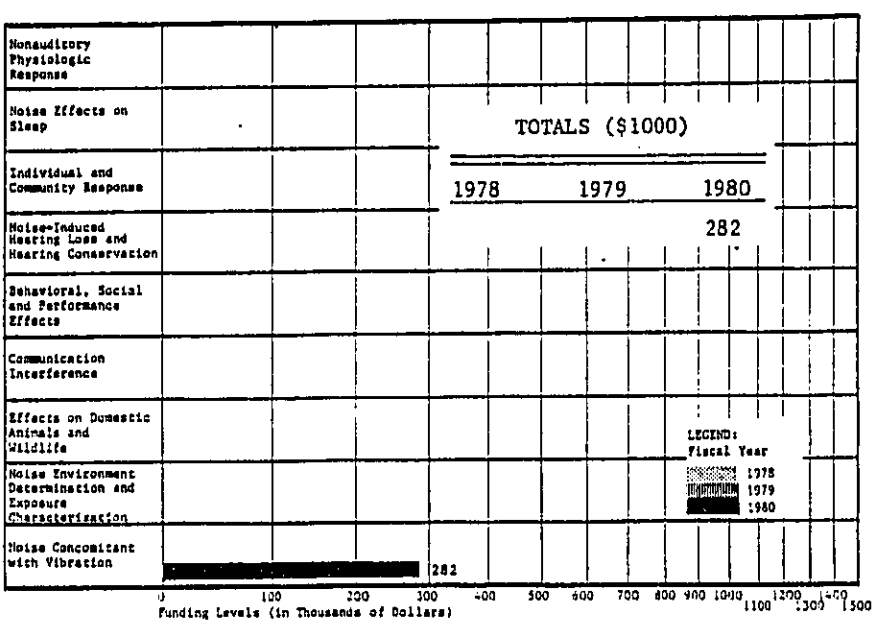
The task of the Health Services Administration is organized around three major elements: 1) to place appropriate health personnel and related services in underserved areas; 2) to improve the organization and efficiency of health care delivery; and 3) to assure the quality of federally financed health services. With regard to noise related health effects research, the Administration is also concerned with communication problems of hearing-impaired children.



DEPARTMENT OF THE INTERIOR

Bureau of Mines

The primary responsibility of the Department of Interior is the management, conservation and development of the nation's natural resources, including federal lands and trust lands, fish and wildlife, water, fuel and minerals. The mission of the Bureau of Mines is to assure the viability of the domestic minerals and materials economy in ways that best protect the public interest. In compliance with the Federal Coal Mine Health and Safety Act of 1969 and the Federal Metal and Non-Metallic Mine Safety Act of 1966, the Bureau's noise related health effects research supports compliance with noise exposure



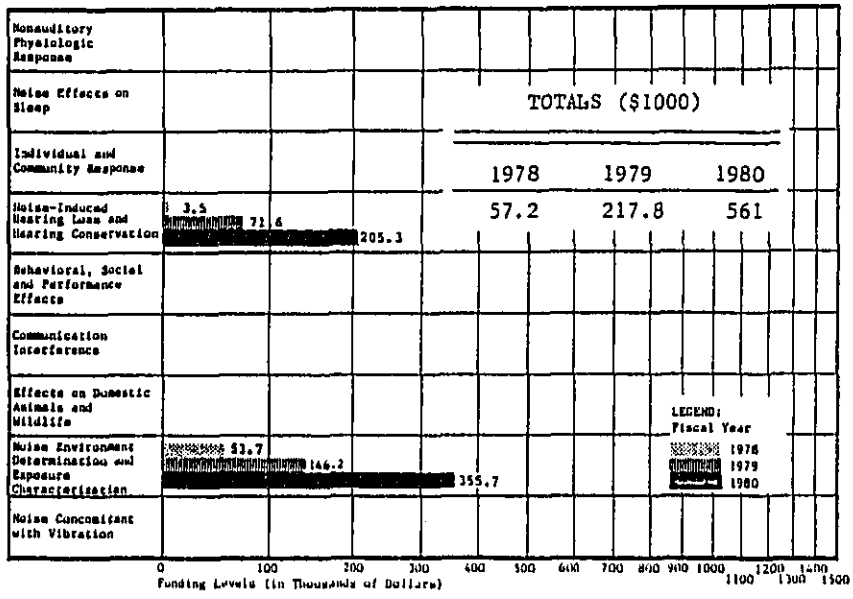
standards for miners. Recent efforts have focused on assessing human response to blast noise and determining the extent and nature of the whole body vibration problem in coal mines.

DEPARTMENT OF LABOR

Federal Mine Safety and Health Administration

Employment Standards Administration/Office of Workers Compensation

The responsibility of the Department of Labor is to foster, promote, and develop the welfare of American workers. Within DOL, the Federal Mine Safety and Health Administration (MSHA), formerly the Mine Enforcement and Safety Administration in the Department of the Interior, develops and enforces mandatory mine safety and health standards to protect the health and safety of miners. MSHA's research effort currently involves studies investigating hearing protector evaluation methods, assessments of hearing protector effectiveness and evaluations of the accuracy and acoustical performance of different

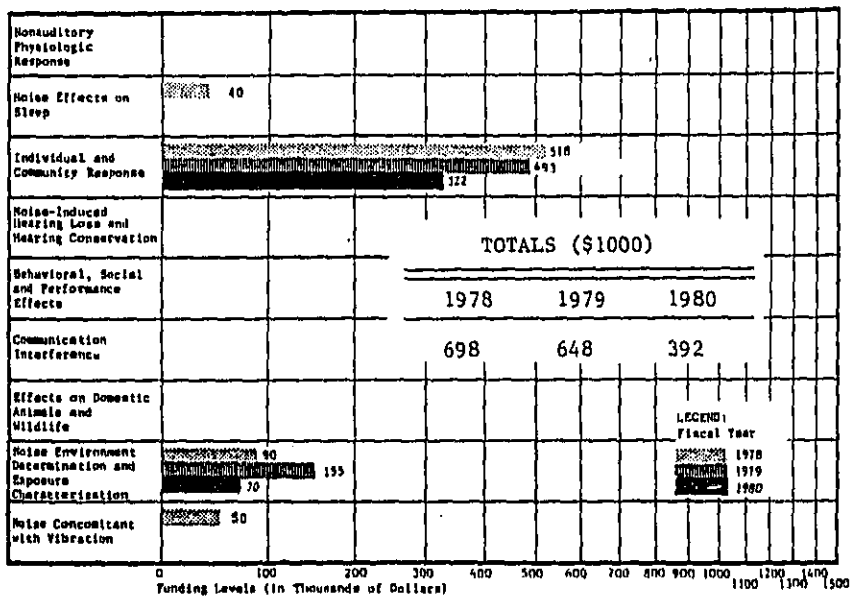


noise measurement systems including dosimeters, impact/impulse sound level meters, and calibrators.

The Employment Standards Administration/Office of Workers Compensation Programs is responsible for the administration of Federal Workers Compensation laws. Their current research effort involves an in-depth literature review of the scientific basis for existing workers compensation provisions for hearing loss including 1) the determination of the most technically appropriate hearing loss criteria; 2) an assessment of the appropriateness of corrections for aging, tinnitus and recruitment; 3) definitions of hazardous noise; and 4) the determination of hearing examination requirements for the awarding of compensation to workers with hearing loss.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

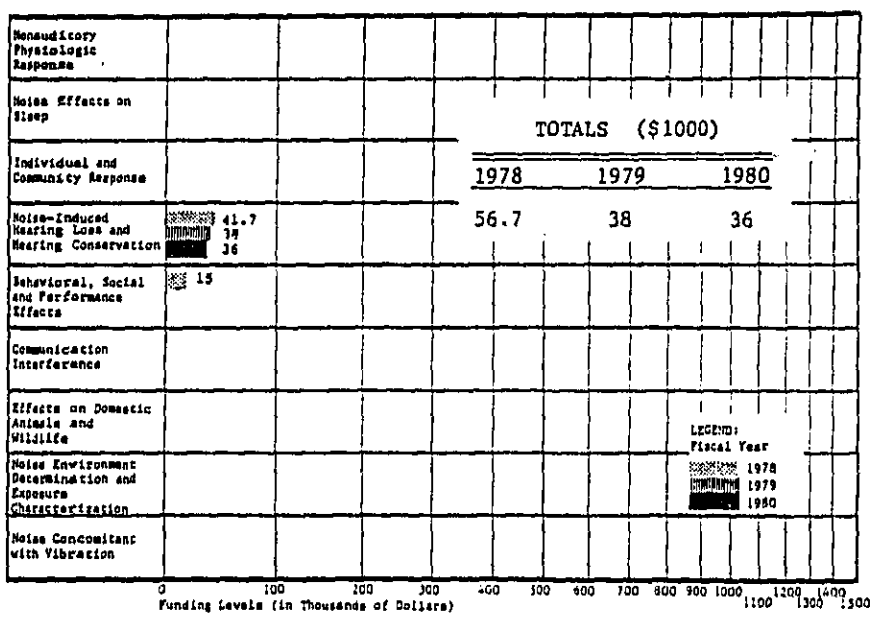
The National Aeronautics and Space Administration conducts research related to the problems of flight, develops and tests aeronautical and space vehicles, and conducts the nation's space exploration program. The majority of NASA's noise related health effects research is conducted at the Langley Research Center in Virginia. Both in-house and contract studies are being performed. Laboratory and field studies are primarily aimed at the investigation of community annoyance and adverse subjective responses to aircraft and helicopter noise, including general aviation noise. A number of interrelated projects are being conducted on the specific human response effects



caused by such factors as tonal components, duration, time of day, multiple events, single event and subject activity. Additional research is being conducted on the sleep disturbing effects of aircraft noise, methodologies for conducting environmental noise surveys, noise impact modeling, and building vibrations due to aircraft overflights.

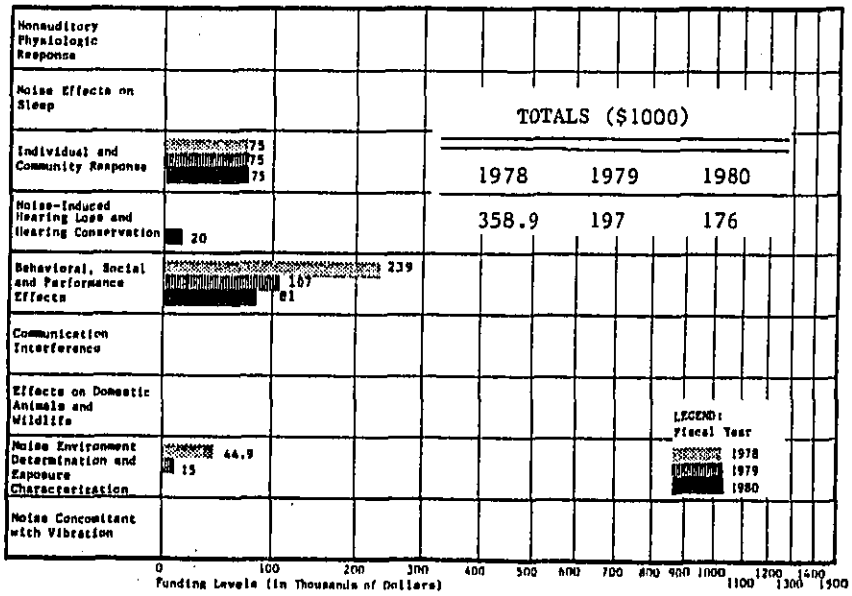
NATIONAL SCIENCE FOUNDATION

The National Science Foundation was established in 1950 to stimulate scientific research, to promote international cooperation through science and to help develop science education programs. The NSF initiates and supports fundamental and applied research in all scientific disciplines. Noise related health effects research projects currently funded by NSF include an investigation of the effects of noise on the functioning of single auditory nerve fibers and an investigation of the physiologic and behavioral effects of aircraft noise in the classroom.



DEPARTMENT OF TRANSPORTATION

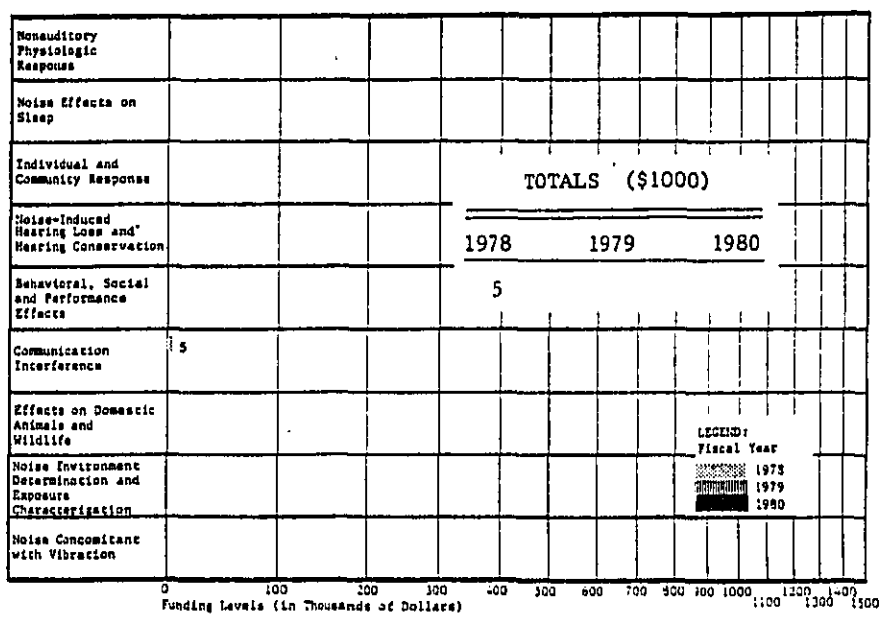
The Department of Transportation's mission is to assure the coordinated, effective administration of the transportation programs of the Federal government, and to develop national transportation policies and procedures conducive to the provision of safe, fast, efficient and convenient transportation. DOT's noise related health effects research effort includes projects funded by the Federal Aviation Administration (FAA), Federal Highway Administration (FHWA), and the Federal Railroad Administration (FRA) pursuant to their respective areas of responsibility. This research effort is concerned with assessing the impact of transportation noise on the public and on vehicle operators. Principle noise effects research projects include an FHWA study to



improve noise descriptors for human response to time-varying traffic noise; an FAA-sponsored investigation of aircraft cockpit noise on hearing; an FRA assessment of locomotive cab noise levels; and a large FHWA field study, jointly being undertaken with the State of California, investigating the effects of highway noise on the hearing and academic achievement of children.

VETERANS ADMINISTRATION

The Veterans Administration administers laws covering a wide range of benefits for former members, and dependents and beneficiaries of deceased members, of the Armed Forces. The VA includes a health care system of more than 170 hospitals and 200 clinics. The VA's noise related health effects research program provides support to its Audiologic Service, whose duties are the diagnosis of Veterans' hearing problems and the provision of rehabilitative services, and the determination of disability claims. Current research includes a number of investigations on the auditory function and hearing loss configurations of persons with noise induced hearing loss, research to improve hearing aid evaluations and hearing aid designs, and a study of the effects



of noise stress on coronary-prone males.

Almost none of the research is separately financed. Research projects are conducted by VA personnel in addition to their major responsibilities which consist of providing diagnostic and rehabilitative services for the hearing impaired Veteran. Therefore, the identified research funding figures do not reflect the level of noise related health effects research being undertaken by the Veterans Administration. Furthermore, the research projects identified in this document are just examples of the research efforts currently underway. Many research projects are not represented here due to the large number of VA hospitals and clinics conducting some degree of research.

CHAPTER IV

SUMMARY AND COMPARISONS

WITH PREVIOUS PANEL'S FINDINGS AND RECOMMENDATIONS

In this chapter summary tables and graphs will be presented which show funding levels for noise-related health effects research by research category and by agency, and the related research trends. The figures represent total expenditures over the fiscal years 1978, 1979 and 1980 for the individual agencies listed in Chapter III. Also presented are the annual noise-related health effects research funding levels during the First (1973-75) and Second (1975-77) Federal Noise Effects Panels, compared to present levels. The research topics identified by the Second Panel in 1978 as needing additional emphasis are listed and compared with current research projects addressing these topics. Finally, a strong recommendation is made for increased cooperation and coordination of all research activities between federal agencies.

1. Funding by Category

Table IV-1 provides a detailed accounting of funding levels during fiscal years 1978, 1979, and 1980 for each noise-related health effects research category. Figure IV-1 portrays the same information graphically. The graphics indicate a small upward trend in overall research funding over the three year period but the trend is not consistent in each category.

As Figure IV-1 shows, three categories accounted for over 80 percent of the federal noise-related health effects expenditures. These categories included *Noise-Induced Hearing Loss and Hearing Conservation*, *Individual and Community Response* and *Noise Environment Determination and Exposure Characterization*

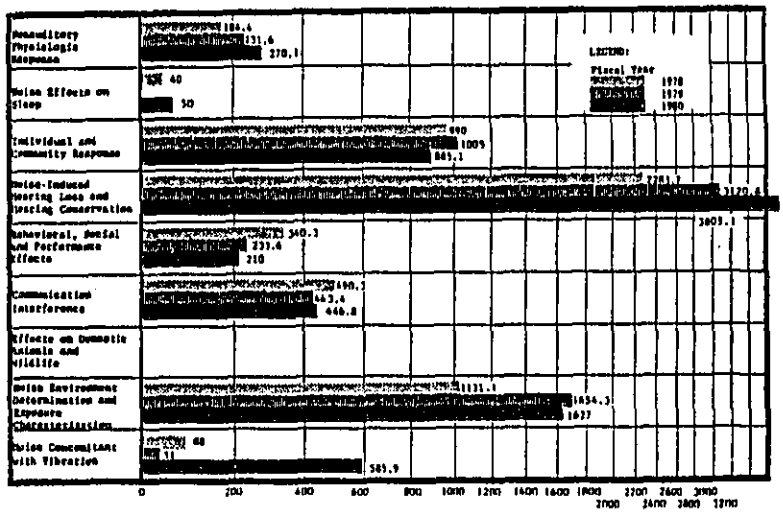
Table IV-1.
NOISE EFFECTS RESEARCH FUNDING
BY CATEGORY

(In thousands of dollars)

CATEGORY	FISCAL YEAR 1978	1979	1980	TOTAL
Nonauditory Physiologic Response	184.8	231.6	270.1	686.5
Noise Effects on Sleep	40	0	50	90
Individual and Community Response	990	1005	885.1	2880.1
Noise-Induced Hearing Loss and Hearing Conservation	2283.7	3120.8	3805.1	9209.6
Behavioral, Social, and Performance Effects	340.3	233.6	210.0	783.9
Communication Interference	490.3	443.4	446.8	1380.5
Effects on Domestic Animals and Wildlife	0	0	0	0
Noise Environment Determination and Exposure Characterization	1131.1	1654.3	1627	4412.4
Noise Concomitant with Vibration	88	31	585.9	704.9
Fiscal Year Totals	5548.2	6719.7	7880	
TOTAL				20147.9

Figure IV-1. NOISE EFFECTS RESEARCH FUNDING BY CATEGORY

(In thousands of dollars)



A detailed breakdown of the research trends within each of these categories reveals the following:

Noise-Induced Hearing Loss and Hearing Conservation (NIHL) received considerably more funds than the other categories--approximately 46 percent of the total. In terms of sources of funding, a number of agencies contribute most of the resources: DOD (especially the Army) and the National Institute of Neurological and Communicative Diseases and Stroke (NINCDS) account for about 70 percent of the spending outlay in this category. The Army's research effort centers principally on its hearing conservation program and the development of impulse noise hearing loss criteria. NINCDS's research program in the NIHL area is concentrated on basic physiologic mechanisms of hearing loss. A third contributor is the National Institute for Occupational Safety and Health (NIOSH), with a broad multitopic research program which accounts for almost 16 percent of the funding.

In terms of distribution of funding by research initiatives or topics within the NIHL category, only an approximate estimate can be made. In many instances rather broad research projects were identified with multiple areas of concern. Over the FY 1978-80 period the following research pattern emerges:

- o $2.4 million or about 26 percent of the total *Noise-Induced Hearing Loss and Hearing Conservation* research funding of $9.2 million has been spent on the development of more effective hearing conservation programs and methods for the prevention of noise-induced hearing loss;
- o $1.9 million or about 21 percent has been spent investigating the auditory effects of impulse noise and intermittent noise in order to develop more responsive criteria for the prevention of hearing loss due to nonsteady-state exposure patterns;
- o $1.8 million or about 20 percent has been spent on microscopic studies of the ear to determine the process by which noise damages the physiological, mechanical and electroneural mechanisms of the ear;

- o $1 million or 11 percent has been spent to study the communicative and social problems of the hearing impaired, including the development of more effective hearing aids, diagnostic assessments, and rehabilitative methods;
- o $800,000 or almost 9 percent of the funding in this category is being spent examining the possible special susceptibility of children and individuals with certain characteristics to noise-induced hearing loss.

Continuing our overview of the three largest categories, funding of *Noise Environment Determination and Exposure Characterization* research accounted for 22 percent of the total federal noise-related health effects research effort. Just under 70 percent of the funding in this category is for the comprehensive noise assessment programs of the Army (about $880,000 over three years), Air Force ($1.5 million) and Navy ($560,000). These comprehensive programs include the development of measurement methodologies and prediction methods, and noise exposure assessments, which are undertaken either directly (dosimetry) or indirectly by combining noise level data with demographic data. Among other agencies:

- o The Mine Safety and Health Administration has been running a significant (about $550,000) program to improve the reliability of measurement instrumentation such as dosimeters;
- o EPA is conducting a long term national ambient noise survey to refine the projections of the total U.S. population impacted by various levels of environmental noise.

Finally, the *Individual and Community Response* category has received $2.9 million or about 14 percent of total funding. The largest single component has been NASA research on various aspects of human response to aircraft noise ($1.3 million or about 45 percent of all funding for this category). The Army survey of response to helicopter noise adds another $250,000 to the overall assessment of aircraft noise.

The remainder of the research was the following:

- Noise sources under investigation besides aircraft noise include transmission lines (DOE/NBS), blast noise (Army), mass transit (EPA/UMPTA), construction sites (EPA/Army), truck engine brakes (EPA) and road traffic (DOT/NBS). About $720,000 has been spent on these projects.
- Integrally related factors being investigated include the relationship between specific acoustical characteristics (such as duration, level, spectral characteristics, and intrusiveness of low-level sounds) and the magnitude of human response.
- Some of the nonacoustical factors being investigated are presence of vegetative cover, subject activity, and time of day.
- There are also a number of general community noise studies assessing overall response to noise.

Of the other six categories, less than one percent of the total was spent on *Effects of Noise on Sleep*, while no research was funded in the category *Effects of Noise on Domestic Animals and Wildlife*. The other categories each received between three and seven percent of total funding. The category given the highest priority by EPA in its "Five-Year Health Effects Research Plan for Noise," *Nonauditory Physiologic Response*, received about $686,000, or only 3.4 percent of total funding. Research in this category has been chiefly devoted to animal and epidemiologic studies to identify possible associations between noise exposures and long term shifts in physiologic indicators or incidence of disease.

- 60 percent of the total funding has gone to animal studies to ascertain blood pressure changes and mechanisms of change;
- 40 percent of the total funding has gone for epidemiologic comparisons in human populations to identify possible associations.

2. Funding by Agency

Table IV-2 shows funding levels for fiscal years 1978, 1979 and 1980 for noise-related health effects research according to agency. Figure IV-2 gives the same information graphically. It can be seen that the Department of Defense and two of the agencies within the Department of Health and Human Services (NINCDS and to a lesser extent, NIOSH), provide most of the funding for noise-related health effects research. The National Aeronautics and Space Administration, and now the Department of Labor and EPA, are also significant contributors, while the other agencies devote lesser amounts. To obtain an overview of the general scope of the research interests of the various agencies, refer to Table IV-3. While the typical agency is funding projects in two or three categories, about a third (8 of 22 agencies) are relatively narrowly focused on one category. At the other end of the spectrum are agencies with relatively broad health effects interests. These include EPA (funding projects in 6 of 9 categories), the Army, Navy and Air Force (5 each), and the National Institute of Environmental Health Sciences, NASA and DOT (4 each). The pattern reflects the diverse noise research interests and noise control missions of each federal agency to protect the public from the adverse effects of noise. The agencies' responsibilities for controlling certain sources of noise and understanding the effects of these sources on special populations, significantly affect the research categories being investigated.

Table IV-2. NOISE EFFECTS RESEARCH FUNDING BY AGENCY

(In thousands of dollars)

AGENCY	FISCAL YEAR 1978	1979	1980	TOTAL
DEPARTMENT OF AGRICULTURE: U.S. Forest Service	107	72.4	33	212.4
DEPARTMENT OF COMMERCE: National Bureau of Standards	75.5	12.5	72.5	160.5
DEPARTMENT OF DEFENSE: U.S. Air Force	913.8	965.8	996.7	2876.3
U.S. Army	1196	1779	1865	4840
U.S. Navy	274.4	518.1	578	1370.5
DEPARTMENT OF EDUCATION: Bureau of Education of the Handicapped		18.8		18.8
DEPARTMENT OF ENERGY	180	200	200	580
ENVIRONMENTAL PROTECTION AGENCY	328.2	339.9	680.8	1348.9
DEPT. OF HEALTH AND HUMAN SERVICES: Center for Disease Control: NIMH	14.4	6.6		21
NIOSH	341.5	538.1	907.6	1787.2
Food and Drug Administration		2.2		2.2
Health Services Administration	36.2			36.2
National Institutes of Health: NHLBI		51.4	41.1	92.5
NICHHD	38.7	19.7		58.4
NIEHS	171	273	269	713
NINCDS	695.7	821.4	789.3	2306.4
DEPARTMENT OF THE INTERIOR: U.S. Bureau of Mines			282	282
DEPARTMENT OF LABOR: Mine Safety & Health Admin. Employment Standards Admin.	57.2	217.8	561	836
NATIONAL AERONAUTICS & SPACE ADMIN.	698	648	392	1738
NATIONAL SCIENCE FOUNDATION	56.7	38	36	130.7
DEPARTMENT OF TRANSPORTATION	358.9	197	176	731.9
VETERANS ADMINISTRATION*	5			5
YEARLY TOTALS	5548.2	6719.7	7880	
TOTAL				20147.9

*Veterans Administration Noise Research is primarily done with no special programmatic funding.

Figure IV-2. NOISE EFFECTS RESEARCH FUNDING BY AGENCY
(In thousands of dollars)

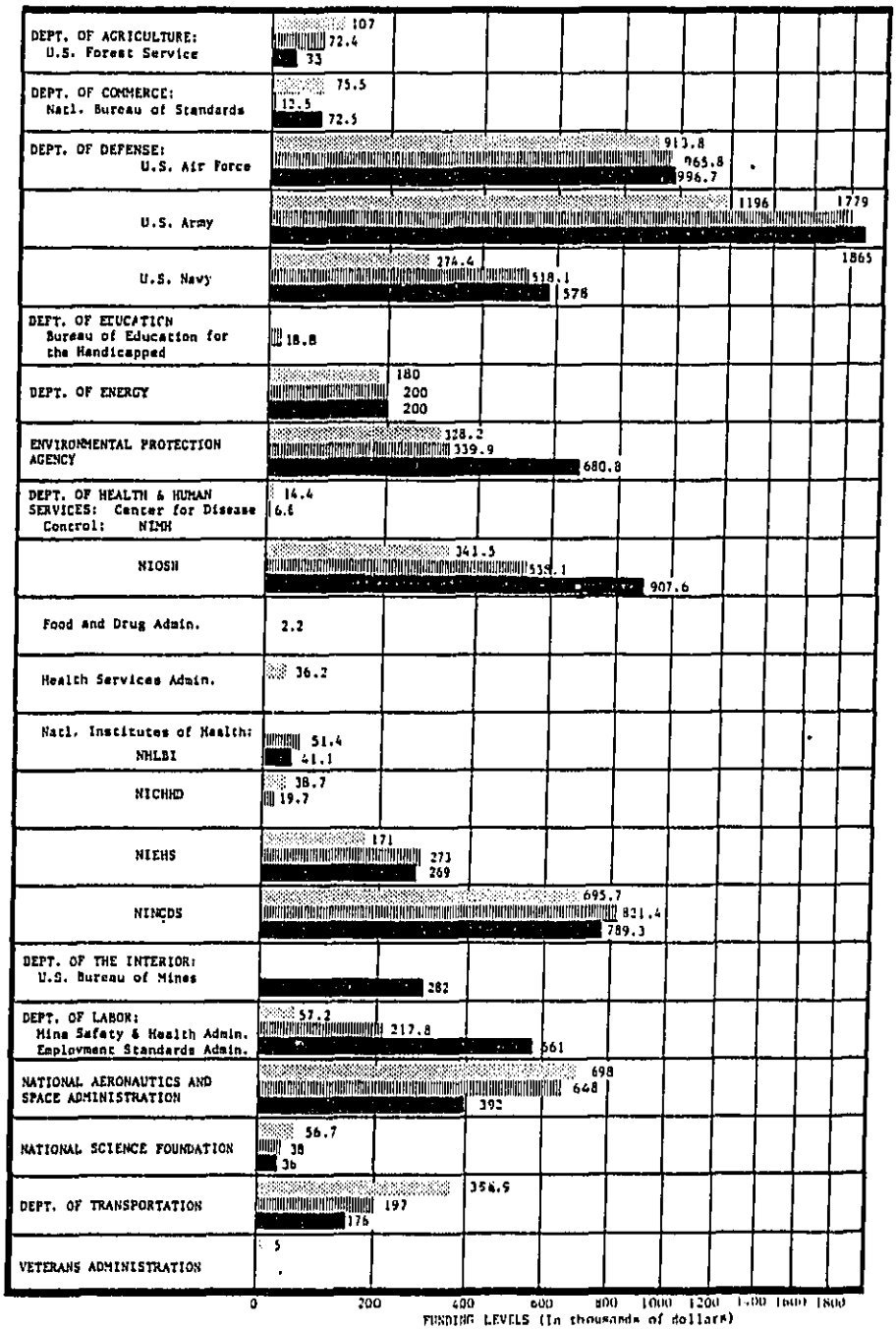


Table IV-3. AGENCY RESEARCH INTERESTS AT A GLANCE

AGENCY	Nonauditory Physiologic Response	Noise Effects on Sleep	Individual and Community Response	Noise Induced Hearing Loss and Hearing Conservation	Behavioral, Social, and Performance Effects	Communication Interference	Noise Environment Determination and Exposure Character	Noise Concomitant with Vibration
DEPARTMENT OF AGRICULTURE: U.S. Forest Service			○			●		
DEPARTMENT OF COMMERCE: National Bureau of Standards			•			○		
DEPARTMENT OF DEFENSE: U.S. Air Force				●	•	●	●	•
U.S. Army			●	●	•	●	●	
U.S. Navy	•			●	●		●	
DEPARTMENT OF EDUCATION: Bureau of Education of the Handicapped				•				
DEPARTMENT OF ENERGY			◐					
ENVIRONMENTAL PROTECTION AGENCY	●	•	●	●		•	●	
DEPT. OF HEALTH AND HUMAN SERVICES: Center for Disease Control: NIMH					•	•		
NIOSH				●				●
Food and Drug Administration	•				•			
Health Services Administration						•		
National Institutes of Health: NHLBI	•							
NICHHD	•							
NIEHS	●			●	•	•		
NINCDS				●		●		
DEPARTMENT OF THE INTERIOR: U.S Bureau of Mines								●
DEPARTMENT OF LABOR: Mine Safety and Health Adminis. Employment Standards Adminis.				●			●	
NATIONAL AERONAUTICS & SPACE ADMIN.		•	●				●	•
NATIONAL SCIENCE FOUNDATION				●	•			
DEPARTMENT OF TRANSPORTATION			●	•	●		•	
VETERANS ADMINISTRATION						•		

● Research Projects totalling $100 K or more in FY 1978-80 period.
• Research Projects in FY 1978-80 period less than $100 K.

3. Funding by Nonfederal Sources

Federally sponsored projects probably account for greater than 90 percent of all U.S. noise-related health effects research. As is pointed out in the Introduction, the information in Appendix B on research sponsored by nonfederal sources is in all probability a representative sample of ongoing research. It should not be mistaken as a comprehensive compilation. It was not the intention of this investigation to be comprehensive in the nonfederal area. A fair amount of research is often conducted in university graduate degree programs and in industrial settings but is not included here. Secondly, acoustic stimuli and noise components are often included in the research efforts in other disciplines in the biomedical sciences. Thus it is extremely difficult to assess the total nonfederal research picture unless all environmental and medical research efforts are surveyed.

For the FY 1978-80 period, approximately $380,000 of nonfederally funded projects were identified. This amounts to about 1.9 percent of the federal total of $20.1 million for the same period. Even if the actual funding of nonfederally sponsored projects were double, triple or five times the identified amount, it would still amount to less than 10 percent of federal funding.

States provide about 18 percent; local governments, 43 percent; and private organizations 39 percent of the total nonfederal research funding. Most of this funding is in three categories: *Noise-Induced Hearing Loss and Hearing Conservation* (49 percent), *Individual and Community Response* (26 percent), and *Noise Environment Determination and Exposure Characterization* (24 percent).

4. Comparisons With Findings of the Previous Panel (Second Panel, 1978)

Thus far in this chapter, an overview of the most recent three-year period has been presented. However, it is also important to examine longer trends in funding. Fortunately, the EPA reports published in 1975* and 1978** on federal noise research activities make such comparisons possible.

Activities of the Previous Panel

Some background information on the Second Federal Interagency Noise Effects Research Panel will assist the reader in interpreting the findings and recommendations in the 1978 report.

Panel members included representatives from most of the same agencies and departments represented in this report. Every major federal agency was invited to send a representative.

The Panel's function was to report on current federal research, and than make recommendations to Congress and the Office of Management and Budget for the most effective use of federal resources. Towards this end specific objectives were set, including:

- Review and assess the current state of research on health effects of noise;
- Identify research gaps, areas of overlap, and areas where more emphasis is needed; and
- Prioritize identified areas of need.

---

* Federal Noise Effects Research: FY73-FY75, Report EPA-600/1-75-001, Prepared by Interagency Noise Effects Research Panel, March 1975.

** Federal Noise Research in Noise Effects (Report of the Second Federal Interagency Noise Effects Research Panel). Report EPA 550/9-78-102, February 1978.

Information on the various agencies' research projects on the health effects of noise was provided by Panel members. The recommendations presented in the 1978 Report represented a general consensus of the Panel members. Although there was wide agreement that certain areas needed increased attention, opinions on other areas were quite mixed and reflected the diversity of interests and missions of the various federal agencies. These recommendations primarily addressed areas that needed further research and the prioritization that should take place within a coordinated federal program.

Trends in Funding

Table IV-4 shows trends in annual funding levels in each research category during the periods in which the First (1975) and Second (1978) Federal Noise Effects Research Panels were operational, compared with the present period. Table IV-5 shows trends in funding by agency. The numbers represent the mean funding level in each three fiscal year reporting period.

Trends in Overall Funding.--It appears that overall funding spent on noise-related health effects research has continued to grow, but recently at a slower rate. Overall funding increased only about 15.0 percent in current dollars, from a three-year average of about $5.8 million per year in the FY 1975-77 period to about $6.7 million in the FY 1978-80 period. Thus, after discounting for inflation, there has been little or no real increase in overall funding. In the two previous three-year periods, overall funding increased about 45 percent, from a three-year average of $4.0 million to a three-year average of $5.8 million. In fact, the actual growth between the 1975-77 period and the present period is probably even slower than the figures indicate, because the previous surveys were not as comprehensive as the present one. It is likely that funding levels for the previous two periods are somewhat underreported.

Table IV-4.
TRENDS IN FUNDING BY CATEGORY

COMPARISON OF NOISE EFFECTS RESEARCH FUNDING BY CATEGORY REPORTED BY THE FIRST TWO PANELS AND IN THE CURRENT UPDATE

(In thousands of dollars)

CATEGORY	AVERAGE FUNDING PER YEAR (AVERAGED OVER EACH THREE-YEAR PERIOD)		
	First Panel 1973-1975	Second Panel 1975-1977	Current Update 1978-1980
Nonauditory Physiologic Response	161	164	228.8
Noise Effects on Sleep	147	109	30
Individual and Community Response*	626	309	960
Noise Induced Hearing Loss and Hearing Conservation*	1391	3082	3069.9
Behavioral, Social, and Performance Effects*	276	1088	261.3
Communication Interference	309	478	460.2
Effects on Domestic Animals and Wildlife	0	50	0
Noise Environment Determination and Exposure Characterization*	1076	338	1470.8
Noise Concomitant with Vibration	New Category	219	235.0
TOTALS	3986	5837	6716

*Categories slightly revised for current update

Trends in Funding by Category.--The pattern of funding by category has remained remarkably stable, especially considering the slight revisions of category definitions that have occurred. *Noise-Induced Hearing Loss and Hearing Conservation* has remained the largest single category of research, though funding has dropped slightly, averaging $3.1 million annually over the last three years, the same as for the FY 1975-77 period.

While the overall spending in this category has remained at about the same level, emphases within the category have shifted:

- Research on the "hearing conservation" topic has increased from about 14 percent of the funding for this category in FY 1975-77 to about 26 percent in FY 1978-80;
- Research on "mechanisms of hearing loss" has decreased from a 35-percent share in FY 1975-77 to a 19-percent share in FY 1978-80;
- Research on NIHL due to "impulse and intermittent noise" has increased slightly from an 11-percent share in FY 1975-77 to a 20-percent share in FY 1978-80.

The next largest categories are *Individual and Community Response* and *Noise Environment Determination and Exposure Characterization*, averaging $1.0 million and $1.5 million, respectively. Both of these have more than tripled since the FY 1975-77 period. This increase, while real, has probably been exaggerated, to some extent, by redefinitions of these categories.

Nonauditory Physiologic Response has increased significantly (by 40 percent) but remains at the relatively low average annual level of $229,000.

Behavioral, Psychological and Performance Effects funding has declined by 76 percent to an average of $261,000 per year.

Funding of effects of noise on human sleep and on animals was small and have been further reduced to $30,000 per year and 0, respectively.

Trends in Funding by Agency.--Table IV-5 reveals the overall funding trends for each federal agency conducting noise research. Steady growth is seen in the research funding for some agencies like the Department of Defense, EPA, NIOSH, NIEHS, Department of Energy, U.S. Forest Service and the Bureau of Mines. Within the Department of Labor, the Mine Safety and Health Administration and the Employment Standards Administration reveal significant increases in funding.

Other agencies reveal a decline in funding levels (NINCDS, NBS, NASA, NSF, and DOT) between the previous reporting periods and the present reporting period. The funding pattern for the Veterans Administration is less readily discernible since research efforts of personnel are combined with their clinical responsibilities.

By a wider margin than ever, the Department of Defense continues to be the leading sponsor, averaging 45 percent of total funding for the last three years. In fact, DOD funding has increased 80 percent over the previous three-year period. DOD funds are largely concentrated in the *Noise-Induced Hearing Loss and Hearing Conservation* and *Noise Environment Determination and Exposure Characterization* categories.

In second place, with a three-year average of $769,000 per year, is the National Institute of Neurological and Communicative Diseases and Stroke (NINCDS) of the National Institutes of Health. However, NINCDS funding has declined 44 percent from its average of $1.4 million per year in the FY 1975-77 period. The National Institute of Occupational Safety and Health (NIOSH) is the third largest sponsor of noise-related health effects research, averaging $595,000 per year. This is an increase of 27 percent over the FY 1975-77 period. Taken together, all of the Department of Health and Human Services programs (including NINCDS) have averaged $1.7 million per year over the last three years, down 21 percent since the previous three-year period.

Table IV-5. TRENDS IN FUNDING BY AGENCY

Comparison of Noise Effects Research Funding by Category Reported
By the First Two Panels and in the Current Update
(in thousands of dollars)

AGENCY	AVERAGE FUNDING PER YEAR (AVERAGED OVER EACH THREE-YEAR PERIOD)		
	First Panel 1973-1975	Second Panel 1975-1977	Current Update 1978-1980
DEPARTMENT OF AGRICULTURE: U.S. Forest Service	*	37	70.8
DEPARTMENT OF COMMERCE: National Bureau of Standards	103.3	265	53.5
CONSUMER PRODUCT SAFETY COMMISSION	*	12	*
DEPARTMENT OF DEFENSE	948	1679	3028.9
DEPARTMENT OF EDUCATION: Bureau of Education for the Handicapped	*	*	6.3
DEPARTMENT OF ENERGY	*	118	193.3
ENVIRONMENTAL PROTECTION AGENCY	237	256	449.6
DEPT. OF HEALTH AND HUMAN SERVICES: Center for Disease Control: NIMH	*	12	7
NIOSH	395	468	595.7
Food and Drug Administration	*	*	.7
Health Services Administration	*	*	12.1
National Institutes of Health: NHLBI	*	*	30.8
NICHHD	*	36	19.5
NIEHS	216.3	222	237.7
NINCDS	768.5	1379	768.8
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT	405	*	*
DEPARTMENT OF THE INTERIOR: U.S. Bureau of Mines	32	65	94
DEPARTMENT OF LABOR: Mine Safety & Health Administration Employment Standards Administration	*	*	278.7
NATIONAL ACADEMY OF SCIENCES	*	33	*
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION	802	718	579.3
NATIONAL SCIENCE FOUNDATION	7	58	43.6
DEPARTMENT OF TRANSPORTATION	77	334	244.0
VETERANS ADMINISTRATION	*	151	1.7
TOTALS: Three year Means	4018	5843	6716

*Not reported

Other leading agencies include NASA ($579,000) and EPA ($450,000). Of these, the EPA program has increased by nearly 90 percent since the FY 1975-77 period, while the program of NASA has declined somewhat (19 percent). Bureau of Mines funding has increased steadily--45 percent since the FY 1975-77 period.

5. Comparison With the 1978 Panel's Recommendations

Overall Funding Recommendations

Based on comparison of three-year averages, overall funding (in current dollars) has increased only about 15 percent instead of the 40 percent recommended by the previous Panel.*

Recommended Priority Categories

The previous Panel identified three categories requiring more funding urgently.

Funding increased in the highest priority category identified by the panel, *Nonauditory Physiologic Response*, from 2.0 percent to 3.4 percent of total funding (three-year averages). While this represents a significant increase in funding share, the share of this category is still very small considering the potential seriousness of the problem and the provocative scientific findings to date.

The other priority categories identified by the Panel were *Effects of Noise on Sleep* and *Community or Collective Response*. The latter category (now *Individual and Community Response*) has received a substantial increase in emphasis, probably due to the fact that human response criteria emanating from this area of research have provided a strong foundation for environmental

* 1978 Report, p. 1.

noise legislation at the federal, state, and local levels of noise control. However, funding on *Effects of Noise on Sleep* has declined (by 72 percent), averaging only an infinitesimal 0.4 percent of total funding over the last three years. This fact is distressing considering that criteria in this area have a large bearing on noise abatement strategies and actions.

The First Panel made largely the same recommendations in 1975 as the Second Panel did in 1978. Thus, the long term pattern has been that, with the recent exception of *Individual and Community Response*, the priority categories have not received the additional emphasis recommended by the Interagency Panels.

Recommended Priority Topics Within Categories

Besides the three high-priority categories identifed by the 1978 Panel, selected topics within the categories were also identified as needing additional emphasis--not only in the high-priority categories, but in the other categories as well. It is therefore of interest to list each of these topics in turn, describing in a summary fashion what work if any has occurred in the last three years. This is done in the following discussion. The implications of these comparisons should be interpreted with caution. The fact that research has in some cases been initiated or continued does not necessarily mean that the identified topic is now receiving sufficient emphasis. The purpose of the discussion is not to evaluate the adequacy of the research per se, but to assess whether the resources being allocated seem to correspond roughly with the levels of emphasis suggested by the previous Panel. It should be noted that not all applicable studies have been listed in this analysis.

Nonauditory Physiologic Response: Cardiovascular and other physiological changes due to noise (short-term) in the general population.

Several studies have looked at the short term, cardiovascular (and other physiological) changes. However, these have not been directed solely at the general population. One study by NHLBI[1] examined the role played by noise stress in the etiology of essential hypertension in young people. The VA sponsored a similar study[2] on coronary-prone and non-prone young men.

Nonauditory Physiologic Response: Worker safety and health

The Department of Defense has made this topic a component of many of their research projects dealing with high intensity noise which is common in military noise environments. Naval studies[3,4,5] also touched on the subject by: (a) trying to determine whether Naval personnel resistant to noise-induced hearing loss are distinguishable along any nonauditory dimensions; (b) testing the acute effects of work-related high intensity noise on nonauditory systems for aircraft maintenance crews and (c) measuring the interactive effects of heat and noise stressors. An EPA-sponsored review[6] has summarized European research on the subject, concluding that there is substantial evidence that long term work under high level industrial noise exposures is associated with chronic changes in cardiovascular function. EPA[7] is currently undertaking a comprehensive review of existing epidemiological research on the nonauditory physiologic effects of noise, utilizing data from industrial settings.

(1) "Orienting Response Deficits in Adolescents with Elevated Blood Pressure," p. A-179.
(2) "Concept Identification in Stress," p. A-295.
(3) "Individual Differences in Susceptibility to Noise-Induced Hearing Loss Among Navy Military and Civilian Personnel," p. A-100.
(4) "High Intensity Energy Effects on Physiological Behavioral and Subjective Response," p. A-91.
(5) "Effects of Noise and Heat as Combined Environmental Stressors on Performance and Physiological States in Navy Machinery Spaces," p. A-93.
(6) "Extra-Auditory Health Effects of Industrial Noise: Survey of Foreign Literature," p. A-125.
(7) "Epidemiology Feasibility Study: Effects of Noise on the Cardiovascular System," p. A-127.

Nonauditory Physiologic Response: Nonauditory health effects of impulse noise.

No projects specifically directed at this topic have been identified.

Nonauditory Physiologic Response: Long-term nonauditory health effects.

This is the highest priority topic in the EPA "Five-Year Health Effects Research Plan for Noise," particularly the study of effects of noise on the cardiovascular system. It partly overlaps the "Worker Safety and Health" topic, because much of the nonclinical data comes from industrial settings. Thus many of the studies mentioned under the previous topic are also pertinent to this topic.

Research on this topic has grown over the last several years, though not extensively. EPA, NIEHS, and NICHD have all sponsored projects in this area. Most notable is the study being performed at the University of Miami. Jointly sponsored by EPA and NIEHS between 1977-79,[8] this project is using Rhesus monkeys to examine the long term effects of everyday and industrial noise on blood pressure. Results from the first set of animals indicate that daily exposure to such noise produced sustained elevations in blood pressure. Due to the complexity of this type of study, more work is clearly needed to assess the long term effects of noise on the cardiovascular system. In an indirectly related EPA study,[9] the 1971-1975 National Health and Nutrition Examination Survey will be analyzed to investigate relationships between certain medically defined health conditions and selected demographic indicators indicative of potentially higher level noise exposures.

(8) "Noise Exposure and Cardiovascular Function," p. A-187.
(9) "Analysis of National Health Survey Data Bases," p. A-150.

In addition, NICHHD[10] has been investigating the effect of environmental noise on the physical growth of children in a community near an airport with high volume activity. Physical growth is being used as a measure of child health in the community.

Noise Effects on Sleep: Effects of chronic sleep interruption by noise.

This topic includes both the study of the disturbance of sleep by noise and the consequent health and performance effects of such disturbance. EPA[11] will be conducting a study to begin to describe and quantify the functional significance of chronic noise-disturbed sleep. Measures related to health and physiologic function will be assessed in this study.

The Navy[12] has made the effects of sleep disruption from Naval noise environments a part of a larger study investigating physiologic and behavioral responses of noise on aircraft maintenance crews.

NASA[13] has completed a study attempting to identify the acoustic parameters of noise that are the best predictors of the degree to which aircraft noise is likely to disturb sleep. This study also investigated the effects of sleep disruption on performance.

(10) "Environmental Noise and Physical Growth of Children," p. A-183.
(11) "Health Consequences of Chronically Noise Disturbed Sleep," p. A-128.
(12) "High Intensity Energy Effects on Physiological, Behavioral, and Subjective Response," p. A-91.
(13) "Acoustic Energy Effects on Sleep and Human Performance--Effects of Certain Fundamental Parameters of Acoustic Stimuli," p. A-261.

Noise Effects on Sleep: Effects of sleep interruption on special populations (e.g., ill, aged, etc.).

No federally sponsored projects have been identified on this topic.

Individual and Community Response: Sociological effects of (community) noise in relation to quality of life.

A study related to this topic is being sponsored by NIMH[14] in order to understand the significance of noise as an urban mental health problem. This study focuses on the emotional distress, behavioral disturbances, and difficulties individuals experience in adjusting to highway noise.

Community noise attitudinal surveys are also being sponsored by EPA[15] to assess adverse reactions to community noise problems.

Topics in Noise-Induced Hearing Loss and Hearing Conservation

Approximately one third of the $9.2 million funded in FY 1978-80 under this category has gone to research in topics identified by the last Panel as needing more emphasis. Each topic recommended by the Panel is covered in the following discussion.

(14) "Personal and Family Adjustment to Urban Noise," p. A-161.
(15) "Social Survey Around Construction Sites: Phase 1," p. A-130; and "Community Noise Attitudinal Assessments," p. A-139.

Noise-Induced Hearing Loss and Hearing Conservation:
Effects of noise on children.

Major emphasis is being placed by EPA in investigating the auditory effects of noise on children. A longitudinal research study jointly sponsored by the Air Force/EPA[16] is now in its fifth year. Changes with age in the auditory thresholds of children are being investigated in relationship to environmental noise exposures and developmental and physiologic variables. Some initial auditory sensitivity trends are prevalent related to noise exposure patterns, age, sex, and physiologic factors. This longitudinal study is projected to continue to follow the children to adulthood.

EPA is also sponsoring a set of field and laboratory studies[17] to determine the magnitude of the TTS problem experienced by children in common high-noise environments. An interrelated segment of the study will assess the consequences of repeated occurrences of TTS.

NINCDS has recently initiated a study[18] to determine the possible effects of hearing aid amplification on the residual hearing of children. A DOT project[19] is acquiring data on the relationship between children's hearing levels and exposure to highway noise, although the focus of the project is more directly related to noise exposure and academic achievement.

(16) "Longitudinal Study of Hearing Levels in Children," p. A-141.
(17) "Temporary Threshold Shift (TTS) Problems and Children," p. A-149.
(18) "Determination of Effects of Hearing Aid Amplification on Children," p. A-224.
(19) "Effects of Freeway Noise on Hearing Level and Academic Achievement of Children," p. A-291.

Noise-Induced Hearing Loss and Hearing Conservation:
Effects of impulsive and intermittent noise.

Considerable work is in progress to better understand the auditory effects of impulse noise. Particular attention is being paid by the Department of Defense[20] to the effects of impulse noises generated by military hardware. These studies will define the physiologic effects of high intensity impulse noise upon the auditory system and the acoustical characteristics of the noise responsible for the injury.

NIOSH[21] has conducted a literature search and on-site industrial visits to estimate the number of American workers exposed to impulse noise as part of a broader program to establish a scientific basis for an impulse noise damage risk criterion. Another NIOSH study[22] is investigating the mechanisms of impulse noise-induced hearing loss.

NIEHS[23] has a multi-element project to investigate the interactions between continuous and impulse noise and vibration and impulse noise using an animal experimental model, the chinchilla.

In the intermittent noise research area, a number of laboratory studies are also being undertaken to assess the differing effects of intermittent and continuous noise exposures on the auditory system in terms of structural, physiologic and biochemical changes. These studies are principally being

(20) "The Medical Effects of Blast Overpressure," (U.S. Army) p. A-65; Functional Effects of Acoustic Exposure," (U.S. Air Force) p. A-17; and "Changes in Auditory Performance from Exposure to Noise of Army Materiel," (U.S. Army) p. A-61.
(21) "Impact/Impulsive Noise Data Base," p. A-174.
(22) "The Effects of Impulse Noise on the Auditory System," p. A-168.
(23) "Combined Impulse and Continuous Noise: Auditory Effect," p. A-191.

funded by the Air Force,[24] NIOSH[25] and NINCDS.[26] In addition, NIOSH[27] is undertaking a large field study in the paperworking industry to quantify the hearing abilities of workers exposed to defined intermittency patterns.

Noise-Induced Hearing Loss and Hearing Conservation:
Longitudinal studies of hearing in normal and noise-exposed populations.

The only longitudinal hearing loss study presently being conducted with federal funding is the ongoing EPA/Air Force[28] effort at Fels Research Institute investigating changes in the auditory sensitivity of children with age.

Noise-Induced Hearing Loss and Hearing Conservation:
Relationship between temporary and permanent threshold shift.

The Air Force,[29] NIEHS,[30] NIOSH,[31] and NINCDS[32] all have supported projects concerned, in part, with the occurrence of TTS and the implications of this occurrence for PTS. In the NIOSH study, an animal model has been identified to study the effects of long term noise on the inner ear of humans in order to maximize the probability that the processes underlying the TTS in the two species are similar. In addition, two studies are being funded by NINCDS to evaluate the correlation between behavioral measures of hearing impairment, neural responses, and anatomical damage to the cochlea.

(24) "Effects of Long-Duration Noise on Human Auditory Processes," p. A-25.
(25) "Animal Model to Study the Effects of Noise on Humans," p. A-165.
(26) "Mechanisms of Hearing Loss," p. A-222.
(27) "Study of Noise/Hearing in the Paperworking Industry," p. A-169.
(28) "Longitudinal Study of Hearing Levels in Children," p. A-141.
(29) "Effects of Long Duration Noise on Human Auditory Processes," p. A-25.
(30) "Combined Impulse and Continuous Noise: Auditory Effect," p. A-191.
(31) "Animal Model to Study the Effects of Noise on Humans," p. A-165.
(32) "Auditory Fatigue: Neurobehavioral Observations in Rhesus Monkeys," p. A-211; and "Effects of Noise on the Ear and Hearing/Auditory Communication and Its Disorders," p. A-212.

Noise-Induced Hearing Loss and Hearing Conservation: Possible high-risk and susceptible populations.

The Navy has been particularly interested in this topic. In two separate studies[33] the Navy is investigating audiometrically dichotomous groups to determine what physical, psychological or behavioral measures might account for their demonstrated difference in susceptibility to hearing loss. Another Navy study[34] is developing a high frequency audiometric procedure to enable early identification of noise-induced hearing loss. Joint EPA/Air Force[35] and NIEHS[36] investigations are assessing the susceptibility of the fetus to hearing loss using sheep and guinea pigs as surrogates for human subjects. As previously mentioned,[30] EPA is investigating the susceptibility of children to noise-induced hearing loss. Little is known about the susceptibility of children. NIEHS[37] is also sponsoring a study to determine the consequences of early noise exposures on animal subjects by assessing differences in anatomical and physiological damage. This research is evaluating the notion of "critical periods" in auditory development when the auditory system may be more prone to damage.

(33) "The Relationship Between Selected Nonauditory Measures and the Hearing Threshold Levels of an Aviation Noise-Exposed Population," p. A-99; and "Individual Differences in Susceptibility to Noise-Induced Hearing Loss Among Navy Military and Civilian Personnel," p. A-100.
(34) "Susceptibility and Early Detection of Noise-Induced Hearing Loss Through High Frequency Audiometry," p. A-101.
(35) "Effect of Noise on Pregnant Animals," p. A-32.
(36) "Prenatal Exposure to High Noise Levels on Auditory Thresholds in Guinea Pigs," p. A-199.
(37) "Physiologic Consequences of Noise Exposure in Young Animals," p. A-190.

Noise-Induced Hearing Loss and Hearing Conservation:
Social and economic impact of noise-induced hearing loss.

This topic has yet to be thoroughly examined, although millions of persons are suffering the consequences of noise-induced hearing loss and millions of dollars are annually paid out in workers compensation claims for hearing loss. DOL is currently sponsoring a large literature review study[38] to determine the most scientifically applicable hearing loss criteria and related provisions for awarding workers compensation for noise-induced hearing loss. The EPA is supporting a small pilot field study[39] to identify the consequences of hearing loss for workers dependent on verbal communication. Applicable studies[40] are being conducted by the Army examining the communicative problems of military personnel with noise-induced hearing loss.

Communication Interference: Prediction of speech intelligibility in noise.
Everyday communication in lifelike noisy environments.

NINCDS[41] and the Department of Defense[42] have sponsored a number of projects addressing the ability of hearing impaired and normal hearing individuals to understand speech signals in the presence of noise under conditions simulating real world environments. DOD is particularly interested in this topic with regard to mission communication capability in noisy military environments and the rehabilitation of military personnel with hearing loss.

(38) "Assessment, Examination, and the Benefit Formula," p. A-251; "Presbycusis, Recruitment and Tinnitus," p. A-252; and "Occupational Noise," p. A-253.
(39) "Social Handicap Caused by Noise-Induced Hearing Loss," p. A-151.
(40) "Evaluation of a Communication Self Assessment Inventory of the Hearing Impaired Soldier," p. A-70; and "Extended High Frequency Amplification for Hearing Loss Above 2000 Hz," p. A-69.
(41) "Evaluation of a Test of Speech Perception in Noise," p. A-234.
(42) "Acoustic Cues for Speech Intelligibility and Discriminability," p. A-37; and "Performance of High Frequency Impaired Listeners with Conventional and Extended High Frequency Amplification," p. A-75.

Communication Interference: Effects of noise on speech and message production.

No recent projects have looked at these effects specifically, though DOD, as indicated, is concerned with communication requirements during military missions and speech levels function as an experimental variable in these studies.

Noise Environment Determination and Exposure Characterization: Development of standard methodologies to measure and characterize the effects of noise.

Much work has been done by a number of agencies, particularly DOD[43] and MSHA,[44] on developing standardized measurement methodologies and assessing the accuracy of instrumentation and measurement procedures for determining sound environments and individual noise exposures.

Noise Environment Determination and Exposure Characterization: National baseline data bank on environmental noise exposure levels.

This topic was originally identified by the 1978 Panel under the *Community Response* category, but has since been moved to the present category. EPA[45] has been primarily involved in this area. The most relevant effort is the expansion of an existing EPA ambient noise data base. Results will provide average ambient noise levels and contributing noise sources associated with different residential and commercial environments to permit projections of national noise levels with greater accuracy.

In addition, the Air Force[46] is making a contribution in this area with its very extensive NOISEMAP and NOISECHECK programs to predict the yearly averaged noise environments produced by aircraft operations around USAF bases.

(43) "Noise Measurement and Monitoring," p. A-83.
(44) "Dosimeter Accuracy Study," p. A-254; and "Impact Impulse Sound Level Meter Evaluation," p. A-256.
(45) "National Ambient Noise Survey," p. A-155.
(46) Numerous separately listed projects under Air Force; pp. A-44, -45, -46, -47, -48, -49, -51, -52, -53.

Noise Environment Determination and Exposure Characterization:
Audiometry (standardized methods and calibration).

This topic is now being addressed under the *Noise-Induced Hearing Loss and Hearing Conservation* category.

Summary

In reviewing the various topics and categories it is clear, solely from a consideration of resources being allocated, that current research funding levels for the *Nonauditory Physiologic Response* and *Effects of Noise on Sleep* categories have not received the additional emphasis recommended by the 1978 Panel. Funding in the *Nonauditory Physiologic Response* category has increased by a yearly average of only $65,000, whereas sleep research has declined by $80,000. Together, they are responsible for only 3.9 percent of total funding. Considering that overall noise-related health effects research funding has increased by 15 percent, research in the categories of *Nonauditory Physiologic Response* and *Effects of Noise on Sleep* have lost further ground since the time these recommendations were made.

Within the other categories, it is more difficult to make an assessment. For example, in the *Noise-Induced Hearing Loss* category, some research is ongoing in almost all topics identified by the Panel, but the question is whether the relatively small funding shares devoted to some of the topics are actually responsive to the Panel's recommendations. Only one third of *Noise-Induced Hearing Loss* research funding now addresses Panel-recommended topics. "Effects of noise on children," "longitudinal studies," "susceptible populations," and "social and economic impact" all seem to be underresearched areas compared to the variety of projects which could be undertaken.

Within the other categories for which the Panel identified topics--*Individual and Community Response*, *Communication Interference*, and *Noise Environment Determination and Exposure Characterization*--a number of projects responsive to the identified topics appear to be ongoing.

6. Continuing Research Needs

Recommendations Since 1978.

Besides the 1978 Panel Recommendations, several more recent assessments of research needs have been initiated.

The first was the result of the 1978 Third International Congress on Noise as a Public Health Problem, held in Freiburg, West Germany, sponsored by the International Commission on the Biological Effects of Noise (ICBN). In the Proceedings* of this Congress, recommendations for further research were made primarily on a scientific basis; i.e., research areas were identified where there were unresolved questions which further work might elucidate.

The second assessment was developed by EPA more in the context of both programmatic and scientific needs. Proceeding from its mandate to carry out the legislative requirements of the Quiet Communities Act of 1978 and coordinate federal efforts to protect the public welfare from the adverse consequences of noise, EPA has developed a Five-Year Plan for research on the health effects of noise. The Plan identifies the key areas where more research must be done to provide the dose-response criteria needed by policy makers to set adequately protective standards.

Both the ICBN and EPA recommendations highlighted the need for additional research on nonauditory physiological effects, as did the 1975 and 1978 federal Interagency Panels. Their other recommendations were also consistent with those of the Panels.

Likewise, a committee (CHABA Working Group 81) of the National Academy of Sciences has recently recommended that investigation of the relationship between noise and medically significant physiological responses be accelerated, with cardiovascular measures as the initial focus.

---

* Proceedings of the Third International Congress on Noise as a Public Health Problem, Freiburg, W. Germany, 1978. Washington, D.C.: American Speech and Hearing Association, 1980.

In addition to these three broad sets of recommendations encompassing all categories of research on the health effects of noise, the National Institute of Neurological and Communicative Disorders and Stroke (NINCDS) sponsored a workshop in 1978 on research needs in the Noise-Induced Hearing Loss category. The top two areas identified by the workshop as needing more emphasis were (1) obtaining epidemiological data on the prevalence of noise-induced hearing loss and (2) quantifying the social impact of noise-induced hearing loss. The latter recommendation is similar to that of the 1978 Panel Report. Only limited research has been initiated in these areas.

Therefore, the overall picture which emerges from this review of the most recent federal research is that expert recommendations for new research emphases have remained nearly constant since 1975, while the overall pattern of federally sponsored research continues to remain little changed from the old pattern.

The Need for Improved Coordination

Such a situation suggests the importance of continued efforts to improve coordination of the overall federal research effort. The update in this report of the "data base" of projects is a necessary part of this coordination. It reflects the research interests and activities of the various agencies. But by itself it will not be sufficient. Also necessary will be increased dialogue between the health professionals of the various agencies, including active planning of research programs and consideration of joint research ventures in key areas. These efforts are needed to complement and support the information requirements of each federal agency. Ultimately, a set of unified interagency research plans should be developed to answer important questions in each health category and derive the most applicable health effects criteria.

These health criteria would form the basis for noise control actions for all federal agencies. Each agency would agree to support certain functional elements of these plans through joint collaboration or individual research efforts. In this manner unified research goals and objectives can be established and work undertaken in a concerted and systematic federal research effort.

Some specific plans for joint research have already been implemented (e.g., EPA/Air Force, NBS/DOT, EPA/NIEHS), and more cooperative projects are being advocated in the EPA "Five-Year Health Effects Plan for Noise (1981-85)." The further development of such plans must be encouraged as a part of the overall coordination effort. The continued activity of the EPA-sponsored "Interagency Health Effects Advisory Group" will facilitate such collaboration.

By coordinating research needs with the resources and talents of each federal agency, it will be far more possible to meet the recommendations made by the First and Second Interagency Panels.

APPENDIX A

FEDERAL RESEARCH PROJECTS ON THE HEALTH EFFECTS OF NOISE

APPENDIX A -- TABLE OF CONTENTS
FEDERAL RESEARCH PROJECTS ON THE HEALTH EFFECTS OF NOISE

(Note: In the main body of Appendix A, complete descriptions of projects are organized by federal agency. A listing of the project titles arranged by research category begins on page A-313.)

DEPARTMENT OF AGRICULTURE

U. S. FOREST SERVICE

DEPARTMENT OF AGRICULTURE

U.S. FOREST SERVICE

INDIVIDUAL AND COMMUNITY RESPONSE

Title: INFLUENCE OF VEGETATION ON MAN'S RESPONSE TO NOISE

Objective: To 1) determine whether man's response to noise is modified by characteristics of the listening site, and determine which site characteristics are influential and in what direction their influence is manifest; 2) determine what aspects of the sounds to which man is exposed in listening sites are most effective in modifying his behavior and determine the direction of influence; and 3) determine which dimensions of behavior are subject to noise-site interactions.

Description: Five field sites were selected which varied in the extent of vegetative cover. A set of tasks was performed by subjects at each site, including a loudness estimation task, a tracking task combined with a high-level cognitive task, completion of an environmental aesthetics questionnaire, and evaluation of naturalistic sounds played through a tape recorder.

Summary of Findings: A site/task interaction with sex of subject was found to be significant. Loudness estimations were found to vary as a function of vegetative cover. Aesthetic reactions differed only between the most urban, least vegetated site and all other sites. Responses to naturalistic sounds were affected by sites.

Where Findings Published: No publications yet; several papers presented including two at the Annual Meeting of the Acoustical Society of America.

Period of Performance: 1978-1980.

Investigator: B.E. Mulligan, Department of Psychology, University of Georgia, Athens, GA 30602 (404/542-2174).

Agency Contact: H.K. Cordell, USDA Forest Service, Urban Forestry Research in the South, Carlton Street, Athens, GA 30602 (404/546-2451).

Fiscal Year Funding ($1000):	1978	1979	1980	1981	
	7	7.4	7		(approx.)

NOISE ENVIRONMENT DETERMINATION AND EXPOSURE CHARACTERIZATION

Title: NOISE POLLUTION PREDICTION METHOD

Objective: Develop a method to predict noise pollution impact on recreationists in a forest environment.

Description: Noise pollution is the by-product of an increasing number of recreational, transportation, and industrial activities on National Forest System lands. The most serious environmental impact of noise in the National Forests is the annoyance that it causes. The degree of annoyance is not dependent on the level of the noise, but upon its signal-to-noise ratio at the listener location and certain factors intrinsic to the listener. It is imperative, therefore, that Forest Service land managers know how far the noise of an activity carries through the Forest, what signal-to-noise ratio the activity causes at the listener's location, and what internal characteristics affecting subjective evaluation of the noise are likely to be typical of listeners. The work done under this project has quantified these parameters. The recreational opportunity presented is used as the main descriptor of the likely "frame of mind" of the listener. The prediction method is presented in an easy-to-use format. Thus, in-the-field managers can utilize it for on-the-ground planning efforts.

Summary of Findings: The Noise Pollution Prediction Method has been field tested in several forest recreational settings. The main need existing is for further simplification of the method, and programming of the method into a programmable hand-held calculator so that untrained technicians may easily use it.

Where Findings Published: The method has been described in a Forest Service publication entitled, "Predicting Impact of Noise on Recreationists," available from the U.S. Forest Service Equipment Development Center, San Dimas, California.

Period of Performance: 1978-1980.

Investigator: Robin Harrison, USDA Forest Service, Equipment Development Center, San Dimas, CA 91773 (213/332-6231).

Agency Contact: Michael B. Lambert, USDA Forest Service (703/235-8114).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	50	35	6	

Title: IMPROVE THE ACOUSTICAL QUALITY OF URBAN ENVIRONMENTS BY USE OF FOREST VEGETATION

Objective: To determine ways in which forest vegetation influences sound attenuation through a program of basic research on the relationship between components of urban trees (canopy, tree bole, and forest floor) and sound attenuation, and to apply results to urban forest management and planning.

Description: Predictive models will be developed to determine total attenuation potential of using urban forest vegetation. Research will also include effects of topography, atmospheric conditions, and urban structures on noise attenuation properties. A number of basic studies have been completed on the way in which components of urban forest stands influence sound attenuation.

Summary of Findings: The general conclusion is that trees can be effective in reducing noise if they are planted in sufficiently wide strips. Space availability in urban areas often reduces the potential to use trees to reduce noise. However, when used in conjunction with topography and physical structures in urban environments, trees can contribute significantly to noise control. Results of past research are summarized in the publications listed below.

Where Findings Published:

1) Heisler, G.M., "Trees Modify Metropolitan Climate and Noise." J. Arboric., 3(11):201-207, 1977.

2) Reethof, G., McDaniel, O.H., and Heisler, G.M., "Sound Absorption Characteristics of Tree Bark and Forest Floor." U.S. Dept. Agric. For. Serv. Gen. Tech. Rept. NE-25:206-217, 1977.

Period of Performance: 1978-1980.

Investigator: Howard Halverson and Gordon Heisler, USDA Forest Service, State College, PA (803/727-1935).

Agency Contact: Howard Halverson, USDA Forest Service (803/727-1935).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
	50	50	50	30	20

DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

INDIVIDUAL AND COMMUNITY RESPONSE

Title: TRANSMISSION LINE AUDIBLE NOISE MEASUREMENTS*

Objective: To provide data bases and the accompanying psychoacoustic research required for managing, through land use planning and building design, the noise emitted by extra high voltage and ultra high voltage transmission lines.

Description: This project is being done in cooperation with the Department of Energy. Corona noise samples for different weather conditions and from different transmission lines are recorded with an already-developed remote tape recording system. These recordings are returned to the laboratory where they are processed along with recordings of other environmental sounds into stimulus tapes. These stimulus tapes are evaluated by listeners under realistic conditions approximating natural environments. The effects of the building shell on the listener's response to corona noise are to be determined also. On the basis of people's responses, criteria will be developed for characterizing the acoustic environment near transmission lines in terms that are relevant to human response, so that decisions about land use planning, building design and construction may be based on users' needs.

Summary of Findings: Five psychoacoustic experiments have been conducted so far. The following are the major findings to date: 1) Corona noise is equally aversive to certain other environmental sounds 8 dB higher in sound level; 2) corona noise is roughly equal in aversiveness to the noise from a room air conditioner; 3) A-weighted sound level predicts listener's response quite well, but D-weighted sound level appears slightly better; 4) knowledge of the source of the corona noise under laboratory conditions does not affect its relative aversiveness; 5) the high-frequency hissing and crackling components are more aversive than the low-frequency humming and buzzing components; 6) distinctly different kinds of corona noise were found, differing both in frequency spectrum and relative aversiveness; and 7) although corona noise heard indoors is less aversive than the corresponding corona noise heard outdoors, indoor listening conditions reduce the aversiveness of corona noise less than they do the aversiveness of certain other environmental noises.

Where Findings Published:

1) Molino, J.A., Zerdy, G.A., Lerner, N.D., and Harwood, D.L., "Human Response to Audible (Corona) Noise from Electric Transmission Lines." J. Acoust. Soc. of Amer., 66:1435-1445, 1979.

2) Molino, J.A., Zerdy, G.A., Lerner, N.D., and Tremaine, S.G., "Initial Psychoacoustic Experiments on the Human Response to Transmission Line Audible Noise." Dept. of Energy Rept. DOE/ET/6010-1, pp. 1-80, 1979.

* Project also listed under Department of Energy, p. A-119.

NBS (Cont'd)

3) Molino, J.A., Zerdy, G.A., Lerner, N.D., and Harwood, D.L., Psychoacoustic Evaluation of the Audible Noise from EHV Power Lines." 7th IEEE/PES Transmission and Distribution Conference and Exposition. IEEE Rept. 79CH1399-5-PWR, pp. 95-98, 1979.

4) Molino, J.A., Zerdy, G.A., and Tremaine, S.G., "Psychoacoustic Evaluation of Transmission Line Audible Noise: Building Attenuation Effects, Methodology Comparison, and Field Study Feasibility." Dept. of Energy Rept. (to be published).

Period of Performance: 1976-present.

Investigator: John A. Molino and Gerald A. Zerdy, Department of Commerce, NBS, Washington, DC (301/921-3704).

Agency Contact: Mr. Alec Bulawka, U.S. Dept. of Energy (202/633-9296).

Fiscal Year Funding ($1000):*	1976	1977	1978	1979	1980
	93	233	180	200	200

*-Funded by the Department of Energy.

Title: HIGHWAY NOISE CRITERIA*

Objective: To provide data bases required for the development of procedures for assessing human response to time-varying traffic noise.

Description: This study is jointly sponsored by the Federal Highway Administration and NBS. Field data has been collected and analyzed on the time histories and spectra of traffic noises corresponding to different traffic situations. In addition, outdoor-to-indoor highway noise isolation data have been gathered in the Washington, DC metropolitan area as have data on how traffic sounds are received in buildings. Laboratory investigations of human response to strings of time-varying highway noises will be conducted in FY 81. Further psychoacoustic studies are planned to evaluate existing rating schemes and, if necessary, to develop an improved rating procedure. A questionnaire and measurement plan will be developed to assess occupants' reactions to highway noise based on the key parameters identified in the project (FY 82). The questionnaire and measurement plan will be made available for validating the results of the work done at NBS.

Summary of Findings: From analyses of the psychoacoustic data collected thus far, it appears that none of the existing schemes predict human response well and that both Leq and L10 do, as well as more complicated schemes that take into account the rate of change of levels with time.

Where Findings Published:

1) U.S. Dept. of Commerce, "Highway Noise Criteria Study: Traffic Noise Data Base," NBS Technical Note 1113-1, April 1980.

2) U.S. Dept. of Commerce, "Highway Noise Criteria Study: Outdoor/Indoor Noise Isolation," NBS Technical Note 1113-2 (in press).

3) U.S. Dept. of Commerce, "Effects of Time-Varying Noise on Human Response: What is Known and What is Not," NBS Publication (in preparation).

4) Bauer, J.W., Danner, Wm. F., and Yaniv, S.L., "Annoyance Ratings and Acceptability Judgments of Traffic Noises," J. Acoust. Soc. Amer., 67(S1):S55, 1980 (Abstract).

Period of Performance: 1977-1982.

Investigator: Simone L. Yaniv, Jay W. Bauer, and Daniel R. Flynn, Department of Commerce, NBS, Washington, DC (301/921-3704).

Agency Contact: Simone L. Yaniv, NBS (301/921-3704).

Fiscal Year Funding ($1000):

1975	1976	1977	1978	1979	1980	1981	1982	1983	
	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	(NBS)
	75	75	75	75	75	75	75	75	(FHWA)

* Project also listed under Department of Transportation, p. A-289.

Title: BUILDING ACOUSTICS TECHNOLOGY

Objective: To develop design criteria for noise isolation of building spaces, building shells, party walls and floor/ceiling assemblies. Noise management through improved design criteria, when included at the early stages of the basic design process, will provide enhanced acoustical performance at little or no cost and will eliminate the need for costly retrofitting of already completed buildings and of sterilization of land around major noise sources.

Description: Acoustic parameters affecting building users' responses will be identified through limited sets of field studies as a function of selected outdoor environments, building types, construction parameters and achieved isolation. Using physical data obtained in the field and simulation of isolation characteristics of actual and modified building structures, psychoacoustic studies will be conducted under realistic laboratory conditions to determine design specifications.

Summary of Findings: A cooperative preliminary psychoacoustic study between NBS and the Centre Scientifique et Technique du Batiment has examined the adequacy of the French standard for indoor-to-indoor noise isolation in which it is specified that a wall must reduce noise levels by an A-weighted level of 51 dB. The approach taken in this study consisted of obtaining annoyance judgments by subjects who listened to a variety of samples of music that were intruding through party walls. The music heard simulated the isolation curves of typical and artificial party walls. Data obtained to date indicate that none of the rating procedures used for party walls are adequate, including the French standard.

Period of Performance: 1980-1984.

Investigator: Simone L. Yaniv, Jay W. Bauer, Gerald Zerdy, John Molino, and Bill Danner, Department of Commerce, NBS, Washington, DC (301/921-3704).

Agency Contact: Simone L. Yaniv, NBS (301/921-3704).

Fiscal Year Funding ($1000):	1980	1981	1982	1983	1984
	60	60	60	60	60

NOISE ENVIRONMENT DETERMINATION AND EXPOSURE CHARACTERIZATION

Title: NOISE EXPOSURE MEASUREMENT SYSTEM

Objective: To develop an automated and accurately calibrated measurement system to be used in enforcing U.S. Department of Housing and Urban Development noise policies and to provide technical assistance and consultation regarding HUD noise abatement and control.

Description: During previous fiscal years, 17 HUD noise exposure measurement systems were provided for HUD by NBS. HUD regional personnel were trained by NBS in the use of the systems. The systems are estimated to have been used in more than 300 HUD building sites resulting in a savings to HUD of approximately $400,000. NBS maintained systems in order to determine reliability of hardware and software (operating system). In addition, NBS provides a continuing consulting role on HUD noise measurement problems.

Summary of Findings: A noise measurement system can be specified and procured that can be used by untrained field personnel to make unattended measurements for 24 hours.

Where Findings Published: Final report in preparation.

Period of Performance: 1978-1979.

Investigator: Donald S. Blomquist, Department of Commerce, NBS, Washington, DC (301/921-3381).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
			30		

NBS (Cont'd)

Title: NOISE IN AND AROUND BUILDINGS

Objective: To review existing criteria that could be applied to rating the noise environment in dwellings, to rating noise isolation between dwellings, and to rating noise isolation from outside to inside a dwelling.

Description: The project identified the effects of loud but infrequent noises that may be introduced into living spaces, rate of change of noise levels, and rise and decay times on users.

Summary of Findings: It was concluded that the central problem is to select appropriate criteria for rating the interior noise environment. Once this is done, criteria for noise isolation can be derived directly and these in turn can be used to derive performance requirements for building elements, such as partitions and exterior walls.

Where Findings Published:

U.S. Dept. of Commerce, "Noise Criteria for Buildings: A Critical Review," NBS Special Publication No. 499, January 1978.

Period of Performance: 1976-1978.

Investigator: Simone L. Yaniv and Daniel R. Flynn, Department of Commerce, NBS, Washington, DC (301/921-3704).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
	33	33	33		

DEPARTMENT OF DEFENSE

U. S. AIR FORCE

DEPARTMENT OF DEFENSE

U.S. AIR FORCE

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: FUNCTIONAL EFFECTS OF ACOUSTIC EXPOSURE

Objective: To examine changes in the auditory system produced by exposure to moderate levels of combined continuous and impulsive noise. The goal of the research is to determine whether a synergistic effect exists between continuous and impulsive noise at moderate exposure levels.

Description: Chincillas were exposed to combined continuous and impulse exposures as well as separate continuous and impulse noise exposures. In addition to behavioral measures of threshold shift, conventional microscopy techniques were employed to determine if microanatomic changes in the inner ear resulted from these exposures.

Summary of Findings: The results of this study indicate that the synergistic interaction previously reported in the literature for combined exposures of impulsive and continuous noise, with resulting inner ear pathology, does not occur when exposure levels are of moderate intensity.

Where Findings Published:

Hamernik, R., Henderson, D., and Salvi, R., "Functional Changes in the Auditory System Following Exposure to Moderately Intense Stimuli" (AMRL-TR-80-68).

Period of Performance: 1979-1980.

Investigator: R. Hamernik and D. Henderson, University of Texas, Callier Center, Dallas, TX 75235 (214/783-3105).

Agency Contact: T.J. Moore, AFAMRL/BBA, Wright-Patterson AFB, OH 45433 (513/255-3664).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	37.5	20		

U.S. AIR FORCE (Cont'd)

Title: CHANGES IN THE ORGAN OF HEARING PRODUCED BY SOUND*

Objective: To examine changes in the auditory system produced by exposure to excessive sound. The project is co-sponsored by EPA/ONAC. The effort will emphasize studies in the infrasound (1-20 Hz) region and long-term, low-level exposures at mid-frequencies (600-2000 Hz). The goal of the research is a reasonable hypothesis of the mechanism of injury production that provides a rationale for treatment and prevention.

A total of 60 chinchillas were used to see if various infrasound exposures (1 Hz, 10 Hz, 20 Hz) can cause ear damage. Sound levels used were 150 dB, 160 dB, and 170 dB either continuous for two minutes or impulsive for one second. Long-term, low-level exposures are carried out on experimental animals and human volunteer subjects at levels which do not produce permanent changes in hearing. Techniques to be employed include light and electron microscopy of inner ear structures, electrophysiological measures of middle ear muscle activity and psychoacoustic measures of changes in auditory acuity.

Summary of Findings: Although there are some inconsistencies, about one-third of the 170-dB exposure group, regardless of type of exposure (continuous or impulsive), showed varying degrees of inner ear damage such as ruptured round window membrane, collapse of Reissner's membrane, strial pathology, and inner ear bleeding. Perforation of saccular wall was also observed in a few cases. Inner ear damage from the 160 dB and 150 dB exposures caused less damage, but a few animals showed damage similar to that in the 170-dB group. Tympanic membrane perforation and bleeding in the tensor tympani muscle were also observed in several cases. This study suggests that infrasound, particularly at 170 dB for all frequencies tested, can cause both cochlear and vestibular damage in chinchillas. Two dogs and two cats were also exposed to 170 dB at 10 Hz. These results suggest that these animals are somewhat less susceptible to infrasound than chinchillas.

Where Findings Published:

1) Lim, D.J., Dunn, D., Johnson, D.L., and Moore, T.J., "Trauma of the Ear from Infrasound" (AMRL-TR-80-24), to be published in Acta Otolaryngologica.

2) Lim, D.J., "Cochlear Anatomy Related to Cochlear Micromechanics" (AMRL-TR-79-11); also published in J. Acoust. Soc. Amer., 67(5), 1686-1695, 1980.

3) Lim, D.J., and Dunn, D., "Anatomic Correlates of Noise-Induced Hearing Loss," Otolaryngologic Clinics of North America, 12(3), 493-513, 1979.

4) "Acoustic Trauma by Infrasound Exposure: An Animal Experiment," paper presented at AFOSR Annual Review of AF Basic Research, September 1978.

Period of Performance: 1977-1980.

* Project also listed under Environmental Protection Agency, p. A-147

Investigator: D. Lim and W. Melnick, Ohio State University, Columbus, OH.

Agency Contact: T.J. Moore, AFAMRL/BBA, Wright-Patterson AFB, OH 45433 (513/255-3664).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980	
		15	18	18	8	AFAMRL
			8	1		EPA

Title: CHANGES IN THE INFORMATION PROCESSING CAPABILITY OF COCHLEAR NUCLEUS NEURONS FOLLOWING EXPOSURE TO MODERATELY INTENSE ACOUSTIC STIMULI

Objective: To investigate, in a pilot study, whether the information processing capabilities of the auditory nervous system may be altered by exposure to moderately intense acoustic stimuli. This question has been extensively studied under the general headings of "auditory fatigue" and "temporary threshold shifts." Research in the area has concentrated on behavioral changes in signal detection thresholds and morphological and biochemical changes within the inner ear. There is some evidence that there are retrocochlear components to this functional change in the performance of the auditory system. The elucidation of the mechanisms involved in this phenomenon will provide basic information that will aid in the development of devices and criteria to protect Air Force personnel exposed to noisy environments.

Description: The animal used was the guinea pig. During the course of this pilot study a total of 32 neurons were studied using single unit electrophysiological techniques. Twenty-five neurons were located in the ventral cochlear nucleus and seven neurons were located in the dorsal cochlear nucleus. Following determination of a neuron's tuning curve and collection of PST histograms for pure tones and synthetic speech signals presented 40 dB above the threshold of the neuron at its best frequency, the animal was exposed to five minutes of pink noise at an intensity 70 dB above the threshold of the neuron at its best frequency. PST histograms for pure tones and synthetic speech were again collected following noise exposure.

Summary of Findings: Analysis of these data indicated that some retrocochlear changes in the functional sensitivity of the auditory system occurred following exposure to moderately intense acoustic stimuli. The changes were primarily decreased amplitude of neural response to both pure tones and synthetic speech signals and a diminution in spontaneous activity following exposure. No changes were found to occur in the response patterns of the neurons as a function of acoustic exposure. The lack of detailed changes in the neural response patterns to speech inputs was taken as evidence that the information processing capability of the auditory system at the cochlear nucleus level was relatively unaffected by moderate levels of acoustic exposure. Those effects that were noted were related to signal detection sensitivity or overall neural responsiveness.

Where Findings Published: It was determined that the results of this pilot study did not warrant publishing a Technical Report.

Period of Performance: 1977-1978.

Investigator: T. Moore, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		30	11		

Title: LONGITUDINAL STUDY OF HEARING LEVELS IN CHILDREN*

Objective: To analyze changes with age in the auditory thresholds of children and to relate changes in auditory sensitivity to environmental noise exposures and developmental and physiologic variables. This information is essential to determine whether additional safeguards are needed to reduce the noise exposures of children. Little is known about the susceptibility of children to noise-induced hearing loss and the applicability of current damage risk criteria for children.

Description: For the past four years, EPA, in cooperation with the Air Force, has funded a longitudinal study at Fels Research Institute of Wright State University. Serial auditory thresholds, speech discrimination, blood pressure, otologic, tympanometric, noise exposure history information and 24-hour noise dosimetry measurements are being recorded at six-month intervals from 400 children and youths aged 4-25 years. It is expected that the children will be monitored periodically through adulthood as well, to assess whether auditory patterns and noise exposures measured during childhood are correlated with hearing acuity later in life.

Summary of Findings: Almost four years of this longitudinal study have been completed. Six-month incremental auditory thresholds have been obtained on most children, totalling 6 to 8 data sets per person. The mean and median hearing thresholds at almost all frequencies are 2 to 6 dB lower (better) than those from recent U.S. national surveys for children. In each sex, auditory thresholds tend to be highest at the frequencies of 4K and 6KHz. There is a trend of increasing sex differences in mean thresholds with age consistent with the trend of increasing sex differences in noise exposure (higher in males). In preliminary analysis, elevations in thresholds were obtained for participants reporting certain noise exposures (e.g., using farm machinery, school bus noise, etc.) relative to children not reporting such exposures. Some trends are also present relative to physiologic and developmental indicators. Future expansion of this study is anticipated with support from NINCDS.

Where Findings Published:

1) Roche, A.F., Siervogel, R.M., Himes, J.H., and Johnson, D.L., "Longitudinal Study of Hearing in Children: Baseline Data Concerning Auditory Thresholds, Noise Exposure, and Biological Factors," J. Acoust. Soc. Amer., 64(6), 1978.

2) Roche, A.F., Himes, J.H., Siervogel, R.M., and Johnson, D.L., "Longitudinal Study of Human Hearing: Its Relationship to Noise and Other Factors. II. Results from the First Three Years," AMRL-TR-79-102, November 1979.

Period of Performance: 1976-present.

* Project also listed under Environmental Protection Agency, p. A-141.

U.S. AIR FORCE (Cont'd)

Investigator: A.F. Roche, Samuel S. Fels Institute, Wright State University School of Medicine, Yellow Springs, OH (513/767-7324).

Agency Contact: M. Stephenson, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3660).

Fiscal Year Funding ($1000):

1976	1977	1978	1979	1980	1981	
15	33	40	44	50	50	(EPA)
4	3	4	4	4	5	(AF/AMRL)

Title: ENVIRONMENTAL NOISE RESEARCH

Objective: To conduct research on selected contemporary bioenvironmental noise problems impacting on USAF operations and functions.

Description: These studies, some of which are jointly supported by EPA/ONAC, include the evaluation of electrically-aided voice communications effectiveness in various AF noise environments, the determination of human auditory response to short duration acoustic stimuli and definition of typical 24-hour exposures of selected populations. Results of these studies support the laboratory's program to determine auditory effects of various AF noises on personnel, to establish exposure criteria, to evaluate and develop personel protective devices and to incorporate these principles and data into guidelines, specifications and regulations to control noise exposure within acceptable levels.

Summary of Findings: The research conducted on contemporary bioenvironmental noise problems impacting USAF operations has been completed and progress includes: (1) A ten-station AIC-25 Aircraft Intercommunication System is now operational in the laboratory for in-house testing of inflight communications in AF noises. Laboratory standard aircraft noises have been recorded on magnetic tape to simulate typical operational noises. (2) The study of human auditory response to very short duration noises is complete. (3) A study has been completed of the 24-hour duration noise exposures of 50 subjects in 5 occupational groups. Analyses of the data suggest that the nonoccupational noise exposure may be worse in some instances than the occupational exposure and that the average 24-hour noise level experienced by people in this study is around 76 dBA.

Where Findings Published: Results of study No. (2) are published in:

Schori, T.A., "Evaluation of Safe Exposure Guidelines for Moderate and High Intensity Continuous Noise." (AMRL-TR-76-97), 1976.

Schori, T.A., and McGotha, "A Real-World Assessment of Noise Exposure" (AMRL-TR-77-96), August 1978.

Period of Performance: 1975-1978.

Investigator: W.J. Hovey, University of Dayton, Dayton, OH.

Agency Contact: C.W. Nixon, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3660).

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978	
	10	14	6	14	6	(AF)
	10	10		10		(EPA)

Title: IMPLEMENTATION OF ANSI SPECIFICATION S3.19-1974 PERSONAL HEARING PROTECTIVE DEVICES FOR USE IN NOISE ENVIRONMENTS

Objective: To identify requirements necessary to implement the new standard, including specification of the instrumentation needed to generate the test signals and record the subjects' responses.

Description: S3.19-1974 is the American National Standard Method for measuring the amount of hearing protection provided by devices such as earplugs, earmuffs, helmets, pressure suits, and the like. The Air Force is required to use this methodology in its evaluations of earmuffs in accordance with Military Specification P-38268B, Protector, Aural, Sound. A survey was made of existing facilities to determine whether modifications of these facilities was required, as well as to determine possible requirements to procure additional instrumentation.

Summary of Findings: During the course of this unit, all requirements necessary to implement American National Standard S3.19-1974 have been identified and met.

Period of Performance: 1977-1978.

Investigator: M. Stephenson and R. McKinley, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		8	8		

Title: EFFECTS OF LONG-DURATION NOISE EXPOSURE ON HUMAN AUDITORY PROCESSES*

Objective: To study the effects of long-duration noise exposure on the human auditory process.

Description: This project was a joint effort with EPA/ONAC. The approach was to measure safe temporary hearing losses induced in human subjects by long-duration, low-level acoustic exposures and to analyze the hearing recovery curves as additional indicators of risk. Human subjects were exposed to broad-band noise with exposure durations of between 24 and 48 hours. Groups of subjects experienced systematic variations of such acoustic parameters as the intensity, duration, and duty cycle of the test stimulus. Effects of the stimuli were identified by monitoring the subjects' audiometric thresholds at specific time intervals. Future efforts conducted under this work unit will be accomplished under a new effort entitled, "Effects of Various Acoustic Exposures on Human Auditory Processes."

Summary of Findings: Analysis of the results of 24-hour exposure to continuous pink noise at levels ranging from 65 to 85 dBA has been completed. Results have demonstrated the greatest effect at 4 KHz for the 85 dBA condition. The TTS values resulting from this exposure are in agreement with earlier exposures to 85 dBA continuous pink noise. Exposure of 12 subjects to 85 dBA continuous noise for 24 hours and 48 hours, and to intermittent noise equivalent to 85 dB for 48 hours has also been completed. Results confirm (a) 48-hour continuous exposure does not produce greater Asymptotic Temporary Threshold Shift (ATTS) than 24-hour continuous exposure, but the recovery from 48-hour exposures is slower than recovery from other exposures; (b) intermittent exposure produces less ATTS than continuous exposure to equivalent noise levels.

Where Findings Published:

1) "Asymptotic Behavior of Human Temporary Threshold Shift and Recovery From 24-48 Hour Noise Exposures," Aviation Space Environ. Med., April 1977.

2) "Long Duration Exposures to Intermittent Noises," Aviation Space Environ. Med., September 1976.

3) "Identification of the Minimum Level of Noise Capable of Producing an Asymptotic Temporary Threshold Shift," Aviation Space Environ. Med., May 1980.

4) "Effects on Human Hearing of Long Duration Noise Exposure," Proceedings of 3rd Internatl. Congress on Noise as Public Health Problem. Freiburg, W. Germany, September 1978.

5) "Growth and Recovery of Temporary Threshold Shifts from 24 Hour Continuous, 48 Hour Continuous and 48 Hour Intermittent Noise Exposure," J. Acoust. Soc. Amer., 64(Suppl. 1), 1978.

* Project also listed under Environmental Protection Agency, p. A-146.

6) "Long Duration (24-48 Hour) Exposure to Continuous and Intermittent Pink Noise," AMRL Technical Report #80-3, 1980.

Period of Performance: 1977-1978.

Investigator: M. Stephenson and D. Johnson, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980	
		17	30.6 (est.)			AFAMRL
		2	2			EPA

Title: LOUDNESS BALANCE METHOD OF EVALUATING HEARING PROTECTORS

Objective: To assess the validity and accuracy of a suprathreshold loudness balance method for evaluating hearing protectors. The hearing protection features of helmets, headsets and hearing protectors are currently evaluated by using standard methods that employ very low level signals. Evaluation procedures that use high level test signals may provide more valid estimates of protector performance in intense noise fields.

Description: Among the loudness balance methods of evaluating hearing protector performance (which use high level test signals), results of the procedure used by the Union of South Africa differ greatly from results obtained by the American National Standard Method employed by the Air Force (which uses low level signals). The South African method was instrumented in the laboratory and hearing protectors tested with this system duplicated their results of significantly lower protection than measured by the Air Force procedure. Numerous elements of the specific loudness balance method were identified for investigation to establish the reason for this unreasonably large difference in results. Several parameters were investigated including altering the duty cycle of the test signal, modification of the reference signal and variations of the reference signal.

Summary of Findings: None of these actions revealed the cause of the differences between the two methods. However, it should be noted that this was only a pilot study, conducted and completed 2 years ago. Since, as the above text states, none of the variables generated significant effects, no follow-on, formal study was attempted.

Period of Performance: 1977-1978.

Investigator: M. Stephenson and C. Nixon, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		5	12		

U.S. AIR FORCE (Cont'd)

Title: HEARING PROTECTOR: EVALUATION, METHODOLOGY AND PERFORMANCE

Objective: To (1) maintain an ongoing program of investigating hearing protection performance of various auditory devices (hearing protectors, helmets, communication headsets); and (2) maintain current methodological procedures and evaluate potential methodologies for determining hearing protector effectiveness, to comply with current AF and national standards for sound attenuation measurements.

Description: Human subjects will be employed in the laboratory evaluation of a hearing protector's sound attenuation characteristics as measured by the American National Standards Institute (ANSI) real ear attenuation at threshold (REAT) method. Hearing protectors, submitted by manufacturers to determine their acceptability or suitability as devices meriting inclusion on the AF qualified products list (QPL), will be evaluated in accordance with the requirements of Military Specification 38268B. Results of these and other evaluations will be used to formulate recommendations to the Office of the AF Surgeon General concerning potential application for widespread or special purpose AF use.

Summary of Findings: During the course of this work, numerous earmuffs as well as earplugs, ground and inflight headsets and helmets have been evaluated to determine their sound attenuation characteristics. Results of these evaluations have been made available to users in the field. Results of these studies are proprietary in nature. However, persons with official need for the data may contact AFAMRL/BBA directly.

Period of Performance: 1977-1982.

Investigator: M. Stephenson and R. McKinley, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980	1981	1982
	12	12	12	13	14	15

Title: EFFECTS OF VARIOUS ACOUSTIC EXPOSURES ON HUMAN AUDITORY PROCESSES

Objective: To identify responses of the human auditory system to various acoustic stimuli.

Description: The stimuli include: (a) long duration (8 hours or greater) exposures to continuous, intermittent and impulse noise, (b) communication signals during ground or inflight conditions and (c) any additional acoustic signal for which there arises an operational requirement to define its effects on man's auditory system. The approach will involve: (a) laboratory measurements of acoustic signals under AF communication devices, (b) field measurements under AF communication devices and (c) exposure of human subjects under laboratory conditions to various acoustic signals. Data will be analyzed in the laboratory to identify operational situations with hearing damage risk potential, factors contributing to the problem and possible remedies. Once responses to various stimuli are defined, the results will be used to quantify the hearing damage risk and/or their effect on man's ability to communicate in the various noise environments.

Period of Performance: 1979-1982.

Investigator: M. Stephenson, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1979	1980	1981	1982	1983
	16	17	18	20	21

Title: HEARING RISK DUE TO COMMUNICATION SIGNALS

Objective: To measure ambient noise and voice communication signal levels under standard AF communication devices during a variety of air and ground operations, to quantify the hearing damage risk, and to consider alternate operating procedures that eliminate such risk. Effective voice communication in high-level noise environments may require air and ground personnel to increase the intensity of the signal to a level that is damaging to hearing.

Description: An initial pilot study was completed in which measurements were taken aboard F-100 aircraft, C-130 aircraft and the HU-153 helicopter. Laboratory work is underway to reevaluate the instrumentation and methodology for reliability and validity to confirm that the source of the data variations was attributable to the methodology/instrumentation, an accurate description of the noise or an artifact.

Summary of Findings: Data may have an artifact due to the instrumentation. Studies to determine the validity of the data have not been accomplished to date due to higher priority projects.

Period of Performance: 1977-1978.

Investigator: R.L. McKinley, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		7	7		

Title: USAF HEARING CONSERVATION PROGRAM

Objective: Many USAF weapon systems and support operations represent potential risk to the hearing of both military and civilian personnel. Loss of highly trained personnel and compensation for hearing loss continue to be major AF problems. The primary objective of this effort is to monitor the USAF hearing conservation program, specifically as defined in AFR 161-35. The prevention of noise induced hearing loss among AF members requires that these personnel be included in a comprehensive hearing conservation program and the purpose of this research is to guarantee that the multifarious elements of the program are effective. Also, research will be performed to validate auditory risk limits, determine the effectiveness of personal ear protection devices and noise control measures, and insure adequacy of criteria and procedures for disposition of noise-exposed personnel who demonstrate shifts in hearing.

Description: AF forms 1490/1491 and associated documents received at the USAF hearing conservation data registry will receive quality control and then be processed by automated techniques. Computer readouts on a routine basis will be used to continually appraise and evaluate the effectiveness of the overall hearing conservation program. The effectiveness of different elements (military or civilian) at a single base will be continually appraised. Instrumentation utilized in monitoring audiometry, personal ear protection, and disposition procedures for personnel who demonstrate shifts will be assessed on a continuing basis. Methods and techniques used to monitor individuals exposed to potentially hazardous noise will also be continually evaluated and deficiencies, once identified, will be carefully studied so that corrective action(s) can be recommended. Auditory acuity of various groups and subgroups of personnel who work in noise will be studied. Recommendations for correction of problem areas will be made to command surgeons and HQ USAF/SGP, as appropriate.

Summary of Findings: Analysis of data obtained during Jan and Feb 79 provided insight concerning the current status of the USAF hearing conservation program. During this time, a total of 27,426 AF forms 1490 were received from 239 bases, of which 7.2 percent were 90-day audiograms, 76.7 percent annual, 5.7 percent were 15-hour follow-up tests, 2.9 percent were 40-hour follow-ups and 7.0 percent were 'other' (detailed follow-up, termination, etc.). One of the most significant findings was that significant threshold shifts (STS) were 16.0 percent for all annual examinations (military and civilian). This means that STS on annual examinations has progressively declined from 24.8 percent during CY 1975, to 22.1 percent during CY 1976 and to 18.5 percent during CY 1977. Although CY 1978 data is in the backlog and is not yet avilable for study, the fact that Jan-Feb 1979 revealed STS of 16 percent documents continued decrease in STS. Seventy four percent of all examinations where STS existed were properly identified by examiners.

Where Findings Published: Reports: USAF School of Aerospace Medicine Technical Reports, Brooks Air Force Base, TX 78235

Period of Performance: 1977-1980

Investigator: Donald C. Gasaway, USAF School of Aerospace Medicine, Brooks AFB, TX (512/536-2178).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):

1977	1978	1979	1980
186.6	130.0	219.6	262.7

Title: EFFECT OF NOISE ON PREGNANT ANIMALS*

Objective: To determine the effect of high intensity noise in the auditory system of a developing fetus.

Description: Twelve pregnant sheep were exposed to broad band noise of 130 dB 4 hours a day, 5 days a week for the period of pregnancy. Five sheep were exposed with earplugs and 5 sheep were exposed without earplugs. Ten non-exposed sheep, 5 with earplugs and 5 without earplugs are being used as controls. The experiment will be undertaken at Wright Patterson Air Force Base. Audio thresholds and evoked response audiometry will be conducted. Ohio State University will study 20 lambs for possible inner ear pathology resulting from intense noise exposure at various times during the gestation period. Light and electron microscopy will be undertaken to investigate whether there are any difference in the auditory system between the lambs from the different groups. Some of the ewes will be preserved until maturity in order to observe whether there are any long range effects.

Period of Performance: 1978-1980

Investigator: R. McKinley, AFMRL, Wright-Patterson AFB, OH 45433 (513/255-3664)
D. J. Lim, Ohio State University Research Foundation

Agency Contact: R. McKinley (513)255-3660

Fiscal Year Funding ($1000):	1978	1979	1980	
	11	4.5	1	(EPA)
	25.7	12.2		(USAF)

* Project also listed under Environmental Protection Agency, p. A-148.

BEHAVIORAL, SOCIAL, AND PERFORMANCE EFFECTS

Title: HUMAN CAPABILITIES IN ACOUSTIC ENVIRONMENTS

Objective: To define noise exposure conditions which degrade and threaten task accomplishment in order to specify safe operating parameters and eventually exposure guidelines. This effort will provide support for the whole body exposure effects standards sections in AFR 161-35.

Description: The approach is to quantify cognitive and psychomotor performance on specific tasks in acoustic environments to such a degree that allowable exposure conditions can be adequately defined. The nature and difficulty of the performance tasks will be varied together with the frequency, duration and intensity of the acoustic stimulus in an effort to identify variables in the stimulus, task or subject that might result in reduced human capabilities. Post-exposure task performance will be examined for continuous and varying acoustic signals. A substantial technology base describing human performance in acoustic environments will be realized when these results are integrated with those from earlier efforts. The voice communication testing of modified H-133 headsets in high level noise, 130 dB and greater, is also part of this effort.

Period of Performance: 1979-1982.

Investigator: C. Harris, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3242).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1978	1979	1980	1981	1982
		24	24	25	26

Title: ACOUSTICAL DEGRADATION OF HUMAN CAPABILITIES

Objective: To investigate the types of noise and exposure conditions which contribute to decrements in cognitive and psychomotor capabilities. Air Force noise environments may affect motor performance, physiological function, thought processes and contribute to fatigue in personnel as well as affecting hearing.

Description: The approach is to measure the effects of noise on human performance (using a battery of standard tasks such as visual search, tracking, and memory) of acoustic stimuli that vary in degree of predictability. The degree of predictability of interrupted continuous and of impulsive noises will be determined by randomly varying the on and off times of the stimuli. Persistency effects will be assessed by measurements taken at various periods following cessation of the acoustic exposure patterns. Findings are to be used to define the acoustical characteristics of Air Force operational environments that contribute to degradation of human capabilities. In the present study, three groups of subjects were exposed to various unpredictable noises in three experiments. The noise stimulus used in the first experiment was the sound of an automobile horn, and in the last two experiments various mixed sounds were presented. In each experiment, there was (1) a control condition (ambient 60 dBA), (2) a fixed intermittent condition (one 7.5 sec. pulse each minute at 105 dBA), and (3) a random intermittent condition (duration of pulse, time of stimulus presentation, and stimulus intensity were all varied randomly). Testing was conducted for a 30-minute period on an arithmetic addition task during each noise exposure. Subsequent to the noise exposure, performance was measured for 15 minutes on a proofreading task in Experiments 1 and 2 and on a serial search task in Experiment 3. Eighteen subjects were tested in each of the first two experiments and twelve subjects were tested in the third.

Summary of Findings: Recent research suggests that unpredictable noise can adversely affect human performance subsequent to the noise exposure. There were no adverse effects of noise on performance in the addition task in any of the three experiments. Similarly, no adverse aftereffects were obtained in Experiment 1 (horn stimulus-proofreading task) or in Experiment 3 (mixed sound stimulus-serial search task). However, in Experiment 2, the mixed sound stimulus produced an adverse aftereffect on performance in the proofreading task. The fixed intermittent noise condition produced statistically significantly less efficient proofreading performance than the control condition and the random intermittent noise condition. This is directly opposite to previous studies where the random intermittent noise condition (unpredictable) produced the greatest effects. There were differences between the present experiment and previous studies in subjects, experimental design, and procedures for scoring the proofreading task. Nevertheless, the practical importance of all research reportedly showing adverse aftereffects of noise should be strongly questioned. Additional research is necessary before the relative importance of intensity of stimulation and unpredictability of stimulation can be evaluated.

Where Findings Published:

Harris, C.S., "Effects of Predictable and Unpredictable Sound on Human Performance," (AMRL-TR-78-81), International Conference on Biological Effects of Noise, Freiburg, W. Germany, September 1978.

Period of Performance: 1977-1978.

Investigator: C. Harris and C. Nixon, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3242).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		17	17		

Title: HUMAN CAPABILITIES IN INFRASOUND

Objective: To systematically investigate the effects of infrasound exposures on the capabilities of human subjects to perform selected tasks. The threshold of these effects, the nature and extent of the interference and the overall performance limits will be defined in terms of the acoustic exposures. This effort will provide support for the whole body exposure effects standards sections in AFR 161-35.

Description: The cognitive performance of 40 subjects was measured during exposure to infrasound and noise in three experiments. In the first experiment, 12 subjects were exposed for 15 minutes to each of four experimental conditions while performing a serial search task. The conditions were: 65 dB ambient noise (AN), a low-frequency background noise (BN) at 110 dB, a 7-Hz tone at 125 dB + AN, and the 125 dB tone + BN. The second experiment was the same as the first except a complex counting task was used and the exposure duration was increased from 15 minutes to 30 minutes. In the third experiment, the Complex Counting Task was used and the subjects were exposed for 15 minutes to each of the following four conditions: BN, 125 dB at 7 Hz plus BN, 132 dB at 7 Hz plus BN, and 142 dB at 7 Hz plus BN.

Summary of Findings: No decrements in performance were obtained in any of the three experiments, and there were no subjective reports of dizziness or disorientation as suggested in some of the previous literature. The authors conclude that adverse effects of infrasound have been exaggerated and the current levels of infrasound components as produced by modern jet aircraft are not considered in themselves a practical problem.

Where Findings Published:

Harris, C.S., and Johnson, D.L., "Effects of Infrasound on Cognitive Performance," Aviat. Space Environ. Med., 49(4):582-586, 1978.

Period of Performance: 1977-1978.

Investigator: D. Johnson and C. Harris, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3242).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):

1976	1977	1978	1979	1980
	16	10		

COMMUNICATION INTERFERENCE

Title: ACOUSTIC CUES FOR SPEECH INTELLIGIBILITY AND DISCRIMINABILITY

Objective: To study tactical voice communications intelligibility, talker discriminability and multi-party communications. Successful tactical air operations demand sustained, effective voice communications for mission fulfillment despite enemy disruption and jamming efforts.

Description: A series of integrated studies in the AFAMRL/BB communications laboratory will investigate tactical voice communication parameters which include (a) identification of critical acoustic cues in the communication signal, (b) determination of the optimum number of competing messages for conferencing, (c) impact of the ambient noise environment and (d) effects on voice communication of bandwidth, signal-to-noise ratio, differential filtering, missing message segments and various other types of signal processing. Results will specify requirements for optimum system design and operation of tactical voice communications.

Where Findings Published:

1) "Evaluation of Word Intelligibility of Two Modems of a Spread Spectrum Communication System in Presence of Simulated Cockpit Noise," AMRL-TR-78-54.

2) "Recommended Test Procedures for Performing Relative Psychoacoustical Evaluations of SEEK TALK Radio Systems," AMRL-TR-79-40.

3) "Comparative Intelligibility of Standardized Test Materials Processed by ARC-164 and ARC-34 Ratio Systems in the Presence of Simulated Cockpit Noise," AMRL-TR-79-108.

Period of Performance: 1977-1981.

Investigator: T.J. Moore and R.L. McKinley, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3242).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	25	50	63	146

Title: PERFORMANCE LIMITS OF EAR INSERT COMMUNICATIONS

Objective: To establish the communication and protection performance limits in high-intensity noise environments of the ear insert communications concept. Air and ground crew voice communications are degraded by high-level noise environments that exceed the performance limits of present standard communication equipment, creating command and control problems and safety hazards in routine as well as emergency situations.

Description: The approach incorporates the laboratory simulation of specific aircraft noise environs, the progressive evaluation of ear insert units at increasingly intense levels of these environs by measurement of hearing protection characteristics and then communication effectiveness. A hearing protection/voice communication envelope of the performance limits will be developed based on these data for both monaural and binaural configurations of the Ear Insert Receiver and compared to the performance of current standard items.

Summary of Findings: During this effort, modifications to standard H-133 headsets were constructed. Voice communication testing of the modified headsets in high level noise, 130 dB and greater, will be done under the project "Human Capabilities in Acoustic Environments." Hearing protection evaluations of the ear insert units have been completed.

Where Findings Published: In-house pilot study; data not published.

Period of Performance: 1977-1978.

Investigator: R.L. McKinley and M.R. Stephenson, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		5	26		

Title: COMMUNICATION INTERFERENCE SYSTEM

Objective: To develop and implement a research and testing system to simulate an operational communication environment and to develop standard research and testing procedures, and data reduction software for evaluation of AF voice communication systems and devices.

Description: The approach was to develop a laboratory aircraft voice intercommunication system which is capable of reproducing a realistic and valid simulation of the operational environment. Accurate simulation of the spectra and levels of specific weapons systems air and ground noise environs, radio static, auditory warning signals and various communication situations such as quiet to noise, noise to noise, etc., was required. An automated display and scoring approach is being incorporated into the system at this time. This will result in significant cost effective use by greatly reducing testing time, data collection and analysis and the number of items that can be evaluated per unit time.

Summary of Findings: The communication interference system has now been named VOCRES (Voice Communication Research and Evaluation System). Any portion of the communication link between the talker and listener can be duplicated or modeled. The system uses a central processing unit for test administration and data collection from 10 human subjects who act as talkers and listeners. This system can be used to measure voice communication intelligibility in any noise environment up to 130 dB.

Where Findings Published:

McKinley, R.L., "Voice Communication Research and Evaluation System" (AFAMRL-TR-80-25), May 1980.

Period of Performance: 1977-1978.

Investigator: R. McKinley, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		13	24		

NOISE ENVIRONMENT DETERMINATION AND EXPOSURE CHARACTERIZATION

Title: NOISE DOSIMETRY AND TYPICAL NOISE DOSES*

Objective: To 1) evaluate the application of personal noise dosimetry in Air Force environments; 2) determine the typical noise exposure of Air Force personnel in order to define typical occupational and nonoccupational noise exposures; and 3) assess typical noise exposures relative to allowable exposures specified in AFR 161-35. This work will be coordinated with the USAF Surgeon General and with base-level bioenvironmental engineers as well as with the U.S. EPA.

Description: Personnel noise dosimetry data was collected by the principal investigator at four different Air Force bases over a one-year period. The information obtained included both occupational and nonoccupational noise exposure data. This data was obtained on military and civilian personnel who were all volunteer subjects. All subjects were selected from AFSC's in the primary noise exposure groups. In addition, data was received from other Air Force bases that were using noise dosimetry.

Summary of Findings: A total of 418 8-hour occupational noise exposure measurements were obtained on 120 different individuals. The range of these exposures was from 66-111 dBA with the median level at 84.5 dBA. A total of 567 useful measurements were obtained from the other bases and this data ranged from 60-101 dBA with a median level of 80.1 dBA. A total of 73 separate 24-hour measurements were obtained on 16 persons who wore an equal energy noise dosimeter for several days to determine their nonoccupational noise exposure. The median daily A-weighted average sound level was 77 dBA.

Where Findings Published:

1) Fairman, T.M., and Johnson, D.L., "Noise Dosimeter Measurements in the Air Force," Av. Sp. Env. Med., pp. 1150-1157, November 1979.

2) Fairman, T.M., "Occupational and Nonoccupational Noise Dosimetry Measurements on Air Force Personnel," J. Acoust. Soc. Amer., 65(Suppl. 1):S125, Spring 1979.

Period of Performance: 1977-1980.

Investigator: T. Fairman and R. McKinley, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980	
		7	6	8	6	(AFAMRL)
			3.6	1		(EPA)

* Project also listed under Environmental Protection Agency, p. A- 158

Title: ATTENUATION CHARACTERISTICS OF THE WOMB*

Objective: To define the acoustic protection provided to the fetus by the maternal environment of several large laboratory animals. Virtually no information is available about possible interactions of pregnant females in intense noise exposure. Before a long-term research program on the fetal effects of noise can be initiated, more information is needed on how much sound the fetus actually receives.

Description: In order to obtain this information, AFAMRL measured the attenuating properties of the womb in one to three fairly large mammals. The pregnant sheep, pig and dog were the animal models chosen for this research. The work is being co-sponsored by EPA/ONAC.

Summary of Findings: The attenuation characteristics of the mother were frequency-dependent. Below about 500 Hz there was very little attenuation whereas above about 4000 Hz, the attenuation was greater than 40 dB. The overall attenuation was on the order of 20 dB.

Where Findings Published:

McKinley, R.L., "Changes in the Fetal Noise Environment Due to Noise," J. Acoust. Soc. Amer., 64(Suppl. 1), Fall 1978.

Period of Performance: 1978-1978.

Investigator: R. McKinley, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		5			(EPA)
			15		(AF)

* Project also listed under Environmental Protection Agency, p. A-157.

Title: EVALUATE/REFINE METHODS FOR ASSESSING AF NOISE IMPACT ON COMMUNITY RESPONSE

Objective: To provide technology to supplement the implementation/application/improvement of existing guidelines for assessing and interpreting community noise exposure. Additionally, the project seeks to insure that these guidelines are reasonable and correct with respect to AF activities and facilities.

Description: This work unit is to aid in the implementation and application of guidelines for assessing and interpreting community noise exposure to ensure that these guidelines are appropriate for AF activities and facilities. Specifically, exceptions and modifications to the average day-night sound level (Ldn) will be determined.

Summary of Findings: This work unit is primarily to support implementation of the above-mentioned guidelines. A paper on "Highlights of the Guidelines for Environmental Impact Statements with Respect to Noise," was presented to Committee E-33 on Environmental Acoustics of the Association of Scientific Testing and Measurement in May 1978. AMRL personnel participated in a workshop on "Surface Mine Blasting and Public Policy." They discussed the use of the guidelines paper for evaluating acoustic exposure to blast noise, April 1978. AMRL personnel participated in an FAA/NASA-sponsored workshop on the day/night penalty used in Ldn. A paper was given describing proposed AF research in the area (Langley, Virginia, 1980). A general plan has been developed to evaluate the feasibility of an AF research program in the area of nonauditory health effects of noise. A magnetic tape of the health records of flight personnel has been obtained for a preliminary assessment of a possible association between hearing loss and various health parameters.

Where Findings Published:

1) Johnson, D.L., "Highlights of the Guidelines for Environmental Impact Statements with Respect to Noise," in R.J. Peppin and C.W. Rodman, Eds., Community Noise. American Society for Testing and Materials, Philadelphia, 1979.

2) Johnson, D.L., and Harris, C.S., "A Procedure to Correct an Equal Energy Noise Dose for Interrupted or Intermittent Noise Exposures," in Proceedings of the Technical Program, Noise Expo, Chicago, 1979.

3) Harris, C.S., "The Nighttime Penalty for Noise, the Percent Highly Annoyed, and the Size of Noise Contours," Joint FAA/NASA Workshop on Noise Penalties, Langley, Virginia, 1980.

Period of Performance: 1977-1980.

Investigator: D.L. Johnson and C.S. Harris, AFARML, Wright-Patterson AFB, OH 45433.

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	32	32	32	

Title: CONDUCT FIELD VALIDATION OF NOISEMAP

Objective: To further assess, through long-term field measurements, the overall ability of NOISEMAP to predict the yearly averaged noise environments produced by aircraft operations for the wide variety of missions and airbase locations within the Air Force as a whole. NOISEMAP is the computerized noise prediction procedure that forms the cornerstone of the USAF Air Installation Compatible Use Zone (AICUZ) Program. The AICUZ Program is used by the Air Force to beddown new weapons systems, select facility sites, evaluate existing operations and determine the land use compatibilities of all USAF bases with the neighboring communities.

Description: This project is to conduct long-term field measurements of total noise exposure at several locations around one or two USAF bases and compare these measured values with those predicted by NOISEMAP. This effort is being accomplished as follows: (1) A written plan was developed delineating the exact number, location and schedule of measurements to be made, the test procedures to be followed and the rationale for each; (2) this plan was submitted to AFAMRL for review and final written approval before any measurements were made; (3) the long-term measurements were conducted of total noise exposure and the field data are being analyzed in accordance with the approved plan; and (4) a final report will be submitted presenting the acquired data, comparisons with the NOISEMAP-predicted values and final conclusions about NOISEMAP's overall effectiveness.

Summary of Findings: Field measurements were conducted at McChord AFB and Norton AFB over a period of nine months. At least 25 weekday Ldn values were acquired for each of 14 various locations. Complete operations data were also acquired from the entire measurement period. The contractor is currently analyzing the data and should have the report ready before October 1980.

Period of Performance: 1979-present.

Investigator: J. Mabry, P. Oncley, J. Ott, MAN-Acoustics and Noise Inc., 2105 N. 45th St., Seattle, WA 98103.

Agency Contact: Robert A. Lee, AFAMRL/BBE, Wright-Patterson AFB, OH 45433 (513/255-3664).

Fiscal Year Funding ($1000):	1977	1978	1979	1980	
			48	22	(AFAMRL)
				23	(AFESC)

Title: PROCEDURE TO PREDICT AIRCRAFT NOISE IN COMMUNITIES

Objective: To insure NOISEMAP remains the state-of-the-art tool for predicting noise exposure around air installations.

Description: Areas of investigation include improving the overall operating efficiency, application guidelines, and excess ground attenuation models. The feasibility of expanding NOISEFILE and NOISEMAP to include helicopter operations was determined. A detailed test protocol for improving the current model used for excess sound attenuation was developed. Studies were also made to determine the practical engineering and economical problems inherent in developing and applying demographic and compatible land use overlays with NOISEMAP as indices of relative environmental noise impact.

Summary of Findings: See contents of reports listed below.

Where Findings Published:

1) Dunderdale, T.C., "Sensitivity of Aircraft Runup/Community Noise Predictions to Excess Ground Attenuation," AFAMRL-TR-77-76, December 1977.

2) Walker, D.G., "An Analysis of Aircraft Flyover Noise," AFAMRL-TR-78-8, April 1978.

3) Seidman, H., "Computer-Aided Collection of Demographic Data Within Day-Night Level Contours: Two Test Cases," AFAMRL-TR-78-39, August 1978.

4) Beckman, J.M., and Seidman, H., "NOISEMAP 3.4 Computer Program Operator's Manual," AFAMRL-TR-78-109, December 1978.

5) Galloway, W.J., "Helicopter Noise Level Functions For Use In Community Noise Analyses," AFAMRL-TR-78-87, January 1979.

Period of Performance: 1976-1979.

Investigator: D.E. Bishop, Bolt Beranek and Newman Inc., Los Angeles, CA (213/347-8360).

Agency Contact: Jerry Speakman, AFAMRL/BBE, Wright-Patterson AFB, OH 45433 (513/255-3664).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		45	45		

U.S. AIR FORCE (Cont'd)

Title: INCORPORATE ENVIRONMENTAL IMPACT INDICES INTO NOISEMAP

Objective: To develop the capability for combining census tract data with NOISEMAP contours to output directly various indices of environmental noise impact. The Air Force uses the NOISEMAP community noise exposure prediction procedure for planning compatible land use around airbases.

Description: NOISEMAP will be mated with commercially available programs for deriving population and socio-economic status information from census tract tapes. This demographic overlay capability will be demonstrated by determining the environmental noise impact of proposed operational changes at two Air Force bases.

Summary of Findings: Software modifications to NOISEMAP and to the CALCOMP General Purpose Contouring Program have been completed and debugged. Demonstration test cases for hypothetical aircraft mission changes at Shaw AFB and McConnell AFB will be performed in August 1980 as part of a training course to be held at the Air Force Engineering and Services Center (AFESC), Tyndall AFB.

Where Findings Published: Final report due in September 1980.

Period of Performance: 1979-present.

Investigator: H. Seidman, Bolt Beranek and Newman Inc., Los Angeles, CA (213/347-8360).

Agency Contact: Jerry Speakman, AFAMRL/BBE, Wright-Patterson AFB, OH 45433 (513/255-3664).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			34	35 (AFESC)

Title: STUDY EXCESS SOUND ATTENUATION (ESA) AND DEVELOP ESA MODEL WITH RESPECT TO AIRBASE/COMMUNITY NOISE

Objective: To develop better models (at least one for ground to ground propagation and one for air to ground for low elevation angles, this second one referred to as flight-ESA) for more accurately predicting ESA in forms suitable for practical implementation in NOISEMAP, the handbook and NOISEFILE. The Air Force assesses the impact of noise around Air Force bases by applying community noise predictive models and noise charts. The accuracy of these models depends to a large extent on the accuracy of algorithms to account for excess ground attenuation.

Description: AFAMRL will conduct airbase noise measurements over a 1-2 year period using 10-13 all-weather acoustic measuring stations. Data taken will define ESA over a range of 75 meters to several kilometers from the source with elevation angles from greater than 0.0 to less than 90.0 from the receiver for times of day/night, various weather conditions, and for flat grassy land. Statistical analyses will provide the basis for new empirical ESA models which better define such attenuation for specific classes of conditions (e.g., day/night, rural/suburban, elevation angles).

Summary of Findings: Ground to Ground ESA - This portion of the study is part-way through the data acquisition analysis phase. Initial findings will be available in the fall of this year. Flight ESA - Analysis of the noise from seven different Air Force aircraft performing level flyovers at Wright-Patterson AFB has been completed and used to develop ESA values for angles of elevation from 3 degrees to 90 degrees. Additional data are to be collected for various weather conditions and different types of ground cover.

Where Findings Published: Flight ESA - Findings have been incorporated into a proposed Aerospace Industry Recommendation report for approval by the Society of Automotive Engineers SAE A-21 Committee on Aircraft Noise.

Period of Performance: 1975-present.

Investigator: R.G. Powell, J.D. Speakman, and J.N. Cole, AFAMRL/BBE, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):

1975	1976	1977	1978	1979	1980	1981	1982
44	64	95	137	176	203	182	109

Title: TECHNOLOGY TO DEFINE AND EVALUATE ADVERSE/HAZARDOUS AF CREW NOISE ENVIRONMENTS

Objective: To develop in more effective form the database and methods necessary to define these physical noise environments for use by MAJCOM bioenvironmental engineers and other agencies concerned about personnel safety and performance.

Description: For the past several years noise environments were measured at ground crew locations during ground operations of most aircraft and ground support equipment in the USAF inventory. In-flight measurements were made on-board most aircraft at pilot/crew and passenger locations during typical operations such as engine start, taxi, takeoff, climb, cruise, approach and at landing. To acquire data on high performance single or two-seat aircraft a small self-contained recording system was developed and fabricated. The system is worn and operated by the pilot or crewmember. Spectral analyses were performed on all data and with OMEGA, a specialized computer program, the required physical and psychoacoustic measures were computed.

Summary of Findings: All data were incorporated into a multi-volume handbook describing the typical noise environments produced by major USAF systems. This handbook provides a convenient and consolidated package of noise data acquired and processed in a uniform manner using established engineering practices. It is a tool to assist bioenvironmental and civil engineers, flight and ground safety personnel and others concerned with noise in the assessments of environmental noise.

Where Findings Published:

Multi-volume USAF Bioenvironmental Noise Data Handbook, AMRL-TR-75-50.

Period of Performance: 1975-present.

Investigator: H.K. Hille, R.G. Powell and T.H. Rau, AFAMRL/BBE, Wright-Patterson AFB, OH 45433 (513/255-3604).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):

1976	1977	1978	1979	1980	1981	1982	1983
45	38	27	46	29	33	37	40

Title: FIELD STUDIES ON APPLICATION OF NOISECHECK TECHNOLOGY FOR MONITORING AIRCRAFT NOISE

Objective: To field test, evaluate and modify, if needed, the aircraft noise monitoring technology developed under other contract work. This technology will then be handed off to Air Force Engineering Services Center (AFESC) for their use in collecting field measured noise exposure data acceptable as evidence in cases involving extreme controversy or litigation.

Description: Field studies to evaluate the NOISECHECK technology were conducted at Laughlin AFB in February, 1979 and at Homestead AFB in September, 1979. The NOISECHECK capability involves both the instrumentation and the field test procedures required to accurately and efficiently measure the noise exposure at specific locations. Several problems with the equipment were encountered and subsequently corrected through equipment and field procedure modification. The methodology for conducting the measurements was found to be location dependent due to the considerable variation in the noise sources at the specific sites.

Summary of Findings: The NOISECHECK methodology was found to be very effective in uncovering the reasons for discrepancies between measured noise exposure and the noise exposure predicted by NOISEMAP. It was found that the measurement duration required for reasonable accuracy could be reduced considerably by zeroing in on the major contributors to the noise at that particular location. The NOISEMAP program can be used to pinpoint these major contributors prior to measurements being taken and then the measurement program can be adjusted to focus on those sources.

Where Findings Published: Program not completed. Results will be published as an AFAMRL report.

Period of Performance: 1978-present.

Investigator: R.A. Lee and J.D. Speakman, AFAMRL/BBE, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
			8	26	8

Title: DETERMINE AIRBASE/COMMUNITY NOISE FROM AF AIRCRAFT/ENGINES OPERATING WITH GROUND RUNUP NOISE SUPPRESSORS

Objective: To acquire the data needed to define the noise radiated by AF aircraft using standard runup noise suppressors in ways suitable for use by NOISEMAP and also for incorporation into the Noise Data Handbook. Aircraft ground runups are one of the major sources of noise on-base and in surrounding communities. Many times aircraft runup noise suppressors are used to reduce the radiated energy. The NOISEFILE used in NOISEMAP presently includes only nominal design levels for such suppressors since adequate measured data as a function of angle around the source are not available. HQ USAF/PRE and MAJCOMS clearly intend to use NOISEMAP as a tool for assessing the need for and potential effectiveness of such multi-million dollar suppressors in specific situations.

Description: Surveys were made on 11 different aircraft/suppressor systems at eight different Air Force and Air National Guard bases. Measurements were made on suppressor systems for the KC-135A, F-4, F-5, F-15, F-16, F-100, F-106, F-111, T-38 and two suppressor systems for the A-7 aircraft. These acoustic data were analyzed according to AFAMRL/BBE Standard Procedures and incorporated into our NOISEFILE (acoustic data base for all Air Force aircraft) and is now being routinely used by the AFESC to run NOISEMAP, the community noise prediction procedure used under the USAF Air Installation Compatible Use Zone (AICUZ) program.

Summary of Findings: Near- and far-field data are now available for the above mentioned aircraft/suppressor systems in a standard format for use by the general public for direct comparison with unsuppressed aircraft and/or other suppressor systems.

Where Findings Published:

1) Lee, R.A., "Community Noise Exposure Resulting From Aircraft Operations: Volume 7. Acoustic Data on Aircraft Ground Runup Noise Suppressors," AMRL-TR-73-110, Vol. 7, December 1979.

2) Lee, R.A., "USAF Bioenvironmental Noise Data Handbook, Volumes 128, 129, 130, 131, 132, 133, 134, 135, 136 and 140," AMRL-TR-75-50. Contact AFAMRL/BBE for Index update for this series of reports.

Period of Performance: 1977-1980.

Investigator: R.A. Lee and Capt R. Gorman, AFAMRL/BBE, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		18	13	14	3

Title: MEASUREMENT AND ANALYSIS OF AIRCRAFT NOISE ENVIRONMENTS FOR DEVELOPING AF PROCEDURES TO PREDICT NOISE EXPOSURE AROUND AIRBASES

Objective: To determine the far-field noise characteristics of military aircraft for flight and ground runup operations for use with the NOISEMAP environmental noise exposure predictive procedure and the USAF Bioenvironmental Noise Data Handbook.

Description: Using standardized equipment and data analysis procedures, measurements are conducted during controlled level flyovers and ground runups at various engine power settings. Modifications to the NOISEFILES are done systematically to reflect proven results on excess sound attenuation and revisions in accepted national and international standards on noise propagation and prediction methodologies.

Summary of Findings: See AMRL-TR-75-50 series of reports for far-field ground runup characteristics of military aircraft and other major Air Force noise sources such as ground or auxiliary power units. See AMRL-TR-73-110 series of reports for aircraft flyover, ground runup, and demountable suppressor noise characteristics.

Where Findings Published:

1) "USAF Bioenvironmental Noise Data Handbook," AMRL-TR-75-50, approximately 150 volumes published to date, June 1975-Present.

2) "Community Noise Exposure Resulting From Aircraft Operations: Acoustic Data on Military Aircraft," AMRL-TR-73-110, seven volumes, November 1977-December 1979.

Period of Performance: 1972-present.

Investigator: J.D. Speakman, R.G. Powell, R.A. Lee, H.K. Hille, and J.N. Cole, AFAMRL/BBE, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):

1975	1976	1977	1978	1979	1980	1981	1982	1983
120	120	116	117	98	122	140	151	145

Title: IMPROVE TECHNOLOGY USED TO PREDICT AIRBASE/COMMUNITY NOISE

Objective: To continue making those studies and modifications which are vital to maintain the present technical credibility of the NOISEMAP procedure. The Air Force uses the NOISEMAP community noise exposure prediction procedure in assessing environmental noise impact and planning compatible land use about airbases. Such actions often involve controversy and even litigation.

Description: This effort is to: (1) perform analytical studies of available measured noise data to determine the effects of excess sound attenuation on predicted flight noise levels of various types of aircraft; (2) develop the capability for combining airbase noise contours with those such as for sonic boom or bomb blast having variable grid spacings; (3) perform analytical studies to quantitate the changes in typical Air Force NOISEMAP contours due to uncertainties in the psychoacoustic penalty associated with nighttime aircraft operations; and (4) perform analytical studies to assess the relative importance of uncertainties in the present rules for summing for numbers of operations when computing cumulative noise exposure.

Summary of Findings: Presently, NOISEMAP assumes that excess sound attenuation is limited to aircraft to ground observer elevation angles of about 7 degrees or less. Reanalysis of FAR Part 36 sideline data for four aircraft indicates excess sound attenuation effects are evident at elevation angles of 25 to 30 degrees and depending on aircraft/engine type as high as 50 or 60 degrees. Spectral analysis of these data show considerable differences when compared with the results of controlled level flyover tests conducted by AFAMRL on seven military aircraft types.

Where Findings Published:

1) Seidman, H., "Computer Program to Add NOISEMAP Grids of Different Spacing," AFAMRL-TR-79-88, May 1980.

2) Bishop, D., and Beckman, J., "Study of Excess Sound Attenuation As Determined from FAR Part 36 Aircraft Noise Certification Measurements," AFAMRL-TR-80-65 (In Press).

Period of Performance: 1975-present.

Investigator: D. Bishop, Bolt Beranek and Newman Inc., Los Angeles, CA (213/347-8360).

Agency Contact: Jerry Speakman, AFAMRL/BBE, Wright-Patterson AFB, OH 45433 (513/255-3664).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
		50	39	(AFAMRL)

Title: DEVELOP NOISECHECK TECHNOLOGY FOR MONITORING AIRCRAFT NOISE

Objective: To develop the aircraft noise monitoring technology needed by Air Force personnel to collect field-measured noise exposure data acceptable as evidence in cases involving extreme controversy or litigation. A vital part of Air Force environmental noise planning effort is the need to perform spot-check noise measurements which provide data supporting predicted noise exposure values and the corresponding decisions made regarding land use compatibility and environmental noise impact.

Description: The present state-of-the-art in aircraft noise monitoring technology will be reviewed. Specific procedures and instrumentation requirements for use by Air Force personnel in collecting noise exposure data able to withstand the closest technical scrutiny will be developed. The adequacy of the proposed AF NOISECHECK methodology will be demonstrated by performing an actual field application study at an AF base. Refinements in NOISECHECK will be made after analysis of the data from the field application study.

Summary of Findings: NOISECHECK instruments were developed and are now commercially available as Digital Acoustics Inc. Model 607P. The instruments along with specific procedures were field tested at Barksdale AFB, LA. The results showed that if the aircraft operational parameters (engine power settings, flight tracks, altitude profiles, etc.) are accurately modeled, then excellent agreement can be obtained between predicted and measured values of Ldn.

Where Findings Published:

1) "Development of NOISECHECK Technology for Measuring Aircraft Noise Exposure," AFAMRL-TR-78-125, July 1980.

2) "NOISECHECK Procedures for Measuring Noise Exposure From Aircraft Operations," AFAMRL-TR-80-45 (In Press).

Period of Performance: 1977-present.

Investigator: P. Rentz and H. Seidman, Bolt Beranek and Newman Inc., Los Angeles, CA (213/347-8360).

Agency Contact: Jerry Speakman, AFAMRL/BBE, Wright-Patterson AFB, OH 45433 (513/255-3664).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	55	47	14	

NOISE CONCOMITANT WITH VIBRATION

Title: COMBINED NOISE AND VIBRATION EFFECTS ON HUMAN CAPABILITIES

Objective: To determine the single and combined effects of 100 dBA broadband noise and complex waveform vertical vibration on cognitive performance.

Description: The performance of 12 subjects was measured on a complex counting task (CCT) during exposure to each of four experimental conditions for a duration of 30 minutes. Two levels of noise, 65 dBA and 100 dBA, were presented both with and without 0.36 R.M.S. Hz sum-of-sines vibration.

Summary of Findings: Combined 100 dBA noise and vibration produced less adverse effect than the vibration combined with 65 dBA noise. In addition, a clear-cut adverse effect of vibration on the CCT was obtained, and an adverse effect of 100 dBA noise on the CCT was demonstrated.

Where Findings Published:

Harris, C. Stanley, and Shoenberger, Richard W. "Combined Effects of Broadband Noise and Complex Waveform Vibration on Cognitive Performance," Av. Sp. Env. Med., 51(1), January 1980.

Period of Performance: 1977-1979.

Investigator: C. Harris and R. Shoenberger, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3242).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		29	23	30	

Title: RESEARCH ON RESPONSE OF VESTIBULAR SYSTEM TO ACOUSTIC STIMULI

Objective: To investigate the manner in which acoustic energy stimulates the vestibular system and determine how high-intensity noise affects equilibrium and produces disorientation. Results will contribute toward the development of threshold criteria for hazardous exposure to high-intensity sounds.

Description: Intense acoustical transients evoke reports of visual field displacement in human subjects. The nature of the displacement reported varies across subjects and as a function of stimulus characteristics (particularly intensity and frequency). Experimental manipulations that increase the ability of subjects to maintain visual fixation or that tend to evoke eye movements in a direction opposite to that expected on the basis of the acoustical stimulation increase the magnitudes of the visual field displacements reported. Disruption of the visual fixation mechanism (e.g., by alcohol ingestion) or reduction of the effective acoustical stimulus at the labyrinth by vibration tend to reduce the magnitudes of the visual field displacements reported by the subjects. The influence of several variables on this phenomenon was examined in 93 subjects in five studies.

Summary of Findings: Experiment I investigated the interaction between acoustical stimulation and angular acceleration. The results of this experiment support the view that the acoustical transients activate semicircular canal receptors. The influence of head vibration on acoustical transient-evoked visual field displacements was examined in Experiment II. Smaller visual field displacements were reported when head vibration was present simultaneously with the acoustical stimulation, probably because the head vibration activated the middle ear reflex. No changes in acoustical stimulus-evoked visual field displacements following exposure to a rotating visual field (Experiment III) or as a function of visual target illumination intensity (Experiment IV) were observed. Finally, alcohol ingestion (Experiment V) reduced the magnitudes of the visual field displacement reported by the subjects.

Where Findings Published:

1) Parker, D.E., et al, "Visual-Field Displacements in Human Beings Evoked by Acoustical Transients," J. Acoust. Soc. Amer., 63(6), June 1978.

2) Parker, D.E., et al, "A Temporary Threshold Shift for Self-Motion Detection Following Sustained, Oscillating Linear Acceleration," Perception and Psychophysics, 23(6), 1978.

3) Parker, D.E., "Effects of Angular Acceleration, Visual-Field Rotation and Alcohol Ingestion on Visual-Field Shifts Evoked by Intense Acoustic Stimulation," AMRL-TR-79-81, Aerospace Medical Research Laboratory, Wright-Patterson AFB, Ohio, August 1979.

Period of Performance: 1975-1979.

Investigator: D.E. Parker, Miami University, Oxford, OH.

Agency Contact: C. Harris, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3242).

Fiscal Year Funding ($1000):	1975	1976	1977	1978	1979
	10	10	15	15	1

DEPARTMENT OF DEFENSE

U. S. ARMY

DEPARTMENT OF DEFENSE

U.S. ARMY

INDIVIDUAL AND COMMUNITY RESPONSE

Title: COMMUNITY RESPONSE TO IMPULSE AND HELICOPTER NOISE

Objective: To address and understand community response for such Army-unique noise sources as blast noise (e.g., artillery, tanks, demolition) and helicopters. This work is part of the Army's overall efforts to create the methods to predict and reduce the noise impact within and adjacent to Army facilities.

Description: This effort is being conducted primarily by means of community attitudinal surveys. One attitudinal survey of over 2,000 respondents has been completed in the vicinity of a major Army base. In this survey, impulse noise and helicopter noise is probed in a background of all noise sources, such as fixed-wing aircraft, traffic, and children.

Summary of Findings: Preliminary results have shown the community responses to be similar or perhaps a little greater than community responses to sonic booms in the Oklahoma City test. Growth rates for blast noise, fixed-wing aircraft, and rotary-wing aircraft as a function of loudness, and as a function of frequency of occurrence are all consistent with one another and with previous work in this area. This effort is also exploring the existence of other correction factors such as nighttime penalties. Additional surveys will be performed in the vicinity of two or three other major Army bases during the next five years.

Where Findings Published: Report to be published 2nd quarter, FY81.

Period of Performance: 1977-present.

Investigator: Paul D. Schomer, U.S. Army, CERL, Champaign, IL (217/352-6511).

Agency Contact: T. Flowe, DAEN-RDM (202/272-0259).

Fiscal Year Funding ($1000):

1978	1979	1980	1981	1982	1983	1984	1985
50	150	50	135	163	81	140	33

U.S. ARMY (Cont'd)

Title: HUMAN RESPONSES TO IMPULSE NOISE

Objective: To better understand the various single parameters which correlate with human response to impulse noise in the residential environment.

Description: This study will be performed in a special test facility at CERL, wherein subjects, in a residential structure, are presented blast sounds created in effect by a giant loudspeaker. The facility is such that the outside of the structure is excited by blast levels with peaks on the order of 1 lb. per square foot and durations from 20-40 ms. This study will concentrate on human response as a function of blast wave form variation and also as a function of variation in the rattles and shakes which are permitted within the structure given the blast stimuli. This work will complement the attitudinal surveys also being performed by CERL.

Period of Performance: To begin in FY81.

Investigator: Paul D. Schomer, U.S. Army, CERL, Champaign, IL (217/352-6511).

Agency Contact: T. Flowe, DAEN-RDM (202/272-0259).

Fiscal Year Funding ($1000):	1980	1981	1982	1983
		20	45	45

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: CHANGES IN AUDITORY PERFORMANCE FROM EXPOSURE TO NOISE OF ARMY MATERIEL

Objective: To elucidate the physiological mechanisms by which noise exposure produces change in the peripheral auditory system. This information will be applied to the design of safer weapons, improved design criteria, and a more accurate damage-risk criterion.

Description: Using the cat ear as a model for the human auditory system, and electrophysiological indices of hearing performance (cochlear microphonic, N1, and brain stem evoked responses) experiments have been directed toward describing the susceptibility of intracochlear structures to damage from intense sound (from 120 to 190 dB Peak SPL) and alterations in the sound produced by the external and middle ears. Experiments have been both acute and chronic and have used impulses from the 90mm recoilless rifle, 105mm, 122mm, and 155mm Howitzer, M-16 rifle, and tone pips.

Summary of Findings: Susceptibility of structures on the basilar membrane to spectrally narrow impulses (tone pips) has been shown to fall at about 5.4 dB/octave (when expressed in stapes displacements) which is consistent with damage produced by mechanical displacement. If the transformation functions of the external and middle ears are accounted for, this implies maximum susceptibility in the 3.0 kHz region with a low frequency slope of 6.0 dB/octave and a high frequency slope of 18 dB/octave. If applied to weapons-type impulses, then it argues that the present DRC for impulse noise over-rates the hazard from large caliber weapons and furthermore needs to be restructured in a theoretically consistent manner. Implications for the design of safer weapons and hearing protective devices have been developed. A test of the relative hazard from weapons impulses with a low spectral frequency peak (cannon) and a higher spectral frequency peak (rifle) is presently under way.

Where Findings Published:

1) Price, G.R., "Toward a Theoretically Based DRC for Impulse Noise," J. Acoust. Soc. Amer., 62:S95(A), 1977.

2) Price, G.R., "Firing From Enclosures with 90mm Recoilless Rifles: Assessment of Acoustic Hazard," Technical Memorandum TM 11-78, U.S. Army Human Engineering Laboratory, 1978.

3) Price, G.R., "Action Potentials in the Cat at Low Intensities: Thresholds, Latencies, and Rates of Change," J. Acoust. Soc. Amer., 64:1400-1405, 1978.

4) Price, G.R., "Spectrum as a Factor in Rating the Hazard of Intense Acoustic Transients," J. Acoust. Soc. Amer., 65:S30(A), 1979.

5) Price, G.R., "Loss of Auditory Sensitivity Following Exposure to Spectrally Narrow Impulses," J. Acoust. Soc. Amer., 66:456-465, 1979.

6) Price, G.R., "A Critical Level for Auditory Damage at High Intensities," J. Acoust. Soc. Amer., 66:S62(A), 1979.

7) Hodge, D.C., Price, G.R., Dukes, N.L., and Murff, S.J., "Effects of Artillery Noise on the Hearing of Protected Crew Personnel," Technical Memorandum TM 17-79, U.S. Army Human Engineering Laboratory, 1979.

8) Price, G.R., "Implications of Basic Research in Hearing for the Design of Safer Weapons," Technical Memorandum TM 20-79, U.S. Army Human Engineering Laboratory, 1979.

9) Price, G.R., "Implications of a Critical Level in the Ear for Assessment of Noise Hazard at High Intensities," J. Acoust. Soc. Amer., 1980 (in press).

Period of Performance: 1975-1980.

Investigator: G.R. Price, U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD 21005 (301/278-4109).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):

1975	1976	1977	1978	1979	1980	1981	1982
136	122	105	92	99	202		

Title: SURVEY OF MILITARY NOISE CRITERIA AND STANDARDS

Objective: To determine the types of noise criteria, limits and documentation used by the U.S. military forces and those of friendly foreign nations. This information will be used to recommend needed standardization of noise criteria among countries desiring to exchange weapons systems.

Description: Various nations' military forces employ different acoustical design criteria for their equipment. This creates a problem when, for example, a nation with a lax design limit desires to sell equipment to a nation with a more conservative standard. In extreme cases, a weapon considered to be "safe" in one country may be assessed as "hazardous" in another. This situation could be ameliorated by the adoption of common acoustical design limits among nations. Information about U.S. and foreign noise criteria and standards is being found by personal contact and other means to determine what types of criteria are in use, the units used to state the criteria, the limits enforced, the documentation that has been published, and the relation of the national military standards to the appropriate civil (occupational) noise criteria.

Summary of Findings: The survey is as yet incomplete, but the preliminary results indicated that more countries have some sort of hearing conservation standards than any other type. However, in the impulse noise and blast area (a very significant problem today) there are at least four different types of evaluative criteria in use.

Period of Performance: 1979-1980.

Investigator: D.C. Hodge, U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD (301/278-3126).

Agency Contact: Georges R. Garinther, U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD (301/278-3265).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
		10	25	

Title: COMBAT VEHICLE CREWMEN (CVC) HELMET-IMPACT AND ACOUSTIC EVALUATION

Objective: To develop a CVC helmet that provides acoustic and impact protection as well as high-quality voice communication without hearing damage.

Description: This will be accomplished by measurement of the impulse noises of combat vehicles; establishment of sound attenuation requirements for adequate protection in CVC environments (using ASA Standard S3.19-1974); establishment of electroacoustic characteristics of equipment to assure compliance with hearing conservation requirements; and the investigation of ear seal configuration for maximum sound attentuation. In addition, impact hazards in combat vehicles and specific criteria will be evaluated; the need for and design of a suspension and retention system will be determined; and qualification test procedures will be established.

Period of Performance: 1979-ongoing.

Investigator: R.T. Camp and J.L. Haley, Aeromedical Research Laboratory, Ft. Rucker, AL (205/255-5107).

Agency Contact: MAJ Jerod Goldstein, Medical Service Corps, U.S. Army, Ft. Rucker, AL (205/255-3083).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			164	185

Title: MEDICAL EFFECTS OF BLAST OVERPRESSURE

Objective: To define physiologic effects upon the auditory system of blast overpressure generated by firing Army weapon systems in terms of the physical characteristics of the pressure waves responsible for injury to the auditory system. Devices and mechanisms required to protect against these effects will also be studied.

Description: The approach will entail physical measurements; validation of hearing protection; direct method of validation of hearing protection; and basic animal and human studies of hearing loss from high-intensity impulse noise to develop accurate tolerance limits.

Summary of Findings: Studies have been completed to define the distribution of blast waves around Army weapons (artillery and antitank) during firing. These studies involve standard blast measurement methodology. The results yield a near-field map of the overpressures which has been used in determining crew safety areas. In other studies, hearing protective devices (earmuffs and helmets) have been evaluated using ANSI Z24.22 methods for determining real-ear attenuation. These protective devices have electronic talk-through circuits to aid in direct voice communication. They were also evaluated for speech intelligibility and electronic characteristics.

Where Findings Published:

1) "Medical Evaluation of Sound Attenuation and Electroacoustics Characteristics of a Prototype DH-178 Protective Helmet," USAARL Report 78-12, June 1978.

2) "Blast Overpressure Produced by Prototype XM198, 155mm Towed Howitzer," USAARL Report 79-2, December 1979.

3) "Medical Evaluation of Sound Attenuation and Electro-Acoustics Characteristics of a NATO (Cosmocord) Peak Limiting Ear Protector," USAARL Report 79-13, July 1979.

4) "Preliminary Evaluation of the Blast Overpressure Field Around the M198 155mm Howitzer Firing the M203E1 Propelling Charge," USAARL Report 80-3, October 1979.

Period of Performance: 1978-1985.

Investigator: J. Patterson, Aeromedical Research Laboratory, Ft. Rucker, AL (205/255-5107).

Agency Contact: MAJ Jerod Goldstein, Medical Service Corps, U.S. Army, Ft. Rucker, AL (205/255-3083).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
		425	500	600 (Proposed)

Title: MEDICAL ASSESSMENT OF HEARING PROTECTIVE DEVICES

Objective: To assess the sound attenuating characteristics of hearing protective devices as to their suitability to meet the needs of the Army and develop new hearing protective devices and methods of evaluating them.

Description: Real-ear attenuation characteristics of hearing protective devices which may have application in the U.S. Army will be developed using the ASA Standard S3.19-1974. Devices which are presently in the inventory will be reevaluated utilizing this method. An objective method to determine attenuation characteristics of circumaural hearing protectors is being developed. This method will be utilized primarily for quality assurance testing of helmets by the procurement activity.

Summary of Findings: Data collection and testing are still in progress. Preliminary findings are discussed in the documents listed below.

Where Findings Published:

1) "Medical Evaluation of Sound Attenuation and Electroacoustics Characteristics of a NATO (Cosmocord) Peak Limiting Ear Protector," USAARL Report 79-13, July 1979.

2) "Attenuation Variation Obtained With Training When Utilizing an In-The-Ear Hearing Protective Device," USAARL Report 80-6, March 1980.

3) "Characteristics of Headsets used with DRIMS Systems," USAARL LR-79-11-2-5, September 1979.

4) "Real-ear Attenuation Measurements of Selected Sound Protectors Identified in the DAF Qualified Products List," USAARL Report 79-10, June 1979.

5) "Medical Evaluation of Sound Attenuation and Electroacoustic Characteristics of a Prototype DH-178 Protective Helmet," USAARL Report 78-12, June 1978.

Period of Performance: 1977-1980.

Investigator: B.T. Mozo, Aeromedical Research Laboratory, Ft. Rucker, AL (205/255-5107).

Agency Contact: MAJ Jerod Goldstein, Medical Service Corps, U.S. Army, Ft. Rucker, AL (205/255-3083).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	110	63	136	187

Title: MILITARY ACOUSTIC HAZARDS: MECHANISMS OF HEARING LOSS

Objective: To explore relationships between the parameters of noise peculiar to the military environment and psychophysical and physiological behavior of the human auditory system. These data will be used to establish valid damage-risk criteria to insure the adequate protection of personnel and to maintain an effective hearing conservation program.

Description: Studies concerned with the adequacy of current damage-risk criteria will be conducted with animal subjects using behavioral audiometry and histology. Damage-risk criteria for impulse noise will be examined in terms of specifying exposures with respect to spectral analysis of the impulses rather than simply in terms of peak pressure level. The effect of exposure to high-intensity low-frequency noise on the threshold of hearing will be determined. These studies involve chinchillas and human subjects. Chinchillas are tested using shock avoidance audiometry and are examined histologically using surface preparation techniques.

Summary of Findings: Although this is an ongoing project, some preliminary findings are discussed in the publications listed below.

Where Findings Published:

1) Burdick, C.E., Patterson, J.H., Mozo, B.T., and Camp, R.T., "Threshold Shifts in Chinchillas Exposed to Octave Bands of Noise Centered at 63 and 1000 Hz for Three Days," J. Acoust. Soc. Amer., 64:458-466, 1978.

2) "High-Frequency Hearing Loss Incurred by Exposure to Low-Frequency Noise," Proceeding of the 1978 Army Science Conference, Vol. I:187-199, 1978.

3) "High-Frequency Hearing Loss Incurred by Exposure to Low-Frequency Noise," USAARL Report 79-3, January 1979.

4) "Threshold Shifts in Chinchillas Exposed to Octave Bands of Noise Centered at 63 and 1000 Hz for Three Days," USAARL Report 79-6, March 1979.

5) "Hearing Loss in Chinchillas Exposed to Octave Bands of Noise Centered at 31.5 and 250 Hz," 99th Meeting of the Acoustical Society of America, Atlanta, GA, April 1980.

6) "Acoustic Properties of the External Auditory Canal in Chinchilla, Guinea Pig, Cat, and Man," 99th Meeting of the Acoustical Society of America, Atlanta, GA, April 1980.

7) "Spectrum of the CM Produced by High-Intensity, Low-Frequency Noise Bands in the Chinchilla," 99th Meeting of the Acoustical Society of America, Atlanta, GA, April 1980.

Period of Performance: 1977-1985.

Investigator: J.H. Patterson, Aeromedical Research Laboratory, Ft. Rucker, AL (205/255-5107).

Agency Contact: MAJ Jerod Goldstein, Medical Service Corps, U.S. Army, Ft. Rucker, AL (205/255-3083).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		105	193	183	214

Title: EXTENDED HIGH FREQUENCY AMPLIFICATION FOR HEARING LOSS ABOVE 2000 HZ

Objective: To assess possible benefit of amplification for individuals whose hearing loss is limited to frequencies above 2000 Hz.

Description: The subjects were nine individuals whose sensorineural hearing loss was limited to frequencies above 2000 Hz bilaterally. The mean age was 51.2 years ranging from 39 to 61 years. Custom in-the-ear aids with wide range receivers were fitted monaurally. Aided and unaided performance in quiet and noise was assessed using the California Consonant Test (CCT). In addition, social hearing handicap index (SHI), developed by Ewertsen and Birk-Nielsen, was used prior to and four to six months after hearing aid fitting to assess subjective benefit from amplification. Results were compared to the performance of normal hearing subjects as well as to the performance of individuals with hearing loss above 1000 Hz who are generally considered good hearing aid candidates.

Summary of Findings: The results indicated that the hearing aid evaluation procedure using the California Consonant Test did not predict aided benefit for most of the subjects with high frequency hearing loss limited to frequencies above 2000 Hz. On the other hand, follow-up assessment of daily usage and subjective reports of improved daily communication suggested that many of these fittings can be considered successful.

Where Findings Published:

Abstract of paper, ASHA, 21(9), September 1979.

Period of Performance: 1979-present.

Investigator: Rauna K. Surr, Army Audiology & Speech Center, Walter Reed Army Medical Center, Washington, DC 20012 (202/576-1649).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1978	1979	1980	1981	1982
		3			

Title: EVALUATION OF A COMMUNICATION SELF-ASSESSMENT INVENTORY OF THE HEARING-IMPAIRED SOLDIER

Objective: To evaluate the appropriateness of the Hearing Performance Inventory (HPI) (Giolas et al., 1979) for use with the noise-induced hearing loss population of the military. The desired applications of the self-assessment communication inventory are to define the patient's communication handicap, to plan aural rehabilitation programs, to assess progress, and to determine short-term and long-term prognoses.

Description: The complete HPI is being administered to large numbers of soldiers with noise-induced hearing loss prior to their attending a two-week aural rehabilitation program. An extensive statistical analysis of the data is being conducted to determine the test's reliability and appropriateness for use with this population. Validation studies are also being planned.

Period of Performance: 1979-present.

Investigator: Brian E. Walden, Army Audiology & Speech Center, Walter Reed Army Medical Center, Washington, DC 20012 (202/576-1685).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1978	1979	1980	1981	1982
		4	17		

Title: FACTORS INFLUENCING USE OF HEARING AIDS

Objective: To 1) describe the hearing aid fitting and usage patterns obtained from clinical records and questionnaire responses; and 2) examine the relationship between reported hearing aid use and audiometric information.

Description: A follow-up questionnaire was mailed to new hearing aid users. The questionnaire responses of 430 persons, 73 percent of the sample, were related to age, audiometric, and hearing aid evaluation data obtained at the time of fitting. Reported usage of the aids was also analyzed in terms of the type of fitting and according to the length of post-fitting training. Further, the reasons for limited or non-use were tabulated. The population in the present study, in comparison with that of previous investigations, was characterized by relatively young age and predominantly noise-induced, sensorineural type hearing loss, with mild hearing loss for speech; these factors led to a high proportion of selective amplification fittings.

Summary of Findings: Reported overall use did not differ among the types of aids. Overall use declined with increasing age, and the majority of persons in this population used their aids selectively rather than on a full-time basis. Length of post-fitting training appeared to increase hearing aid use. Mean audiometric and hearing aid evaluation data remained relatively constant across usage categories. Excessive background noise and lack of need constituted 63 percent of the reasons given for limited use or non-use.

Where Findings Published:

Surr, R.K., "Factors Influencing Use of Hearing Aids." Arch. Otolaryngol., 104, December 1978, and reprinted by Hearing Instruments, October 1979.

Period of Performance: 1975-1978.

Investigator: Rauna K. Surr, Army Audiology & Speech Center, Walter Reed Army Medical Center, Washington, DC 20012 (202/576-1649).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1975	1976	1977	1978	1979
	4		3	1	

Title: ELECTROACOUSTIC CORRELATES OF HEARING AID QUALITY JUDGMENTS

Objective: To investigate quality judgments of hearing processed speech in hearing impaired listeners, with a view toward defining perceptual dimensions related directly to the electroacoustic characteristics of the instruments.

Description: Ten subjects with high frequency hearing loss and ten with flat loss judged quality of a speech sample processed through 20 hearing aids in a paired-comparison paradigm. Perceptual dimensions underlying hearing aid quality judgments were derived from multidimensional scaling and were correlated with 15 electroacoustic characteristics.

Summary of Findings: Results revealed that only one dimension of a three-dimensional solution, low-frequency cutoff, formed the primary basis for quality judgments for both persons with flat and high frequency audiometric patterns.

Where Findings Published:

Presented at the Annual Convention of the American Speech and Hearing Association, Atlanta, Georgia, November 1979 (manuscript in preparation).

Period of Performance: 1978-1980.

Investigator: Daniel M. Schwartz, Army Audiology & Speech Center, Walter Reed Army Medical Center, Washington, DC 20012 (202/576-1685).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	8	18		

Title: TEST OF THE ASSUMPTIONS UNDERLYING THE COMPARATIVE HEARING AID EVALUATION

Objective: To test the assumptions which underlie the Comparative Hearing Aid Evaluation (CHAE). Specifically, the research is designed to determine if: 1) significant performance differences exist among preselected hearing aids; 2) the frequency with which interactions between patients and instruments are observed; 3) the test-retest reliability of standard monosyllabic word tests in CHAE's; 4) the stability of the performance hierarchy for preselected instruments; and 5) the extent to which performance in the clinical CHAE predicts performance in daily use.

Description: Fifty subjects with noise-induced hearing loss will receive a standard CHAE on two occasions separated by ten days. Between CHAE's the subjects will wear each of the hearing aids evaluated in the CHAE for a period of a few days. Ratings of listener acceptance will be obtained during this trial period. Results will be analyzed to test the assumptions outlined above.

Summary of Findings: Preliminary results from the test of assumption #1 suggest that statistically significant differences among hearing aids selected to be appropriate to the patient's hearing loss rarely occur in a CHAE. Data acquisition to test the remaining assumptions is underway.

Where Findings Published:

Presented at the Annual Convention of the American Speech and Hearing Association, Detroit, Michigan, November 1980.

Period of Performance: 1980-present.

Investigator: Brian E. Walden, Army Audiology & Speech Center, Walter Reed Army Medical Center, Washington, DC 20012 (202/576-1685).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1978	1979	1980	1981
			10	10

Title: SOME EFFECTS OF TRAINING ON SPEECH RECOGNITION BY HEARING-IMPAIRED ADULTS

Objective: To determine some of the effects of consonant recognition training on the speech recognition performance of adults with noise-induced hearing loss.

Description: Two groups of ten subjects each received seven hours of either auditory or visual consonant recognition training, in addition to a two-week, group-oriented, inpatient aural rehabilitation program. A third group of fifteen subjects received the two-week inpatient program, but no supplementary individual consonant recognition training. An audiovisual sentence recognition test, as well as tests of auditory and visual consonant recognition, were administered both prior to and following training.

Summary of Findings: The results revealed that subjects in all three groups significantly increased in their audiovisual sentence recognition performance, but that improvement for the subjects receiving the individual consonant recognition training was significantly greater than for the subjects receiving only the standard two-week program. A significant increase in consonant recognition ability was observed in the two groups receiving the auditory or visual consonant recognition training. The data are discussed from varying statistical and clinical perspectives.

Where Findings Published: Journal Speech Hearing Research (in press).

Period of Performance: 1977-1979.

Investigator: Brian E. Walden, Army Audiology & Speech Center, Walter Reed Army Medical Center, Washington, DC 20012 (202/576-1685).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980	1981
	5	10	10		

Title: PERFORMANCE OF HIGH FREQUENCY IMPAIRED LISTENERS WITH CONVENTIONAL AND EXTENDED HIGH FREQUENCY AMPLIFICATION

Objective: To determine if a high-pass hearing aid can provide increased improvement in word recognition and consonant discrimination over that of a conventional high frequency emphasis hearing aid in listeners with hearing loss limited to frequencies above 1000 Hz.

Description: Word and consonant discrimination were assessed in quiet and in the presence of 12-talker speech babble for 10 subjects under three listening conditions: 1) unaided; 2) wearing a conventional high frequency emphasis hearing aid; and 3) wearing an experimental high-pass instrument. The speech testing materials included: 1) Northwestern University Auditory Test No. 6; 2) California Consonant Test; and 3) eight voiceless English consonants.

Summary of Findings: Results suggested that both instruments provided similar benefit in quiet for improving word recognition and resolving consonant error. For the noise condition, however, the experimental high-pass aid provided a considerable advantage in both word recognition and consonant identification and was particularly sensitive to reducing within- and between-manner voiceless consonant confusions. Furthermore, measurements of real-ear gain revealed that the high-pass aid afforded considerably greater acoustic gain above 4000 Hz than that shown for the conventional high frequency emphasis hearing aid.

Where Findings Published:

Schwartz, D.M., "Performance of High Frequency Impaired Listeners with Conventional and Extended High Frequency Amplification." Audiology, Vol. 18, 1979.

Period of Performance: 1977-1979.

Investigator: Daniel M. Schwartz, Army Audiology & Speech Center, Walter Reed Army Medical Center, Washington, DC 20012 (202/576-1685).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980	1981
	6	6	2		

Title: RESEARCH OF IMPACT AND NOISE ATTENUATING CRASHWORTHY HELMET EARCUP

Objective: To design, construct and medically evaluate the impact and noise attenuating properties of a crashworthy helmet earcup for Army aviators.

Description: Twenty hand-made "test-bed earcups" will be fabricated. The cups will be installed in helmets for in-flight evaluation by USAARL flying personnel under all flying conditions. They will be subjected to accepted standardized impact and acoustic protection evaluation techniques (ANSI Z24.22, Z90.1, etc.) to determine the effectiveness in known physical environments.

Summary of Findings: Preliminary "test-bed" earcups in a round configuration, not installed in helmets, have been evaluated, and the most promising type of corrugated aluminum was selected for further development. The aluminum prototype earcups will be installed in Army flight helmets and evaluated further in 1980 and 1981.

Period of Performance: 1978-1981.

Investigator: J.L. Haley, Aeromedical Research Laboratory, Ft. Rucker, AL (205/255-5107).

Agency Contact: MAJ Jerod Goldstein, Medical Service Corps, U.S. Army, Ft. Rucker, AL (205/255-3083).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	34	20	29	3

Title: CONSONANT SIMILARITY JUDGMENTS BY NORMAL AND HEARING-IMPAIRED LISTENERS

Objective: To identify listener strategies or perceptual modes that might be adopted by hearing-impaired listeners when making similarity judgments among pairs of speech sounds. Further, an attempt was made to describe the relationship between similarity judgments and auditory confusions for such listeners.

Description: Groups of adventitiously (noise-induced hearing loss) and congenitally hearing-impaired subjects provided similarity ratings and recognition responses to consonant vowel syllable pairs.

Summary of Findings: The resulting similarity judgments were organized into a variety of similarity matrices and analyzed via multidimensional scaling and hierarchical clustering, as well as by traditional descriptive and interpretative statistics. The analyses suggested that, in making similarity ratings between consonants, hearing-impaired listeners apply phonemic labels to the stimuli and base their ratings on these labels rather than on the unlabeled acoustic characteristics of the speech sounds. Analysis of the recognition data suggested that those consonants which are most confusable are not necessarily the most conceptually similar to the listener.

Where Findings Published:

Walden, B.E., "Consonant Similarity Judgments by Normal and Hearing-Impaired Listeners." Journal Speech Hearing Research, 23(1), March 1980.

Period of Performance: 1975-1979.

Investigator: Brian E. Walden, Army Audiology & Speech Center, Walter Reed Army Medical Center, Washington, DC 20012 (202/576-1685).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
	9	10	5	10	

BEHAVIORAL, SOCIAL, AND PERFORMANCE EFFECTS

Title: NEURAL AND BEHAVIORAL RESPONSE TO SENSORY STIMULATION

Objective: To establish and evaluate an animal model to measure the interrelationships between sensory stimulation, nervous system responses (e.g., evoked potential), and behavioral manifestations of stimulus control, attention and vigilance.

Description: Emphasis will be on methods requiring minimal physical and chemical restraint in order to permit realistic simulations of military environments demanding prolonged vigilance and cognitive performance, and of the disruptors (such as altered sleep and feeding patterns, and noxious stimuli such as noise or exposure to chemical agents) which impinge upon task performance in those situations. The data base generated will be part of our program to examine the maintenance and decrement of satisfactory military performance in stressful situations. Using the methods of animal psychophysics and electrophysiology, methods will be developed to permit measurement of neural electrical potentials from awake subjects attending and responding to auditory and other environmental stimuli. Rats will be used initially, while chinchillas will be used as the study progresses. Interrelationships between these auditory and other environmental signals and neural and behavioral responses will be established and then studied under conditions which interfere with optimal performance such as circadian desynchronization, sleep loss, increased noise or decreased signal resolution, or emotional disruptors.

Period of Performance: 1978-continuing.

Investigator: C.F. Tyner and S.R. Hursh, U.S. Army Medical Research & Development Command, Walter Reed Institute of Army Research, Washington, DC (202/576-3037).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1978	1979	1980	1981	1982
		20	20	20	

COMMUNICATION INTERFERENCE

Title: EFFECTS OF MULTI-TALKER COMPETING SPEECH ON THE CALIFORNIA CONSONANT TEST

Objective: To study the effects of background speech competition on California Consonant Test (CCT) scores in a sound field, and to determine the test-retest reliability of the CCT in quiet and under adverse listening conditions in an effort to assess the variability in performance associated with the introduction of a competing speech babble.

Description: Performance on the CCT was assessed in the unaided sound field in quiet and at message-to-competition ratios (MCRs) of +12, +6, 0 and -6 dB for 40 normal hearers and 30 listeners with high frequency sensorineural hearing loss beginning at 1500 Hz. Further, recognition performance in quiet and noise was retested for the 30 hearing impaired subjects to examine test-retest reliability.

Summary of Findings: The noise interference functions for both subject groups were characterized by a gradual decline in recognition performance as the listening condition became more adverse. Dispersion among scores for the hearing impaired subjects remained relatively constant regardless of the listening condition as compared to the results of normal hearing individuals. Test-retest reliability across conditions was examined via correlational analysis and by computing test-retest difference scores for each individual subject. Results showed that testing in the presence of competing speech served to increase experimental error to the extent that considerable differences among homogeneous hearing aids would be difficult to assess on the basis of CCT performance scores. Variability was also shown to be heightened concomitant with using abbreviated list presentation (i.e., 50 words). These data are discussed relative to the use of the CCT in the hearing aid evaluation.

Where Findings Published: Being submitted to Journal of American Audiology Society.

Period of Performance: 1977-1978.

Investigator: Rauna K. Surr, Army Audiology & Speech Center, Walter Reed Army Medical Center, Washington, DC 20012 (202/576-1649).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980	1981
		4	1	2	

Title: THREE EXPERIMENTS ON THE CALIFORNIA CONSONANT TEST

Objective: To 1) determine the performance-intensity function for the California Consonant Test (CCT) for normal hearers and hearing impaired listeners; 2) compare performance scores on the CCT with those of the N.U.-6 lists; and 3) examine internal consistency and split-half reliability of forms 1 and 2 of the CCT.

Description: Experiment I involved the determination of a performance-intensity function for the CCT with 12 normal hearers and 12 listeners with high frequency sensorineural hearing loss. Experiment II compared performance scores achieved on the CCT to those of the N.U.-6 lists in 60 subjects with high frequency sensitivity loss similar to those used in Experiment I. Experiment III examined the internal consistency and split-half reliability of the CCT to assess the effects of shortening the number of test items.

Summary of Findings: Results demonstrated almost a linear function for both subject groups (approaching asymptote at 50 dB SL) as compared to the typical sigmoidal function obtained with conventional word recognition tests. Experiment II compared results of the CCT to those of the N.U.-6 lists in 60 subjects with high frequency hearing loss. Consistent with previous findings, relatively high word recognition scores were obtained for the N.U.-6 materials whereas the range of scores on the CCT approximated a normal distribution. Experiment III examined the internal consistency and split-half reliability of the CCT. Despite significant (p = less than or equal to 0.05) correlation coefficients, the wide variability between half-list scores among individual listeners does not support the use of half-list testing.

Where Findings Published:

Schwartz, D.M., "Three Experiments on the California Consonant Test." Journal of Speech and Hearing Disorders, 44(1), February 1979.

Period of Performance: 1977-1979.

Investigator: Daniel M. Schwartz, Army Audiology & Speech Center, Walter Reed Army Medical Center, Washington, DC 20012 (202/576-1685).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	6	4		

Title: HEARING PERFORMANCE REQUIREMENTS OF ARMY PERSONNEL

Objective: To establish the hearing skills required by soldiers in tactical situations, and to predict the effect of reduced hearing acuity on soldiers' performance. This information will be used to improve existing noise criteria and standards, and provide hearing loss tolerances for new damage risk criteria.

Description: An analysis of soldiers' functions in tactical situations published in 1975 indicated that a critical performance area is detecting the presence or nearness of enemy personnel. In the first phase of the project, detection of personnel sounds in quiet was investigated. A model was developed to predict sound detection, based on the ear's spectral sensitivity and temporal integration abilities. Currently, the second phase (started 1977) is nearing completion in which personnel sound detection is being investigated in quiet and in the presence of realistic outdoor masking sounds (wind, insect sound, etc.). The predictive model is also being restated in terms of 1/3-octaves rather than critical bands to simplify the sound analyses.

Summary of Findings: An average correlation of .95 was found between predicted and actual detection levels in the first phase, and indicated that the model predicted performance quite well. The results of the second phase indicated that mid-range hearing (500-2000 Hz) is particularly important in the detection of personnel sounds under realistic listening conditions. Conversion of the model's spectral base to 1/3-octaves seems to have reduced the accuracy of prediction significantly, but this may be due to limitations of the available analysis system.

Where Findings Published:

Results from Phase I are reported in HEL Technical Memorandum 35-76. A report on Phase II results is in preparation.

Period of Performance: 1978-1980.

Investigator: D.C. Hodge, U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD (301/278-3126).

Agency Contact: Georges R. Garinther, U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD (301/278-3265).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	75	75	75	

NOISE ENVIRONMENT DETERMINATION AND EXPOSURE CHARACTERIZATION

Title: ACOUSTIC MODEL DEVELOPMENT AND SOURCE DATA

Objective: To provide the additional models required within the integrated noise contour system (INCS). These models include rockets, vehicular sources and fixed sources, and emission data on new weapons such as the Black Hawk helicopter, rockets, M-1 tanks, infantry-fighting vehicles, etc.

Description: Acoustic models are derived in a standard manner which requires the means to predict source emissions, to find propagation from source to receiver, and predict the community or receivers response to the noise. Rocket noise will be examined to determine the proper types of models. Weapons are measured for their acoustic directivity patterns and the relationship of charge weight to sound emissions and previous measurements.

Summary of Findings: Models are currently incorporated for rotary-wing aircraft and for impulse noise. These are based in part on emissions data for large weapons and for helicopters.

Where Findings Published:

1) CERL Report N-60, Acoustic Directivity Patterns for Army Weapons.

2) CERL Report N-38, Rotary-Wing Aircraft Operational Noise Data.

Period of Performance: 1975-present.

Investigator: Paul D. Schomer, U.S. Army, CERL, Champaign, IL (217/352-6511).

Agency Contact: T. Flowe, DAEN-RDM (202/272-0259).

Fiscal Year Funding ($1000):

1975	1976	1977	1978	1979	1980	1981	1982	1983
80	80	90	90	100	80	150	182	156

Title: NOISE MEASUREMENT AND MONITORING

Objective: The purpose of this effort is twofold. First, the noise monitoring is to be used for validation of physical predictions of the noise emissions from blasting activities and rotary-wing aircraft from Army bases. Second, the data, as it modifies predictions, is to be used to correlate with attitudinal surveys dealing with blast noise and helicopter noise emanating from Army facilities. As a part of the monitoring methods, this effort is also developing a scientific basis upon which confidence values can be placed on temporarily-sampled data which is used to estimate a true yearly Ldn or other community measure.

Description: This work is being conducted using two types of data. First, data is gathered at and near Army installations using the CERL-developed true integrating noise monitors and sound exposure level meters and secondly, by using long-term monitor data gathered in the vicinity of airports such as Lindburg Field (San Diego), Miramar NAS, Los Angeles International, Dulles International, Washington National, and Boston Logan.

Summary of Findings: Although this is an ongoing project with no final report available, some preliminary findings are discussed in the documents listed below.

Where Findings Published:

1) CERL Report N-20, Analysis of Environmental Noise Monitors.

2) CERL Technical Report N-41, True Integrating Environmental Noise Monitor and Sound Exposure Level Meter (Volumes I through IV).

3) DeVor, R.E., et al, "Development of Temporal Sampling Strategies for Monitoring Noise," Journal of the Acoustical Society of America, 66(3), September 1979.

4) Schomer, P.D., and DeVor, R.E., "On the Estimation of Long-Term Mean Noise Levels in the Vicinity of Airports," submitted to Journal of the Acoustical Society of America and currently available in draft form as CERL Technical Manuscript N-84.

Period of Performance: 1978-present.

Investigator: Paul D. Schomer, A. Averbuch, U.S. Army, CERL, Champaign, IL (217/352-6511).

Agency Contact: T. Flowe, DAEN-RDM (202/272-0259).

Fiscal Year Funding ($1000):

1978	1979	1980	1981	1982	1983	1984	1985	1986
90	75	40	100	100	100	100	110	125

Title: DEVELOPMENT OF THE INTEGRATED INSTALLATION NOISE CONTOUR SYSTEM (INCS)

Objective: To develop methods for the facilities engineer and districts to quantitatively predict the noise pollution impact of all major Army operations, including armor, artillery and EOD operations, helicopter operations, small arms ranges, fixed-wing aircraft support operations, vehicular sources, and industrial plants on the civilian and military populations.

Description: The prediction will be in the form of "equal noisiness" Ldn contours as suggested by the Federal EPA and the National Academy of Science to be overlayed on area land use maps as well as the base master plan. User manuals and computer programs will be the products of this research which will yield the Integrated Installation Noise Contour System (INCS) capability. For each of the Army noise source types, a data base will be compiled, a noise prediction sub-model will be created and computerized, and the results documented. The initial helicopter sub-model will be computerized. Existing vehicle noise data sources and models will be reviewed and the results incorporated into the INCS Program (FY81). Also homogeneous noise areas and rocket noise will be investigated and added to the INCS Program. A manual method to combine the contours will be developed and documented.

Summary of Findings: As of the end of FY80, the Army's blast noise contour program BLAST MAP, the Air Force's NOISE MAP for fixed-wing aircraft, and the Air Force's NOISE MAP program modified for Army rotary-wing aircraft will all be operational on one computer system. Output from the various contouring modules will be able to be combined by computer.

Where Findings Published:

1) CERL Technical Report E-17, Predicting Community Response to Blast Noise.

2) CERL Report N-75, The Blast Noise Prediction Program: User Reference Manual.

3) CERL Report N-82, Compilation of Operational Blast Noise Data.

4) Numerous documents by the Air Force relating to the NOISE MAP program.

Period of Performance: 1975-present.

Investigator: Paul D. Schomer, A. Averbuch, U.S. Army, CERL, Champaign, IL (217/352-6511).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):

1975	1976	1977	1978	1979	1980	1981	1982	1983
100	100	125	60	90	55	150	182	156

Title: ACOUSTICAL PROBLEMS OF ARMY MATERIEL

Objective: To investigate techniques which might be used to predict the blast levels and contour patterns which would result when firing artillery and to investigate improved methods of protecting personnel. This effort is in response to the fact that blast produced by large caliber weapons produces hearing loss, other physiological damage and operational problems among Army personnel.

Description: Preliminary tests have been conducted to determine the effectiveness of various size barriers against the noise of a 155mm howitzer. Small barriers have been investigated in an anechoic chamber to determine their attenuation characteristics against steady state noise to aid in the prediction for impulse noise. A computer model has been developed to predict the attenuation of various shaped barriers against noise.

Summary of Findings: Results indicate that barriers provide substantial energy reduction at those frequencies where the ear is particularly sensitive. However, very little protection would be provided to other parts of the body which are affected by the low frequency nature of large caliber weapons. A computer program has been developed to perform a spectrum analysis of impulse noise produced by weapons. This program will be used to help provide an improved method of assessing hearing damage from impulse noise and to predict the attenuation afforded by hearing protectors, barriers, etc.

Period of Performance: 1979-1980.

Investigator: J.T. Kalb, U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD.

Agency Contact: Georges R. Garinther, U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD (301/278-3265).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
		100	100	

DEPARTMENT OF DEFENSE

U. S. NAVY

DEPARTMENT OF DEFENSE

U.S. NAVY

NONAUDITORY PHYSIOLOGIC RESPONSE

Title: THE EFFECTS OF WHOLE-BODY EXPOSURE TO UNDERWATER SOUND ON THE HEALTH OF NAVY DIVERS

Objective: To develop safety standards for Navy divers working in intense underwater sound field or to identify requirements for research which will lead to such safety standards. Navy divers are currently exposed to intense sound in water which originates from active sonar systems tested in port and from acoustic diver tracking systems. More frequent exposure of divers is anticipated as more acoustic systems are developed and deployed.

Description: This research was exploratory in nature consisting of a literature review, consultations with experts in medical ultrasonics, and visits to bioacoustics laboratories. The literature review covered the field of medical ultrasonics and whole-body immersion in underwater sound fields. Consultants were employed to assist in assessing the relevance of such data to the problem of whole-body immersion in underwater sound fields. Visits to various bioacoustics laboratories were made to gain knowledge of the methodologies used in determining safe dosage levels for acoustic radiation as well as the results of those methodologies.

Summary of Findings: The relevance of existing biomedical ultrasonics literature to the problem of exposure of divers to intense sound in water was explored. Noise levels to which some divers are currently exposed and the levels produced by the Portable Acoustic Tracking System (PATS) are above the range of intensities at which bioeffects occur. Insufficient data are available to specify safe dosage levels. The PATS may be hazardous to unsuited swimmers or decompressing divers. No basis exists for specifying general hearing conservation standards nor for establishing performance interference levels for underwater noise exposure.

Where Findings Published:

1) Rooney, James A., "Biological Effects of Ultrasound and Their Relevance to the Establishment of Safety Standards for Exposure of Divers to Intense Ultrasound," NSMRL Report No. 893, May 9, 1979.

2) Smith, P.F., and Hunter, W.L., Jr., "On the Effects of Exposure to Intense Underwater Sound on Navy Divers: A Report of a Conference on the Bio-effects of Sound," NSMRL Memo Report No. 80-1, February 20, 1980.

3) Smith, P.F., "Considerations for Establishing Hearing Conservation Standards for Underwater Noise Exposure," NSMRL Report No. 923, in preparation.

Period of Performance: April 1978-September 1978.

Investigator: J.D. Harris, Auditory Department, Naval Submarine Medical Research Laboratory, Groton, CT 06340 (203/449-3398).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
		24.9		

Title: HIGH INTENSITY ENERGY EFFECTS ON PHYSIOLOGICAL, BEHAVIORAL, AND SUBJECTIVE RESPONSE

Objective: To determine the degree of acute vestibular and vestibulo-ocular dysfunction due to noise as measured by brain stem auditory evoked potentials, optokinetic nystagmus, pendular eye tracking, and whole body balance (Phase I). In addition, subjective reports including health perception, mood and sleep characteristics will be obtained. This effort is in response to the fact that aircraft maintenance crews at NAS, Miramar are exposed to very high intensity noise and vibration as part of several routine jobs. Day-to-day exposure on these jobs may induce acute effects on performance and possibly chronic, degenerative or suppressed effects.

Description: For the purposes stated in Phase I of this study, a mobile van was instrumented as a temporary test station and deployed to the region adjacent to one of the noise suppressors near Hangar 1, NAS, Miramar in November 1979. The physiological data that assess vestibular and vestibulo-ocular dysfunction was obtained in the form of direct computer print-out and in analog form on magnetic tape recorders. The acute effects are being determined by applying time series analysis to the balance, eye tracking and nystagmus data. Fourteen volunteer subjects from the Air Intermediate Maintenance Department, the Final Inspection Team, and the Hush House Noise Suppressor were run through the one hour test. In addition, 14 volunteers in other regions of the Miramar station who are not around the high intensity noise were run. The test of acute effects of work-related high intensity noise on nonauditory systems and subjective response is being determined by comparing the responses in two groups. Statistical analysis consists of comparing the group mean spectra for the measure of balance from a biomechanical force platform, group mean cross-correlograms for eye-tracking, and group mean measures of abnormal nystagmus as determined from polygraph print-outs. The group mean brain stem auditory response, consisting of seven positive waves in the 10 millisecond epoch following an auditory stimulus, is similarly compared between groups. The second part of this work which is directed toward the measure of chronic, degenerative or suppressed effects of work-related high intensity noise is scheduled to begin this year. Health records from personnel having long periods of noise exposure will be compared to records from personnel not so exposed. The variables of interest will include cardiovascular disorders, sleep problems and other malfunctional medical or behavioral data. This part of the work will consist of extracting pertinent information from existing data banks and utilizing a multivariate statistical procedure, such as discriminant function analysis, to determine the extent to which the variables of interest can classify individuals into noise-related work histories. In addition, it will be important to measure the psychophysiological aspects of high noise work environments. Cardiovascular malfunction, as measured by electrocardiograms and peripheral vasomotor tone will be determined. Cognitive and sensory motor function will be determined by a neuropsychological test battery, and sleep disorders, as measured by sleep stage percentages will be determined.

Summary of Findings: The data from the first phase of the study are currently being analyzed. The conclusion so far is that neurophysiological damage at the level of the brain stem and the major auditory sensory pathway is not in evidence in this sample. Vestibulo-ocular and whole body balance, as measures of noise-induced acute effects, will be determined shortly. Somatic complaints, which are assessed with the Wahler Physical Systems Inventory, have also been analyzed and show that the group exposed to high noise work environments have no greater subjective level of physical complaints or negative mood than the control group. Group mean differences were assessed with student's t-test.

Period of Performance: 1979-1984.

Investigator: David Hord, Environmental Physiology Division, Naval Health Research Center, P.O. Box 85122, San Diego, CA 92138.

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1979	1980	1981	1982
			80	80

Title: EFFECTS OF NOISE AND HEAT AS COMBINED ENVIRONMENTAL STRESSORS ON PERFORMANCE AND PHYSIOLOGICAL STATES IN NAVY MACHINERY SPACES

Objective: To 1) determine whether the separate stressors heat and noise, when present simultaneously, interact to produce greater effects on man than either stressor applied alone; 2) measure the extent of such interactive effects; and 3) determine whether a need exists to modify existing threshold limit values for heat and noise for those situations in which both stressors are present simultaneously. The environments of immediate interest are submarine and shipboard machinery spaces.

Description: An experiment will be conducted on human volunteers to measure the effects of noise and heat stressors on physiological and psychological variables known to be affected by these stressors operating singly or in combination. Subjects will be exposed to combinations of noise and heat levels ranging from comfortable (65 dBA, 20 degrees C.WBGT) to uncomfortable (95 dBA, 32 degrees C.WBGT) while performing psychomotor tasks. Heart rate, blood pressure, core temperature and other variables will be measured throughout the exposure and temporary auditory threshold shifts will be measured at the completion of the exposure. These data will provide the basis for recommending modifications to existing threshold limit values for heat and noise.

Period of Performance: 1980-1982.

Investigator: P.F. Smith, Auditory Department, Naval Submarine Medical Research Laboratory, Groton, CT 06340 (203/449-3398).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1980	1981	1982
		55	55

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: THE PREVALENCE OF HEARING LOSS AMONG VARIOUS NAVY RATED PERSONNEL

Objective: To determine the prevalence of hearing loss among various Navy rated personnel.

Description: Hearing threshold levels and noise history questionnaire data were obtained on statistically significant numbers of Navy personnel working in various Navy rated job specialties. Average hearing levels for the various specialties were compared with baseline audiometric threshold data obtained from young adult males entering the Navy and control groups of equivalent time in service.

Summary of Findings: Hearing loss problems were more widespread than anticipated. Over 12.5% of the control subjects and 25% of the experimental subjects had significant high frequency hearing loss.

Where Findings Published:

Robertson, R.M., Page, J.C., and Williams, C.E., "Prevalence of Hearing Loss Among Various Navy Rated Personnel." NAMRL Report 1251, September 1978.

Period of Performance: 1977-1978.

Investigator: R.M. Robertson and J.C. Page, Naval Aerospace Medical Research Laboratory, Pensacola, FL (904/452-4457).

Agency Contact: CMDR Parsons (Code 47), Naval Medical and Research Development Command, Bethesda, MD (301/295-1028).

Fiscal Year Funding ($1000):	1975	1976	1977	1978	1979
	40.8	109	102.5		

Title: ACUTE AND CHRONIC EFFECTS OF NOISE EXPOSURE ON COCHLEAR VASCULATURE

Objective: To evaluate the influence of brief (30 minutes) noise exposure of high intensity on the various vascular elements of the inner ear. Immediate effects are being compared to effects observed at various times up to one month following exposure.

Description: Guinea pigs are used in this investigation. In the acute study following a 30 minute exposure, the animals are immediately decapitated, the cochleas are removed, the temporal bones decalcified, and prepared with a "soft surface preparation" technique. Vascular elements in the lateral wall, the basilar membrane and the modiolus are evaluated for density of blood cell packing, the appearance of pericytes, vessel wall thickness and avascular channels.

Summary of Findings: While the studies are not yet completed, the evidence, particularly from the acute exposure indicates primary effects on vessels of the basilar membrane, consisting of a decrease in vessel lumen, and an increase in the appearance of pericytes. An increase in red blood cell packing in both the basilar membrane vessels and vessels of the lateral wall have been observed.

Period of Performance: 1978-1980.

Investigator: Alf Axelsson, University of Goteborg, Sweden; Josef M. Miller, University of Washington, Seattle, WA (206/543-5230).

Agency Contact: Leonard Libber, Office of Naval Research (202/696-4053).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			15	15

Title: EXPLORATORY ASSESSMENT OF AUTOMATED HEARING TEST SYSTEMS FOR USE IN NAVY HEARING CONSERVATION PROGRAMS

Objective: To assess selected prototype and/or production model automated hearing test systems for potential use in Navy hearing conservation programs and to develop basic performance requirements for the development of such a system for Navy use.

Description: Exploratory laboratory and field assessments of selected prototype and/or production model automated hearing test systems were conducted. In addition to determining the relative merits of the systems, hearing threshold levels on normal hearing individuals and individuals with sensorineural hearing losses was obtained. Thresholds on the same subjects utilizing conventional manual audiometry were also obtained. Thresholds and the time required to obtain them were compared. On the basis of the exploratory assessments, a set of performance requirements for the development of an automated hearing test system for Navy use was developed.

Summary of Findings: A laboratory and field assessment of several recently developed microprocessor-controlled audiometers indicates that they produce, within acceptable variation, hearing threshold levels comparable to those obtained with manual audiometry and within similar timeframes. The new generation of audiometers makes it possible for any threshold-seeking procedure to be programmed and standardized at all test locations. Moreover, these automated hearing test instruments can also be programmed to provide fault detection algorithms which make it difficult for individuals to falsify the audiometric data. Tentative performance specifications have been identified for the development of a microcomputer-controlled audiometer for use in Navy hearing conservation programs.

Where Findings Published:

Robertson, R.M., "Exploratory Assessment of Automated Hearing Test Systems for Use in Navy Hearing Conservation Programs." NAMRL Technical Report No. 1263, 1978.

Period of Performance: 1977-1978.

Investigator: R.M. Robertson, Acoustical Science Division, Naval Aerospace Medical Research Laboratory, Pensacola, FL (904/452-4457).

Agency Contact: CMDR Parsons (Code 47), Naval Medical Research and Development Command, Bethesda, MD (301/295-1028).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
		86		

Title: DEVELOPMENT OF SPECIFICATIONS FOR A MICROPROCESSOR CONTROLLED AUDIOMETER, DATA BANK AND DATA BASE MANAGEMENT SYSTEM FOR USE IN NAVY HEARING CONSERVATION PROGRAMS

Objective: To develop specifications for a microprocessor controlled audiometer for use in Navy hearing conservation programs. Develop a hearing conservation data base and data base management system responsive to both O&M and R&D needs.

Description: Four prototype microcomputer controlled group audiometers are being field tested to include hearing tests on both military and civilian government employees. Audiometer performance specifications for the Navy are being written and input information requirements for the data bank are being defined. The applicability of available hearing conservation data base management systems for Navy use are being analyzed. A model data bank will be established.

Period of Performance: 1978-1981.

Investigator: R.M. Robertson, Naval Aerospace Medical Research Laboratory, Pensacola, FL (904/452-4457).

Agency Contact: CMDR Parsons (Code 47), Naval Medical Research and Development Command, Bethesda, MD (301/295-1028).

Fiscal Year Funding ($1000):	1977	1978	1979	1980	1981
			103	133	

Title: ASSESSMENT OF BIOMEDICAL AUDITORY INSTRUMENTATION AND DEVICES FOR NAVY USE

Objective: To enhance the selection and utilization of biomedical instrumentation and devices appropriate to specific Navy operational environments and requirements.

Description: Standardized methodologies and procedures will be utilized to conduct assessments of biomedical auditory instruments and devices (e.g., hearing protective devices, noise dosimeters, audiometers, sound level meters, etc.). In those instances where standardized assessment methodologies are non-existent, appropriate evaluative procedures will be developed to obtain the necessary data. A repository of sound attenuation and speech intelligibility data will be developed on Navy hearing protective devices and sound attenuating headsets.

Summary of Findings: Laboratory test facilities have been modified and updated to meet requirements specified in the new ANSI Standard for evaluating the real-ear attenuation of hearing protective devices. Thus far, real-ear attenuation data have been obtained on three hearing protective devices. Speech intelligibility data have been obtained on an engineering development model of a new protective communications helmet. Preliminary laboratory data and limited field data have been obtained on one of the new generation of statistical noise analyzers and profiling dosimeters.

Period of Performance: 1979-1984.

Investigator: C.E. Williams, Naval Aerospace Medical Research Laboratory, Pensacola, FL (904/452-4457).

Agency Contact: CMDR Parsons (Code 47), Naval Medical Research and Development Command, Bethesda, MD (301/295-1028).

Fiscal Year Funding ($1000):	1979	1980	1981	1982	1983
	35	48			

Title: THE RELATIONSHIP BETWEEN SELECTED NON-AUDITORY MEASURES AND THE HEARING THRESHOLD LEVELS OF AN AVIATION NOISE-EXPOSED POPULATION

Objective: To determine whether normal-hearing and impaired-hearing groups of noise-exposed naval aviators could be differentiated on the basis of selected physical, psychological, or behavioral measures.

Description: Two audiometrically dichotomous groups of retired naval aviators, each averaging 14.4 years of flying time, were identified and compared along a total of 33 nonauditory dimensions including measures of cardiovascular fitness, smoking history, alcohol use, social index, psychological temperament, and physical features.

Summary of Findings: Results indicated that the group with clinically normal hearing (n=97) had consumed fewer cigarettes for a shorter period of time than the group with impaired hearing (n=104) and that blue-eyed individuals were over-represented in the impaired hearing group and under-represented in the normal hearing group, whereas the reverse was true for brown-eyed aviators. The remaining variables failed to appear differentially in the two groups.

Where Findings Published:

Thomas, S.B., Williams, C.E., and Hoger, N.G., "The Relationship Between Selected Nonauditory Measures and the Hearing Threshold Levels of an Aviation Noise-Exposed Population." NAMRL Report No. 1266, February 1980.

Period of Performance: 1978-1979.

Investigator: Gerald B. Thomas and Carl E. Williams, Naval Aerospace Medical Research Laboratory, Pensacola, FL.

Agency Contact: J.R. Schmidt, Naval Medical Research and Development Command, Bethesda, MD (301/295-1468).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
		30	28	

U.S. NAVY (Cont'd)

Title: INDIVIDUAL DIFFERENCES IN SUSCEPTIBILITY TO NOISE-INDUCED HEARING LOSS AMONG NAVY MILITARY AND CIVILIAN PERSONNEL

Objective: To obtain basic psychoacoustic profiles of those individuals who are especially resistant to deleterious auditory noise effects and to determine whether these individuals are distinguishable along any nonauditory dimensions.

Description: Audiometric and noise exposure screening of several populations has begun in order to identify individuals (and their controls) who have successfully resisted the deleterious effects of years of hazardous noise exposure. Target and control groups will be compared along several auditory and nonauditory dimensions and a basic psychoacoustic profile of the healthy, relatively noise-resistant ears will be obtained. It is hoped that variables relevant to the ultimate development of a multivariate noise susceptibility test battery will be identified.

Period of Performance: October 1979-ongoing.

Investigator: Gerald B. Thomas, Carl E. Williams, and Ronald M. Robertson, Naval Aerospace Medical Research Laboratory, Pensacola, FL (904/452-4457).

Agency Contact: CMDR Parsons (Code 47), Naval Medical Research and Development Command, Bethesda, MD (301/295-1028).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
				45

Title: SUSCEPTIBILITY AND EARLY DETECTION OF NOISE-INDUCED HEARING LOSS THROUGH HIGH-FREQUENCY AUDIOMETRY

Objective: To 1) develop a high-frequency audiometric procedure for Navy Hearing Conservation Programs that would enable early detection of noise-induced hearing loss (NIHL), as well as identification of individuals that are more or less susceptible to this impairment; and 2) survey currently available high-frequency audiometers and make recommendations as to the most efficient and reliable device for use in a broadbased NIHL screening program. Accomplishing these objectives could serve to improve prevention and rehabilitation of noise-induced hearing loss, and alleviate many conservation and compensation costs.

Description: Hearing sensitivity and presence of temporary and permanent hearing loss due to noise exposure in the frequencies between 500 to 8000 Hz and between 8000 to 18,000 Hz (high-frequency audiometry) will be evaluated in two groups: 1) a sample of Navy personnel currently working in hazardous noise environments; and 2) a sample of applicants to Submarine School with normal hearing, exposed to intense band-limited noise in laboratory conditions. An analysis of the power of high-frequency audiometric tests to detect noise-induced hearing loss will be made, and their feasibility and cost-effectiveness will be evaluated.

Period of Performance: 1980-1982.

Investigator: P.F. Smith, Auditory Department, Naval Submarine Medical Research Laboratory, Groton, CT 06340 (203/449-3398).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1979	1980	1981	1982
			33	33

Title: CONCURRENT VALIDATION OF AUDIOMETRIC COMPUTER PARADIGMS FOR NAVY HEARING CONSERVATION PROGRAMS

Objective: To explore the utility of a computerized version of a self-recording audiometric test.

Description: The study will compare data obtained with the experimental computerized self-recording paradigm and two additional experimental paradigms with criterion data taken under existing standard field and clinical practices. These comparisons will yield a basis for recommending the adoption of an efficient, reliable, and valid computer controlled audiometric technique for use in Navy hearing conservation programs. Three experimental computer administered audiometric tests will be given to Navy personnel and civilian employees included in the hearing conservation program at the Submarine Base, New London. Two criterion tests will also be administered. These will be (1) a standard audiometric procedure administered by hearing conservation program technicians and (2) a standard audiometric test independently administered by NSMRL clinical audiologists. The data will be analyzed to identify the experimental paradigm having the highest utility for hearing conservation program purposes.

Period of Performance: 1979-1980.

Investigator: P.F. Smith, Auditory Department, Naval Submarine Medical Research Laboratory, Groton, CT 06340 (203/449-3398).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
				29

Title: COMPARISON OF THE VALIDITY AND COST-EFFECTIVENESS OF COMPUTERIZED INDIVIDUAL AND GROUP AUDIOMETRIC SYSTEMS

Objective: To develop a cost-effective group audiometric system of the highest validity for use in Navy hearing conservation programs. This work unit applied computer techniques to create the most efficient group testing system which will (1) accommodate large numbers of persons with minimal reliance on the intervention of audiometric technicians, (2) provide record-keeping and retrieval functions, (3) require the least time away from work for the tested persons, and (4) be uniform throughout the Navy.

Description: Eight separate testing methods were under investigation. A computer presents stimuli, records and evaluates responses, and stores data for interrogation. Each method was compared with standard manual clinical audiometry. Methods were assessed for cost-effectiveness on uniformed personnel and on naval civilian employees in shipyards and shops.

Summary of Findings: Of several considered, three paradigms for individual audiometry have been evaluated experimentally. All were found to be as reliable as manual audiometry. A computer controlled version of the adaptive Bekesy paradigm was shown to excel in test-retest reliability, ability to test difficult subjects, and to require the least time. It took an average 12.7 (±4) seconds to measure a hearing threshold at a single frequency as compared to 30 seconds for commercial self-recording audiometers and a minimum of 40 seconds for a computerized Hughson-Westlake procedure. Further work with pulse-count audiometry confirmed its utility for large group testing. This method is not efficient for individual testing.

Where Findings Published:

1) Harris, J.D., "Proem to a Quantum Leap in Audiometric Data Collection and Management." J. Auditory Research, 18:1-27, 1978 (NSMRL Rept. No. 900).

2) Harris, J.D., "Optimum Threshold-Crossings and Time-Window Validation in Pure-Tone Computerized Audiometry." J. Acoust. Soc. Amer., 66(5): 1545-1547, Nov. 1979 (NSMRL Rept. No. 889, May 8, 1979).

3) Harris, J.D., and Smith, P.F., "A Comparison of a Standard and a Computerized Adaptive Paradigm in Bekesy Fixed-Frequency Audiometry." J. Auditory Research, 19:1-22, 1979 (NSMRL Rept. No. 901).

4) Harris, J.D., "The NSMRL Group Pure-Tone Audiometer in 1979." NSMRL Rept. No. 910.

Period of Performance: 1977-1979.

Investigator: J.D. Harris, Auditory Department, Naval Submarine Medical Research Laboratory, Groton, CT 06340 (203/449-3398).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
		16.5	16.5	

U.S. NAVY (Cont'd)

Title: AIRBORNE NOISE REDUCTION

Objective: To develop and fabricate a hearing protective device with the following specifications: shall provide 25 to 30 dB attenuation within specified frequency range, shall be comfortable, and shall be easily cleaned.

Description: Physical properties, acoustic attenuation and criteria used for the selection of materials chosen for the earcup and seal were evaluated. Drawings with dimensions and approximate weights for the individual components were provided as well as sizing requirements to fit the device to the 96th percentile. Results of prototype testing, demonstrating the devices's attenuation properties and prolonged wearability were prepared.

Summary of Findings: All objectives were met. Tests and analysis are complete. The final report and 500 units of the prototype protector were delivered.

Period of Performance: 1978-1979.

Investigator: R.S. Harrah; M. Lepor, Naval Ocean Systems Center.

Agency Contact: Commander, Naval Ocean Systems Center, San Diego, CA 92152 (Code 5121) Attention: M. Lepor (714/225-7916).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
		15	15	(approx.)

BEHAVIORAL, SOCIAL AND PERFORMANCE EFFECTS

Title: DEVELOPMENT OF AUDITORY PERFORMANCE STANDARDS FOR NAVY AVIATION PERSONNEL

Objective: To develop a workable set of psychoacoustic standards which reflect the operational requirements for the human auditory system over a broad spectrum of naval aviation tasks.

Description: The research will define the role of the human auditory system in relation to task performance. Auditory requirements will be derived from an operational model of task performance. Inputs to the model will come from: 1) analyses of operational tasks; 2) analyses of operationally relevant auditory sensory inputs and auditory processing requirements; 3) analyses of environmental and psychophysiological factors which influence auditory performance; and 4) laboratory and field experiments utilizing military personnel to confirm the applicability of the psychoacoustic standards.

Summary of Findings: Requisite auditory tasks have been tentatively identified and are being tested in laboratory experiments.

Period of Performance: 1976-1981.

Investigator: James D. Mosko, Naval Aerospace Medical Research Laboratory, Pensacola, FL (904/452-4457).

Agency Contact: CMDR Biersner (Code 44), Naval Medical Research and Development Command, Bethesda, MD (301/295-1525).

Fiscal Year Funding ($1000):

1977	1978	1979	1980
23	52	46	55

NOISE ENVIRONMENT DETERMINATION AND EXPOSURE CHARACTERIZATION

Title: DEVELOPMENT AND VALIDATION OF SHIPBOARD NOISE EXPOSURE DATA ACQUISITION PROCEDURES

Objective: To 1) identify the Navy information needs on shipboard noise exposure and occupational hearing loss, 2) assess the presently used shipboard noise exposure compliance procedures, 3) develop a noise data acquisition system that is compatible with present practice and the requirements of a noise exposure data management system, and 4) validate the effectiveness and accuracy of the proposed system.

Description: The study is to develop and validate a noise data acquisition procedure which is consistent with the requirements of the noise exposure model. A model was previously designed to calculate personnel noise exposure, to rank order noisy shipboard locations in accordance with their contributions to noise exposure and to compute minimum noise reduction requirements. This procedure, to be used by regional Environmental Preventive Medicine Units (EPMU) would form the basis of a noise exposure data management system that may be used in hearing conservation programs, individual ship compliance inspections and be an aid in setting priorities for engineering noise control programs. An evaluation of the present noise level measurement practices was conducted at the regional EPMU's in San Diego, California and Norfolk, Virginia. Based on these results a set of forms and procedures was developed. These forms, designed specifically to survey the engineering spaces of the FF1052 class, contain all of the information necessary to compute noise exposure including standardized measurement locations, personnel assignment data and ship operating conditions.

Summary of Findings: To date, 10 ships have been surveyed and the necessary acoustic and manning information collected. Two additional ships will be surveyed in the near future. Using the model, the personnel noise exposure of the engineering personnel will then be calculated. An assessment of the accuracy of the method will be made by comparing the calculated values with dosimetry information.

Where Findings Published: Relevant information can be found in the following report. It is not, however, a final report.

Kugler, B.A., Hale, M.E., and Rentz, P.E., "Occupational Noise Exposure on FF1052 (Knox) and DD963 (Spruance) Class Ships," BBN Report 3410, January 1977.

Period of Performance: 1978-1980.

Investigator: B. Andrew Kugler and E.G. Wilby, Bolt, Beranek and Newman, Inc., Los Angeles, CA 90305 (213/347-8360).

Agency Contact: D. Woodward, Office of Naval Research, Arlington, VA (703/696-4053).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			60.9	

Title: AIRBORNE NOISE CRITERIA FOR SHIPS

Objective: To establish measurement methods and criteria for limiting airborne noise in ship spaces, and prepare enforceable specifications for acceptable noise by ship equipment. Airborne noise on Naval vessels is a constant threat to operational capability and crew safety. Noise interferes with hearing verbal commands, produces hearing loss, and limits habitability of quarters. Since noise quieting is costly, a constant review of Naval missions and tasks as affected by noise is necessary to set cost-effective criteria for noise on ships.

Description: Measurements of airborne noise were to be obtained in various ship interior spaces and compared with measures of performance and habitability. Data were obtained on shipboard and in the laboratory. The adequacy of measurement procedures were evaluated under actual shipboard conditions in the laboratory, in the field, and in contractor plants.

Summary of Findings: Noise measurements and crew questionnaires providing data on criteria in B&C spaces were obtained and are being analyzed for eight Navy ships. Reports on measured noise levels, a subjective data analysis method, and requirements for sleep, solving problems, and speech communication in shipboard spaces have been prepared. Data were collected to support ship design. Noise data from Navy ships are being compared with similar data from US merchant ships. Laboratory tests are underway which investigate the effects of hearing protectors on threshold, localization, detection, and identification of shipboard machinery sounds ("cues"). Tests use rooms with controlled reverberation time, recorded ship engineering noise, and multiple loudspeakers. The first threshold test has been analyzed and a report is in preparation. Additional tests are underway.

Where Findings Published:

1) Lambert, D.R., and Hafner, F.S., "Behavioral and Physiological Effects of Noise on People; a Review of the Literature," NOSC TD 267, April 30, 1979.

2) Lambert, D.R., "Airborne Noise Levels on Merchant Ships," NOSC TD 243, April 30, 1979.

3) Lambert, D.R., "A Simple Method for Predicting Subjective Response to Noise on Navy Ships," NOSC TD 296, November 15, 1979.

Period of Performance: 1960-present.

Investigator: R.S. Gales, D.R. Lambert, and R.G. Klumpp (NOSC 5121) (714/225-7255).

Agency Contact: Commander, Naval Ocean Systems Center, San Diego, CA 92152 (Code 5121), Attention: M. Lepor (714/225-7916).

Fiscal Year Funding ($1000):

1975	1976	1977	1978	1979	1980
50	50	72.5	50	60	110

U.S. NAVY (Cont'd)

Title: ENVIRONMENTAL NOISE DATA SYSTEM

Objective: To validate technology and instruments for acquisition of environmental noise data in the vicinity of Air installations, and be cost-effective and compatible with current NAVSEA and DOD guidelines. Determine suitability of equivalent continuous sound level (Leq) as basic noise measure for land use planning. Recommend adjustments were needed. Optimize procedures for application of Leq criteria.

Description: Portable noise monitoring equipment was tested with direct digital printout. The utility, cost and reliability was compared with that of conventional instruments. The influence of local topography and weather on noise was investigated. Also investigated was the utility of a continuous noise monitor system for a Naval Air Station, compared with alternative monitoring equipment. A cost-benefit matrix was developed for evaluating alternatives for procurement. NAS Miramar operations data was analyzed to specify "average busy day." Laboratory listening tests were conducted to determine helicopter "blade-slap" and ground run-up corrections. The effect of ground run-up noise duration on annoyance was studied.

Summary of Findings: All work on specification and evaluation of portable noise monitoring equipment is completed. Studies of the effect of helicopter blade slap on annoyance were completed. Recordings for the ground run-up noise duration study have been obtained. Studies comparing noise of military versus commercial airports will use data from Lindbergh Field, which was recently obtained on a separate project.

Where Findings Published:

1) "Field Experience with Three Types of Portable Integrating Noise Monitors," NOSC Technical Report 251, September 1977.

2) Klumpp, R.G., and Schmidt, D.R., "Annoyance of Helicopter Blade Slap," NOSC Technical Report 247, July 3, 1979.

3) "Aircraft Noise Monitoring at Naval Training Center and Marine Corps Recruit Depot in San Diego in 1978 and 1979." NOSC-TR-465, September 1979.

4) (NOSC-115)

Period of Performance: 1976-ongoing.

Investigator: R.S. Gales (NOSC 5121) (714/225-7255).

Agency Contact: Commander, Naval Ocean Systems Center, San Diego, CA 92152 (Code 5121), Attention: M. Lepor (714/225-7916).

Fiscal Year Funding ($1000): 1977 1978 1979 1980

24

Title: MERCHANT MARINE OCCUPATIONAL NOISE

Objective: To provide information on existing noise levels and vibration levels aboard U.S. Coast Guard inspected and certificated vessels, inspected and non-certificated vessels, and outer continental shelf oil and gas drilling platforms, in order that the Coast Guard may promulgate the necessary regulations or requirements to insure the safety of personnel involved in these operations.

Description: Background information will be expanded on noise and vibration conditions on U.S. Merchant vessels and outer continental shelf drilling platforms. This will involve conducting noise measurements on selected merchant ships and a comparison with existing noise survey data. Noise and vibration measurements will be taken aboard outer continental shelf oil and gas drilling platforms selected to be representative of types and locations currently in use. The occupational noise exposure problem aboard these platforms will be evaluated. A standard procedure for measurement of merchant ship noise will be developed and evaluated.

Summary of Findings: Earlier data on shipboard noise measurements on large tankers, freighters, and ore carriers has been supplemented by measurements on smaller vessels, which include tugs, ferries, fishing boats, and assorted work boats. Noise and vibration measurements have been made on two offshore oil platforms. These include an oil island and a fixed leg-supported platform. A standard procedure for shipboard noise measurement has been prepared and submitted to the U.S. Coast Guard.

Where Findings Published:

1) Gales, R.S., Schmidt, D.R., and Lambert, D.R., "Noise on US Merchant Ships," NOSC TD 257, April 30, 1979.

2) Gales, R.S., "Airborne Noise Limits for Merchant Ships," NOSC TD 254, April 30, 1979.

3) Lambert, D.R., "Airborne Noise Levels on Merchant Ships," NOSC TD 243, April 30, 1979.

4) Schmidt, D.R., "Noise Levels and Crew Noise Exposure Aboard US Merchant Vessels," NOSC TR 405, April 30, 1979.

Period of Performance: 1978-ongoing.

Investigator: R.S. Gales, D.R. Schmidt, and D.R. Lambert (NOSC 5121) (714/225-7255).

Agency Contact: Commander, Naval Ocean Systems Center, San Diego, CA 92152 (Code 5121), Attention: M. Lepor (714/225-7916).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			56.6	93

Title: ENVIRONMENTAL NOISE STUDY: MARINE CORPS RECRUIT DEPOT-NAVAL TRAINING CENTER

Objective: To provide information on the impact of noise from aircraft operations at Lindbergh Field on the Marine Corps Recruit Depot (MCRD) and Naval Training Center (NTC), San Diego, California, for facilities planning, and to determine compliance of Lindbergh Field with existing agreements.

Description: Initial efforts determined the distribution of noise at various locations, and its variation with time of day, and day of week at MCRD and NTC. This was accomplished by placing portable, digital recording noise monitors at strategic locations at each base and measuring continuously at such locations for sufficient time to determine the time dependence of the noise. Locations were selected to determine the effect of specific flight patterns. MCRD personnel assisted by observing specific flight patterns and aircraft types. Data from the Lindbergh Field fixed monitor system was compared with that from the Navy monitors. Future noise conditions will be estimated based on predictions of Lindbergh Field traffic.

Summary of Findings: Aircraft noise from Lindbergh Field was measured during 1978 and 1979 at selected locations within the Naval Training Center (NTC) and the Marine Corps Recruit Depot (MCRD) and compared with noise measured by another organization in 1972. The comparison showed that at two locations the noise level had increased and at one location it had decreased. Noise contours based on the 1978-1979 measurements were generated for NTC and MCRD using a NOISEMAP computer program. Contours were then projected to 1985 by using assumptions concerning aircraft mix and numbers of operations.

Where Findings Published:

Schmidt, D.R., and Klumpp, R.G., "Aircraft Noise Monitoring at Naval Training Center and Marine Corps Recruit Depot," NOSC Technical Report 465, September 15, 1979.

Period of Performance: January 1979-September 1979.

Investigator: R.S. Gales (NOSC 5121) (714/225-7255).

Agency Contact: Commander, Naval Ocean Systems Center, San Diego, CA 92152 (Code 5121), Attention: M. Lepor (714/225-7916).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			13	

Title: VIEQUES LITIGATION SUPPORT

Objective: To provide expert witness on environmental impact of Navy-generated noise at Vieques, Puerto Rico.

Description: An environmental noise data base was established on Navy-generated noise at Vieques by acoustical measurement and a literature search.

Summary of Findings: Measurements of noise of Navy flight and weapons operations were made over a period of 11 days at four key locations on Vieques. These data have been analyzed and integrated with data available from other sources. Testimony was delivered at the court sessions in October-November. A final documentation of noise finding has been prepared.

Where Findings Published:

Young, R.W., "Noise Measurements on Isla de Vieques." NOSC TN 549, January 1979.

Period of Performance: September 1979-January 1979.

Investigator: R.W. Young (NOSC 5121) (714/225-7916).

Agency Contact: Commander, Naval Ocean Systems Center, San Diego, CA 92152 (Code 5121), Attention: M. Lepor (714/225-7916).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			10.1	

Title: NAVY NOISE POLLUTION ABATEMENT

Objective: To 1) define Navy's noise problems; 2) coordinate the Navy noise pollution abatement efforts; and 3) promulgate cost-effective solutions while maintaining mission readiness.

Description: Assigned programs were reviewed with program managers at NAVSEA, NAVFAC, NAVAIR, and BUMED. Means for consolidating and coordinating the overall abatement effort were developed. An optimal resource base for the mitigation of the Navy's noise problems was also developed. Cost-effective solutions were evaluated.

Summary of Findings: An Exploratory Development Program Plan for Navy Airborne Noise Pollution Abatement was prepared. An Airborne Noise Information Exchange was established to compile information in order to facilitate cost-effective solutions. A Program Plan with responsible personnel at NADC, NAVSEA, NAVFACENGCOM and BUMED was reviewed. A report for detailing hearing loss compensation and projected savings of noise abatement strategies is in preparation.

Period of Performance: 1978-ongoing.

Investigator: M. Lepor (NOSC 5121) (714/225-7916).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			35	50

DEPARTMENT OF EDUCATION

DEPARTMENT OF EDUCATION

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: THE CONDITION OF CLASSROOM AMPLIFICATION IN A PUBLIC SCHOOL PROGRAM

Objective: To 1) investigate the types of classroom amplification systems that are currently in use in the United States; and 2) examine several performance aspects of these systems.

Description: The investigation primarily involved a questionnaire developed especially for this study. Questions centered around the type of system used as well as several performance parameters of those systems.

Summary of Findings: It has been determined that most programs use the wireless FM system, but the respondents expressed dissatisfaction with the system or with the service needs of the equipment and repair policies of the manufacturer. A sample of the devices used in a typical school setting will be evaluated for faulty components, and assess the electroacoustic characteristics of the aids used in an actual school setting.

Period of Performance: July 1979-December 1979.

Investigator: Fred H. Bess, Vanderbilt University, Nashville, TN 37232 (615/322-2446).

Agency Contact: Allen Dittmann, Department of Education, Bureau of Education for the Handicapped, Washington, DC (202/245-9836).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	13			

Title: ELECTROACOUSTIC ASSESSMENT OF FM TRAINERS IN THE SCHOOLS

Objective: To 1) assess laboratory electroacoustic performance characteristics for contemporary FM auditory trainers, and 2) compare these laboratory results to the electroacoustic findings measured under classroom conditions.

Description: Classroom amplification systems for the hearing-impaired were measured in this project under laboratory conditions and classroom conditions. Included in this comparison were such variables on signal transmission as distance between teacher transmitter unit and student receiver unit, effects of classroom lighting, and body baffle effects.

Period of Performance: July 1979-December 1979.

Investigator: Fred H. Bess and J. Stephen Sinclair, Bill Wilkerson Hearing & Speech Center, Nashville, TN 37212 (615/320-5353).

Agency Contact: Allen Dittmann, Department of Education, Bureau of Education for the Handicapped, Washington, DC (202/245-9836).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
		5.8		

DEPARTMENT OF ENERGY

DEPARTMENT OF ENERGY

INDIVIDUAL AND COMMUNITY RESPONSE

Title: TRANSMISSION LINE AUDIBLE NOISE MEASUREMENTS*

Objective: To provide data bases and the accompanying psychoacoustic research required for managing, through land use planning and building design, the noise emitted by extra high voltage and ultra high voltage transmission lines.

Description: This project is being done in cooperation with the Department of Energy. Corona noise samples for different weather conditions and from different transmission lines are recorded with an already-developed remote tape recording system. These recordings are returned to the laboratory where they are processed along with recordings of other environmental sounds into stimulus tapes. These stimulus tapes are evaluated by listeners under realistic conditions approximating natural environments. The effects of the building shell on the listener's response to corona noise are to be determined also. On the basis of people's responses, criteria will be developed for characterizing the acoustic environment near transmission lines in terms that are relevant to human response, so that decisions about land use planning, building design and construction may be based on users' needs.

Summary of Findings: Five psychoacoustic experiments have been conducted so far. The following are the major findings to date: 1) Corona noise is equally aversive to certain other environmental sounds 8 dB higher in sound level; 2) corona noise is roughly equal in aversiveness to the noise from a room air conditioner; 3) A-weighted sound level predicts listener's response quite well, but D-weighted sound level appears slightly better; 4) knowledge of the source of the corona noise under laboratory conditions does not affect its relative aversiveness; 5) the high-frequency hissing and crackling components are more aversive than the low-frequency humming and buzzing components; 6) distinctly different kinds of corona noise were found, differing both in frequency spectrum and relative aversiveness; and 7) although corona noise heard indoors is less aversive than the corresponding corona noise heard outdoors, indoor listening conditions reduce the aversiveness of corona noise less than they do the aversiveness of certain other environmental noises.

Where Findings Published:

1) Molino, J.A., Zerdy, G.A., Lerner, N.D., and Harwood, D.L., "Human Response to Audible (Corona) Noise from Electric Transmission Lines." J. Acoust. Soc. of Amer., 66:1435-1445, 1979.

2) Molino, J.A., Zerdy, G.A., Lerner, N.D., and Tremaine, S.G., "Initial Psychoacoustic Experiments on the Human Response to Transmission Line Audible Noise." Dept. of Energy Rept. DOE/ET/6010-1, pp. 1-80, 1979.

* Project also listed under NBS, p. A-9.

DOE (Cont'd)

3) Molino, J.A., Zerdy, G.A., Lerner, N.D., and Harwood, D.L., Psychoacoustic Evaluation of the Audible Noise from EHV Power Lines." 7th IEEE/PES Transmission and Distribution Conference and Exposition. IEEE Rept. 79CH1399-5-PWR, pp. 95-98, 1979.

4) Molino, J.A., Zerdy, G.A., and Tremaine, S.G., "Psychoacoustic Evaluation of Transmission Line Audible Noise: Building Attenuation Effects, Methodology Comparison, and Field Study Feasibility." Dept. of Energy Rept. (to be published).

Period of Performance: 1976-present.

Investigator: John A. Molino and Gerald A. Zerdy, Department of Commerce, NBS, Washington, DC (301/921-3704).

Agency Contact: Alec Bulawka, U.S. Dept. of Energy (202/633-9296).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
	93	233	180	200	200

U. S. ENVIRONMENTAL PROTECTION AGENCY

U.S. ENVIRONMENTAL PROTECTION AGENCY

NONAUDITORY PHYSICOLOGIC RESPONSE

Title: NOISE EXPOSURE AND CARDIOVASCULAR FUNCTION*

Objective: To determine whether realistic patterns of long-term noise exposure influence cardiovascular regulations.

Description: In order to maximize the utility of the results for predicting human reactions, the following methodological design has been employed:

a) Use of a primate model;
b) Careful control and specification of the stimulus: 24 hour noise exposure sequence consisting of representative transportation, household and industrial noises (Leq24 = 86 dB);
c) Exclusion or control of potentially confounding variables;
d) Computer-based sampling of cardiovascular responses; heart rate and blood pressure sampled on a minute by minute basis;
e) A protracted exposure period.

The study will be expanded in FY 81 to increase the number of animals and to begin to examine in detail the cardiovascular and biochemical changes related to the observed blood pressure elevation.

Summary of Findings: Results from the first four animals indicate that daily exposure over nine months to everyday and industrial noise episodes, produced in the two experimental animals sustained elevations in blood pressure but not in heart rate to return to control or pre-exposure levels was observed during a 30-day post-exposure period. An important facet of these findings is that the cardiovascular changes were produced in the absence of measurable hearing loss.

Where Findings Published:

1) Peterson, E.A., Tanis, D.C., Augenstein, J.S., Seifer, R.A. and Bromley H.R., "Noise and Cardiovascular Function in Rhesus Monkeys: II," In: Third International Congress on Noise as a Public Health Problem. Ed. J.V. Tobias, et al., ASHA Monographs.

* Project also listed under NIEHS, p. A-187.

2) Peterson, E.A., "Noise and Laboratory Animals," In: Defining Laboratory Animal and Its Environment: Setting the Parameters. Ed. E.C. Melby Jr., Laboratory Animal Science (In Press).

3) Peterson, E.A.; Augenstein, J.S.; Tanis, D.C.; and Augenstein, D.G., "Noise Raises Blood Pressure without Impairing Auditory Sensitivity," Science, (in press).

Period of Performance: 1978-1983.

Investigator: E.A. Peterson, University of Miami School of Medicine, Miami, FL (305/547-6413).

Agency Contact: David M. DeJoy, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000)*:	1977	1978	1979	1980	
	52	35	99	136	(EPA)
	30	39	39		(NIEHS)

* Jointly funded study from 1977-79.

Title: EXTRA-AUDITORY HEALTH EFFECTS OF INDUSTRIAL NOISE: SURVEY OF FOREIGN LITERATURE

Objective: To examine and interpret data from studies in the European literature on the nonauditory physiologic effects of noise.

Description: The report is a summary of the author's interpretation of key studies in the European literature on the nonauditory physiologic effects of noise. The literature review includes a cross-section of long-term occupational noise exposure studies investigating the nonauditory effects of noise in a number of different nations and many different industries. The foreign literature reviewed predominately includes studies investigating the cardiovascular effects of noise. However, studies considering the gastrointestinal, neurological, infectious disease, and reproductive effects of noise are also described.

Summary of Findings: Based on the literature reviewed, the author concludes that there is very substantial evidence that long-term work under high level industrial noise exposures is associated with chronic changes in cardiovascular function. The best documented change is an impaired regulation of blood pressure, mostly manifested as an increased prevalence of hypertension in the middle and latter decades of life. Interpretation of these observations is subject to the usual constraints inherent in the analysis of retrospective data.

Where Findings Published:

Welch, B., Extra-Auditory Health Effects of Industrial Noise: Survey of Foreign Literature. Final Report Prepared for Aerospace Medical Research Laboratory, AMRL-TR-79-41, June 1979.

Period of Performance: 1978-1979.

Investigator: Bruce Welch, Welch Associates, Woodbridge, CT 06525.

Agency Contact: David M. DeJoy, EPA/ONAC (703/557-0592).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	3.5			

Title: HYPOTHESIZED RELATIONSHIPS BETWEEN NOISE, GENERAL STRESS RESPONSES, AND CARDIOVASCULAR DISEASE

Objective: To provide a detailed analysis and assessment of the relationship between noise exposure and cardiovascular system effects, taking into consideration contemporary concepts of biologic stress and cardiovascular disease processes.

Description: This project involved a critical review of relevant literature, and the development of a coherent framework which attempted to synthesize the results of research in the many disciplines relevant to understanding stress-mediated cardiovascular effects of noise. The results of this analysis, in the form of a working paper, served as the focal point of a workshop in which experts from various disciplines (physiology, biostatistics, bioacoustics, etc.) addressed the major conceptual and methdological issues in this area. The workshop resulted in modifications and/or elaborations of the framework, and the identification of promising areas for future experimental and epidemiological research.

Summary of Findings: Although the possible relationships between noise, stress and cardiovascular disease are extraordinarily complex, the available information provides substantial grounds to suspect that under some circumstances transient responses to high level noise exposure may contribute to cardiovascular pathology. Evidence appears most prevalent for increased risk for hypertention. Other evidence, although more indirect, tends to suggest the possibility of the involvement of noise in other cardiovascular disease processes as well. Some conceptual problems and a number of promising research approaches and methodologies are identified.

Where Findings Published:

"Noise, General Stress Responses, and Cardiovascular Disease Processes: Review and Reassessment of Hypothesized Relationships," EPA/ONAC Final Report, June 1980.

Period of Performance: 1978-1980.

Investigator: Nicholas A. Ashford and Dale Hattis, Center for Policy Alternatives, Massachusetts Institute of Technology, Cambridge, MA 02139 (617/253-1667).

Agency Contact: David M. DeJoy, EPA/ONAC (703/557-0592).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	28.7	10.3		

Title: EPIDEMIOLOGY FEASIBILITY STUDY: EFFECTS OF NOISE ON THE CARDIOVASCULAR SYSTEM

Objective: To assist EPA/ONAC in determining the feasibility of conducting epidemiological research on the nonauditory physiological effects of noise, particularly cardiovascular effects. The results will provide guidance to EPA in developing a program of epidemiology research as well as the general form that such a program should take.

Description: The components of this study will include:

A) Providing a review and critical analysis of existing foreign and domestic epidemiological research on the nonauditory physiological effects of noise.

B) Reviewing the scientific literature on hypertension, cardiovascular disease, and general stress for its applicability to noise effects epidemiology.

C) Providing information and recommendations pertinent to a number of substantive and methodological issues related to the design and conduct of future noise effects epidemiology.

Period of Performance: 1980-1981.

Investigator: Dr. Shirley J. Thomson, Dept. of Epidemiology and Biostatistics, University of South Carolina, Columbia, SC 29208 (803/777-7353).

Agency Contact: David M. DeJoy, EPA/ONAC (703/557-0592).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
			50	40

NOISE EFFECTS ON SLEEP

Title: HEALTH CONSEQUENCES OF CHRONICALLY NOISE DISTURBED SLEEP

Objective: To begin to describe and quantify the impact of chronic noise disturbance of sleep. While noise is known to produce disturbed sleep patterns, the ultimate effects of this disturbance on health and performance are not well known, aside from subjective reports.

Description: The study will characterize the sleep, daytime sleepiness, performance, respiratory and cardiac function, and response to stress, throughout 24 hours in ten apparently normal male subjects, aged 40-50, who are chronically exposed to airport noise during sleep. These results will be compared to the data obtained from an identical study of ten matched control subjects, not exposed to noise during sleep. The study of the ten noise-disturbed subjects will be repeated during five nights of sleep in an environment with low noise levels.

Period of Performance: 1980-1981.

Investigator: William C. Dement, Sleep Research Center, Stanford University, School of Medicine, Stanford, CA 94305 (415/497-7859).

Agency Contact: Raelyn Janssen, EPA/ONAC (703/557-0592).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
			50	60

INDIVIDUAL AND COMMUNITY RESPONSES

Title: PSYCHOACOUSTIC STUDY OF ENGINE BRAKE NOISE

Objective: To examine the ability of existing sound descriptors to acceptably account for anticipated human response to the peculiar characteristics of engine brake noise, most notably repetitive-impulsiveness.

Description: The investigator will acquire a data base of the characteristics of engine brake operation and use. Once this information has been obtained a psychoacoustic test program will be initiated. The laboratory test program will (1) comparatively evaluate listener's subjective (annoyance) responses to engine brake noise relative to truck and bus noise without the brake, and to other automotive and non-automotive stimuli, and (2) evaluate the effectiveness of various measures of impulsiveness to predict subjective response. The test signals will be in a range realistically approximating community exposure and will be presented to simulate indoor listening conditions.

Period of Performance: 1980-1981.

Investigator: Sanford Fidell, Bolt, Beranek and Newman, Inc., Los Angeles, CA (213/347-8360)

Agency Contact: Jeffrey Goldstein, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
			60	

U.S. EPA (Cont'd)

Title: SOCIAL SURVEY AROUND CONSTRUCTION SITES

Objective: To acquire community response data around construction sites, and establish a relation between construction noise and degree of community impact. No social survey data currently exists that are directly applicable to construction noise.

Description: During Phase I, work will be conducted for the development of the attitudinal survey questionnaire and the noise measurement protocol. This phase will concentrate on both the survey questionnaires as well as the noise measurement protocol to accompany the survey. Two questionnaires will be developed. One will deal with community response to construction site noise in the home, and the second will deal with response to construction site noise in the office/work environment. This phase will also consider the possibilities and the extent of the questionnaires which might deal with the "man-on-the-street" exposed to construction site noise. A noise measurement protocol will be developed including necessary instrumentation and preferred measurement procedures. Phase II will include the conduct of a pilot study to pre-test the Survey Questionnaire and the noise measurement protocol, as well as to collect preliminary data on the stability of longitudinal responses to construction noise. Phases III and IV will encompass survey administration and data analysis, respectively.

Period of Performance: 1980-1893.

Investigator: Paul Schomer, U.S. Army Construction Engineering Research Laboratory, Champaign, IL (217/352-6511).

Agency Contact: Jeffrey Goldstein, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1978	1979	1980	1981	1982	1983
			35	100*	100*	65*

* Providing EPA/ONAC receives minor financial support from other agencies.

Title: SCALING ANNOYANCE FOR SOCIAL SURVEYS OF COMMUNITY REACTION TO NOISE EXPOSURE

Objective: To develop a closed response five point scale for describing annoyance attributable to community noise source exposures. The scale will be used in future community survey questionnaires.

Description: Two studies were conducted to select a set of response categories for self reports of degree of annoyance with community noise in social survey interviews administered by telephone. In the first study, 55 people assigned the numerals one to five to each of 52 terms in accordance with the degree to which the terms appeared to express a degree of annoyance with community noise exposure. All terms were presented aurally in the interests of deriving a scale from information collected under circumstances similar to telephone interviewing. In the second study, 40 people used four different sets of response categories (annoyance scales) to rate the annoyance of a set of common community noise sources heard under free field conditions at a wide range of levels.

Summary of Findings: No appreciable differences among scales were discovered. All correlated extremely well with signal presentation level and each other; none was sensitive to gender or order of presentation of category labels; the variance of judgments observed on different scales was similar; and so forth. It was concluded that continuity and consistency of research methods provided the simplest criterion for selection of a scale for future survey research. Since scales employing category labels of "Not At All", "Slightly", "Moderately", "Very" and "Extremely Annoyed" have been used extensively in prior survey work, their use should be continued in the interests of standardization.

Where Findings Published:

Fidell, S., and Teffeteller, S.R., "Scaling Annoyance for Social Surveys of Community Reaction to Noise Exposure." BBN Report No. 4211, February 1980.

Period of Performance: 1979-1980.

Investigator: Sanford Fidell, Bolt, Beranek and Newman, Inc., Los Angeles, CA 213/347-8360).

Agency Contact: Jack Shampan, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
			19.6	

U.S. EPA (Cont'd)

Title: INDIVIDUAL NOISE MITIGATION TECHNIQUES APPLIED TO CITY TRANSIT SYSTEMS*

Objective: To study various noise mitigation techniques as applied to city transit-bus systems. An integral part of the program was an attitudinal noise survey. The intent of the survey component was to determine the activity profiles of typical pedestrian plaza users, their awareness and sensitivity to ambient noise levels, and noise control preferences.

Description: An attitudinal survey program was conducted in New York City at pedestrian plazas of various design, construction and traffic patterns to determine user's response to noxious factors including noise. Various measures of noise abatement design were also evaluated. The questionnaire took approximately 10 minutes to complete. Several plazas were also monitored for noise. Once the traffic noise levels and user responses had been determined, various noise mitigation techniques were evaluated.

Summary of Findings: Results indicated a substantial awareness of the noise and overall annoyance to the user. The largest number of respondents felt that trees would best alleviate the noise. A low percentage were aware of barriers, yet barriers were determined to provide the most effective reduction of noise. A variety of design elements were ultimately used in the design of the Broadway Mall to maximize traffic noise reduction. Also, a monograph and calculation methodology were developed to assist planners in projecting noise levels and speech interference levels for pedestrian projects.

Where Findings Published:

"Noise and Urban Pedestrian Areas". Administration and Management Research Association of New York City, Inc., in cooperation with WAPORA, Inc., October 1979.

Period of Performance: 1977-1981.

Investigator: Steven Wolf, WAPORA, Inc.

Agency Contact: Eugene Wyszpolski, EPA/ONAC (703/557-2126), Joseph Goodman, DOT/UMTA, (202/426-4984).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		40		10	

* This program is part of a multi-million dollar grant to the city of New York for the design and construction of the Broadway Transit Mall.

Title: ANNOYANCE, LOUDNESS, AND MEASUREMENT OF REPETITIVE TYPE IMPULSE NOISE SOURCES

Objective: To evaluate subjective and objective aspects of moderate levels of noise from repetitive type impulse sources.

Description: The investigation included a review and evaluation of the literature of subjective effects of impulsive noise with emphasis on data relating to annoyance, noisiness, or loudness of repetitive types of impulsive noise. The study also included a brief experimental evaluation of measurement of a wide variety of simulated repetitive impulsive-type signals varying in duty cycle, repetition rate, pulse frequency, and ratio of peak impulse signal level to continuous background noise level.

Summary of Findings: Based on the most pertinent literature, it was tentatively concluded that a subjective impulse correction factor of +7 dB applied to the A-weighted equivalent sound levels of these types of repetitive impulsive noise sources would better define their effective level in terms of annoyance reactions. No additional correction was identified for crest level or repetition rate. Research on subjective correction factors for helicopter blade slap was also reviewed and potential reasons for the smaller subjective correction factors (i.e., 0 to 6 dB) for annoyance response to this type of sound were discussed. In the experimental component, when repetitive impulses were measured using maximum values of A-weighted (slow) readings on an Impulse Sound Level Meter, no objective correction was found to be necessary in order to measure, with an accuracy of ± 1.5 dB, the equivalent sound level (Leq) of the wide variety of impulsive signals investigated.

Where Findings Published:

"Annoyance, Loudness and Measurement of Repetitive Type Impulse Noise Sources," EPA Report No. 550/9-79-103, 1979.

Period of Performance: 1978-1979.

Investigator: L.C. Sutherland, R.E. Burke, Wyle Research Laboratories, El Segundo, CA (213/322-1763).

Agency Contact: Jeffrey Goldstein, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
	22.1		9.5		

Title: RELATIONSHIP BETWEEN DETECTABILITY CALCULATIONS AND ANNOYANCE OF INTRUSIVE SOUNDS

Objective: To determine whether verbal descriptions of annoyance could be systematically related to the intrusiveness of a subset of test signals as a function of a foreground task.

Description: Using the original test signals developed from a previous experiment (Fidell and Teffeteller, 1978, see p. A-135) the investigators placed subjects in an absorbing foreground task. The task consisted of challenging electronic games on a color television display with the scores displayed to the subjects as a feedback measure of their performance. The subjects were required to press buttons indicating whether a sound had been detected and the degrees of the resultant annoyance on a 5 category scale.

Summary of Findings: The investigation concluded that:

1. The noticeability of low-level sounds heard in the presence of background noise is strongly influenced by the degree of cognitive involvement in a foreground task.

2. The judged annoyance of intrusive sounds heard can be related to an objective scale of detectability of such sounds.

3. Criteria for predicting the annoyance of intrusive sounds may be based on more definitive information collected from larger numbers of people using refinements of the present technique.

Period of Performance: 1978-1979.

Investigator: Sanford Fidell, Bolt, Beranek, and Newman, Inc., Los Angeles, CA (213/347-8360).

Agency Contact: Jeffrey Goldstein, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
		12.1		

Title: THE RELATIONSHIP BETWEEN ANNOYANCE AND DETECTABILITY OF LOW-LEVEL SOUNDS

Objective: To investigate preliminary hypotheses about the relationship between detectability and annoyance of low-level signals. The major goal was to identify a relationship that was strong and orderly enough to support justifiable inferences about the intrusiveness of low-level sounds.

Description: The study examined the relationship between the predicted detectability and judged annoyance of 25 low-level sounds heard in three noise backgrounds using an adaptive paired comparison procedure under free field listening conditions. The range of detectability was maximinzed by establishing absolute levels for the signals which the subjects heard within a variance of 30 dB. A pilot study and subsequent main study was implemented in which each of 30 subjects compared the annoyance of twenty-four signals heard at fixed levels in an anechoic chamber with the annoyance of an octave band of noise centered at 1 kHz. The comparisons were made by a procedure requiring the subjects to push a button corresponding to the more annoying of a pair of two sounds, each four seconds in duration. A laboratory computer controlling the equipment that generated the sounds adjusted the level of the 1 kHz band of noise until it determined that the sounds were equally annoying within 1 dB.

Summary of Findings: The predicted detectability of the set of sounds accounted for almost 90 percent of the variance in the annoyance judgments in a conventional (falling spectrum) background noise environment. This strong relationship between predicted detectability and annoyance appears capable of supporting objective scales of the intrusiveness of low-level sounds heard under everyday circumstances. However, the study did reveal greater variability in subject detectability at low levels. A decrease in the strength of the relationship also appears to be due to the relative detectability of the low and high frequency portions of a signal's spectrum. (i.e., a signal is likely to be detectable at high frequencies in the falling background, but at low frequencies in the rising spectrum.

Where Findings Published:

S.F. Fidell, et al., "Predicting Annoyance From Detectability of Low-Level Sounds", J. Acoust. Soc. Amer., 66(5):1427-1439, 1979.

Period of Performance: 1977-1978.

Investigator: Sanford Fidell, et al., Bolt, Beranek, and Newman, Inc., Los Angeles, CA (213/347-8360).

Agency Contact: Jeffrey Goldstein, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			67.7	

Title: COMPARISON OF VARIOUS METHODS FOR PREDICTING THE LOUDNESS AND ACCEPTABILITY OF NOISE: PART II - EFFECTS OF SPECTRAL PATTERNS AND TONAL COMPONENTS

Objective: To (1) determine whether subjective judgments of particular types of noise, categorized by spectral shape, are better approximated by some descriptors (frequency weighting and calculation procedures) than others; and (2) investigate the role of tonal components in these studies and to assess the adequacy of several tone correction procedures.

Description: The authors undertook a systematic analysis of the previously compiled psychoacoustic data (Scharf, et. al., 1977) in order to (a) account for certain apparent anomalies in the data analyzed earlier as part of this program, (b) examine the sensitivity of various frequency weightings and rating schemes to spectral differences of the sound stimuli used in the investigations, and (c) evaluate subjective response to discrete frequency components superimposed over a background. The authors identified and classified more than 600 spectra that encompassed a wide variety of natural and simulated noises. In addition, a statistical analysis of subjective measurements produced by the noises in each spectral category and across spectral categories was made based on four frequency weighting functions (A, D1, D2, E) and four calculation procedures (Stevens' Mark VI and Mark VII Loudness Calculation, Perceived Noise Level, and Zwicker's Loudness Calculation Procedure).

Summary of Findings: The results provide partial but needed information of the relative ability of computational procedures and frequency weightings to assess subjective loudness and acceptability of sounds with different spectral shapes, the necessity of tonal corrections at low and high levels of noise, an indication as to the magnitude of a correction, and the overall effectiveness of commonly used tonal procedures. The analysis of the data by spectral shape produced a mixed outcome. Results showed that no overall advantage would accrue from regrouping sets of data across studies on the basis of similar spectral shapes. However, although variability was not reduced when considered across nine spectral categories, the interaction between spectral shape and descriptor was highly significant. The examination of the spectra with and without tonal components provided only tentative support for the trends noted in the literature. When the judged attribute is either loudness or noisiness, tonal components do not seem to add to the subjective magnitude of broad-band noise below 80 dB sound pressure level.

Where Findings Published:

Scharf, B., Hellman, R., "Comparison of Various Methods for Predicting the Loudness and Acceptability of Noise - Part II," EPA Report 550/9-79-102, 1979.

Period of Performance: 1978-1979.

Investigators: B. Scharf, Auditory Perception Laboratory Northeastern University, Boston, Massachussetts; R. Hellman, Department of Speech Pathology and Audiology, Boston University, Boston, MA (617/437-3084).

Agency Contact: Jeffrey Goldstein, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	30			

Title: COMMUNITY NOISE ATTITUDINAL ASSESSMENTS

Objective: To enable communities to assess citizen attitudes towards noise and determine the impact of noise using EPA's Social Survey Workbook. The administration of these attitudinal assessment programs will enable communities to define their noise control problems, identify priorities for action and determine their noise control needs. This information will assist in establishing a basis for noise abatement action and designing a responsive noise control program. Three of these assessments were funded under EPA's Quiet Communities Program.

Description: Five communities including Allentown, Kansas City, Spokane, Salt Lake City and Philadelphia have administered attitudinal assessment programs based upon EPA's Social Survey Workbook for noise. The survey program was developed by the UCLA Institute for Social Science Research and Wyle Laboratories. Detailed instructions are provided for the design and administration of a comprehensive assessment program including a questionnaire, sampling plan, administrative and training procedures, and a survey data analysis program. The total program can be totally self administered by a local government. Some of the major areas investigated in the survey are:

- Perception of urban and environmental problems
- Awareness and evaluation of environmental programs and services
- Assessment of the adverse effects of noise on residents health and welfare
- Identification of specific problem noise soruces and understanding of factors causing adverse community response
- Determination of support of noise control in the community, most supported noise control measures, and willingness to pay for program.

Spokane, Kansas City, and Allentown have also administered a community noise measurement program for the determination of environmental noise levels throughout these communities. The noise measurement protocol used was based upon an EPA Community Noise Measurement Workbook. The sampling procedures are compatible in both workbooks for the integration of results.

Summary of Findings: Findings have been used to form the basis of specific noise control strategies in these communities and the design of responsive noise control measures.

Where Findings Published: Findings published in technical reports of these local govenments (See pages B-10 and 11). EPA protocol published as "Community Noise Assessment Manual: Social Survey Work Book", Wyle Research and UCLA Institute for Social Science Research, July 1978.

Period of Performance: 1977-Present

Investigator: Patti Fricks, Salt Lake City, Utah (801/532-2002)
Cynthia Clark, Allentown, PA (215/437-7561)
James Kusick, Kansas City, MO (816/274-1597)
Michael Wolf, Deleware Valley Regional Planning Commission, Phil, PA. (215/LO-73000)
Edward Pickett, Spokane, Wash. (509/456-3630)

Agency Contact: Joseph Montgomery EPA/ONAC (703/557-9307).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	40	83	45	44

U.S. EPA (Cont'd)

Title: HEALTH AND WELFARE IMPLICATIONS OF GENERAL AVIATION AIRCRAFT NOISE

Objective: To assess the applicability of existing health and welfare criteria to noise from general aviation (GA) aircraft, taking into consideration the particular acoustic and operational environments of general aviation airports.

Description: This project involved the identification and critical analysis of existing health and welfare information and criteria applicable to all noise sources, particularly aviation; a detailed analysis of the acoustic and operational environment of GA with particular reference to those characteristics most closely related to human response; and a determination of the applicability of existing effects criteria to GA noise. As part of this effort, consideration was given to assessing the suitability of various noise descriptors in characterizing GA noise impact, and to identifying additional data and information needs.

Summary of Findings: Based on the analysis of existing information, the following conclusions were drawn:

1. A-weighted sound level (L_A) appears to be an applicable single event descriptor for assessing response to GA noise. Evidence indicates that L_A is as accurate and consistent as the more complicated, calculated sound level measures, and it is also the most widely used descriptor at present.

2. Day-night average sound level (Ldn) appears to be an applicable cumulative descriptor for assessing community response to GA noise. Existing data suggests that Ldn correlates well with community response as reflected in the percentage of the population highly annoyed.

3. No recommendations can be offered concerning duration, pure tone, or background level corrections, although there is some data which indicate that these factors may have a significant influence upon community response. Accordingly, these factors require further study.

4. There is a need for additional research. This research should take the form of a) in-depth, psychoacoustic laboratory studies examining human response to noise from the current fleet of GA aircraft, and comparing this with response to commercial aviation noise, and b) large-scale attitudinal research around several representative GA airports to examine community annoyance response to GA noise.

Period of Performance: 1978-1979

Investigator: Larry A. Ronk, Science Applications, Inc., McLean, Va.

Agency Contact: David M. DeJoy, EPA/ONAC (703/557-0592)

Fiscal Year Funding ($1000):

1978	1979	1980	1981
25			

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: LONGITUDINAL STUDY OF HEARING LEVELS IN CHILDREN*

Objective: To analyze changes with age in the auditory thresholds of children and to relate changes in auditory sensitivity to environmental noise exposures and developmental and physiologic variables. This information is essential to determine whether additional safeguards are needed to reduce the noise exposures of children. Little is known about the susceptibility of children to noise-induced hearing loss and the applicability of current damage risk criteria for children.

Description: For the past four years, EPA, in cooperation with the Air Force, has funded a longitudinal study at Fels Research Institute of Wright State University School of Medicine. Serial auditory thresholds, speech discrimination, blood pressure, otologic, tympanometric, noise exposure history information and 24-hour noise dosimetry measurements are being recorded at six-month intervals from 400 children and youths aged 4-25 years. It is expected that the children will be monitored periodically through adulthood as well, to assess whether auditory patterns and noise exposures measured during childhood are correlated with hearing acuity later in life.

Summary of Findings: Almost four years of this longitudinal study have been completed. Six-month incremental auditory thresholds have been obtained on most children, totalling 6 to 8 data sets per person. The mean and median hearing thresholds at almost all frequencies are 2 to 6 dB lower (better) than those from recent U.S. national surveys for children. In each sex, auditory thresholds tend to be highest at the frequencies of 4K and 6KHz. There is a trend of increasing sex difference in mean thresholds with age consistent with the trend of increasing sex differences in noise exposure (higher in males). In preliminary analysis, elevations in thresholds were obtained for participants reporting certain noise exposures (e.g., using farm machinery, school bus noise, etc.) relative to children not reporting such exposures. Some trends are also present relative to physiologic and developmental indicators. Future expansion of this study is anticipated with support from NINCDS.

Where Findings Published:

1) Roche, A.F., Siervogel, R.M., Himes, J.H., and Johnson, D.L., "Longitudinal Study of Hearing in Children: Baseline Data Concerning Auditory Thresholds, Noise Exposure, and Biological Factors". J. Acoust. Soc. Am., 64 (6), Dec. 1978.

* Project also listed under U.S. Air Force, p. A-21

2) Roche, A.F., Himes, J.H., Siervogel, R.M., and Johnson, D.L., "Longitudinal Study of Human Hearing: Its Relationship to Noise and Other Factors. II. Results from the First Three Years". AMRL-TR-79-102, November 1979.

Period of Performance: 1976-Present.

Investigator: A.F. Roche, Samuel S. Fels Institute, Wright State University School of Medicine, Yellow Springs, OH (513/767-7324).

Agency Contact: Jack Shampan, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980	1981	
	15	33	40	44	50	50	(EPA)
	4	3	4	4	4	5	(AF/AMRL)

Title: TEMPORARY THRESHOLD SHIFTS FOR ELEMENTARY SCHOOL CHILDREN AFTER RIDING ON A SCHOOL BUS: A PROCEDURAL PILOT STUDY

Objective: To develop and field test an experimental protocol to investigate the relationship between noise source exposures of children and the resulting TTS in their hearing sensitivity. School bus noise was selected as the model for this pilot effort.

Description: Each day for a five-day period, elementary school children were given a 60 minute ride on a typical school bus currently in use as part of the Knoxville (TN) public school system. Noise dosimeters were placed on selected students during the bus rides in the front, middle, and rear of the bus. Ten subjects on each ride were designated as the experimental subjects and were given two hearing tests and a tympanometric exam to establish audiometric baselines. Then, immediately after the bus ride (within three minutes of arrival at the school) and at intervals of 30 minutes, post-ride, hearing tests were given until baseline values were reached.

Summary of Findings: Since the study was of a pilot nature and was intended to develop and assess the feasibility of an experimental protocol for measuring TTS in children, the primary findings included methodological recommendations for a larger-scale study. Although only a pilot study, the limited results did show some degree of susceptibility to TTS for a limited number of subjects.

Where Findings Published:

Final Report, "Temporary Threshold Shifts for Elementary School Children After Riding a School Bus: A Procedural Study." University of Tennessee, August 1979.

Period of Performance: 1979-1979.

Investigator: David M. Lipscomb, Department of Audiology and Speech Pathology, University of Tennessee, Knoxville, TN 37916 (615/974-4123).

Agency Contact: Jack Shampan, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
		6.5		

U.S. EPA (Cont'd)

Title: WORKERS COMPENSATION PROGRAMS FOR NOISE-INDUCED HEARING LOSS

Objective: To investigate the status of State and Federal Workers compensation programs for noise-induced hearing loss and the equity and effectiveness of their hearing loss claims provisions.

Description: The study examined State and Federal hearing loss claims activity, their specific claims procedures, the scientific and technical basis behind the hearing loss criteria and provisions in use, and some of the background judicial decisions and social, political, and economic forces historically influential in the development of compensation programs for noise-induced hearing loss. Information came from a review of the scientific literature, correspondence with compensation officials at the State and Federal levels, and an analysis of a sample of Wisconsin and Federal claims.

Summary of Findings: The main findings of the resultant report are as follows:

1) Only nine states compensate more that a token number of claims. Hearing loss compensation represents only .3 of 1 percent of the total workers compensation costs.

2) Approximately 70% of the nations manufacturing workers live in States where compensation is not normally paid due to restrictive state laws. Most States have few or no claims because of a variety of restrictive criteria and unsubstantiated provisions including their hearing loss formulas, deductions for aging, definitions of hazardous noise exposure, short filing limitations, long waiting periods, and the requirement to prove economic loss or total impairment.

3) There is a need to adopt rules which reflect current scientific knowledge and do not discourage rightful claimants. A number of States have recently adopted hearing impairment criteria which include high frequency components. Specific recommendations are made for further research to improve the basis of claims criteria and procedures.

Where Findings Published:

Ginnold, R.E., "Occupational Hearing Loss: Workers Compensation Under State and Federal Programs", EPA 550/9-79-101, August 1979.

Period of Performance: 1977-1979.

Investigator: R. Ginnold, University of Wisconsin School for Workers Madison, WI (608/262-2111).

Agency Contact: Jack Shampan, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1977	1978	1979	1980	1981
	10	10			

Title: EFFECTS OF LONG-DURATION NOISE EXPOSURE ON HUMAN AUDITORY PROCESSES*

Objective: To study the effects of long-duration noise exposure on the human auditory process.

Description: This project was a joint effort with the Air Force. The approach was to measure safe temporary hearing losses induced in human subjects by long-duration, low-level acoustic exposures and to analyze the hearing recovery curves as additional indicators of risk. Human subjects were exposed to broad-band noise with exposure durations of between 24 and 48 hours. Groups of subjects experienced systematic variations of such acoustic parameters as the intensity, duration, and duty cycle of the test stimulus. Effects of the stimuli were identified by monitoring the subjects' audiometric thresholds at specific time intervals.

Summary of Findings: Analysis of the results of 24-hour exposure to continuous pink noise at levels ranging from 65 to 85 dBA has been completed. Results have demonstrated the greatest effect at 4 KHz for the 85 dBA condition. The TTS values resulting from this exposure are in agreement with earlier exposures to 85 dBA continuous pink noise. Exposure of 12 subjects to 85 dBA continuous noise for 24 hours and 48 hours, and to intermittent noise equivalent to 85 dB for 48 hours has also been completed. Results confirm (a) 48-hour continuous exposure does not produce greater Asymptotic Temporary Threshold Shift (ATTS) than 24-hour continuous exposure, but the recovery from 48-hour exposures is slower than recovery from other exposures; (b) intermittent exposure produces less ATTS than continuous exposure to equivalent noise levels.

Where Findings Published:

1) "Growth and Recovery of Temporary Threshold Shifts from 24 Hour Continuous, 48 Hour Continuous and 48 Hour Intermittent Noise Exposure," J. Acoust. Soc. Amer., 64(Suppl. 1), 1978.

2) "Long Duration (24-48 Hour) Exposure to Continuous and Intermittent Pink Noise," AMRL Technical Report #80-3, 1980.

Period of Performance: 1977-1978.

Investigator: M. Stephenson and D. Johnson, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Jack Shampan, EPA/ONAC (703/557-0592).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980	
		17	30.6 (est.)			(AFAMRL)
		2	2			(EPA)

* Project also listed under U.S. Air Force, p. A-25.

Title: CHANGES IN THE ORGAN OF HEARING PRODUCED BY SOUND*

Objective: To examine changes in the auditory system produced by exposure to excessive sound. The project is co-sponsored with the Air Force. The effort will emphasize studies in the infrasound (1-20 Hz) region and long-term, low-level exposures at mid-frequencies (600-2000 Hz). The goal of the research is a reasonable hypothesis of the mechanism of injury production that provides a rationale for treatment and prevention.

Description: Infrasound exposures are carried out only on experimental animals. Long-term, low-level exposures are carried out on experimental animals and human volunteer subjects at levels which do not produce permanent changes in hearing. Techniques to be employed include light and electron microscopy of inner ear structures, electrophysiological measures of middle ear muscle activity and psychoacoustic measures of changes in auditory acuity.

Summary of Findings: Preliminary findings are reported in the publications listed below.

Where Findings Published:

1) Lim, D.J., Dunn, D., Johnson, D.L., and Moore, T.J., "Trauma of the Ear from Infrasound" (AMRL-TR-80-24), to be published in Acta Otolaryngologica.

2) Lim, D.J., "Cochlear Anatomy Related to Cochlear Micromechanics" (AMRL-TR-79-11), also published in J. Acoust. Soc. Amer., 67(5):1686-1695, 1980.

3) Lim, D.J., and Dunn, D.J., "Anatomic Correlates of Noise-Induced Hearing Loss," Otolaryngologic Clinics of North America, 12(3):493-513, 1979.

4) "Acoustic Trauma by Infrasound Exposure: An Animal Experiment," paper presented at AFOSR Annual Review of AF Basic Research, September 1978.

Period of Performance: 1977-1980.

Investigator: D. Lim and W. Melnick, Ohio State University, Columbus, OH.

Agency Contact: Jack Shampan, EPA/ONAC (703/557-0592).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980	
		15	18	18	8	(AF)
			8	1		(EPA)

* Project also listed under U.S. Air Force, p. A-18.

Title: EFFECT OF NOISE ON PREGNANT ANIMALS*

Objective: To determine the effect of high intensity noise in the auditory system of a developing fetus.

Description: Twelve pregnant sheep were exposed to broad band noise of 130 dB 4 hours a day, 5 days a week for the period of pregnancy. Five sheep were exposed with earplugs and 5 sheep were exposed without earplugs. Ten non-exposed sheep, 5 with earplugs and 5 without earplugs are being used as controls. The experiment will be undertaken at Wright Patterson Air Force Base. Audio thresholds and evoked response audiometry will be conducted. Ohio State University will study 20 lambs for possible inner ear pathology resulting from intense noise exposure at various times during the gestation period. Light and electron microscopy will be undertaken to investigate whether there are any difference in the auditory system between the lambs from the different groups. Some of the ewes will be preserved until maturity in order to observe whether there are any long range effects.

Period of Performance: 1978-1980

Investigator: R. McKinley, AFMRL, Wright-Patterson AFB, OH 45433 (513/255-3664)
D. J. Lim, Ohio State University Research Foundation

Agency Contact: J. Shampan, EPA/ONAC (703)557-0592

Fiscal Year Funding ($1000):	1978	1979	1980	
	11	4.5	1	(EPA)
	25.7	12.2		(USAF)

* Project also listed under U.S. Air Force, p. A-32.

Title: TEMPORARY THRESHOLD SHIFT (TTS) PROBLEMS AND CHILDREN

Objective: To design and conduct studies to determine the magnitude and consequences of temporary reduction in auditory sensitivity commonly experienced by children in certain noise source environments. The TTS incurred by children in their daily activities may warrant special consideration where the reduction in sensitivity interferes with ongoing activities.

Description: The research investigation will include the following work components:

1) Noise dosimetry measurements, diary and activity pattern assessments and an analysis of available noise exposure data bases will be undertaken to identify the most hazardous noise source exposures of children and teenagers.

2) Well controlled field and laboratory TTS studies will be conducted using children as subjects to determine the magnitude of the TTS problem caused by exposure to their five most hazardous noise source environments. The results will be compared with TTS data for adults under similar conditions.

3) A pilot study will be designed and performed to assess the deleterious effects of repeated occurrences of TTS on the performance, communication and achievement of children.

Period of Performance: 1980-1982.

Investigator: To be determined.

Agency Contact: Jack Shampan, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1979	1980	1981	1982
		50	50	

Title: ANALYSIS OF NATIONAL HEALTH SURVEY DATA BASES

Objective: To determine 1) the prevalence of noise-induced hearing loss (NIHL), 2) the medically significant illnesses, physiologic conditions, and auditory difficulties associated with hearing loss and occupational noise exposure, and 3) trends in the hearing status of the population.

Description: The principal data base for this research will be provided by the National Center for Health Statistics of the Public Health Service. The results from the 1971-1975 National Health and Nutrition Examination Survey (HANES) and to a limited extent, previous National Health Surveys will be the focus of the analysis. The HANES Survey is periodically conducted to obtain national estimates of the health status of the population, and the prevalence of certain defined illnesses. The project will provide for the statistical analysis and interpretation of relevant data sets. Particular emphasis will be placed in the analysis of data from the hearing and cardiovascular components, as well as demographic variables and indices related to noise exposure. This information will assist in determining the magnitude of the health problem caused by noise.

It is expected that a noise exposure questionnaire component will be added to the HANES Survey planned to start in FY 1982. With the addition of this new component, future HANES Surveys will assist in describing the extent and severity of hearing loss due to different patterns of noise source exposures. Analysis requirements during the FY 1982-85 period will be directed in this area.

Period of Performance: 1980-1985.

Investigator: J. Singer, Abt Associates, Boston, MA (617/492-7100).

Agency Contact: Jack Shampan, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1979	1980	1981
		50	50

Title: SOCIAL HANDICAP CAUSED BY NOISE-INDUCED HEARING LOSS

Objective: To determine the effects of varying degrees of hearing loss on the social, emotional, psychological, and economic functioning of the noise-exposed individual.

Description: The study will include the following work components:

1. Review and evaluation of the previous studies investigating the relationship between hearing loss and social and personal handicaps. Studies investigating the handicaps caused by other bodily impairments in the workplace will be included.

2. The design and pre-testing of self reporting questions to assess hearing handicap and the associated social and economic effects on workers who require significant interaction and verbal communication in their daily work responsibilities.

3. Development of a methodological design for a comprehensive study in the future to assess the effects of hearing loss on the total functioning of hearing impaired workers.

Period of Performance: 1980-1981.

Investigator: R. Ginnold, Labor Occupational Health Program, University of California at Berkeley, CA (415/642-5507).

Agency Contact: Jack Shampan, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
			9.9	

COMMUNICATION INTERFERENCE

Title: FEMALE VOICE RECORDING AND PILOT TESTING OF NORTHWESTERN SPEECH DISCRIMINATION TEST (NU #6)

Objective: To re-record the NU #6 speech discrimination test using a female speaker with babble noise in the background and conduct a pilot study to provide normalized data for a young population. The test will then be incorporated into the Fels longitudinal study* to assess sensitive changes in the speech discrimination abilities of children as a function of age.

Description: The project was completed in two phases:

1. Re-recording of the NU #6 using a female speaker in the same format as recorded by Tillman (1966). Babble noise was recorded on a separate channel for each speech list at a signal-to-noise ratio of 0. Statistical analysis of recorded levels across lists was also provided.

2. Pilot testing of a small sample of children 8 to 16 years of age at varying signal to noise levels. Performance intensity functions was also derived.

Summary of Findings: Children showed poorer speech discrimination ability using female voice recording than would be expected under the same conditions with a male speaker.

Period of Performance: 1979-1980.

Investigator: G. Donald Causey, Biocommunications Laboratory, University of Maryland, College Park, MD

Agency Contact: Jack Shampan, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
		5		

* See page A-141.

NOISE ENVIRONMENT DETERMINATION AND EXPOSURE CHARACTERIZATION

Title: ANALYSIS OF HUMAN ACTIVITY PROFILES

Objective: To develop a flexible and easily-operated computer program that allows a thorough investigation and analysis of human activity profiles from two large existing data bases in terms of the relationships between people's primary activities, secondary activities, location, activity duration, and presence of human company (identified hereafter as simply company) throughout the day. The results obtained from this program will greatly enhance and supplement existing knowledge of human activities, and can be utilized for developing daily personal noise exposures models and for environmental analysis studies which may require knowledge of human activity profiles.

Description: The Human Activities Profile is composed of two human activity bases which identify the respondents' and their spouses' use of time in terms of their sequence of activities throughout the day, including each activity duration, location, and presence of human company, and background information on each respondent. In its entirety, the combined data base represents human activities for over 3500 individuals covering a sample of over 8000 person-days of activities. The data base for human activities has been stored in a computer. The computer program developed in the study allows six main types of analyses to be performed on any selected sample of respondents from these two data bases, and also provides a systematic means of integrating this unique data base on human activity so that it will be available for any additional analysis not covered in the study. The six types of analyses or output modules which can be performed on any specified sample to produce the desired tables are: 1) correlation of activity and location for any specified company situation; 2) analysis of time duration of activity for any specified location and company; 3) analysis of time duration with location for any specified activity and company; 4) analysis of time sequence and activity (time profile) for any specified location and company; 5) investigation of the relationship between primary and secondary activities for any specified location and company; and 6) analysis of activity sequence for any specified location and company.

Period of Performance: 1979-1980.

Investigator: Marilyn Auerbach and Richard Petersen, Wyle Research Laboratories, El Segundo, CA (213/322-1763).

U.S. EPA (Cont'd)

Agency Contact: Jeffrey Goldstein, EPA/ONAC, (703/557-0592).

Fiscal Year Funding ($1000):	1977	1978	1979	1980	1981
		38.9	5.2		

Title: NATIONAL AMBIENT NOISE SURVEY

Objective: To provide for the development and expansion of an ambient noise data base which can permit projections of national noise levels of gradually increasing accuracy. This will serve as the basis for EPA's planning and will provide a means of assessing the impact of the Agency's noise control efforts.

Description: Efforts in the first year will involve: Forty eight 24-hour central measurement sites spread over the 12 selected residential noise environment categories which form the main basis of the ambient noise survey; peripheral (satellite) measurement sites with 1/2-hour measurement samples which supplement the "central site" noise measurements; noise source identifications and traffic counts at a number of the above sites; and one continuous 6-month measurement site to measure long-term temporal patterns. A sample of 16 non-residential measurement sites will also be selected to represent the outdoor commercial noise environment to which people are exposed. Results from this study will provide the average ambient noise levels and contributing noise sources associated with 12 types of residential noise environments. A methodology has been developed to extrapolate these results to the nation, based on Table 20 of the 1970 Census of Population and the National Roadway Traffic Noise Exposure Model. From this, the national population exposed to the various ambient noise levels and contributing noise sources associated with each type of environment can be calculated. Analysis of survey results will also provide the relationship of ambient noise levels to such factors as urbanized area size, urban zone population density, traffic impact (in terms of distance from type of roadway and traffic flow), geographic region, weather conditions, time of day and day of week.

Summary of Findings: The Survey Plan has been completed and monitoring has begun. No reports have been published as yet.

Period of Performance: 1979-1980 (First Phase).

Investigator: Daryl May, Wyle Laboratories, El Segundo, CA (213/322-1763).

Agency Contact: Joseph Montgomery, EPA/ONAC (703/557-9307).

Fiscal Year Funding ($1000):	1979	1980	1981	1982	1983
	96.3	37	75	65	200

U.S. EPA (Cont'd)

Title: INDUSTRIAL MACHINERY NOISE MODEL

Objective: To 1) develop a model of the industrial workplace that has the capability of determining the daily noise exposure to industrial equipment, as well as the sources of this exposure; 2) develop a model that will support the establishment of priorities for noise reduction among equipment based upon noise exposure impact; and 3) determine the benefits to be gained from reducing the various machine sources.

Description: Basic model development has already been completed and has been programmed for use on the EPA IBM 360 computer. Because of the large data inputs and computations involved, computer use of the model is essential. The model calculates the contributions of each industrial machine for each worker job classification. The model can be applied to a given plant, but is being developed for application to an industry at the two, three, and four digit Standard Industrial Classification (SIC) code levels (see codes below). Application of the model to any one situation requires the taking of appropriate field measurements. Original plans were to apply the model to five three digit SIC industries. However, current plans now are not to model all five industries, but instead to perform some additional work (sensitivity analyses).

SIC CODES:

SIC242	Sawmill Mills and Planer Mills
SIC332	Iron and Steel Foundries
SIC221,222	Textiles
SIC346	Metal Forgings and Stampings
SIC341	Metal Cans and Shipping Containers

Summary of Findings: To date, field measurements have been made for SIC indsutries of 242 and 332. Measurements were made at plants representative of industry operations.

Period of Performance: 1979-1980.

Investigator: B. Andrew Kugler, Bolt, Beranek and Newman Inc., Los Angeles CA (213/347-8360).

Agency Contact: Roger Heymann, EPA/ONAC (202/551-2126).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
			88.3	

Title: ATTENUATION CHARACTERISTICS OF THE WOMB*

Objective: To define the acoustic protection provided to the fetus by the maternal environment of several large laboratory animals. Virtually no information is available about possible interactions of pregnant females in intense noise exposure. Before a long-term research program on the fetal effects of noise can be initiated, more information is needed on how much sound the fetus actually receives.

Description: In order to obtain this information, AFAMRL measured the attenuating properties of the womb in one to three fairly large mammals. The pregnant sheep, pig and dog were the animal models chosen for this research. The work is being co-sponsored by EPA/ONAC.

Summary of Findings: The attenuation characteristics of the mother were frequency-dependent. Below about 500 Hz there was very little attenuation, whereas, above about 4000 Hz the attenuation was greater than 40 dB. The overall attenuation was on the order of 20 dB.

Where Findings Published:

. McKinley, R.L., "Changes in the Fetal Noise Environment Due to Noise," J. Acoust. Soc. Amer., 64(Suppl. 1), Fall 1978.

Period of Performance: 1978-1978.

Investigator: R. McKinley, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Jack Shampan, EPA/ONAC (703/557-0592).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		5			(EPA)
			15		(AF)

* Project also listed under U.S. Air Force, p. A-41

Title: NOISE DOSIMETRY AND TYPICAL NOISE DOSES*

Objective: To 1) evaluate the application of personal noise dosimetry in Air Force environments; 2) determine the typical noise exposure of Air Force personnel in order to define typical occupational and nonoccupational noise exposures; and 3) assess typical noise exposures relative to allowable exposures specified in AFR 161-35.

Description: Personnel noise dosimetry data was collected by the principal investigator at four different Air Force bases over a one-year period. The information obtained included both occupational and nonoccupational noise exposure data. This data was obtained on military and civilian personnel who were all volunteer subjects. All subjects were selected from AFSC's in the primary noise exposure groups. In addition, data was received from other Air Force bases that were using noise dosimetry.

Summary of Findings: A total of 418 8-hour occupational noise exposure measurements were obtained on 120 different individuals. The range of these exposures was from 66-111 dBA with the median level at 84.5 dBA. A total of 567 useful measurements were obtained from the other bases and this data ranged from 60-101 dBA with a median level of 80.1 dBA. A total of 73 separate 24-hour measurements were obtained on 16 persons who wore an equal energy noise dosimeter for several days to determine their nonoccupational noise exposure. The median daily A-weighted average sound level was 77 dBA.

Where Findings Published:

1) Fairman, T.M., and Johnson, D.L., "Noise Dosimeter Measurements in the Air Force," Av. Sp. Env. Med., pp. 1150-1157, November 1979.

2) Fairman, T.M., "Occupational and Nonoccupational Noise Dosimetry Measurements on Air Force Personnel," J. Acoust. Soc. Amer., 65 (Suppl. 1):S125, Spring 1979.

Period of Performance: 1977-1980.

Investigator: T. Fairman and R. McKinley, AFAMRL, Wright-Patterson AFB, OH 45433 (513/255-3664).

Agency Contact: Jack Shampan, EPA/ONAC (703/557-0592).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980	
		7	6	8	6	(USAF)
			3.6	1		(EPA)

* Project also listed under U.S. Air Force, p. A-40

DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTE OF MENTAL HEALTH

DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTE OF MENTAL HEALTH

BEHAVIORAL, SOCIAL AND PERFORMANCE EFFECTS

Title: PERSONAL AND FAMILY ADJUSTMENT TO URBAN NOISE

Objective: To 1) describe the initial short-term effects of the noise, 2) describe the level of adjustment achieved several months later, 3) test and develop hypotheses about the factors which influence individual differences in sensitivity to noise, 4) test and develop hypotheses about the relationship between different coping mechanisms and eventual adaptation, and 5) contribute to the understanding of the significance of noise as an urban mental health problem.

Description: This is an exploratory study of the psychological impact of a new community noise problem. One hundred and eighty residents of a community in which a section of the Interstate Highway System is under construction will be interviewed door-to-door before the highway is completed, shortly after traffic begins, and then again four to six months later. The investigation will focus on the emotional distress and behavioral disturbances which occur and the difficulties individuals experience in adjusting to the noise. In this work, noise is viewed as a complex physical and psychosocial stimulus. Its effects will be interpreted within the framework of theories of psychological stress and coping. Questions asked during the interviews will concern attitudes toward the community, affective responses to the noise, and the different methods of direct and intrapsychic coping people use.

Summary of Findings: Preliminary findings show that attempts to use human judgments to assess environmental quality are complicated by the fact that people exposed to the same situation often report very different reactions. The analysis of two community surveys shows that these individual differences tend to be consistent across various environmental issues; people tend to be critical or uncritical about all aspects of their surroundings. About 20 percent of the variability in ratings of such topics as air pollution, noise, privacy, safety, community services, neighbors, and neighborhood amenities can be explained by a single variable which represents a person's location along this critical-uncritical dimension. People at the critical end of this dimension appear to make more differentiated judgments than those who are less critical.

Where Findings Published:

Weinstein, N., "Individual Differences in Critical Tendencies and Noise Annoyance," J. Sound Vibration, 68(2):241-248, 1980.

Period of Performance: 1976-1979.

Investigator: N.D. Weinstein, Rutgers University, New Brunswick, NJ (201/932-9169).

Agency Contact: Richard Wakefield, NIMH (301/443-3373).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
	34.9		7.3	6.6	

COMMUNICATION INTERFERENCE

Title: THE MASKING OF SPEECH BY SPEECH

Objective: To determine the efficiency with which the central auditory system can separate out and attend to competing auditory messages. These objectives are important since the masking of speech by speech is a phenomenon which depends upon and invokes the functioning of very critical information processing mechanisms within the central nervous system.

Description: In the experiments, listeners will be required to respond to a speech target presented (1) against a competing speech babble of five voices reading prose passages and (2) against a speech-multiplied noise -- that is, a white noise shaped to have the same long-term spectral characteristics as the five-voice speech babble noise. The speech stimuli are the list of thirty-six spondee words developed by Hirsh, et al. (J. Speech and Hearing Disorders, 17:321-337, 1952). Subjects are twelve young adults with normal hearing and twelve children, 6 to 7 years of age.

Summary of Findings: For both the adults and children, more intensity was required to reach the SRT when the speech masker was used as competition compared to when the noise masker was the competition. Specifically, the differences in the SRT's when obtained against speech competition versus the noise competition was 4.0 dB and 5.6 dB for the adults and children, respectively. These differences were significant at the .05 level of confidence. This suggests that the auditory system has more difficulty in separating a speech target from a speech masker than it does from disentangling a speech target from a noise masker. This increased difficulty is represented by the increased intensity necessary to reach the Speech Reception Threshold when the babble is the competition. However, the difference between the results obtained with the children versus those yielded by adults were not significantly different. Consequently, it would appear that children, at least by the time they reach 6.0 to 7.0 years of age, are just as efficient as adults in separating a speech target from a speech masker. Whether this is the case for younger children is not known.

Where Findings Published: To be presented at the annual convention of the American Speech and Hearing Association. Formal journal publication is not planned until further studies are completed.

Period of Performance: 1978-1979.

Investigator: L.L. Young, Indiana University, Bloomington, IN.

Agency Contact: E.S. Stover, NIMH (301/443-4337).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	7.1			

DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: ANIMAL MODEL TO STUDY THE EFFECTS OF NOISE ON HUMANS

Objective: To identify an appropriate animal model to study the effects of long-term noise on the inner ear of humans. By finding an animal model whose temporary threshold shift (TTS) data is similar to man's, it should be possible to maximize the probability that the processes underlying the TTS in the two species are similar.

Description: Three different institutions are combining their skills and facilities to perform simultaneous testing of humans and monkeys under extremely similar conditions, and, for higher level exposures, to monitor anatomical changes within the monkey inner ear concurrently. A variety of noises are being used, including both artificially-generated noises and recorded factory noises. Noise exposure durations replicate workday durations, with each animal and human subject, after initial training, being exposed to each noise for two 8-hour periods. This permits the determination of subject reliabilities and ranges of normal TTS's for both species for comparison purposes. TTS growth is measured at 1, 2, 4 and 8 hours of exposure and at 1 and 16 hours of recovery. In addition, future studies with humans will include dosimeters that will allow measurement of differences in intra- and inter-subject TTS related to differences in level of exposure at each ear. Also to be investigated is whether overall SPL measures or dosimeter measures are best correlated with the resulting TTS for a variety of noise exposures. Furthermore, small groups of squirrel monkeys will be exposed to selected industrial noises at high levels that will cause PTS to discover the behavioral and histological consequences of such exposures.

Summary of Findings: To date, 22 humans and 12 monkeys have each been exposed twice to two levels of five noises. The noises used are: two octave band noises centered at 500 Hz and 4 kHz; pink noise; stamping mill noise; and stall-wrench, assembly line noise. Statistical analysis of the data is currently being conducted. Preliminary results indicate that the growth of TTS for all exposures is similar for the two species, both showing great variability. Different growth functions were found for the two factory noises, which differed in both frequency and temporal characteristics. The temporal bones of five unexposed squirrel monkeys have been prepared for histological analysis to allow us to develop a new preparation technique for light and transmission electron microscopic evaluation of squirrel monkey cochleas which eliminates the harsh decalcification effects normally caused by removing the temporal bone.

Where Findings Published: Results are preliminary and have not yet been published.

Period of Performance: 1979-1982.

Investigator: Donald W. Nielsen, 7036 Education and Research Building, Otological Research Laboratory, Henry Ford Hospital, Detroit, MI 48202 (313/876-1016); Donald N. Elliott, Wayne State University, College of Liberal Arts, Office of the Dean, Detroit, MI 48202 (313/577-2809); Ivan Hunter-Duvar, Elm Street Wing, Hospital for Sick Children, 555 University Avenue, Toronto, Ontario, Canada M5G1X8 (416/597-1500 ext. 2486).

Agency Contact: Joseph W. West, NIOSH, Rockville, MD 20857 (301/443-3122).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
		166.5	161	

Title: HEARING CONSERVATION METHODOLOGY

Objective: To develop methodologies for protecting industrial workers from hearing loss caused by occupational noise exposure. Hearing conservation programs are the central theme with special emphasis on the use of hearing protectors on-the-job. Hearing protectors are being assessed for their on-the-job effectiveness in reducing noise exposures.

Description: Pilot studies concerning advanced engineering and administrative noise control techniques, and the development of instrumentation for field use in evaluating the effectiveness of hearing protectors in actual industrial environments, have been accomplished.

Hearing protectors have been assessed for their effectiveness in reducing occupational noise exposures. Results from tests performed using a standard method (ANSI S3.19-1974) for determining the attenuation of hearing protectors under "best-fit" laboratory conditions were initially used to document and evaluate the noise reduction afforded by earplugs and ear muffs. Subsequently, a field study was initiated to determine the effectiveness of earplugs as they are fit and worn in the workplace. The field method of testing developed to conduct this study utilizes an audiometric test van which can be located at the worksite. Testing has been conducted at six industrial plants to study the performance of three different types (designs) of earplugs, "twin-flanged," "V-51R," and "Swedish Wool." Additional testing will be performed on workers using other types (designs) of earplugs.

Summary of Findings: Comparison of preliminary field test attenuation data to corresponding data established in the laboratory showed that half of the workers tested in the field were receiving less than one-third of the average laboratory attenuation value in terms of noise reduction in dBA. This reduced performance probably was due to the workers using the wrong size earplugs for their ear canals and/or improperly inserting the earplugs.

Where Findings Published:

1) "Survey of Hearing Conservation Programs in Industry," NIOSH No. 75-178.

2) "List of Personal Hearing Protectors and Attenuation Data," NIOSH No. 76-120.

3) "A Real-Ear Method for the Measurement of Noise Attenuation of Insert-Type Hearing Protectors," NIOSH No. 76-181.

4) "A Field Investigation of Noise Reduction Afforded by Insert-Type Hearing Protectors," NIOSH No. 79-115.

Period of Performance: 1975-1980.

Investigator: Barry L. Lempert, NIOSH, Cincinnati, OH (513/684-8281).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):

1975	1976	1977	1978	1979	1980
78.2	98.7	24.4	32.9		1.8

Title: THE EFFECTS OF IMPULSE NOISE ON THE AUDITORY SYSTEM

Objective: To 1) establish a scientific basis for an impulse noise damage risk criterion; and 2) understand the mechanisms of impulse noise-induced hearing loss and delineate the differences between impulse and continuous noise-induced loss.

Description: To these ends we have developed an animal model of noise-induced hearing loss and are systematically studying the contribution of the various parameters of impulse noise to the production of hearing loss, i.e., peak pressure, duration, number, etc. Progress toward the second objective (underlying mechanisms) involves anatomical, histochemical, and physiological analysis of cochleas damaged by impulse noise.

Summary of Findings: Work on Asymptotic Threshold Shifts (ATS) from impulse noise sources have shown that an ATS state is reached faster, that the level of ATS as a function of stimulus level grows faster, and that the amount of cochlear damage for equal amounts of ATS is greater for impulse noise than for continuous noise. Research has also been conducted on extending the "Equal Energy Hypothesis" to impulse noise, and on the correlations between behavioral, physiological, and anatomical changes in the cochlea and VIII nerve.

Where Findings Published:

1) Henderson, D., Hamernik, R.P., "Long-Term Impulse Noise Studies in the Chinchilla." International Scientific Noise Teams Symposium on Noise as a Public Health Problem (III), Freiberg, Germany, September 1978.

2) Blakeslee, E.A., Hynson, K., Hamernik, R.P., Henderson, D., Asymptotic Threshold Shift in Chinchillas Exposed to Impulse Noise." J. Acoust. Soc. of Amer., 63(3), 1978.

Period of Performance: 1976-1980.

Investigator: D. Henderson, E.A. Blakeslee, R.D. Hamernik, and R.J. Salvi; State University of New York, Syracuse, NY (315/473-5573).

Agency Contact: Barry Lempert, NIOSH, Cincinnati, OH (513/684-8281).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	91.8	91.1	80.8	

Title: STUDY OF NOISE/HEARING IN THE PAPERWORKING INDUSTRY

Objective: To fill research gaps relating to non-steady noise identified in the NIOSH Criteria Document on Noise and the OSHA recommended standard for noise.

Description: This study was initiated in late 1973 following a request of the United Paperworkers International Union. The data collection phase has been completed in five different paper plants in the Greater Cincinnati area. The study involved hearing tests and intermittent noise exposure measurements on approximately 2,000 paperworkers. Hearing tests were given in the NIOSH mobile hearing laboratory. The intermittent noise measurements were obtained with the NIOSH developed chronodosimeter system.

The final year of the project (FY80) will be concerned with the analysis of the hearing data and the correlation between time at a certain job and the amount of hearing loss observed. These analyses can then be compared to previous data showing the amount of hearing loss associated with exposure to a steady-state noise source.

Summary of Findings: To date, only the results of the factory noise measurements have been analyzed. It was found that the equivalent eight hour levels (based on the OSHA formula) ranged from 81 to 94 dBA for the various job processes surveyed. The noise exposure to the worker appears to be intermittent; however, no consistent patterns of intermittency for the same job from day to day could be uncovered.

Where Findings Published: Not yet published.

Period of Performance: 1975-1980.

Investigator: R. Tubbs, NIOSH, Cincinnati, OH (513/684-8281).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):

1975	1976	1977	1978	1979	1980
41.1	37.0	63.1	64.4	83.7	57.2

NIOSH (Cont'd)

Title: NOISE/CHEMICAL AGENTS EFFECTS ON HEARING

Objective: To explore possible interactive effects of lead and noise on hearing. Background literature suggests that lead may be ototoxic.

Description: This project seeks verification of these findings and, in addition, will ascertain whether combination lead/noise exposures will cause additive or synergistic effects on hearing. Aspirin, a known ototoxic agent, will also be evaluated for its ototoxicity in this effort both singly and in combination with noise.

Overall, the proposed experiment will test laboratory animals under separate and combination treatment conditions involving lead, noise and aspirin. Answers to the following questions will be sought:

1) Do elevations in hearing threshold levels occur as a function of increased lead intake?

2) Does lead in combination with noise produce greater hearing losses than that found for either agent when presented by itself?

3) Does noise in combination with aspirin evoke greater hearing loss in comparison to separate administration of these two agents?

4) If demonstrated, what are the mechanisms underlying the noise-lead and/or noise-aspirin interactions as described in 2 and 3 above?

Period of Performance: 1980-1982.

Investigator: To be determined.

Agency Contact: R. Tubbs, NIOSH, Cincinnati, OH (513/684-8281).

Fiscal Year Funding ($1000):	1979	1980	1981	1982	1983
		149	150	101	

Title: DAMAGE RISK CRITERIA FOR INTERMITTENT NOISE EXPOSURE

Objective: To determine the relations between noise intensity and pattern of intermittence that will just keep temporary threshold shift (TTS) at tolerable levels, in order to establish valid exposure limits for industrial noises that are not steady.

Description: Normal young adults were exposed to both broad-band and narrow-band noises whose pattern of occurrence was varied over a large range of burst durations, on-off ratios, and regularity. The intensity of the noise was gradually increased in successive test sessions until the TTS2 (TTS 2 min after exposure) reached some safe criterion value. Attempts are now being made to determine the empirical laws that determine the growth of TTS with time, spectrum, level, burst duration and on-off ratio, in order to specify as succinctly as possible the limits of exposure that will lead to insignificant hearing losses.

Summary of Findings: A monograph covering the entire research program is still being written. However, the chief practical conclusion is that the present trading relation between time and intensity used by federal regulations applicable to industrial noise, namely, an increase of 5 dB being permitted if the exposure time is cut by half, is basically correct when the reduction in exposure time is by means of intermittence. For noise bands below 2000 Hz, an even greater departure from the total-energy assumption (which implies a 3 dB per halving correction) would be appropriate. In the course of the studies, other conclusions have also been reached. Intermittent exposures, like steady exposures, develop asymptotic values of TTS in about 8 hours, and further exposure (at these moderate levels) produces no additional effect, even on time until full recovery, at least for exposures up to 24 hours in duration. In a noise whose level fluctuates over a wide range, the TTS will be proportional to the average SPL of the noise, not the equivalent (in energy) SPL. The TTS is dependent on the average burst duration and duty cycle of the exposure pattern, whether these are regular or irregular. The TTSs produced by pure tones, narrow bands of noise, and octave bands of noise are indistinguishable. Alcohol ingestion does not affect TTS. Effective quiet--the highest SPL that will neither produce a TTS that increases with time nor retard recovery from an existing TTS--is between 70 and 76 dBA, depending on the specific spectrum of the noise.

Where Findings Published:

1) Ward, W.D., "The Hazard of Exposures to Intermittent Noise." Proceedings of the Eleventh World Congress on Otorhinolaryngology, Buenos Aires, March 1977.

2) Ward, W.D., "TTS from Time-Varying Noise: A Function of Average Level, Not Equivalent Level." Proceedings of the Ninth International Congress on Acoustics, Madrid, 1977.

Period of Performance: 1971-1980.

Investigator: W. Dixon Ward, University of Minnesota, MN (612/373-4565).

Agency Contact: R. Tubbs, NIOSH, Cincinnati, OH (513/684-8281).

Fiscal Year Funding ($1000):

1975	1976	1977	1978	1979	1980	1981
47	41			18.7		

Title: PREVALENCE OF MIDDLE-EAR DISORDERS IN COAL MINERS

Objective: To determine whether coal miners have a higher incidence of middle ear problems.

Description: In this investigation, audiologic tests and middle ear and ear canal physical examinations were performed on a sample of 350 underground coal miners and 150 noise-exposed workers from other industries (controls). This study is based upon a previous study that surveyed the hearing levels of underground coal miners (NIOSH Publication No. 76-172, "Survey of Hearing Loss in the Coal Mining Industry").

Summary of Findings: The results indicated that there are no differences between these groups in terms of the incidence of middle ear or ear canal physical findings or in conductive hearing problems. The principal anomalies found in these groups preceded their work experience. It is not possible to relate these findings to the general population since so little is known about the overall incidence and prevalence of middle ear disorders and conductive hearing loss.

Where Findings Published: Not published.

Period of Performance: 1977-1979.

Investigator: Norma Hopkinson, University of Pittsburgh, PA.

Agency Contact: Barry Lempert, NIOSH, Cincinnati, OH (513/684-8281).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	50	2.5		

Title: A SYMPOSIUM: THE EFFECTS OF NOISE ON HEARING

Objective: To conduct a symposium that examined the various effects of noise on hearing.

Description: In the summer of 1975 a conference on "The Effects of Noise on Hearing: Critical Issues," was held in Syracuse, New York. The conference was attended by over 150 scientists, clinicians and government officials who are involved with problems of noise and its effect on hearing. The direct product of the conference was a book summarizing the results of the symposium proceedings. This volume now serves as a valuable reference text for scientists and government official dealing with noise problems. Since the original symposium, there have been a number of relevant research findings that have important implications for audiological diagnoses and ultimately noise standards. Furthermore, progress has been made on demographics of industrial noise-induced permanent threshold shift (NIPTS), especially in several European countries. In light of these findings, the authors will conduct a three-day symposium to provide a forum for discussing new basic science and demographic data which are specifically germane to the issue of noise standards and hearing hazards. Special emphasis is to be given to impulse noise. The proceedings of this conference, containing approximately 25 summary papers arranged in five chapters, will be published and made widely available through a commercial publishing firm (Raven Press).

Period of Performance: 1979-1980.

Investigator: D. Henderson, R.P. Hamernik, R.J. Salvi (authors), State University of New York, Syracuse, NY (513/473-5573).

Agency Contact: Joseph West, NIOSH, Rockville, MD (301/443-3122).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
		38.3		

NIOSH (Cont'd)

Title: IMPACT/IMPULSIVE NOISE DATA BASE

Objective: This project is designed to develop a data base from which an occupational noise standard on exposure to impact/impulse noise can be generated.

Description: A literature search and on-site inspections of industries where impact/impulse noise is present have been performed. Existing audiometric, laboratory, environmental measurement techniques and instrumentation will be critically examined to their usefulness relative to impact/impulse noise. If necessary, modifications and/or new techniques will be developed in the laboratory for use during occupational field studies. Field studies will include epidemiological, audiometric, and environmental measures. Laboratory animal research will be used to further assess the relative hazards of a wide variety of occupational impact/impulse noise exposure. The use of an animal data base is essential since occupational exposures to impulsive noise are too variable to permit adequate determination of risk criteria for epidemiological data. Laboratory work using human subjects has been limited to temporary effects studies for which no relationship has been established to predict chronic effects.

Summary of Findings: The results of the literature search and site visits indicate that some 2.7 million workers in the United States are exposed to occupational impact/impulse noise. In conjunction with The Ohio State University, laboratory animals have been exposed to tape recordings of industrial noise to provide baseline indices of damage to the auditory system.

Where Findings Published:

Poulos, A.C., Wasserman, D.E., and Doyle, T.E., "Occupational Impact/Impulse Noise--An Overview," Sound and Vibration, 14(1):8-12, 1980.

Period of Performance: 1976-1980.

Investigator: Barry L. Lempert, NIOSH, Cincinnati, OH (513/684-8281).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
		149.9	139.8	153.9

NOISE CONCOMITANT WITH VIBRATION

Title: EFFECTS OF SEGMENTAL VIBRATION AND NOISE ON MINERS

Objective: To develop permissible exposure limits to vibration impinging on the hands from the use of vibrating hand tools. NIOSH estimates that there are some 1.2 million workers in United States industries exposed to segmental vibration of which 40,000 are estimated to be exposed in mines.

Description: An extensive field study will be conducted on vibration and noise-exposed hard-rock miners to determine both the incidence and prevalence of Vibration White Finger Disease (Raynaud's Phenomenon) and the amount of hearing loss in the miners. The pneumatic hand tools yield vibration to the hands as well as an intermittent noise source to the ears. These noise data from miners will be added to the developing NIOSH data base on the amount of hearing loss associated with intermittent noise exposures. Also, any interrelationship between tool noise and vibration will be examined. Workers' exposure levels to vibration and intermittent noise will be measured to obtain data to support recommendations for control of vibration and intermittent noise levels.

Period of Performance: 1980-1982.

Investigator: Donald E. Wasserman, NIOSH, Cincinnati, OH.

Agency Contact: R. Tubbs, NIOSH, Cincinnati, OH (513/684-8281).

Fiscal Year Funding ($1000):	1979	1980	1981	1982	1983
		303.9	214.4	131.7	

DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL HEART, LUNG, AND BLOOD INSTITUTE

DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL HEART, LUNG, AND BLOOD INSTITUTE

NONAUDITORY PHYSIOLOGIC RESPONSE

Title: ORIENTING RESPONSE DEFICITS IN ADOLESCENTS WITH ELEVATED BLOOD PRESSURE

Objective: To 1) study the role psychological stress plays in the etiology of essential hypertension in adolescents, and 2) investigate whether adolescents with elevated blood pressure differed from adolescents with average pressures in their response to stimuli designed to elicit orienting responses.

Description: A series of psychophysiological studies were conducted with a group of 167 eighth-graders whose systolic or diastolic blood pressures fell above the 95th percentile. Each subject was matched on the basis of age, race, sex and ponderal index (height/cube root of weight) to a normotensive control. Four intensity levels of a 600 Hz auditory tone (20, 40, 70 and 80 dB SPL) were presented to subjects as well as two levels of white noise (one-second bursts of 90 dB SPL and 50 dB SPL noise).

Summary of Findings: In the series of studies conducted, adolescents with elevated blood pressures showed larger magnitude and more stereotypic autonomic responses to psychological stimuli. Results of these and previously reported experiments have indicated that adolescents with elevated blood pressure respond with cardiovascular overreactivity to both passive and active coping tasks and no not make fine cardiac discriminations to orienting stimuli. The results are consistent with previous reports of an association between elevated blood pressure and diminished baroreflexes. The authors sugggest that cardiovascular overreactivity to psychological stimuli may predict a propensity to develop essential hypertension.

Where Findings Published:

Texas Psychologist, (in press).

Period of Performance: 1977-1980.

Investigator: Kenneth P. Price, University of Texas Health Science Center, Dallas, TX 75235 (214/387-4222).

Agency Contact: Thomas Blaszkowski, National Heart, Lung, and Blood Institute, National Institutes of Health, Bethesda, MD (301/496-1841).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			51.4	41.1

DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTE OF CHILD HEALTH AND HUMAN DEVELOPMENT

DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTE OF CHILD HEALTH AND HUMAN DEVELOPMENT

NONAUDITORY PHYSIOLOGIC RESPONSE

Title: ENVIRONMENTAL NOISE AND PHYSICAL GROWTH OF CHILDREN

Objective: To determine if exposure to relatively high noise levels produced by nearby jetplane traffic has, in children, a detrimental effect on their physical growth. Here, physical growth is a measure of child health in the community. Children may be affected since they are likely to have spent a large portion of their lives in the noisy environment and during that period, they are susceptible to many environmental influences.

Description: Growth data are obtained through anthropometric examinations on approximately 300-500 subjects (age 5 through 12 years) from communities near an international airport where noise levels have been measured and are known to be high. Data on factors which may also affect growth (e.g., birth order, family size, family income, etc.) were obtained from personal interviews with the children's families. The community has been divided into zones of noise exposure based on measurements of noise levels in the community and the analysis will compare physical growth in these zones to each other and to a similar but more remote community. The influence of socioeconomic status as a growth-affecting variable will be considered and, if necessary, controlled statistically through an analysis of covariance, or through a matched pair study design.

Summary of Findings: Collection of baseline data through parental interviews and anthropometric examinations of study subjects has begun with no findings to date.

Where Findings Published:

1) "Environmental Noise and Human Prenatal Growth," (under editorial review) Amer. J. Physical Anthro.

2) "Environmental Noise and Other Factors in Birth Weight," abstract, Amer. J. Physical Anthro., 50:479, 1979.

3) "Environmental Noise and Other Factors in Human Post Natal Growth," abstract, Amer. J. Physical Anthro., 52:277, 1980.

Period of Performance: 1977-1979.

Investigator: F.E. Johnson and L.M. Schell, University of Pennsylvania, Philadelphia, PA (518/457-8404).

Agency Contact: Gilman D. Grave, NICHD/CRMC (301/496-5755).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	38.7	19.7		

DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES

DEPARTMENT OF HEALTH AND HUMAN SERVICES
NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES

NONAUDITORY PHYSICOLOGIC RESPONSE

Title: NOISE EXPOSURE AND CARDIOVASCULAR FUNCTION*

Objective: To determine whether realistic patterns of long-term noise exposure influence cardiovascular regulations.

Description: In order to maximize the utility of the results for predicting human reactions, the following methodological design has been employed:

a) Use of a primate model;
b) Careful control and specification of the stimulus: 24 hour noise exposure sequence consisting of representative transportation, household and industrial noises (Leq24 = 86 dB);
c) Exclusion or control of potentially confounding variables;
d) Computer-based sampling of cardiovascular responses; heart rate and blood pressure sampled on a minute by minute basis;
e) A protracted exposure period.

The study will be expanded in FY 81 to increase the number of animals and to begin to examine in detail the cardiovascular and biochemical changes related to the observed blood pressure elevation.

Summary of Findings: Results from the first four animals indicate that daily exposure over nine months to everyday and industrial noise episodes, produced in the two experimental animals sustained elevations in blood pressure but not in heart rate to return to control or pre-exposure levels was observed during a 30-day post-exposure period. An important facet of these findings is that the cardiovascular changes were produced in the absence of measurable hearing loss.

Where Findings Published:

1) Peterson, E.A., Tanis, D.C., Augenstein, J.S., Seifer, R.A. and Bromley H.R., "Noise and Cardiovascular Function in Rhesus Monkeys: II," In: Third International Congress on Noise as a Public Health Problem. Ed. J.V. Tobias, et al., ASHA Monographs.

* Project also listed under Environmental Protection Agency, p. A-123.

2) Peterson, E.A., "Noise and Laboratory Animals," In: Defining Laboratory Animal and Its Environment: Setting the Parameters. Ed. E.C. Melby Jr., Laboratory Animal Science (In Press).

3) Peterson, E.A.; Augenstein, J.S.; Tanis, D.C.; and Augenstein, D.G., "Noise Raises Blood Pressure without Impairing Auditory Sensitivity," Science, (in press).

Period of Performance: 1978-1983.

Investigator: E.A. Peterson, University of Miami School of Medicine, Miami, Florida (305/547-6413).

Agency Contact: T. Konishi, NIEHS, (919/541-3247).

Fiscal Year Funding ($1000)*:	1977	1978	1979	1980	1981	
	52	35	99	136	175	(EPA)
	30	39	39			(NIEHS)

* Jointly funded study from 1977-79.

Title: STUDIES OF NONAUDITORY EFFECTS OF NOISE (TERATOGENIC, HORMONAL) IN RODENTS

Objective: To 1) identify the organs or systems affected; 2) determine the levels and acoustic spectra at which effects begin to occur in various species; and 3) the mechanisims through which the effects occur.

Description: Pregnant mice were exposed to noise systematically varied in level, temporal, and frequency content, covering both the human and more extended rodent audibility range. Catecholamine and corticosterone plasma levels were measured in some groups of mothers and all young were checked for structrual and visceral alterations.

Summary of Findings: Teratogenic and reproductive effect of noise: Significantly (p = less than 0.05) decreased pregnancy rates were noted in all groups exposed to noise except in the group exposed to the very high frequency noise from days 6-15 of gestation. Significantly decreased maternal weight gain occurred in the group exposed to high intensity startling sounds, from days 1-6 of gestation. Significant embryolethal effects occurred in the group exposed to the extremely high intensity jet noise paradigm, from days 1-6 of gestation, and significant fetolethal effects occurred in the group exposed to the very high frequency noise paradigm from days 6-15 of gestation. No significant noise-related changes were noted in the incidence structural alterations or in the concentration of plasma corticosterone. Catecholamine level measures, being accomplished under contract, are not complete.

Where Findings Published:

1) Kimmel, C.A., Cook, R.O., and Staples, R.E., "Teratogenic Potential of Noise in Mice and Rats." Toxicology and Applied Pharmacology, 36:239-245, 1976.

2) Nawrot, P.S., Cook, R.O., and Staples, R.E., "Embroyo and Fetotoxicity of Various Noise Stimuli in the Mouse." Teratology, (In Press).

3) Nawrot, P., Cook, R.O., Hamm, C.W,. and Staples, R.E., "Effects of Continuous Random Onset and High Frequency Noise on Embryo Development in Mice." J. Acous. Soc. Amer. 64(1), 1978.

Period of Performance: 1976-Present.

Investigator: R.O. Cook, P. Nawrot, T. Konishi, NIEHS, Research Triangle Park, NC. (919/541-3247).

Agency Contact: R.O. Cook, NIEHS, (919/541-3247).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
	5	5	15	10	3

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: PHYSIOLOGICAL CONSEQUENCES OF NOISE EXPOSURE IN YOUNG ANIMALS

Objective: To ascertain the developmental consequences of early noise exposure in animal subjects. A number of investigations clearly indicate that the cochleas of young animals (mice, hamsters, rats, guinea pigs, and kittens) are more susceptible to damage from noise exposure than those of adults. More work, however, is needed to identify the peripheral or central consequences of this early noise exposure and its long-term effects.

Description: Mice subjects are exposed to one-octave band noise (8-16 kHZ, 110 dB SPL, 90 seconds) at various test ages from 14 days through 65 days. Five days post-exposure, evoked activity from the cochlear nucleus is evaluated. Threshold levels of evoked activity are measured as are evoked response tuning curves using a simultaneous masking procedure. Thus, the effects of noise exposure on threshold sensitivity and frequency selectivity is evaluated. The histopathology of the organ of Corti due to noise exposure is further evaluated using the surface preparation technique or scanning electron microscopy.

Summary of Findings: Although the project is still in progress, some preliminary results are reported in the publications listed below.

Where Findings Published:

1) Saunders, J.C., and Beck, G.R., "Influences of Early Auditory Trauma on Auditory Development," Studies on the Development of Behavior and the Nervous System, Vol 4: Early Influences, G. Gottlieb (ed.), New York: Academic Press, 1978, pp. 249-287.

2) Saunders, J.C., and Restifo, L.L., "Changes in Auditory Threshold Sensitivity and Frequency Selectivity After Noise Exposure in Neonatal C57BL/6J Mice," Soc. and Neurosci. Abstr., Vol. 5, 1979, p. 98.

3) Saunders, J.C., Dolgin, K., and Lowry, L.D., "The Maturation of Frequency Selectivity in C57BL/6J Mice Studied with Auditory Evoked Responses Tuning Curves," Brain Res., 1980, (In Press).

Period of Performance: 1978-1980.

Investigator: James C. Saunders, University of Pennsylvania School of Medicine, Philadelphia, PA.

Agency Contact: Edward Gardner, Scientific Program Branch, NIEHS (919/755-9021)

Fiscal Year Funding ($1000):	1977	1978	1979	1980
		10	10	10

Title: COMBINED IMPULSE AND CONTINUOUS NOISE: AUDITORY EFFECT

Objective: To understand the conditions leading to, and the mechansisms underlying, the synergistic interaction of ototraumatic agents. The results will also provide insights into the establishment of scientifically-based noise standards. There were six specific experimental objectives that were pursued from March 1977 to the present time: (1) An evaluation of the acoustic parameters of the impulse and continuous noise exposures that are required for synergistic interactions; (2) explore the feasibility of initiating long-term impulse noise exposures (either 8 hours/day for five days or 24 hours/day for 10 days); (3) indirectly probe the mechanism of the noise-noise interactions by studying the temporal properties of the two noises that control the effect; (4) probe the mechanisms of the interaction by an evaluation of the ultrastructural or histochemical changes in cochleas that were injured by noise exposures; (5) study the effects of combination exposures on the vestibular system; and (6) observe the acoustic reflex activity during combination exposures.

Description: The interactions between continuous and impulse noise and vibration and impulse noise will be studied using an experimental animal model (chinchilla). The rationale for these studies is that noise rarely exists as a sole hazard to hearing in many industrial and military work environments. Specific studies will include: (1) Long-term combination noise exposures leading to a state of asymptotic threshold shift (ATS). The intensity and spectrum of both the impulse and background noise will be varied to provide a perspective on the noise parameters essential for the "interaction effect." (2) Using an ATS exposure paradigm, the influence of acceleration on the interaction of noise and vibration will be studied. (3) Psychophysical tuning curves will be used to study changes in frequency selectivity resulting from some of the complex patterns of damage induced by the noise exposures. The final format of the data will include a comprehensive description of the noise exposure, a profile of the animal's hearing capability before and after the treatment and a detailed quantitative morphological analysis of the cochlea.

Summary of Findings: The findings, as well as the objectives and descriptions, of the subprojects are presented in the following five abbreviated abstracts.

Where Findings Published:

1) Hamernik, R.P., Henderson, D., Crossley, J.J., Salvi, R.J., "Interaction of Continuous and Impulse Noise: Audiometric and Histological Effects," J. Acoust. Soc. Amer., 55:117, 1974.

2) Henderson, D., Hamernik, R.P., Crossley, J.J., "New Data for Noise Standards," Laryngoscope, 84(5):714, 1974.

3) Hamernik, R.P., Henderson, D., "The Uncertainties of Present Noise Damage Risk Criteria," National Noise Exposition, Chicago, IL, 1974; also Contributions of Animal Research to Noise Standards, Sound & Vibration, September 1975.

4) Hamernik, R.P., Henderson, D., "The Potentiation of Noise by Other Ototraumatic Agents," Proc. Internat. Noise Symposium, The Effects of Noise on Hearing: Critical Issues," Henderson, D., Hamernik, R.P., Mills, J.H., Dosanjh, D.S., Eds., Raven Press, New York, 1976.

5) Woodford, C.W., Henderson, D., Hamernik, R.P., "The Effects of Combinations of Sodium Salicylate and Noise on the Auditory Thresholds of the Chinchilla," Ann. Otol., Rhin., Laryngol., 87:117, 1978.

6) Hamernik, R.P., Henderson, D., Hynson, K., "Impulse Noise and Synergistic Effects Aggravate Hearing Loss," Occupational Health and Safety, January/February 1978.

7) Henderson, D., Hamernik, R.P., "Long Term Impulse Noise Studies in the Chinchilla," International Scientific Noise Teams - Symposium on Noise as a Public Health Problem (III) Freiberg, W. Germany, September 1978, ASHA monographs.

Period of Performance: 1974-1980.

Investigator: R.P. Hamernik, State University of New York, Syracuse, NY (315/684-8281).

Agency Contact: Edward Gardner, Scientific Programs Branch, NIEHS (919/755-9021).

Fiscal Year Funding ($1000):*

1974	1975	1976	1977	1978	1979	1980	
35	35	35	35	35	35	35	(approx.)

*-Funding figures are for all subprojects combined.

The following are subprojects under the overall program "Combined Impulse and Continuous Noise: Auditory Effect."

Title: ACOUSTIC PARAMETERS AFFECTING THE INTERACTION OF IMPULSE AND CONTINUOUS NOISE

Objective: To study the intensity limits of the interaction of impulse and continuous noise.

Description: The relationships between the intensity of the impulse and the interaction effect was studied. In this experiment, a 2-4 kHz background noise was maintained at 95 dB SPL and a 40 microsec A-duration impulse was varied from 158, 147, 142 to 137 dB peak SPL. In the last two and one half years, the converse of the preceding study was finished, i.e., the impulse was maintained at a constant 158 dB and the level of the 2-4 kHz noise band was varied from 95, 92, 89 to 83 dB SPL.

Summary of Findings: The principle finding was that the interaction effect requires an intensity of 147-142 dB for the 40 microsec impulse. At the lower impulse intensities, the interaction effect could be seen in the TTS measures, but since all the animals recovered to pre-exposure threshold levels, the interaction effect was lost in the PTS measure. However, the TTS effect may have implications for exposures which last for more than 1 hour. The results are not clear cut as in the manipulation of impulse level. There is a systematic reduction of TTS, PTS and hair cell loss as the background level is reduced from 95 to 89 dB; however, three of the five animals exposed to the 158 dB impulse in combination with 83 dB background noise developed somewhat greater TTS and PTS than those exposed to the higher intensities. In order to determine if this is a real effect of simple variability, additional animals will be exposed. In summary, the titration of noise levels showed that the interaction phenomena was a persistent effect and that the severity of the interaction decreased as intensity levels of both noises were reduced.

Title: SPECTRAL CONSIDERATIONS IN NOISE-NOISE INTERACTIONS

Objective: To indirectly probe the mechanisms of noise-noise interactions.

Description: In the original noise combination experiment (Hamernik, et al., 1974), the spectrum of the background noise and the impulse essentially overlapped. In this case, the spectral loading of both the background and impulse noise was varied in order to determine the spectral limits of the interaction phenomenon. Impulse durations of either 30, 40 or 60 microsec A-duration were used and the continuous noise was either a 2-4 kHz or 0.35-0.7 kHz band of noise.

Summary of Findings: The tentative conclusion is that the largest interaction occurs when the spectrum of the two noises overlap in the frequency domain. However, even with mismatched spectra (e.g., 40 microsec A-duration wave and an octave band of continuous noise centered at .5 kHz). there still is an interaction effect, but not as dramatic as when the two noises have the same frequency range.

NIEHS (Cont'd)

Title: LONG-TERM NOISE EXPOSURES

Objective: To explore the feasibility of experimentally initiating long-term impulse noise exposures.

Description: To test the feasibility of this approach, a group of five chinchillas have been exposed to a 113 dB reverberant impulse (200 msec, B-duration) presented at a rate of 1/sec for 10 days; a second group received the same exposure, but on a "work week" schedule, i.e., 8 hours/day for five days.

Summary of Findings: These experiments are important because they demonstrate (1) that exposure to impulse noise could produce a state of asymptotic threshold shift with an attendant reduction in variability, and (2) that the level of ATS was essentially the same for the 10-day group and the "work week" group but the animals for the 10-day exposure group were left with more PTS and larger hair cell losses. Perhaps even more importantly, it has been shown that the time to reach ATS from impulse noise is about 1 hour while from continuous noise it is about 8-24 hours. This result has important practical implications and may be used to further explain the variability seen in the 1-hour experiments. Eventually, these two groups will serve as a basis for comparison of future combination exposures.

Title: NOISE AND VIBRATION

Objective: To study the interaction of impulse noise and vibration.

Description: Two experiments have been completed. The first study showed that 1 g vibration at 30 Hz measured at the chinchilla's head during exposure to 50 impulses at 158 dB (40 microsecond A-duration) significantly increased the damage to the cochlea and the size of the permanent threshold shift compared to the effects of the noise and vibration alone. The enhancement of the effects of the impulse noise by the vibration was very dramatic. A second study has been completed which incorporated an ATS paradigm and which was more realistic in terms of the levels of noise and vibration used. Three groups of animals (5/group) were exposed to the following: (1) 113 dB impulse noise 1/sec for 19 days. The impulse has a broad spectrum with a peak at approximately 0.8 kHz. (2) Vibration of 1 g rms at the cage (0.3 - 0.4 g rms at the animal's head) at 30 Hz for 10 days, and (3) the combination of the above.

Summary of Findings: An increased hearing loss of both ATS and PTS is effected by the addition of vibration. What makes the two noise and vibration experiments particularly interesting is the fact that the vibration alone does not seem to have a measurable effect on hearing thresholds. These experiments show that a low-frequency sensitivity of the ear may manifest itself in something other than threshold measures. Furthermore, the emphasis placed upon the A-weighting manipulations for evaluating noise impulses may lead to an underestimate of the ototraumatic power of low-frequency energy.

Title: TEMPORAL CONSTRAINTS OF THE INTERACTION

Objective: To examine the temporal constraints of continuous/impulse noise interaction.

Description: Early combination experiments showed that the potentiating effects of the continuous/impulse noise combinations could be eliminated by interrupting the background noise for approximately 2 seconds and presenting the impulse during the quiet period. A precise knowledge of the minimum window necessary to eliminate the interaction could give some clues to the mechanism necessary for the interaction. To date, 12 chinchilla have been exposed to impulses which are embedded within a silent window (100 msec, 500 msec and 2000 msec) in an otherwise continuous noise.

Summary of Findings: An interaction effect appears to persist out to a 100 msec silent window, although the magnitude of the effect is reduced. At the 2-second condition, however, the animals generally recover to pre-exposure conditions. These results may be revealing for understanding the mechanisms of noise interaction. The lack of an effect with 2-second gaps suggests that the background noise may induce a condition of vulnerability in the cochlea that is exploited by the impulse, but the condition is very labile and dissipates quickly with a time constant between 100 and 500 ms.

Title: AUDITORY EFFECTS OF EXPOSURE TO LOW LEVELS OF NOISE

Objective: To determine qualitative and quantitative factors of noise-induced hearing loss (NIHL), and to determine and assess the audiometric correlates of NIHL.

Description: Human subjects are placed in a diffuse sound field for durations ranging from a few hours to a few days. Measurements of hearing are made before, during and following a noise exposure. These measurements include auditory sensitivity, temporal integrations, simultaneous masking, and forward masking with and without suppressor tones. Physiological measurements are made as well with focus on N1 and Wave V. The masking and physiological measurements are made using a "tuning-curve" paradigm.

Summary of Findings: Several qualitative and quantitative factors of NIHL have been documented, and attempts to model NIHL are in progress. For steady-state expsoure, growth and decay of TTS is exponential in form, and TTS after 8 hours or so of exposure increases about 1.7 dB/dB increase in noise level above a critical level. Critical levels are frequency and species dependent. For non-steady-state exposures, the trade off between time and intensity is complicated and ranges from 0-8 dB depending upon a number of factors. Studies of audiometric correlates are in progress. The most striking results to date are large changes in behavioral psychophysical tuning curves and in suppression areas even when the noise exposure has produced minimal or not measurable changes in auditory sensitivity. While experiments with N1 and Wave V are in progress, N1 appears to be especially sensitive to noise. Correspondence between behavioral data and physiological data in some cases is minimal and in others it is excellent.

Performance: 1979-1982.

Investigator: J.H. Mills, Medical University of South Carolina, Charleston, SC (803/792-3531).

Agency Contact: E. Gardner, Scientific Programs Branch, NIEHS, (919/755-9021).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
		72	76	

Title: THE EFFECTS OF NOISE AND DRUGS ON THE ELECTROCHEMISTRY OF THE COCHLEA

Objective: To find physiological correlates to account for the loss of cochlear sensitivity during the initial stages of noise overexposure.

Description: The endocochlear potential, the tone-induced cochlear responses and the activity of K+ in the endolymph of anesthetized guinea pigs was monitored with liquid membrane K sensitive electrodes. The endocochlear potential was recorded from the ioninsensitive barrel of the electrodes. Changes in K+ concentration, endocochlear potential and tone-induced potentials were studied during repeated 20 min exposures to noise at intensities from 95 to 125 dBA.

Summary of Findings: When overstimulated with broad band noise at 115 dBA, cochlear microphonics and action potentials were suppressed, while endocochlear potential and K+ concentration in the endolymph were slightly increased. With 125 dB noise K+ concentration and the endocochlear potential decreased after repeated 20 min exposure.

Where Findings Published:

Salt, A.N. and Konishi, T. "Effects of Noise in Cochlear Potentials and Endolymph Potassium Concentration Recorded with Potassium Selective Electrodes." J. Hearing Res. (1):343-363, 1979.

Period of Performance: 1977-present.

Investigators: T. Konishi, A.N. Salt, and E. Lebetkin, NIEHS, Research Triangle Park, NC (919/541-3247).

Agency Contact: T. Konishi, NIEHS, (919/541-3247).

Fiscal Year Funding ($1000):	1977	1978	1979	1980	1981
	10	10	10	10	10

Title: COMPARISON OF IMPACT NOISE AND CONTINUOUS NOISE EFFECTS ON COCHLEAR POTENTIALS

Objective: To test the validity of the equal energy concept under controlled laboratory conditions. Proposed hearing loss standards are based on the assumption that noise-induced hearing loss may be estimated from the acoustical energy of the noise.

Description: Impact noise with peak sound pressure up to 132 dB was generated with a mechanical noise generator. Continuous broad band noise of equal energy was generated by a loudspeaker system. Changes in cochlear potentials during 20 min exposure to impact and continuous noise of equal energy were compared in anesthetized guinea pigs or guinea pigs with chronically implanted electrodes.

Summary of Findings: Impact noise produced considerable suppression of both cochlear microphonics (CM) and action potential but neither potential was totally abolished. Continuous noise of equal energy produced significantly less CM suppression than impact noise, while the action potential was totally suppressed. The data suggest that continuous and impact noise of equal energy do not have equivalent effects on cochlear responses. The equal energy hypothesis does not therefore predict the suppression of cochlear responses under these conditions of continuous or impact noise exposure.

Where Findings Published:

1) Salt, A.N., et al., "Comparison of Impact Noise and Continuous Noise on Cochlear Function," J. Acoust. Soc. Amer., 64, S132, 1978.

2) Salt, A.N., and Konishi, T. "Comparison of Impact Noise and Continuous Noise on Cochlear Potential." (In preparation).

Period of Performance: 1978-present.

Investigators: A. N. Salt and T. Konishi, NIEHS, Research Triangle Park, NC. (919/541-3247).

Agency Contact: T. Konishi, NIEHS, (919/541-3247).

Fiscal year Funding ($1000):	1978	1979	1980	1981
	3	3	5	5

Title: PRENATAL EXPOSURE TO HIGH NOISE LEVELS ON AUDITORY THRESHOLDS IN GUINEA PIGS

Objective: To determine whether hearing damage might be induced by exposure to excessive noise levels (115 dBA) before birth. Evidence for a period of enhanced susceptibility to auditory damage from noise overload have been presented in several species. This period has generally corresponded to the final maturation of an auditory system, which varies from some months post-conception in the human to some weeks after birth in some animals occurring near birth in the guinea pig.

Description: Pregnant guinea pigs were exposed to tape recorded textile mill (weaving room) noise (115 dBA). The hearing level of offspring were measured by BSER Techniques and compared with that of offspring of otherwise identical mothers.

Summary of Findings: Offspring of exposed mothers were found to have significantly poorer hearing than offspring of mothers not so exposed.

Where Findings Published: Report in preparation.

Period of Performance: 1978-present.

Investigators: R. O. Cook, T. Konishi and A. Salt, NIEHS, Research Triangle Park, NC. (919/541-3247).

Agency Contact: R. O. Cook, NIEHS, (919/541-3247).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	8	8	5	

Title: STUDIES ON ELECTROPHYSIOLOGICAL MECHANISMS UNDERLYING NOISE-INDUCED HEARING LOSS

Objective: To study ion movement or transport mechanisms which are directly linked to the mechanoelectric transduction process in the cochlea under normal conditions and their alterations under noise exposure conditions.

Description: Guinea pigs were exposed to broad band noise for 7 days (16 hours on and 8 hours off). After exposure the cochlear potentials were measured and the rate constants for exchange of ^{43}K. ^{22}Na and ^{36}Cl in the endolymph were estimated by perfusion of the perilymphatic space. Results obtained from 20 noise-exposed animals were compared with those from control guinea pigs.

Summary of Findings: After 7 days exposure at a noise level sufficient to suppress the cochlear potentials (110-120 dBA, the dc endocochlear potential and endolymph K+ concentration were elevated above the pre-exposure level. The rate of K+ turnover were decreased, while the rate constant for Cl- remained little changed. These results indicate that ionic permeability changes of the endolymph-perilymph barrier are a significant factor in the physiological mechanism underlying noise-induced hearing loss.

Where Findings Published:

1) Konishi, T., Walsh, P.J., and Hamrick, P.E., "Ion Transport in Guinea Pig Cochlea, K+ and Na+ Transport," Acta Otolaryngol, (Stockholm) 86:22-34, 1978.

2) Konishi, T., and Hamrick, P.E., "Ion Transport in the Cochlea of Guinea Pig, Chloride Transport," Acta Otolaryngol, 86:176-184, 1978.

3) Konishi, T., Salt, A.N., and Hamrick, P.E., "Effects of Exposure To Noise on Ion Movement in Guinea Pig Cochlea." J. Hearing Res. 1:325-342, 1979.

Period of Performance: 1977-present.

Investigator: T. Konishi and A. N. Salt, NIEHS Research Triangle Park, NC. (919/541-3247).

Agency Contact: Principle Investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980	1981
	15	15	20	10	10

Title: DEVELOPMENT OF DEVICES FOR HEARING STUDIES

Objective: To develop a variety of special devices for hearing loss studies. Development of these devices, which are not commercially available, will make it possible to investigate specific hearing loss parameters not otherwise possible.

Description:

(A) Impact noise generator: The purpose of this project is to refine a previously constructed prototype impact noise generator to the point where peak level, rise time, and decay can be experimentally manipulated so that the effects of these parameters on hearing loss can be studied in laboratory animals.

(B) Direct ossicular chain-coupled piezoelectric driver: The objectives of this study were to determine whether waveforms not accurately reproducible acoustically could be imparted onto the ossicular chain of guinea pigs by direct coupling, and whether the fidelity of speech so delivered would be equal to that delivered by conventional acoustic presentation.

(C) Linear high-level closed system electroacoustical activator: The objective of this project is to develop a device that can deliver 120 dB SPL, across a 20 kHz bandwidth at no more than 1 percent distortion, into a closed volume of about 1-2cc.

(D) Electronic Tone Burst Parameter Shaper: The purpose was to deliver means whereby the on-off time and phase of tone bursts used in basic hearing mechanisms studies could be systematically varied while eliminating transients.

(E) Speech discrimination test parameter manipulator: The purpose was to develop a simple instrument with which speech segments could be equated on either an rms (Leq) or peak basis and from which white, pink, or speech spectrum masking noise could be obtained. Speech or noise modulation capability was also included.

Summary of Findings:

(A) After several prototypes, a pneumatically actuated impact noise generator having a low failure rate was fabricated and is currently undergoing parameter testing (1978-1980 ongoing).

(B) The direct activated ossicular chain coupled method was found equivalent to acoustical presentation and superior to hearing aids in maintaining speech fidelity (1976-1979, completed).

(C) Several prototypes which have approached, but not met requirements have been constructed. Design iteration is continuing (1978-1980).

(D) An instrument which met all design requirements was designed, constructed, and put into use (1980).

(E) An instrument has been designed and constructed and is presently undergoing parameter testing (1980).

Where Findings Published:

1) Akay, A. and Hodgson, T.W.,"Sound Radiation from an Accelerated or Decelerated Sphere," J Acoust. Soc. Amer., 63(2): 313, 1978

2) Akay, A., "A Review of Impact Noise," J Acoust. Soc. Amer., 64(4): 977, 1978.

3) Cook, R.O.; Hamm, C.W.; and Thomas, W.G., "Discrimination of Acoustically Coupled and Direct Ossicular Chain Coupled Speech." (Submitted).

4) Cook, R.O.; Thomas, W.G.; Konishi, T.; Hamm, C.W.; and Yankwich, A.H., "Speech discrimination derived from guinea pig CM initiated ossicular chain coupled piezoelectric drivers, by hearing aids, and by conventional acoustic presentation." J. Acoust. Soc. Amer., 58(1), 1977.

5) Akay, Adnan; Cook, Reginald O.; and Hamm, Charles W., "Mechanical impact noise generator for hearing loss studies." J. Acoust. Soc. Amer., 64(1), 1978.

6) Akay, Adnan; Cook, Reginald O., "Sound Radiation Due to Rapid Deformation of an Impacted Plate." J. Acoust. Soc. Amer., 64(1), 1978.

Period of Performance: 1976-present.

Investigator: R.O. Cook, NIEHS, Research Triangle Park, NC. (919/591-3247).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
	15	15	21	21	22

Title: NONCONTACTING, ANGSTROM LEVEL AUDITORY AND MECHANICAL SYSTEM MOTION MEASURING INSTRUMENTATION DEVELOPMENT AND AUDITORY SYSTEM PHYSICAL MEASURES

Objective: To develop unique instrumentation allowing convenient measurement of physical motion quantities which currently prevent understanding of complex signal processing by the auditory system and of sound radiation from impacted machinery parts and other sources of hearing loss significance. Although a few experiments utilizing these instruments are being accomplished in our laboratory, the major aim is to release the technology for use by others.

Description: State of the art electro-optic (including fiber optic) technology is being coupled with similar very high speed, low noise operational amplifiers to produce economical non-contacting motion measuring instruments having subatomic resolution.

Summary of Findings: Optimized ossicular chain creditory motion measurement versions have been built and tested along with electronic circuiting for continuous in situ calibration. Other versions optimized for the study of mechanical parameters associated with impulsive sound radiation from impacted plates have been similarly constructed and tested. Both have sub-angstrom resolution and wideband frequency response.

Where Findings Published:

1) Cook, R.O., and Hamm, C.W. "The Fiber Optic Lever Displacement Transducer", Appl. Optics. 18 (19):3230-3241, 1978.

2) Cook, R.O., Hamm, C. W., and Akay, A. "A Fiber-Optic Lever for Noncontact Shock and Vibration Measurements." J. Acoust. Soc. Amer., 64(1):1978.

3) Cook, R.O. "Fiber Optic Level Optimized for Ossicular Chain Motion Measures." In preparation.

Period of Performance: 1977-ongoing.

Investigator: R. O. Cook, NIEHS, Research Triangle Park, NC (919/541-3247).

Agency Contact: Principal investigator.

Fiscal Year Funding ($1000):	1977	1978	1979	1980	1981
	5	5	5	8	8

BEHAVIORAL, SOCIAL, AND PERFORMANCE EFFECTS

Title: PHYSIOLOGICAL, MOTIVATIONAL AND COGNITIVE EFFECTS OF AIRCRAFT * NOISE ON CHILDREN

Objective: To study the generality of laboratory effects of noise on behavior in a naturalistic setting and to examine the course of adaptation to noise over a one year period.

Description: The project consists of a longitudinal study designed to assess the impact of noise on attentional strategies, feelings of personal control and physiological processes related to health. Children were tested on the same measures twice with a one year interval between sessions. The study compares elementary school children under the corridor of a busy metropolitan airport to a matched group of children living in relatively quiet neighborhoods. This longitudinal data is used to determine whether children adapt to the aircraft noise over the one year period and to assess the effectiveness of noise abatement interventions introduced in a number of noise impacted classrooms. Cross-sectional data provides evidence of the effects of noise on the entire sample (the attrition rate was about 33%) and provides further information on the utility of noise abatement.

Summary of Findings:

Cross-sectional data - The entire sample: In general, the results were consistent with laboratory work on physiological response to noise and on uncontrollable noise as a factor in helplessness. Thus children from noisy schools had higher blood pressure than those from matched control (quiet) schools. Noise school children were also more likely to fail on a cognitive task and were more likely to "give up" before the time to complete the task had elapsed. The development of attentional strategies predicted from laboratory and previous field research was, on the whole, not found. Noise abatement had small ameliorative effects on performance of a cognitive task and on a standardized test of school achievement.

Longitudinal Data - The attrition sample: In general, there was little evidence for adaptation to noise over the one year period. Noise abatement affected childrens' ability to hear their school teachers but had relatively little impact on other tasks. (School achievement data were not available one year later and thus were not included in this analysis.) Children from noisy schools who had high blood pressure were likely to move out of the neighborhood within a two year period after the original testing. This was not true of children with high blood pressure from quiet neighborhoods.

* Project also listed under National Science Foundation, p. A-285.

Where Findings Published:

1) Cohen, S. et al., "Physiological, Motivational and Cognitive Effects of Aircraft Noise on Children: Moving from the laboratory to the Field." American Psychologist, 35(3), 231-243, 1980.

2) Cohen, S., and Weinstein, N., "Nonauditory Effects of Noise on Behavior and Health," invited paper, J. Social Issues, (special issue on environmental stress, in press).

3) Cohen, S. et al., "Aircraft Noise and Children: Longitudinal and Cross-Sectional Evidence on Adaptation to Noise and the Effectiveness of Noise Abatement." Under editorial review. Available from author.

Period of Performance: 1977-1980

Investigator: Sheldon Cohen, Department of Psychology, University of Oregon, Eugene, Oregon, 97403 (503/686-4921).

Agency Contact: Edward Gardner, Scientific Programs Branch, NIEHS, (919/755-9021).

Fiscal Year Fundings ($1000):	1977	1978	1979	1980	
	44	15			(NSF)
			30	30	(NIEHS)

COMMUNICATION INTERFERENCE

Title: EFFECTS OF OTOTOXIC INSULT ON CODING OF COMPLEX SIGNALS IN THE AUDITORY SYSTEM

Objective: To use the rapid signal analysis ability of minicomputers to determine the auditory response to speech and speech-like signals including pseudo-random noise under normal conditions and conditions of auditory fatigue and permanent damage. Results of behavioral and audiological tests with humans imply that the ability to understand speech and other complex signals (particularly in a noisy listening situation) suffers loss from noise insult in excess of what could be inferred from pure tone thresholds measured in quiet. These findings suggest that ac complex interaction between the various levels of the auditory nervous system and functionally different receptors of the auditory end organ play a vital role in "sharpening" the sensory process.

Description: Auditory fatigue and recovery processes of single nerve fibers to speech and speech-like stimuli will be studied. The requirement of high speed data throughput for nearly absolute phase matching of acoustical input and physiological output signals, and for accurately processing neural pulse trains necessitated the design and building of complex peripheral devices.

Summary of Findings: Efforts to date have been in the design, construction and debugging of the electronic devices and software necessary to accommodate the high speed throughput for nearly absolute phase matching or acoustical and physiological signals, and for processing neural pulse trains. Pilot experiments are scheduled for Fall 1980.

Period of Performance: 1978-1981.

Investigators: T. Konishi, R. O. Cook, and C. Hamm, NIEHS, Research Triangle Park, NC (919/591-3247).

Agency Contact: R. O. Cook, NIEHS (919/591-3247).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
	10	10	15	

DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTE OF NEUROLOGICAL, COMMUNICATIVE DISORDERS, AND STROKE

DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTE OF NEUROLOGICAL, COMMUNICATIVE DISORDERS, AND STROKE

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: MICROSCOPIC STUDIES OF THE INNER EAR

Objective: To enhance understanding of sensorineural hearing impairment and vestibular dysfunction in man through the study of inner ear pathology in a) human temporal bones obtained at autopsy from patients with a history of noise-induced, presbycusic, ototoxic, and other forms of sensorineural hearing loss; and b) temporal bones from experimental animals especially monkeys and guinea pigs, exposed to extreme noise and/or ototoxic drugs.

Description: Human temporal bones from patients with sensorineural hearing loss due to noise exposure are examined by the method of microdissection and surface preparations as described by Hawkins and Johnsson (1976). Complete counts are made of inner and outer hair cells present and absent, and cytocochleograms are plotted indicating the percent of hair cells remaining in the respective rows per millimeter of length throughout the extent of the organ of Corti. Portions of the osseous spiral lamina in which a full complement of myelinated cochlear neurons appear to be present are also indicated in the cytocochleograms, together with areas of neural degeneration. The stria vascularis and spiral ligament are also examined for possible correlation (usually not found) between areas of atrophy and of hair cell loss. In monkeys and guinea pigs, temporary and permanent threshold shifts produced by noise and/or ototoxic drugs are measured by behavioral audiometry with positive reinforcement. Cochlear function is also assessed by measuring cochlear potentials in waking guinea pigs by means of an electrode permanently implanted on the round window membrane, in accordance with the method of Aran and Erre (1979). Inner ear tissues are examined by light microscopy (surface preparations and celloidin sections) and by electron microscopy (SEM, TEM).

Summary of Findings: Cochleas from patients with a history of noise exposure show the characteristic lesion at 9-13 mm associated with the 4-kHz dip. This lesion may expand toward the apex and basalward, eventually forming the typical pattern of high-tone loss. After impulse noise, lesions may be confined to the area below 9 mm. In three monkeys exposed to noise of relatively short duration at 120 dB or long duration at 120 dB SPL, juxtafenestral lesions have been found without evidence of any tonotopical lesion, suggesting that in primates the juxtafenestral lesion may occur first. Monkeys exposed to a recorded industrial noise at 105 dBA showed essentially normal hair cell patterns. With recorded impulse noise, hair cell losses were slight.

Where Findings Published:

1) Johnsson, L-G., and Hawkins, J.E., Jr., "Degeneration Patterns in Human Ears Exposed to Noise." Ann. Otol. Rhinol. Laryngol., 85:725-739, 1976.

2) Moody, D.B., Stebbins, W.C., Hawkins, J.E., Jr., and Johnsson, L-G., "Hearing Loss and Cochlear Pathology in the Monkey (Macaca) Following Exposure to High Levels of Noise." Arch. Oto-Rhino-Laryng., 220:47-72, 1978.

Period of Performance: 1964-1980.

Investigator: J.E. Hawkins, Jr., Kresge Hearing Research Institute, University of Michigan Medical School, Ann Arbor, MI 48109 (313/764-0215).

Agency Contact: Michael F. Halasz, Executive Secretary, CSSS, NINCDS, National Institutes of Health, Bethesda, MD (301/496-7550).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
		49	51.3	74.8

Title: AUDITORY FATIGUE: NEUROBEHAVIORAL OBSERVATIONS IN RHESUS MONKEYS

Objective: To develop a neural assay that can predict the deleterious effects of loud sound on hearing function.

Description: Towards this end, in a series of behavioral and/or neural studies, following determination of behavioral and neural (single cochlear nucleus cells) thresholds, monkeys are exposed to a few minutes of high-level sound. Immediately following sound exposure, behavioral and neural thresholds are redetermined and the threshold shift is calculated for both measures and compared. Additionally, the respective recovery time courses are determined. Using the awake and behaving rhesus monkey preparation, it is felt that field and clinic conditions similar to those involving humans can be approximated. Since a number of lines of evidence involving independently observed anatomical and electrophysiological findings, are suggesting that the routine pure-tone audiogram is not sensitive enough to identify a potentially harmful sound until a great deal of irreparable cellular damage occurs. The monkey model which permits the simultaneous functional measurement of hearing and its underlying neural components promises to offer a direct comparison of the sensitivity of clinical to basic science techniques.

Summary of Findings: These studies have not yet been completed; however, the majority of the data has been collected and the findings suggest that, indeed, the behavior of individual cells does suggest that a critical level of damage is necessary before a behavioral hearing loss is demonstrated. In every case (n=80 auditory brainstem cells), the neurophysiological properties of the cells were drastically altered by sound exposures that produced minimal and short-lasting changes, if any, in auditory threshold.

Where Findings Published: These results are being prepared for submission in the form of a two-paper report to the Journal of Neurophysiology.

Period of Performance: 1977-1980.

Investigator: Brenda L. Lonsbury-Martin, Glen K. Martin, and Josef M. Miller, Department of Otolaryngology, University of Washington School of Medicine, Seattle, WA (206/543-5230).

Agency Contact: Michael F. Halaz, Executive Secretary, Communicative Sciences Study Section, NINCDS, Bethesda, MD (301/496-7550).

Fiscal Year Funding ($1000):	1978	1979	1980	1981	
	22	22	22		(approx.)

Title: EFFECTS OF NOISE ON THE EAR AND HEARING/AUDITORY COMMUNICATION AND ITS DISORDERS

Objective: To learn (1) the rules for the contributions of each of the physical dimensions of exposures in noise to loss of hearing and to anatomical injuries; (2) the variations in susceptibility to cochlear damage that may depend on prior injury or inherited differences; (3) the changes in properties of neural responses during and after noise exposure, and (4) the nature of any changes in audibility function other than simple loss of auditory sensitivity that are manifested behaviorally during and following exposure to noises that both do and do not lead to permanent threshold shifts.

Description: This project consists of a number of separate projects which are all part of a larger research program entitled "Auditory Communication and Its Disorders." These individual projects are detailed separately in the following five abstracts. However, common to all of them is the continuous and intermittent exposure of chinchillas to noises of various durations to produce changes in the ear and hearing. The changes will be measured behaviorally, physiologically, and anatomically.

Summary of Findings: The findings of the individual projects are summarized in the five reports following this general description.

Period of Performance: 1974-1984.

Investigator: Co-Principal Investigator, Donald H. Eldredge (Principal Investigator for program: Ira J. Hirsh); Subproject Investigators: Barbara A. Bohne, William W. Clark, Donald Ronken, Patrick M. Zurek, Central Institute for the Deaf, St. Louis, MO (314/652-3200).

Agency Contact: J. Buckminister Ranney, Communicative Disorders Program, NINCDS, Federal Building, Room 1C11, 7550 Wisconsin Ave., Bethesda, MD 20205 (301/496-1806).

Fiscal Year Funding ($1000):

1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
61	65	69	73	77	82	87	92	97	103

*-Funding figures presented here cover the following five projects.

Title: A: GROWTH OF HEARING LOSS AND COCHLEAR LESION WITH INCREASING DURATION OF EXPOSURE

Objective: To (1) evaluate the correlation between behavioral measures of hearing impairment and anatomical damage to the sensory cells of the cochlea, (2) determine the pattern and extent of growth of damage to the cochlea with increasing duration of exposure, and (3) discover the validity of the concept of Asymptotic Threshold Shift (ATS) as a predictor of permanent hearing loss produced by exposure to noise.

Description: Chinchillas were exposed for 2, 9, 18, 27, 36, 45, 54, or 108 days to an octave band of noise (OBN) with a center frequency of 500 Hz and a sound pressure level (SPL) of 95 dB. In each of the 9-, 18-, 36- and 108-day groups, two of the animals were behaviorally trained by food-reward operant conditioning techniques so that their pure-tone thresholds could be determined before, during, and after their exposure to noise. In addition, for the 36- and 108-day groups, temporal integration functions and psychophysical tuning curves were obtained at several frequencies pre- and post-exposure. After post-exposure recovery times of 90 days, the animals were sacrificed, the cochlea dissected and plastic-embedded flat preparations were prepared for examination by phase contrast microscopy. Counts of missing inner and outer hair cells were made.

Summary of Findings: The longer the duration of exposure, the greater was the loss of sensory cells. In the low-frequency region of the cochlea, outer hair cell loss grew from 15% at 27 days to 31% at 108 days. In the high-frequency region, narrow areas of concentrated loss of hair cells, nerve fibers and supporting cells were present and increased with increasing duration of exposure. The level of behavioral threshold shift at asymptote remained stable out to 108 days of exposure. PTS in the high frequencies grew with increasing duration of exposure; only 108-day exposure produced significant PTS in the low frequency region.

Where Findings Published:

Clark, W.W., and Bohne, B.A., "Animal Model for the 4-kHz Tonal Dip." Annals of Otology, Rhinology, and Laryngology, 87:supp. 51, 1978. Proceedings of the International Symposium on the Effects of Noise on Hearing, Cazenovia, NY, June 15-18, 1980. To be published by Raven Press.

Period of Performance: 1976-1978.

Investigator: William W. Clark and Barbara A. Bohne.

Fiscal Year Funding ($1000):*

*-Included in "Effects of Noise on the Ear and Hearing/Auditory Communication and Its Disorders."

Title: B: CHANGES IN PSYCHOPHYSICAL TUNING CURVES AND TEMPORAL INTEGRATION FUNCTIONS IN CHINCHILLAS EXPOSED TO NOISE

Objective: To evaluate behaviorally-determined psychophysical tuning curves and temporal integration functions in chinchillas before and after noise exposure that produces moderate loss of outer hair cells in apical areas of the cochlea without any corresponding elevation in pure-tone thresholds at low frequencies. It was hypothesized that these measures may be more sensitive to loss of outer hair cells than a simple measure of presence or absence of response to an acoustic stimulus.

Description: Temporal Integration: A positive-reinforcement behavioral procedure was used to determine thresholds at 0.25, 0.715, 1, 2, and 4 kHz. The duration of the signal was varied in logarithmic steps from 15 msec to 1.5 seconds. These measures were made before and after exposure to an octave band of noise centered at 0.5 kHz at 95 dB SPL for 36 or 108 days. Psychophysical tuning curves: Psychophysical tuning curves with simultaneous masking were obtained in behaviorally-trained animals before and after the noise exposure listed above.

Summary of Findings: Temporal Integration: Plomp and Bouman's energy-integrator adequately described all the data. The time constant varied from about 400 msec at the low frequencies to about 100 msec at the high frequencies. After noise exposure, the function was unchanged if the threshold for long-duration signals (1.5 sec) was not elevated; if there was a threshold shift, the new temporal integration function was well-described by the equation named above with only slight changes. Psychophysical Tuning Curves: In animals with elevated thresholds after noise, the Q10dB of the psychophysical tuning was significantly reduced (3.1 to 1.5); in animals exposed to noise but without elevated thresholds the Q10dB was mildly reduced (3.1 to 2.9). Thus, the Q of the psychophysical tuning curve was not more sensitive to OHC loss than pure-tone threshold shift.

Where Findings Published:

Manuscript in preparation; J. Acoust. Soc. Amer., 65:554-555, 1979.

Period of Performance: 1979-1984.

Investigator: William W. Clark.

Fiscal Year Funding ($1000):*

*-Included in "Effects of Noise on the Ear and Hearing/Auditory Communication and Its Disorders."

Title: C: ACOUSTIC COMBINATION TONES 2f1-f2 RECORDED FROM THE EAR CANALS OF NORMAL AND NOISE-DAMAGED CHINCHILLAS

Objective: To evaluate the efficacy of measuring the distortion product 2f1-f2 in the ear canals of normal and noise-exposed chinchillas as an indicator of temporary or permanent hearing loss. A secondary objective was to determine the usefulness of physical measures of the distortion product 2f1-f2 in the ear canal as a screening procedure before extensive efforts are made to train these animals with behavioral techniques.

Description: The earpiece of a Grason-Stadler Oto Admittance Meter was used as the three-channel probe to which two Knowles receivers and a Knowles microphone were attached, one transducer to each tube. The earpiece was carefully inserted and taped into the ear canal of anesthetized chinchillas. Primary tones were presented in the following pairs: (1) f1=765 Hz, f2=915 Hz; (2) F1=1530 Hz, f2=1830 Hz; (3) F1=3060 Hz, F2=3660 Hz. Measurements were made at the frequency of the cubic difference tone (2f1-f2) for all pairs at levels from 40 dB SPL to 100 dB SPL. Measures were made in normal animals and in animals exposed to: (1) a tone at 1.0 kHz at 110 dB SPL for 10 minutes; (2) an octave band of noise centered at 0.5kHz at 95 dB SPL for 9 days, with measures before, immediately after, and 12 days post-exposure; (3) the same OBN for 36 or 108 days, with measures 90 days post-exposure.

Summary of Findings: From the results of this study, it is clear that relatively small or moderate degrees of damage to the cochlea result in measurable changes in the amplitude of the acoustic combination tone at 2f1-f2. These changes were entirely consistent with behaviorally-measured changes in sensitivity observed after similar exposures. Finally, the complete absence of measurable combination tones in ears in which the cochlea was surgically destroyed lends support to the assumption that these combination tones are produced in the cochlea.

Where Findings Published: A manuscript is in preparation.

Period of Performance: 1978-1980.

Investigator: Patrick M. Zurek and William W. Clark.

Fiscal Year Funding ($1000):*

*-Included in "Effects of Noise on the Ear and Hearing/Auditory Communication and Its Disorders."

Title: D: CENTRAL NERVOUS SYSTEM CHANGES IN CHINCHILLAS DAMAGED BY EXCESSIVE EXPOSURE TO NOISE.

Objective: To examine the correlation between changes in the cochlea and in the cochlear nucleus, superior olivary complex and inferior colliculus in noise-exposed chinchillas.

Description: A series of chinchillas was exposed for one hour and 45 minutes to an octave band of noise with a center frequency of 4 kHz and a sound pressure level of 108 dB. Half of the animals had had the malleus-incus complex removed from the left ear prior to the exposure. Two animals (one binaural and one ossicular removal) were sacrificed at 1, 2, 4, 8, 16 and 32 days following termination of the exposure. In each animal, the cochleas were fixed *in vivo* by perfusing scala tympani with 1% osmium tetroxide in Dalton's buffer. Following fixation of both ears, the animals were perfused intravascularly with formolsaline. The cochleas were embedded in araldite and prepared for phase-contrast microscopic examination. The brainstems were prepared according to Nauta-Rasmussen and Protargol methods for identification of degenerating axons.

Summary of Findings: In the cochlear nucleus, superior olivary complex and inferior colliculus, sparse, fine degeneration made its appearance by the fourth day. A distinct pattern of preterminal degeneration was found at 8 and 16 days, reaching its fullest expression at 32 days. The pattern of degeneration in the CNS could be correlated with the pattern of hair cell loss in the cochlea. No significant hair cell loss occurred in the operated ear and there was no significant degeneration in the brainstem on the same side. In the dorsal cochlear nucleus (DCN) on the exposed side, heavy fine-fiber degeneration corresponded to loss of outer hair cells. These findings were most common in the basal one-half of the cochlea and the presumed high-frequency region of the DCN. In the ventral cochlear nucleus (VCN), outer hair loss could be correlated with very sparse fine-fiber generation only. Loss of inner hair cells was correlated with massive coarse and heavy fine-fiber degeneration in sharp bands in the ventral and dorsal cochlear nuclei. This finding was most common in the 4-kHz region of the cochlea.

Where Findings Published: To be submitted to Science.

Period of Performance: 1976-1979.

Investigator: Barbara A. Bohne, in collaboration with D.K. Morest, University of Connecticut, Storrs, CT.

Fiscal Year Funding ($1000):*

*-Included in "Effects of Noise on the Ear and Hearing/Auditory Communication and Its Disorders."

Title: E: CHANGES IN COCHLEAR POTENTIALS AND RESPONSES OF AUDITORY NEURONS PRODUCED BY EXPOSURES TO NOISE.

Objective: To provide measurements of changes in cochlear potentials and neural responses in chinchilla at various stages in the acquisition and recovery from temporary threshold shifts (TTS) and after permanent threshold shifts (PTS) produced by the exposures to noise used in the associated behavioral and anatomical studies.

Description: Cochlear microphonic (CM) and whole-nerve action potentials (AP) or responses of single auditory neurons are measured (a) at intervals during the acquisition of TTS from exposures to noise, (b) at intervals during the recovery from threshold shifts which may have only TTS or have included PTS, and (c) after recovered thresholds have reached a stable state of PTS.

Summary of Findings: Loss of CM sensitivity grossly reflects the loss shown by behavioral measures of sensitivity for both TTS and PTS. Precision in this method of study is limited by the fact that when local CM responses near a pair of differential electrodes are diminished, these electrodes may often record residual voltages from more remote areas. During acute exposures to a high-pass noise affecting primarily the basal turn of the cochlea, the normal tuning to a best frequency of CM responses in the second turn is diminished or lost. The tips of frequency tuning curves of single auditory neurons appeared in exploratory experiments to be more vulnerable to exposures to noise than one would expect from measures of behavioral thresholds.

Where Findings Published:

Manuscripts in preparation and work in progress. See CID Research Department Periodic Progress Reports No. 21, 22, and 23 for the period 1 July 1977 to 30 June 1980.

Period of Performance: 1977-1984.

Investigator: Donald H. Eldredge and Don A. Ronken.

Fiscal Year Funding ($1000):*

*-Included in "Effects of Noise on the Ear and Hearing/Auditory Communication and Its Disorders."

NINCDS (Cont'd)

Title: BIOCHEMICAL CORRELATES OF NOISE

Objective: To study the noxious effects of noise upon the hair cells of the organ of Corti (OC) which are caused or mediated chemically. This effort is part of a larger project studying the dynamics of the inner ear.

Description: Quantitative histochemical procedures were developed for the study of metabolic substances in different cell types of the OC of the guinea pig and chinchilla. These methods appeared ideally suited to the study of noise effects. First analyzed were the adenine nucleotides ATP and 5'AMP in the chinchilla following exposure to an octave band noise centered at 500 Hz at an SPL of 95 dB for 2 or 9 days. Because of the important role of cyclic AMP in the conversion of light into neural excitation in the retina, the behavior of this substance was studied next. Because the amino acids glutamate and aspartate are considered as putative afferent transmitter candidates in the cochlea, these substances were tested in a different type of noise exposure in the guinea pig (octave band noise centered at 500 Hz at an SPL of 115 dB for 6 hours). It should be pointed out that deoxyglucose, a nonmetabolizable sugar, is a widely used substance to test changes in the metabolic rate of organs depending on glucose as nutrient. Drastic increases of incorporation of the substances are seen in the auditory pathway of the brain following moderate levels of noise exposure. However, for various reasons it is not certain that this technique can be applied in a meaningful way to noise studies in the cochlea.

Summary of Findings: No significant changes in compounds ATP and 5'ATP were seen in the inner or outer hair cells between exposed and nonexposed ears. No significant differences between inner and outer hair cells (with administration of AMP), and between exposed and nonexposed ear were seen. Negative results were also obtained with the enzyme glucose-6-phosphate dehydrogenase. No significant differences were found with administration of amino acids glutamate. One should realize though, that all the methods used reflect steady-state levels and do not necessarily reveal changes in turnover rates. There are certain indications that the stria vascularis may play an important role in providing the additional energy required in the auditory transduction process during noise exposure. It is believed that a vascular perfusion method of the cochlea with synthetic blood as developed in the laboratory can profitably be applied to this question. With this method, the glucose concentration can be lowered to the point where the endolymphatic potential is barely maintained (critical level 10-15 mg%). Under such rate-limiting conditions, the additional energy used under noise exposure might be manifested by a decline of the endolymphatic potential or changes in the energy state of the tissue.

Where Findings Published:

1) Thalmann, R.R., "Quantitative Biochemical Techniques for Studying Normal and Noise-Damaged Ears." In: Effects of Noise on Hearing, (Eds. D. Henderson, R.P. Hamernik, D.S. Dosnajh, and J.H. Mills), Raven Press, New York, pp. 129-155, 1976.

2) Thalmann, R., Thalmann, I., Ise, I., and Paloheimo, S., "Noxious Effects Upon Cochlear Metabolism." Laryngoscope 87:699-721, 1977.

3) Thalmann, R., and Thalmann, I., "Noise and Chemical Agents." Proc. 3rd Intern. Congress on Noise as a Public Health Problem. Ed. J. Tobias, ASHA Monographs.

Period of Performance: 1975-1981.

Investigator: R. Thalmann, Washington University School of Medicine, St. Louis, MO (314/454-2426).

Fiscal Year Funding ($1000):*	1977	1978	1979	1980	1981
	78.8	83.5	88.3	93.4	

*-The funding figures are for the entire grant.

Title: AUDITORY ADAPTATION FOR SUPRATHRESHOLD STIMULI

Objective: To measure the performance of the auditory system in various supra-threshold tasks following exposure to intense stimuli.

Description: This project is part of a larger program entitled "Psychophysics in Binaural Hearing." In this project, baseline psychophysical data are obtained over the course of several weeks prior to any exposures. The exposures are gradually increased in magnitude and/or duration in an attempt to achieve about 20-25 dB of temporary threshold shift (TTS). Following each exposure, TTS and some supra-threshold auditory tasks are monitored in alternate 45-second intervals for about 45 minutes. Supra-threshold tasks to be examined eventually are temporal integration, temporary pitch shift, intensity discrimination, and psychophysical tuning curves, among others. To date, the effort has concentrated on temporary loudness shifts (TLS) and recruitment. An alternate binaural loudness balance (ABLB) technique has been used for this work, and adaptive psychophysics is used for the threshold measurements.

Summary of Findings: Much of the time to date has been spent developing and calibrating the psychophysical procedures. It is believed that powerful enough, yet efficient, procedures for investigating a wide array of supra-threshold phenomena is available. The data indicate that many subjects do not show the same half-octave shift in TLS that they show in TTS. For example, following exposure to an intense tonal stimulus a subject may show no TTS at the exposure frequency (and about 20 dB of TTS a half-octave above the exposure frequency), but as much as 15-20 dB of TLS at that frequency. That is, there is a partial dissociation of threshold (TTS) and supra-threshold (TLS) effects. Entire loudness contours post-exposure are being mapped out for detailed comparison with the frequency pattern of TTS. A second, minor, finding is that less variable matches are obtained with the ABLB technique when a short interval (50-75 msec) is placed between the successive presentations of the stimuli, a fact of potential value in the clinic as well as in the lab.

Where Findings Published: Reports for publication are being prepared.

Period of Performance: 1979-1984.

Investigator: Dennis McFadden, Dept. of Psychology, University of Texas, Austin, TX 78712 (512/471-4324).

Agency Contact: J. Buckminister Ranney, Communicative Disorders Program, NINCDS, Federal Building, Room 1C11, 7550 Wisconsin Ave., Bethesda, MD 20205 (301/496-1806).

Fiscal Year Funding ($1000):*	1978	1979	1980	1981
		80	62.9	

*-Funding figures for all projects in the program. Other program elements are on pp. A-221 and A-230.

Title: SHORT-TERM AND LONG-TERM AFTEREFFECTS OF EXPOSURE TO NOISE BANDS WITH STEEP SPECTRAL SKIRTS

Objective: To establish whether and to what degree the normal processes of hearing are affected by intermittent exposures to waveforms having steep spectral skirts.

Description: This project is part of a larger program entitled "Psychophysics in Binaural Hearing." In this project, it was serendipitously discovered that for some listeners the psychophysical tuning curve (PTC) is broadened following intermittent exposure (4 min on, 1 min off; 2 hours/day, 5 days/week for 8 weeks) to a noise band 1000 Hz wide centered at 3500 Hz and having a low-frequency skirt of about 415 dB/octave. The noise band was only about 65 dB SPL overall--well below the level generally viewed as necessary for auditory fatigue. The changes in the PTC were greatest for signal frequencies close to the lower edge of the noise band and diminished gradually as signal frequency was lowered further. There was also some evidence of altered lateral suppression in these subjects, but pre-exposure data were not obtained on this task. Controlled exposures were initiated for additional subjects. Broadening of the PTC persisted for as long as 20-30 minutes following exposure to 15 minutes of the steep-sided noise band. Similar exposures using a noise band with a low-frequency skirt of 70 dB/octave never produced a short-term change in the PTC.

Summary of Findings: The implication of this research is that waveforms having steep spectral skirts have the potential to alter the normal hearing mechanism. The effect is surely not cochlear. It is reversible, but the process can be protracted. The effect is reminiscent of the short-term and long-term aftereffects in the visual system originally reported by McCullough. Waveforms with very steep-sided spectra are increasingly more common in everyday life as synthesizers are being adapted to new applications.

Where Findings Published: A preliminary report is scheduled to appear as a chapter; more complete reports are now in preparation.

McFadden, D., and Pasanen, E.G., "Altered Psychophysical Tuning Curves Following Exposure to a Noise Band with Steep Spectral Skirts." In G. van den Brink and F.A. Bilsen (Eds.), Psychophysical, Physiological Behavioural Studies in Hearing. Delft University Press: Delft, The Netherlands, 1980.

Period of Performance: 1978-1980.

Investigator: Dennis McFadden, Dept. of Psychology, University of Texas, Austin, TX 78712 (512/471-4324).

Agency Contact: J. Buckminister Ranney, Communicative Disorders Program, NINCDS, Federal Building, Room 1C11, 7550 Wisconsin Ave., Bethesda, MD 20205 (301/496-1806).

Fiscal Year Funding ($1000):*	1978	1979	1980	1981
		80	62.9	

*-Funding figures for all projects in the program. Other program elements are on pp. A-220 and A-230.

Title: MECHANISMS OF HEARING LOSS

Objective: To study the relations between steady and intermittent noise exposure and the resulting changes in behavioral auditory capabilities, in electrophysiological characteristics, and in structural and biochemical features.

Description: Ten groups of four chinchillas have been trained, exposed to various patterns of 700-2800 Hz noise, and examined histologically. Changes in structure of the stria vascularis and the constitution of the fluids of the inner ear associated with both temporary and permanent hearing losses will receive particular attention. Analogous studies will involve the action of ototoxic drugs, and the synergistic action between drugs and noise. The perception and misperception of auditory stimuli, both pure tones and speech, will be studied very intensively in a relatively small number of human patients with selected specific sensory losses and a few with more central damage. Emphasis will be on temporal resolution, frequency discrimination, and pitch perception. Finally, analysis of temporal bones from persons with hearing losses of known etiology will be used to develop techniques for differential diagnosis of types of sensorineural loss.

Summary of Findings: Over the somewhat restricted range of these first experiments, single uninterrupted exposures (exceeding 105 dB SPL for 220 minutes or its equivalent), resulted in cochlear damage determined only by the total energy of the exposure. For intermittent or repeated exposures, however, the total-energy hypothesis does not hold; the result of interruptions being a reduction in the effective energy of the exposure by up to at least 2/3 (5 dB), depending on the temporal pattern. As yet, there is scant evidence that the safety of a given exposure can be guaranteed solely on the basis of the TTS produced by either that or any other exposure. Single-unit recordings were made in the acoustic nerves of normal chinchillas and of chinchillas with damaged cochleas. Cochlear injuries were produced by acoustic overstimulation, kanamycin injection or surgical intervention. After 1-6 months, automated tuning curves and samples of spontaneous activity were obtained from 50-150 fibers in each animal. A systematic inverse relationship exists between threshold at best frequency (BF) and level of spontaneous activity. Cochlear regions with substantial outer-hair-cell loss were correlated with elevated thresholds, with tuning-curve-shape distortions or with absence of responsive neurons in the appropriate best-frequency range. On the other hand, severe physiological abnormalities were often accompanied by only minimal hair cell loss.

Where Findings Published:

1) Nelson, D.A., and Keister, T.E., "Frequency Discrimination in the Chinchilla." J. Acoust. Soc. Amer., 64:114-126, 1978.

2) Nelson, D.A., "Two-tone Masking and Auditory Critical Bandwidth." Audiology, 18:279-306, 1979.

3) Ward, W.D., Keister, T.E., and Turner, C.W., "Total-Energy Principle Incorrect for Twice-Weekly Exposures." J. Acoust. Soc. Amer.,65:S117, 1979.

4) Ruggero, M.A., "Auditory Nerve Correlates of Acoustic Trauma." J. Acoust. Soc. Amer., 64:S136, 1978.

5) Ruggero, M.A., "Tuning Curves from Auditory-Nerve Fibers Innervating Injured Cochleas." Assoc. for Res. in Otolaryngol., Midwinter Mtg. Abstracts: p. 8, 1979.

Period of Performance: 1977-1979.

Investigator: M.M. Paparella, D.A. Nelson, W.D. Ward, A.J. Duvall, S.K. Juhn, C. Speaks, N. Viemeister, M. Ruggero, and P.A. Santi, Univ. of Minnesota, Minneapolis, MN (612/373-4565).

Agency Contact: Earleen Elkins, NINCDS (301/496-5061).

Fiscal Year Funding ($1000):	1976	1977	1978	1979
		144.2	143.1	146.3

Title: DETERMINATION OF EFFECTS OF HEARING AID AMPLIFICATION OF CHILDREN

Objective: To determine the possible effects of hearing aid amplification on the residual hearing of children with sensorineural hearing loss.

Description: The study is designed to determine whether hearing aid amplification significantly affects the residual hearing of the groups of children under study and if the significant relative threshold shift (comparison of pure-tone threshold shift over time between the aided and unaided ears) relates to: (a) the electroacoustic characteristics of the hearing aid, including, saturation sound pressure level, acoustic gain, basic frequency response, frequency range, comprehensive frequency response, and harmonic distortion; (b) the amount of hearing aid usage in hours per week and number of months and/or years; (c) the degree of hearing loss when the aid was introduced; (d) the earmold or coupling system used with the hearing aid; (e) specific or nonspecific etiological information; and (f) progressive hearing deterioration in a significant manner.

Period of Performance: 1980-1983.

Investigator: C. Binnie, Purdue University, W. Lafayette, IN.

Agency Contact: Earleen Elkins, NINCDS (301/496-5061).

Fiscal Year Funding ($1000):	1979	1980	1981	1982
		151.6	120.7	109.3

Title: CENTRAL PROJECTIONS OF RESIDUAL SPIRAL GANGLION CELLS

Objective: To determine how the long-term loss of the organ of Corti affects the spiral ganglion, cochlear portion of the VIII Nerve, and cochlear nuclei. Primary concerns are to anatomically characterize the residual spiral ganglion cell bodies and axons, and to describe changes in the neuropil of the cochlear nuclei.

Description: While profound deafness in humans and other animals usually results in a severe loss of nerve fibers and spiral ganglion cells, in most cases some residual spiral ganglion cells persist. These surviving nerve cells, which represent less than 15 percent of the normal complement, are the type II and type III spiral ganglion cells of Spoendlin. The present investigation will use three groups of deaf guinea pigs: 1) genetically deaf waltzing guinea pigs; 2) guinea pigs deaf from antibiotic administration; and 3) guinea pigs deaf from noise exposure. When these animals have been deaf for at least 10 months, discrete lesions will be made in their spiral ganglion on one side only. The area of the lesion and at least one sample through each half-turn of the spiral ganglion will be described. Using Fink-Heimer techniques, the central projections of residual spiral ganglion cells will be determined. The nature and location of these central projections may be important in the search for an adequate cochlear implant prosthesis, since these residual spiral ganglion cells are the only nerves that are available to be stimulated by such devices.

Summary of Findings: It has been shown that destruction of the guinea pig organ of Corti by trauma, drug intoxication, noise, and genetics all result in a secondary loss of most, but not all, spiral ganglion neurons, and in degenerative debris in the cochlear nuclei which persists for 9 to 15 months. By lesioning the cochlear portion of the VIII Nerve one year or more after organ of Corti destruction, it has also been demonstrated that the few residual spiral ganglion cells project their axons to the same areas of the cochlear nuclei as does the normal spiral ganglion population, retaining the cochleotopic organization. Data analyses indicate that neurons of the cochlear nuclei, superior olivary complex, and inferior colliculus have significantly reduced soma size following long-term organ of Corti loss.

Where Findings Published:

1) Webster, D.B., and Webster, M., "Cochlear Insults from Noise, Drugs, and Genetics." J. Acoust. Soc. Amer., 63:S43, 1978.

2) Webster, D.B., and Webster, M., "Cochlear Nerve Projections Following Organ of Corti Destruction." Otolaryngology, 86:342-353, 1978.

3) Webster, M., and Webster, D.B., "Cochlear Nuclear Projections from Outer Hair Cells." Neuroscience, 4:11, 1978.

Period of Performance: 1977-1979.

Investigator: D.B. Webster and M. Webster, Louisiana State University, New Orleans, LA (504/947-6641).

Agency Contact: Earleen Elkins, NINCDS (301/496-5061).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	36.8	36.9	38.7	

Title: INVESTIGATION OF AGENTS WHICH DAMAGE THE EAR - PHYSIOLOGICAL MEASURES OF ACOUSTIC OVERSTIMULATION

Objective: To 1) identify agents which exert deleterious effects upon the ear; 2) attempt to understand the mechanism by which the damage is produced and 3) seek ways to provide protection from, or relief from, or compensation for the damaging effects.

Description: This project is part of a broader program (NS 09889-05A1) whose summary states: The purpose of the Kresge Hearing Research Laboratory is to conduct intradisciplinary studies of the clinical problems produced by damage to the ear. The identification and understanding of agents producing damage includes those agents which interact with each other to produce damage as well as the single offenders to the ear. The methods of investigation involve the use of animal models as well as human subjects. The techniques utilized are: 1) recording of electrophysiological events in the auditory system (AC cochlear potential, endolymphatic potential, N1 action potential of the VIIIth nerve, single unit activity of the IIIrd nerve and evoked responses in the auditory cortex); 2) behavioral measures of hearing in animals using operant conditioning techniques; and 3) histological assessment of the inner ear including hair cell counts by the surface preparation technique, serial sectioning using celloidin embedding and electronmicroscopy.

Summary of Findings: Following seven consecutive days of exposure to broad band noise and aminoglycoside drug treatment, four groups of guinea pigs were studied by measuring cochlear electrophysiology and hair cell counts. Data revealed a significant interaction which is substantially greater than the summation of the two individual insults. The same interaction effect is currently under study using kanamycin instead of neomycin. Frequency specific N1 potentials were used to assess the effect of acoustic overload upon the auditory system. Overload was produced at 7 kHz using 85, 90 and 95 dB SPL for durations extending from 1 to 20 minutes. The results revealed a time-intensity relationship as expected. The maximum effect of the overload was always at 1/2 an octave above the overload frequency regardless of intensity or duration of the overload stimulus. N1 facilitation was often observed at frequencies of approximately 1/2 to 1 octave below the overload frequency. N1 testing was conducted at every 1/8 octave interval between 2 kHz and 20 kHz. Other frequencies and SPLs of 100, 105, 110 and 115 are under study.

Where Findings Published:

Vernon, J.A., Brown, J., Meikle, M., and Brummett, R.E., "The Potentiation of Noise-Induced Hearing Loss by Neomycin." Trans. Am. Acad. Ophth. Otolaryng. 86:123-124, 1978.

Period of Performance: 1976-1979.

Investigator: J.A. Vernon, University of Oregon, Portland, OR.

Agency Contact: Earleen Elkins, NINCDS (301/496-5061).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	33.5	30.7		

Title: CRITICAL BIBLIOGRAPHY OF THE EFFECTS OF NOISE ON HEARING

Objective: To develop a critical review of currently existing data and identify specific areas in need of additional research on the effects of noise on hearing.

Description: A critical review, analysis, and synthesis of currently existing national and international data on the effects of noise on hearing will be prepared. The following concerns related to noise damage will be addressed: (1) Anatomy and physiology, (2) Biochemistry, (3) Temporary Threshold Shifts (TTS), Permanent Threshold Shifts (PTS), and Asymptotic Threshold Shifts (ATS), (4) Noise and other ototraumatic agents, (5) Continuous, intermittent, and impulse noise, (6) Differential diagnosis of noise-induced hearing loss, (7) Individual differences and susceptibility, (8) Protection and conservation of hearing, and (9) Relation of existing sensorineural hearing loss and PTS, TTS, and ATS. A position paper which enumerates important questions concerning the effects of noise on hearing and which outlines and discusses possible research design and data collection and analysis procedures will be completed.

Period of Performance: 1980-1982.

Investigator: To be awarded.

Agency Contact: Earleen Elkins, NINCDS (301/496-5061).

Fiscal Year Funding ($1000):	1979	1980	1981	1982
		58	140	

Title: MECHANICAL PROPERTIES OF THE EAR

Objective: To study the discrepancy between stimulus frequency and frequency of maximal loss.

Description: Work is currently in progress to investigate the mechanical properties of the peripheral auditory mechanism by studying: (1) displacement of the cochlear partition, measured by laser interferometry; (2) power transfer through the middle ear; and (3) noise-induced hearing loss.

Summary of Findings: It has been shown that the noise-induced audiometric notch at 4 kHz is causally linked to the ear canal resonance at 3 kHz. Evidence was given by lowering the ear canal resonance by extension of its length. While in this frequency range the frequency interval between stimulus and point of maximal TTS is approximately 1/2 octave, the relation is different in other frequency ranges. The same experimental technique is being employed to explore the frequency interval between stimulus and point of maximal TTS for other stimulating (pure tone) frequencies.

Where Findings Published:

Caiazzo, A.J., and Tonndorf, J., "Ear Canal Resonance and Temporary Threshold Shift." J. Acoust. Soc. Amer., 61, Suppl. No. 1, 1977.

Period of Performance: 1978-1979.

Investigator: J. Tonndorf and S.M. Khanna, Columbia University, New York, NY (212/694-3993).

Agency Contact: Earleen Elkins, NINCDS (301/496-5061).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
			8.5	28.4	35.8

NINCDS (Cont'd)

Title: DETECTION AND LATERALIZATION OF SIGNALS IN NOISE

Objective: To establish the limits of signal detection and lateralization in noise backgrounds.

Description: This project is part of a larger program entitled "Psychophysics in Binaural Hearing." In this project, a series of different experiments measured subjects' abilities to detect and to lateralize (a form of sound localization) tonal signals in noise backgrounds of various sorts. Some of these signal/masker configurations were ones known to produce the release from masking known as the masking-level difference (MLD). MLDs exist whenever the signal/masker configuration produces binaural cues for detection--interaural time and/or intensity differences--the cues also used to localize unmasked signals in space.

Summary of Findings: Obviously the presence of noise degrades lateralization and localization performance, but the magnitude of the impairment depends greatly on the particular signal/masker configuration chosen. In general, a low-frequency tonal signal is best lateralized in interaurally-correlated noise when its interaural level difference is large and its interaural time difference small; a high-frequency tonal signal can be lateralized only by using level differences. Complex waveforms can be lateralized using interaural time differences in their fine structures (cycle-by-cycle time differences) or in their envelopes, depending upon the relative availabilities of the two. If the signal is spectrally similar to the noise background, lateralization performance does not vary monotonically with interaural time delay. Rather, time delays corresponding to negative values in the autocorrelation function produce greatly depressed performance, depending upon the signal-to-noise ratio.

Where Findings Published:

1) McFadden, D., and Pasanen, E.G., "Binaural Detection at High Frequencies with Time-Delayed Waveforms." J. Acoust. Soc. Amer., 63:1120-1131, 1978.

2) McFadden, D., and Pasanen, E.G., "Lateralization at High Frequencies Based on Interaural Time Differences." J. Acoust. Soc. Amer., 59:634-639, 1976.

Period of Performance: 1974-1980.

Investigator: Dennis McFadden, Dept. of Psychology, University of Texas, Austin, TX 78712 (512/471-4324).

Agency Contact: J. Buckminister Ranney, Communicative Disorders Program, NINCDS, Federal Building, Room 1C11, 7550 Wisconsin Ave., Bethesda, MD 20205 (301/496-1806).

Fiscal Year Funding ($1000):*	1978	1979	1980	1981
		80	62.9	

*-Funding figures for all projects in the program. Other program elements are on pp. A-220 and A-221.

Title: BINAURAL HEARING

Objective: To understand binaural interaction and to apply this understanding to the problems of the hearing impaired.

Description: The experimental research on normal listeners includes the study of the discrimination of interaural parameters, of interactions between interaural time delay and interaural amplitude ratio, of detection of signals in noise, of lateralization and loudness in the presence of noise, and of techniques for measuring the shape of the binaural image. The experimental research on impaired listeners includes the study of localization, lateralization, interaural discrimination, and detection signals in noise. The theoretical research includes application of the theory based on auditory-nerve data to further experimental results on normal listeners, further development of the central structures postulated in the theory, and preliminary work on the application of the theory to impaired hearing.

Period of Performance: 1978-1980.

Investigator: H.S. Colburn, N.I. Durlach, W.M. Siebert, L.D. Braida, and C.L. Thompson, Massachusetts Institute of Technology, Cambridge, MA (617/253-2575).

Agency Contact: Earleen Elkins, NINCDS (301/496-5061).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
			20.5	28.3	

Title: FREQUENCY SELECTIVITY IN NORMAL AND IMPAIRED EARS

Objective: To investigate auditory masking in listeners with hearing loss due to cochlear (sensorineural) pathology.

Description: The abnormally prominent upward spread of masking observed with listeners having sensorineural hearing damage not only provides insight into the nature of the underlying pathology, but also serves as a partial explanation of why impaired listeners report experiencing great difficulty understanding speech in the presence of competing background noise. These masking results have been incorporated into an audiological test for predicting the speech perception handicap in noise. In an expansion of the scope of the grant, an applied program directed toward development of a new approach to hearing prosthesis has been initiated. In this effort, a prototype for a close-talking detachable-microphone hearing aid, utilizing infrared light transmission of the acoustical signal, has been assembled.

Summary of Findings: The pattern of tonal masking as well as speech intelligibility in noise was evaluated on a sample consisting of listeners having normal hearing, presbyacusis, noise trauma and ototoxic poisoning. In general, masked speech intelligibility thresholds (speech-to-noise ratio) for the impaired listeners were about 10 dB higher than for the normal control group. In addition, there was a strong quantitative relationship between masked speech intelligibility threshold and the upward spread of masking, suggesting that the masking pattern could serve as an audiological predictor of the speech communication handicap. Initial audiological evaluation of the prototype hearing aid indicates that it is far superior to the personal hearing aid currently in use by many listeners.

Where Findings Published:

1) Leshowitz, B., and Henderson, D., "Sensorineural Hearing Loss: Insights from Sensory Psychology." Oral Presentation: American Speech and Hearing Association, Chicago, October 1977.

2) Leshowitz, B., "Relationship of Tonal Masking to Speech Intelligibility in Noise for Listeners with Sensorineural Hearing Damage." Oral Presentation: Acoustical Society of America, Miami, December 1977.

Period of Performance: 1976-1979.

Investigator: B.H. Leshowitz, Arizona State University, Tempe, AZ (602/965-4687).

Agency Contact: Earleen Elkins, NINCDS (301/496-5061).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		81.8	80.2	81.2	

Title: BINAURAL HEARING AIDS IN NOISE AND REVERBERATION

Objective: To compare binaural and monaural speech intelligibility and localization of hearing-impaired adults with and without hearing aids in the presence of varying degrees of noise and reverberation. The results of the study will identify the conditions in which the binaural advantage for intelligibility and/or localization of individual listeners can be reliably measured. This study should provide the basic data for developing a clinical test to identify those who can and cannot benefit from binaural hearing aids.

Description: Subjects will have sensorineural binaural hearing losses with various configurations of pure tone audiograms. The measurements of intelligibility will be performed for five speech-to-noise ratios, three reverberation times, monaural and binaural conditions, and unaided listening (without hearing aids) and aided listening (through ear-level commercial hearing aids). The binaural and monaural localization, with and without hearing aids, will be tested with phantom sources produced by two signals arriving to the subject with a time difference. The position of the phantom source depends on the time and intensity differences of the two signals. For the aided condition, the gain controls of hearing aids will be adjusted to see if hearing-impaired subjects can achieve localization similar to that demonstrated by normal hearing subjects.

Summary of Findings: Preliminary data with normal-hearing subjects indicate that localization in the binaural condition is easy for real and phantom sources. However, with an increased noise level there is a tendency for a greater spread of judgments for the phantom sources, while the real sources seem to be more resistant to the increased noise. In the monaural condition, the source positions are judged incorrectly. All speech sounds are judged as coming from the loudspeakers at the side of the open ear while the babble is judged as coming from the same loudspeaker as speech or from a position shifted toward the midline. There is a tendency to separate the positions of the speech and babble sources. There is no obvious relationship to the positions judged in the binaural listening.

Where Findings Published:

Nabelek, A.K., and Robinette, L., "Influence of the Precedence Effect on Work Identification by Normally Hearing and Hearing-Impaired Subjects." J. Acoust. Soc. Amer., 63:187-194, 1978.

Period of Performance: 1977-1980.

Investigator: A.K. Nabelek, L.N. Robinette, and D.L. Mason, University of Tennessee, Knoxville, TN (615/974-4123).

Agency Contact: Earleen Elkins, NINCDS (301/496-5061).

Fiscal Year Funding ($1000):

1977	1978	1979	1980
65.2	68.3	89.9	86.8

Title: EVALUATION OF A TEST OF SPEECH PERCEPTION IN NOISE

Objective: To conduct experimental work to determine the interlist equivalency, performance by signal-to-babble (S/B) functions, and validity of the Speech Perception in Noise (SPIN) Test.

Description: This study will establish the interlist equivalence for all ten recorded forms of the SPIN Test on a sample of hearing-impaired subjects, treating high- and low-predictability words as two separate domains. The effect of signal-to-babble ratio upon the SPIN Test scores of hearing-impaired and normal-hearing subjects will be assessed. Finally, the validity of this test as a predictor of the degree of benefit persons with acquired sensorineural hearing loss will appreciate from a properly selected hearing aid will be determined.

Summary of Findings: All ten forms of the SPIN Test have been presented to 128 hearing-impaired listeners at a level calculated to correspond to the loudness equivalent of 60 dB SPL for a normal-hearing listener, and the babble noise was set 8 dB lower. Half of the subjects heard the test through earphones and half via loudspeaker; half were tested in a single session and half in two sessions. Statistical analyses of these results indicated that (a) transducer, (b) visits, and (c) order of testing had no influence on test scores. The average reliability coefficient was 0.906 for the high-probability items and 0.848 for the low-probability items in each form. The ten forms tested, however, do not constitute a set of equivalent forms; and it is difficult to identify a subset of equivalent forms, because of the large differences in difficulty among forms with respect to the low-probability sentences.

Where Findings Published:

Bilger, R.C., Rzcezkowski, C., Nuetzel, J.M., and Rabinowitz, W.M., "Evaluation of a Test of Speech Perception in Noise (SPIN)." Oral Presentation: American Speech and Hearing Association Annual Meeting, November 1979.

Period of Performance: 1977-1981.

Investigator: R.C. Bilger, University of Illinois, Urbana, IL.

Agency Contact: Earleen Elkins, NINCDS (301/496-5061).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
		80	90	122

DEPARTMENT OF HEALTH AND HUMAN SERVICES

U. S. FOOD AND DRUG ADMINISTRATION

DEPARTMENT OF HEALTH AND HUMAN SERVICES

U.S. FOOD AND DRUG ADMINISTRATION

NONAUDITORY PHYSIOLOGIC RESPONSE

Title: INVESTIGATION OF POTENTIAL HAZARDS OF AIRBORNE ULTRASOUND DEVICES

Objective: To develop a risk assessment for use of airborne ultrasound devices.

Description: A literature study is being undertaken to investigate research efforts concerning possible adverse effects of airborne ultrasound on humans. A survey of output levels of selected devices producing airborne ultrasound is in progress.

Summary of Findings: Preliminary results indicate that ultrasound levels as produced by devices in use (both industrial and consumer applications) are probably not high enough to cause harmful auditory effects. They can, however, produce "subjective" effects (headaches, nausea, irritability, etc.) and levels measured are, in some cases, above published exposure criteria. Indications are that the high frequency, barely audible component is the major causative factor. Little research has been undertaken to determine if levels high enough to induce "subjective effects" can, over a long time period, produce subtle physiological damage.

Where Findings Published: Will be published as a BRH Report, probably in early 1981.

Period of Performance: 1979-1980.

Investigator: Bruce Herman, Bureau of Radiological Health, Acoustics Branch, FDA, Rockville, MD (301/443-6113).

Agency Contact: Dewitt Hazzard, FDA (301/443-4190).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
				2.2	

Title: ENVIRONMENTAL FACTORS INFLUENCING INSULIN BIOASSAY

Objective: There were several objectives to this project. The first was to determine the need for control of certain environmental factors in the insulin bioassay. Secondly, the effect of stimuli from altering environmental conditions on parameters of the bioassay such as weight and validity was determined. Finally, the nature of blood sugar change, if any, and the time required for stabilization following various stimuli such as noise production was investigated.

Description: Several trials were made during which animals received different doses of insulin by subcutaneous injection. Blood sugar was measured at 0, 1, and 2-1/2 hours after injection. At the last bleeding all animals were exposed to a sudden noise level of 85 decibels with a 20-second duration. On some occasions animals were exposed to elevated noise levels 2-1/2 hours after receiving quantities of insulin sufficient to cause significant differences in blood sugar values between doses and control animals. After exposure to elevated noise levels, blood sugar was determined at intervals of up to 10 minutes.

Summary of Findings: Only limited data could be generated on this project because of the certification program test load. Deliberate noise generation during a bioassay would violate compendial and legal requirements, so data were acquired after the official test was over (i.e., after 2-1/2 hours after dose injection). It was found that the effect of noise was transitory and of about 5 minute duration. It could not be determined if animals become tolerant of the noise stimulus because of the mentioned workload. It is also not within compendial description to obtain blood every 10 minutes because the taking of the blood sample is itself a stimulus. No plans are in effect at this time to proceed further with the noise aspect of the factors influencing insulin bioassay.

Where Findings Published: Study was incomplete. Not enough data for publication.

Period of Performance: 1977-1978.

Investigator: J.F. Reilly, J.E. Collins, C.T. Dieter, and K.M. Driego, Food and Drug Administration, Washington, DC.

Agency Contact: John E. Collins, HFD 412 FDA, 200 C St., S.W., Washington, DC 20204 (202/245-1217).

Fiscal Year Funding ($1000): No special programmatic funding.

DEPARTMENT OF HEALTH AND HUMAN SERVICES

HEALTH SERVICES ADMINISTRATION

DEPARTMENT OF HEALTH AND HUMAN SERVICES

HEALTH SERVICES ADMINISTRATION

COMMUNICATION INTERFERENCE

Title: LINGUISTIC SKILLS OF CHILDREN WITH MONAURAL DEAFNESS

Objective: To ascertain if children with unilateral hearing loss exhibit deficits in their auditory and linguistic performance.

Description: More specifically, the purposes of this investigation were twofold. The first was to determine the degree to which young children with unilateral hearing loss exhibit auditory impairments in a) word and sentence discrimination under quiet and noise conditions; b) localization abilities (quiet and noise), and c) auditory perceptual skills as determined from selected subtests of the Goldman-Fristoe-Woodcock Auditory Skills Test Battery (GFW Battery) and the tests of auditory temporal processing as discussed by Tallal. The second was to determine the nature and extent of linguistic, cognitive, and educational problems in children with unilateral hearing loss, as measured by assessment of left and right hemisphere perceptual and processing skills. The study assessed the horizontal sound localization skills of three groups of subjects: normal-hearing adults, normal-hearing children, and unilaterally hearing-impaired children. The ability of these subjects to localize pure-tones of 500 and 3000 Hz in quiet and in background cafeteria noise was evaluated.

Summary of Findings: Results indicated a significant effect of signal frequency in all three groups of listeners. The hearing-impaired children performed poorer than their normal-hearing counterparts under all conditions. Individual differences in sound localization ability among the hearing-impaired listeners is explained largely through effects of age and degree of hearing impairment. The study suggests that the unilaterally hearing-impaired school-age child has considerable difficulty in localizing sound and, therefore, will experience a significant decline in communicative efficiency in many everyday situations.

Period of Performance: 1978-1979.

Investigator: F.H. Bess, S. Allen, P.F. Norlin, J. Culbertson, R. Norris, Vanderbilt University, Nashville, TN (615/322-2446).

Agency Contact: Adele Schwartzart, Health Services Administration/Maternal Child Health Services.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
			36.2		

DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

NOISE CONCOMITANT WITH VIBRATION

Title: ASSESSMENT OF WHOLE BODY VIBRATION LEVELS OF COAL MINERS

Objective: To assess the extent and nature of whole body vibration for the United States worker population for above ground and underground coal mines.

Description: The extent to which miners are exposed to whole body vibration is largely unknown. Also, the sources of whole body vibration have not been identified and characterized. The purpose of this contract is to identify which mining occupations expose the workers to excessive whole body vibrations and to document the vibration intensity levels. Additionally, a literature search will be conducted to identify any documented cases where exposure to whole body vibrations, similar to those found in the mining environment, may have caused physiological changes. Field surveys will be initiated during 1980 at an Eastern Kentucky surface mine.

Period of Performance: 1979-1981.

Investigator: Paul Remington, Bolt, Beranek and Newman, 15 Moulton Street, Cambridge, MA 02138 (617/491-1850).

Agency Contact: Thomas G. Bobick, DOI/U.S. BOM, Pittsburgh Research Center, Pittsburgh, PA (412/675-6673).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
			80	

Title: HUMAN RESPONSE TO BLAST NOISE AND GROUND AND STRUCTURE VIBRATIONS

Objective: To determine the subjective response of humans to surface mine and quarry blasting by correlating human response with amplitude, frequency, duration, and damping characteristics of the air, ground, and structure vibrations.

Description: Community attitude surveys will be made around mines to assess reactions of the people to blasting, and will be followed by studies of subjects' reactions to on-site blasts. Blast levels of vibration and noise will be measured for correlation so that annoyance levels can be established. A laboratory phase of study will follow in order to obtain additional data which cannot easily be collected in the field environment. Peoples' responses to transient noise and vibrations, similar to blasting, will be assessed and combined with the data obtained in the field studies in order to provide adequate relationships between annoyance and blasting.

Period of Performance: 1980-1982.

Investigator: Sanford Fidell, Bolt, Beranek and Newman, Inc., Los Angeles, CA 91305 (213/347-8360).

Agency Contact: John W. Kopp, Technical Project Officer, DOI/Twin Cities Research Center, Twin Cities, MN.

Fiscal Year Funding ($1000):	1977	1978	1979	1980	1981
				202	121

DEPARTMENT OF LABOR

DEPARTMENT OF LABOR

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: EVALUATION OF METHODS FOR CALCULATION OF ATTENUATION FACTORS OF HEARING PROTECTORS

Objective: To evaluate various methods for calculating effective R-factors for hearing protectors.

Description: Currently, many miners are wearing personal hearing protection devices. For the MSHA inspector to accurately determine the noise exposure of the worker, he must know the dBA attenuation (R-factor) of a particular protective device. The Branch has been evaluating various methods for calculating the effective R-factor. Over the last several years, there have been numerous ways to calculate the attenuation or R-factor of hearing protectors. This includes OSHA methods, NIOSH methods, EPA method, Botsford method, etc. Due to the uniqueness of the mining environment, the noise levels and frequency distribution of the noise, a study has been in progress to determine which method would be most applicable to the mining industry. Other studies done by various people in other industries have also examined the problem of on-the-job effectiveness of hearing protectors versus laboratory measurements. Possibly this can also be taken into account in the mining industry.

Period of Performance: 1974-present.

Investigator: L. Marraccini, Physical Agents Branch, Pittsburgh, PA.

Agency Contact: Jerry Brasch, MSHA/Office of Coal Mine Safety and Health (703/235-1140).

Fiscal Year Funding ($1000):

1975	1976	1977	1978	1979	1980	1981	1982
2	3	3.2	3.5	4.0	4.0		

DOL (Cont'd)

Title: LABORATORY EVALUATION OF ACTIVE HEARING PROTECTORS

Objective: To evaluate two active hearing protectors (devices with small microphones, speakers and electronic circuitry which attenuates or filters out noise) and a passive hearing protector (common commercially available hearing protector) with regard to relative attenuation and speech intelligibility effectiveness. The study was undertaken because many miners are exposed to excessive noise levels in the mining industry and have listening problems using the protectors.

Description: The Branch conducted an evaluation of two types of active or discriminating ear protectors and a passive ear protector with regard to relative attenuation and speech intelligibility effectiveness. The first part of this evaluation involved using a standard anthropometric test dummy. Each hearing protector was fitted on the dummy. Noise measurements were made on the outside of the hearing protector and also under the hearing protector. The relative attenuation between the various hearing protectors was thus determined. In the second part, human volunteers were used to determine the speech intelligibility effectiveness while wearing the hearing protectors. A modified Rhyme Test was given to the volunteers. This test included a 50-word list that had been tape recorded with various signal-to-noise ratios.

Summary of Findings: The active protectors attenuate relatively the same as a passive hearing protector. However, due to some electronic problems, the active hearing protectors were not very effective in speech intelligibility. Possibly some modifications to the electronics incorporated in the active ear protector need to be made.

Where Findings Published: To be published at a later date.

Period of Performance: 1978-1979.

Investigator: G. Durkt, L. Marraccini, Physical Agents Branch, Pittsburgh, PA.

Agency Contact: Jerry Brasch, MSHA/Office of Mine Safety and Health (703/235-1140).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
				13.8	

Title: ASSESSMENT, EXAMINATION AND THE BENEFIT FORMULA

Objective: To investigate and analyze the following: 1) The appropriate frequencies to be used in assessing hearing impairment under a compensation formula; 2) the need for multiple examinations involving an otolaryngologist and/or audiologist in diagnosing hearing loss; and 3) the appropriate mathematical formula for converting a hearing impairment into a compensation benefit.

Description: An extensive literature review of the most current medical and scientific findings relevant to hearing loss assessment will be undertaken which addresses three areas:

(1) The relationship between loss of sensitivity for pure tones and hearing for communication purposes which focuses on important frequencies for hearing speech: Topics included in the review will include Federal and State standards related to assessment, literature on psychoacoustics, speech perception, and speech reception with hearing impaired individuals. In addition hearing loss claims records will be reviewed to determine impact estimates of whatever options seem appropriate.

(2) Examination procedures and protocols required to obtain reliable and valid measures of hearing loss: Audiological test procedures necessary for accurate assessment of organic and functioning hearing loss and the conditions under which these tests are performed will be evaluated and recommendations will be made on appropriate test procedures and conditions. Data bases will be examined to obtain a cost-benefit analysis of introducing such procedures.

(3) The relationship between hearing impairment and hearing handicap and how handicap can be quantified (the benefit formula): The present OWCP benefit formula will be reviewed with regard to its appropriateness to realistic loss in speech discrimination as a result of hearing impairment at the 25 dB low fence and 92 dB high fence for the average frequencies of 1,000, 2,000, and 3,000 Hz. Alternative methods for defining impairment and measuring the quantifying handicap will be outlined and the ramifications explored by applying them to one or more data bases.

Where Findings Published:

Hardick, E.J., Melnick, W., et al., "Compensation for Hearing Loss for Employees Under Jurisdiction of the U.S. Department of Labor: Benefit Formula and Assessment Procedures," Final Report, U.S. Department of Labor, 1980.

Period of Performance: 1979-1980.

Investigator: Edward J. Hardick and William Melnick, Ohio State University, Columbus, OH.

Agency Contact: Donald Ridzon, DOL/Employment Standards Administration (202/523-8509).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
					143.5

DOL (Cont'd)

Title: PRESBYCUSIS, RECRUITMENT AND TINNITUS

Objective: To produce recommendations on whether or not the relationship between hearing loss and age should be taken into account in a compensation formula and how much correction should be made and for whom. The project will also assess the effects of recruitment and tinnitus on hearing loss impairment and determine whether these conditions should be taken into account as compensable items.

Description: A thorough literature review will be conducted and existing hearing survey data on the correlation between hearing loss and age will be examined. In the literature review, an assessment of the current opinion on correction factors will be made to determine whether correction factors can be derived from existing data and if so, the feasibility of deriving such a factor for presbycusis in compensation cases for noise-induced hearing loss. The literature on recruitment will be reviewed to examine the incidence and degree of recruitment among individuals. If the presence of recruitment merits consideration in evaluating compensation claims, audiometric techniques will be proposed for identifying and quantifying its presence. Literature on tinnitus will be reviewed to determine present knowledge between quality and degree of tinnitus and associated interference. The extent to which the presence of tinnitus contributes to hearing loss will be assessed.

Where Findings Published:

Hardick, E.J., "Presbycusis, Recruitment and Tinnitus," Final Report, U.S. Department of Labor, 1979.

Period of Performance: 1978-1980.

Investigator: Edward J. Hardick, Ohio State University, Columbus, OH.

Agency Contact: Donald Ridzon, DOL/Employment Standards Administration (202/523-8509).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
				53.8	

Title: OCCUPATIONAL NOISE

Objective: To determine what constitutes a potentially hazardous exposure in individual cases for continuous and impact/impulse noise, and provide information and guidelines on the level, frequency, and durational characteristics of noise that are capable of causing hearing impairment, with which the government can use to develop policy options to fairly and equitably compensate employees with legitimate hearing impairments resulting from occupational noise.

Description: Literature on the relationship between hearing loss and continuous noise exposure encountered in work-related situations will be reviewed with emphasis on data which became available since 1974. This review will be examined to evaluate various time-weighted exposure levels, noise spectrum weighting, and exposure durations. These factors will be described in relation to the percentage of the population which will incur various amounts of hearing loss. Where actual data are not available, statistical and mathematical methods will be used to interpolate and extrapolate data points. Further review of literature and research reports will be made to develop a data base to assess the effects of impulse and impact noise. The relationship of various parameters of short duration noises including peak sound pressure level, rise and decay times, number of impulses and other parameters which affect hearing loss will be investigated. Data from this review will be subjected to statistical analysis to derive an appropriate mathematical method to describe the apparent effects of impact noise in industry as well as the impulsive noise associated with artillery and gunfire in the military.

Period of Performance: 1979-1980.

Investigator: William Melnick, Ohio State University, Columbus, OH (614/422-4004).

Agency Contact: Donald Ridzon, DOL/Employment Standards Administration (202/523-8509).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
					57.8

DOL (Cont'd)

NOISE ENVIRONMENT DETERMINATION AND EXPOSURE CHARACTERIZATION

Title: DOSIMETER ACCURACY STUDY

Objective: To show the degree to which noise exposure measurements made with sound level meter techniques and noise dosimeters agree or disagree under field conditions. Additionally, it will be determined why the results agree or disagree.

Description: To accomplish this, noise exposure surveys will be conducted simultaneously using noise dosimeters, sound level meters, and tape recorders on test subjects in surface mines, underground mines, and preparation plants. Sound level meters will follow the procedure MSHA Inspectors follow when conducting inspections. The results will be compared as to the degree of correlation between the different techniques.

Period of Performance: 1978-1980.

Investigator: J.P. Seiler, Physical Agents Branch, MSHA, Pittsburgh, PA (412/621-4500).

Agency Contact: Jerry Brasch, MSHA/Office of Coal Mine Safety and Health (703/235-1140).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
				6.9	36.1

Title: CALIBRATION OF ACOUSTICAL CALIBRATORS AND NOISE DOSIMETERS

Objective: To develop techniques and implement a program for the annual calibration of noise dosimeters and acoustical calibrators used by MSHA inspectors.

Description: To this end, calibration procedures are being developed, tested, reviewed by outside experts, and implemented. Procedures developed will meet MSHA calibration needs as opposed to manufacturers' procedures which are for production purposes.

Summary of Findings: Initial findings are that 90 percent of all acoustical calibrators are within accuracy specifications between calibration cycles. Results of the dosimeter program are inconclusive at this point. Thus, coupled with a field verification program between calibration cycles, a high degree of accuracy can be maintained for acoustical calibrators. Similar results are expected for dosimeters.

Period of Performance: 1977-present.

Investigator: J.P. Seiler, Physical Agents Branch, MSHA, Pittsburgh, PA (412/621-4500).

Agency Contact: Jerry Brasch, MSHA/Office of Coal Mine Safety and Health (703/235-1140).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
			53.7	49.3	265.7

Title: IMPULSE/IMPACT SOUND LEVEL METER EVALUATION

Objective: To determine the suitability of impulse/impact sound level meters for the measurement of impulse noise in surface and underground mines.

Description: Test procedures for evaluation are being developed. Three different instruments are also being evaluated in the laboratory. Mining operations thought to be impulsive in nature will be measured using commercially available test impulse/impact sound level meters and compared to standard measurement techniques.

Period of Performance: 1979-1980.

Investigator: M.E. Banks, Physical Agents Branch, MSHA, Pittsburgh, PA (412/621-4500).

Agency Contact: Jerry Brasch, MSHA/Office of Coal Mine Safety and Health (703/235-1140).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
					32.6

Title: EVALUATE A NOISE DATA LOGGER SYSTEM

Objective: To demonstrate the accuracy of and use of information from a commercially available noise data logger system.

Description: The project will consist of evaluating the acoustical performance of 4 dB-301 metrologgers in the laboratory and demonstrating their use in noise surveys performed in underground mines. The factors to be evaluated in the laboratory include A-weighting response, linearity, and accuracy of the noise dose accumulation. The field phase will compare the instruments under actual in-mine conditions.

Period of Performance: 1978-1980.

Investigator: J.P. Seiler, C.A. Dirkmaat, Physical Agents Branch, Pittsburgh, PA (412/621-4500).

Agency Contact: Jerry Brasch, MSHA/Office of Coal Mine Safety and Health (703/235-1140).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
				36.5	21.3

Title: DEVELOPMENT OF A FIELD SYSTEM FOR DOSIMETER FREQUENCY RESPONSE MEASUREMENT

Objective: To develop and evaluate a field system to indicate whether noise dosimeters have response problems from 1 kHz - 8 kHz.

Description: A small reverberant test box was developed. Noise dosimeters were exposed to 1/3 octave bands of pink noise in the test enclosure. The dosimeter response was measured and ANSI Type II tolerances applied. An approximate determination of whether or not the instrument was within specifications was then made.

Summary of Findings: The test system measurements are repeatable and accurate in screening out faulty instruments. One can determine those dosimeters having poor high frequency response outside of an acoustical laboratory. The procedure can be used as part of a screening system for checking dosimeters.

Where Findings Published: Findings not yet published; report currently being prepared.

Period of Performance: 1978-1979.

Investigator: J.P. Seiler, C.A. Dirkmaat, Physical Agents Branch, Pittsburgh, PA (412/621-4500).

Agency Contact: Jerry Brasch, MSHA/Office of Coal Mine Safety and Health (703/235-1140).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
				53.5	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

EFFECTS OF NOISE ON SLEEP

Title: ACOUSTIC ENERGY EFFECTS ON SLEEP AND HUMAN PERFORMANCE--EFFECTS OF CERTAIN FUNDAMENTAL PARAMETERS OF ACOUSTIC STIMULI

Objective: To perform a systematic investigation of the sleep disturbing effects of aircraft noise with particular emphasis on studies of how specific parameters of auditory energy cause arousal during sleep.

Description: Laboratory testing of subjects has been carried out over the past several years on the nature and effects of an individual's response to auditory noise during sleep. Studies were performed to determine whether an individual responds similarly during sleep and wakefulness and whether sleep disruption may carry over to wakefulness in terms of the individual's estimate of sleep quality and overt performance.

Summary of Findings: The response of an individual to an auditory stimulus when awake is, at best, only minimally predictive of how he will respond when asleep. Neither subjective loudness nor increased annoyance appear to be a particularly good predictor of sleep disruption. Rise time (onset of acoustic signal) was found to be an important parameter in determining sleep disruption. Sleep disruption was found to produce a fourfold to fivefold increase in response time involving memory demands.

Where Findings Published:

LeVere, T.E., "Arousal From Sleep: The Uniqueness of an Individual's Response and the Problem of Noise Control." Final Report NGL 34-002-095. Proposed NASA CR, 1979.

Period of Performance: 1972-1979.

Investigator: T.E. LeVere, Department of Psychology, North Carolina State University, Raleigh, NC 27650.

Agency Contact: W.H. Mayes, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
	30	30	40		

Title: COMPARATIVE STUDY OF COMMUNITY REACTIONS TO ENVIRONMENTAL NOISE

Objective: To (1) develop a catalog of existing social surveys of community reaction to environmental noise, (2) establish a data archive for selected community noise surveys, (3) identify survey designs which would improve the precision of the surveys' conclusions, and (4) consolidate the knowledge from existing surveys on selected topics.

Description: Over 150 surveys of people's response to environmental noise in their residential environments have been identified. A catalog of these surveys is being prepared. The Social Science Research Council (SSRC) data archive at the University of Essex, England is archiving selected surveys. Eight environmental noise surveys are in the SSRC Archive now. Other surveys are being prepared for the archive. A reanalysis of seven surveys together with a review of existing publications has consolidated existing information about noise level and number of noise event relationships and about social survey designs for time-of-day studies. The effects of sampling variability and the noise measurement program's precision on community noise surveys' results are being quantified.

Summary of Findings: The number of noise events increases noise annoyance beyond that which would be expected from peak noise level alone. However, the estimate of the form of the number effect and the relative importance of number and peak level varies greatly from survey to survey. Some of the inconsistencies between surveys on this and other noise index construction issues is created by incomparable annoyance questions, variability in the precision of noise level estimates, inappropriate analysis techniques, and inefficient study designs.

Where Findings Published:

1) Fields, J.M., "The Relative Importance of Noise Level and Number of Events on Human Reactions to Noise: Community Survey Findings and Study Methods." NASA TM 81795, March 1980.

2) Fields, J.M., "Designing Community Surveys to Provide a Basis for Noise Policy." To be published as a NASA Technical Memorandum.

3) Clevenson, S.A., and Shepherd, W.T. (Eds.), "Time-of-Day Corrections to Aircraft Noise Metrics Workshop." To be published as a NASA Conference Paper, July 1980.

Period of Performance: 1979-1981.

Investigator: J.M. Fields, Noise Effects Branch, Acoustics and Noise Reduction Division, NASA Langley Research Center, Hampton, VA.

Agency Contact: D.G. Stephens, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			50	50

NASA (Cont'd)

Title: COMMUNITY RESPONSE TO AIRCRAFT NOISE

Objective: To (1) quantify the relationship between subjective reaction and aircraft noise within airport communities; (2) assess the variation in this relationship attributable to time of day, ambient noise level, and various aircraft operation parameters such as aircraft type, operation mode, flight tracks, etc.; and (3) determine the validity of various noise descriptors or metrics for quantifying the aircraft noise.

Description: The plans of this research program are to address these objectives in a series of airport community studies in order to provide accurate information for each objective; test methods of successive studies will vary slightly. However, all studies will be conducted within airport communities and will involve simultaneous measurement of subjective reactions and aircraft noise. The initial study of this research program provides for testing 400 residents within 100 homes (four residents/home).

Summary of Findings: Tests not completed; however, preliminary findings have been published below.

Where Findings Published:

Dempsey, T.K., DeLoach, R., and Stephens, D.G., "Supporting Statement for Community Study of Human Response to Aircraft Noise." NASA TM 81803, March 1980.

Period of Performance: 1979-1983.

Investigator: T.K. Dempsey, R. DeLoach, D.G. Stephens, NASA Langley Research Center, Hampton, VA (804/827-3561).

Agency Contact: T.K. Kempsey, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
				100

Title: GENERAL STUDIES IN HUMAN RESPONSE TO NOISE

Objective: To provide background information on human response to noise.

Description: There are three activities underway. The largest involves a grant with Columbia University to examine the methodology for conducting environmental noise surveys. Additionally, two publications (The Effects of Noise on Man and Handbook of Noise Ratings) will be revised and updated.

Where Findings Published:

1) Kryter, K.D., The Effects of Noise on Man, Academic Press, New York and London, 1970.

2) Pearsons, K.S., and Bennett, R.L., Handbook of Noise Ratings. NASA CR-2376, April 1974.

3) Borsky, P.N., "Research Plan for Establishing the Effects of Time Varying Time Exposures on Community Annoyance and Acceptability." NASA CR-159197, January 1980.

Period of Performance: 1978-1980.

Investigator: K.D. Kryter, Stanford Research Institute (415/326-6200); R. Bennett, Bolt, Beranek and Newman, Inc.; P. Borsky, Columbia University, New York, NY (516/352-4906).

Agency Contact: D.G. Stephens, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
			223	108	

NASA (Cont'd)

Title: THE EFFECTS OF AIRCRAFT SOURCE DIFFERENCES ON PASSENGER AND COMMUNITY ANNOYANCE

Objective: To establish levels of equal noisiness for a variety of aircraft including advanced turboprop, general aviation, helicopters, and conventional turbofan aircraft.

Description: Human response to interior (passenger) noise and community flyover situations will be examined both in the field and in the laboratory. Variables will include the noise level, the tonal content, and duration of exposure. In addition to defining effects of source differences on responses, results will be correlated with current noise metrics to examine the effectiveness of the metrics for predicting the noisiness of a variety of aircraft noise sources.

Period of Performance: 1979-1981.

Investigator: In-house, NASA Langley Research Center, Hampton, VA.

Agency Contact: D.G. Stephens, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
			50	

Title: EFFECT OF HELICOPTER NOISE ON PASSENGER ANNOYANCE

Objective: To determine the effects of helicopter interior noise on passenger annoyance for both reverie and listening situations as well as the relative effectiveness of several metrics (OSPL, dBA, SIL) for quantifying annoyance responses for these situations.

Description: Subjects were asked to make annoyance judgments (using a nine-point unipolar scale of annoyance) of various interior noise stimuli while engaged in a listening task or under a reverie (no task) condition. The listening task required the subjects to listen to a record of phonetically-balanced (PB) words presented within the various noise environments.

Summary of Findings: Results indicated that annoyance during a listening condition was generally higher than annoyance under a reverie condition for corresponding interior noise environments. Attenuation of the tonal components of the interior noise spectra resulted in increased listening performance but had only a small effect upon annoyance for a given noise level. The noise metric found most effective for estimating annoyance response under both the task and no-task conditions was the A-weighted sound pressure level.

Where Findings Published:

Clevenson, S.A., and Leatherwood, J.D., "Effect of Noise Spectra and a Listening Task Upon Annoyance in a Helicopter Interior Noise Environment." NASA TP-1590, December 1979.

Period of Performance: 1979-1979.

Investigator: S.A. Clevenson and J.D. Leatherwood, NASA Langley Research Center, Hampton, VA (804/827-3561).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000): No special programmatic funding.

Title: TIME-OF-DAY EFFECTS ON THE NUMERICAL REPRESENTATION OF COMMUNITY RESPONSE TO NOISE

Objective: To identify factors that may alter the annoyance of aircraft overflights that occur at various times of the day.

Description: Annoyance levels and temporal variations in annoyance are being collected from communities differentially impacted by aircraft noise. In addition, people are being asked for their preferred hours for reduced noise levels.

Summary of Findings: Curves of relative annoyance to noise as a function of time of day in hours have been generated for several communities having different night time noise exposure. Results of these preliminary studies clearly indicate a rise in annoyance (or a preference for quiet) in the evening hours and a general decline in annoyance after midnight.

Period of Performance: 1978-1987.

Investigator: E. Galanter, Columbia University, New York, NY (212/280-4382).

Agency Contact: D.G. Stephens, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
			50	50	

Title: FIELD STUDY OF THE EFFECTS OF TIME-OF-DAY ON HUMAN RESPONSE TO AIRCRAFT NOISE

Objective: To investigate, in an actual airport community, the effects of time-of-day on human response to noise. In particular, the nighttime correction factors (penalties) are being studied.

Description: Using a compact mechanical counter and preprinted postcard report forms, test subjects in the airport community recorded the number of times they were annoyed by aircraft flyovers during various time periods of the day as they went about their normal daily routines. The subject responses were then correlated with measured noise levels in the community for various time periods of the day.

Summary of Findings: The significance of this study is that the results should provide some insight into the validity of the 10 dB penalty which many noise rating indices assign to nighttime noise events. Although the study has not been completed, some preliminary results are reported in the publication listed below.

Where Findings Published:

Horonjeff, Richard D., and Teffeteller, Sherri R., "Initial Study of the Immediate Annoyance of Aircraft Noise as a Function of Time of Day." NASA Contractor Report 159167, April 1980.

Period of Performance: 1978-1980.

Investigator: K.S. Pearsons, Bolt, Beranek and Newman, Inc., Los Angeles, CA (213/347-8360).

Agency Contact: D.A. McCurdy, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
			48	3	7

NASA (Cont'd)

Title: COMMUNITY RESPONSE TO GENERAL AVIATION NOISE

Objective: To define and assess the particular problems associated with general aviation noise. Included will be an assessment of the impact and annoyance caused by aircraft noise in general-aviation airport communities and in mixed general aviation-CTOL airport communities.

Description: Two independent but parallel contract studies are being conducted which include tasks associated with problem definition, noise measurement and analysis, noise modeling and comparison of measurement and modeling results. In one study, in addition to the above parallel tasks, community involvement meetings and interviews will be conducted with planning personnel and managers at several airports in order to identify noise problems, community opinions and attitudes associated with general aviation operations. In the other study, annoyance and activity interference information will be obtained from a limited number of residents and will be related to the daily and cumulative general aviation noise exposure over a 5-day period.

Period of Performance: 1978-1980.

Investigator: J. Stearns, Wyle Research, El Segundo, CA (213/322-1763);
J. Mabry, MAN Acoustics, Seattle, WA (206/633-5913).

Agency Contact: C.A. Powell, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
		77	112	

Title: EFFECTS OF SUBJECT ACTIVITIES ON ANNOYANCE DUE TO MULTIPLE-EVENT AIRCRAFT NOISE SITUATIONS

Objective: To determine the influence of subject activity on laboratory annoyance judgments.

Description: In the in-house study, annoyance responses are being obtained for typical home aircraft noise exposures while subjects are engaged in different activities commonly associated with home life. Differences in response to the same exposure but for different activities will be determined for incorporation in community response models. In the contract study, a battery of tasks representative of the psychological processes inherent in a wide range of human activities will be developed. These tasks will be used in a variety of noise environments to assess possible relationships between activity interference and annoyance responses.

Summary of Findings: One in-house study has been completed in which annoyance responses were obtained from subjects engaged in face-to-face communication and reverie tasks. No significant differences in annoyance could be attributed to the two tasks. Measurements of speech interference were also obtained during conversation periods.

Where Findings Published: Report in editorial process.

Period of Performance: 1979-1981.

Investigator: K.F. Key, NASA Langley Research Center, Hampton, VA;
M.D. Arnoult, Dept. of Psychology, Texas Christian University, Fort Worth, TX.

Agency Contact: C.A. Powell, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			20	35

Title: EFFECTS OF NUMBERS AND LEVELS OF AIRCRAFT EXPOSURE ON ANNOYANCE IN MULTIPLE-EVENT NOISE SITUATIONS

Objective: To determine the most effective descriptors for multiple-aircraft noise exposures.

Description: Subjects are exposed to, and will make annoyance judgments of, sessions of multiple aircraft noises. The number and level of the individual noises vary between sessions. The subjective data are to be compared with various physical measures and relationships to determine the most appropriate community noise descriptor.

Summary of Findings: The findings thus far have indicated that energy average measures such as Leq provide a good measure of central tendency of laboratory annoyance. The results of these studies should provide some insight as to the most appropriate descriptor of cumulative noise exposure or the need for new descriptors.

Where Findings Published: Two reports are in editorial process.

Period of Performance: 1975-1980.

Investigator: C.A. Powell, NASA Langley Research Center, Hampton, VA; K.P. Shepherd, The Bionetics Corp., Hampton, VA.

Agency Contact: C.A. Powell, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):

1977	1978	1979	1980
50	30	40	30

Title: EFFECTS OF SINGLE-EVENT HELICOPTER NOISE ON ANNOYANCE

Objective: To determine the annoyance characteristics of noise sources peculiar to helicopters. The findings of these studies are of particular significance to domestic and international noise certification of helicopters.

Description: Subjects will judge the annoyance of real and simulated helicopter noises in tests covering a range of variables associated with helicopter noise. The subjective judgments are compared with various physical measurements to determine the most appropriate descriptor for the variable of interest. In the present in-house study, simulated noises will be used which cover the range of impulsiveness and repetition rate of main and tail rotors in carefully planned factorial designs. In the grant study, noises of the same spectral content and repetition rates but with differing phase relationships will be compared for differences in annoyance characteristics. In the contract study, recordings of actual and electronically modified helicopter flyovers will be used. The prime objective of this latter study is to study the possible relationship between detectability and annoyance for a wide range of helicopter and ambient noise situations. The helicopter noises will be selected especially to reduce multi-colinearity between the chosen samples.

Summary of Findings: Findings to date in a study in which subjects judged actual helicopter flyover noises and a study in which subjects judged recordings of the same noises indicated no improvement in annoyance prediction ability of descriptors with impulse corrections over the basic descriptors without specific impulse corrections.

Where Findings Published:

1) Lawton, B.W., "Subjective Assessment of Simulated Helicopter Blade-Slap Noise." NASA TND-8359, December 1976.

2) Powell, C.A., "Annoyance Due to Simulated Blade-Slap Noise, in Helicopter Acoustics." NASA Conference Publication 2052, 1978.

3) Powell, C.A., "A Subjective Field Study of Helicopter Blade Slap Noise." NASA TM-78758, July 1978.

4) Shepherd, K.P., "A Laboratory Study of the Subjective Response to Helicopter Blade-Slap Noise." NASA Contractor Report 158973, December 1978.

Period of Performance: 1976-1982.

Investigator: C.A. Powell, NASA Langley Research Center, Hampton, VA; A. Ahamada, Jr., Stanford University, Palo Alto, CA (415/497-4061); D. May and J.B. Ollerhead, Wyle Research, El Segundo, CA (213/322-1763).

Agency Contact: C.A. Powell, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):

1977	1978	1979	1980
30	60	50	120

NASA (Cont'd)

Title: EFFECTS OF DURATION ON ANNOYANCE OF SINGLE-EVENT AIRCRAFT NOISE

Objective: To determine the effects of duration on the annoyance caused by single-event aircraft noise. The studies were designed to control for a number of factors believed to be responsible for the differences in results from previous studies.

Description: Test subjects made annoyance judgments of recordings of a variety of real and simulated aircraft noises having a wide range of durations. The peak levels of the stimuli ranged from 65 to 90 dBA. The research is unique in that in most of the studies the duration, Doppler shift, and spectral content of the noise stimuli were individually controlled. This was accomplished by specifying aircraft operational factors in a computer synthesis of the noises or by manually modifying recordings of real aircraft noises.

Summary of Findings: The results are generally consistent with the equal energy hypothesis of an effect equivalent to a 3 dB increase in annoyance per doubling of duration. These findings are significant in that they confirm the duration corrections used in the aircraft noise certification metric, EPNL.

Where Findings Published:

1) Shepherd, K.P., "The Subjective Evaluation of Noise from Light Aircraft." NASA CR-2773, December 1976.

2) McCurdy, D.A., and Powell, C.A., "Effects of Duration and Other Noise Characteristics on the Annoyance Caused by Aircraft-Flyover Noise." NASA TP-1386, March 1979.

3) Shepherd, K.P., "The Effect of Duration of Jet Aircraft Flyover Sounds on Judged Annoyance." NASA CR-159132, September 1979.

4) McCurdy, D.A., "Effects of Sound Level Fluctuations on Annoyance Caused by Aircraft-Flyover Noise." NASA TP-1576, December 1979.

Period of Performance: 1976-1979.

Investigator: D.A. McCurdy, NASA Langley Research Center, Hampton, VA;
K.P. Shepherd, University of Utah and the Bionetics Corporation.

Agency Contact: D.A. McCurdy, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
		37	30	30	

Title: EFFECTS OF TONAL COMPONENTS ON ANNOYANCE OF SINGLE-EVENT AIRCRAFT NOISE

Objective: To assess the contribution of tonal components in noise on the magnitude of judged annoyance and noisiness. The results of this type of research is of great importance in assessing whether tone correction procedures are needed in aircraft certification noise descriptors or other regulatory noise descriptors.

Description: In these laboratory experiments, subjects will judge the magnitude of annoyance, noisiness, and loudness of bursts of broadband noises with added tonal components. Broadband noises of different spectral character will be used. Frequency and signal-to-noise ratio of the tonal components will be the primary variables. The judgments will be compared with various models accounting for summation and inhibition to determine when tone corrections to noise descriptors are needed and how to implement such corrections.

Period of Performance: 1979-1980.

Investigator: R.P. Hellman, Boston University, Boston, MA (617/353-3188).

Agency Contact: C.A. Powell, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			30	30

NASA (Cont'd)

Title: EVALUATION OF SINGLE-EVENT AIRCRAFT NOISE DESCRIPTORS FOR CTOL FLEET

Objective: To assess the ability of various metrics to quantify the noisiness of the present CTOL fleet during takeoff and landing operations. The ability of the metrics to properly quantify tonal components is of particular interest.

Description: Subjects will rate the noisiness of a large number of selected aircraft noise recordings in environments which simulate outdoor and indoor conditions. These ratings will be compared with acoustical analyses of the noises in terms of the more common physical rating scales.

Period of Performance: 1979-1981.

Investigator: J.E. Mabry, MAN Acoustics and Noise Inc., Seattle, WA (206/633-5913).

Agency Contact: C.A. Powell, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			75	

NOISE ENVIRONMENT DETERMINATION AND EXPOSURE CHARACTERIZATION

Title: AIRCRAFT NOISE LEVELS AND ANNOYANCE MODELS

Objective: To develop the technology for noise impact assessment and minimization in airport communities.

Description: Focus for this program is an airport community computer simulation model called ALAMO (Aircraft-Noise Levels and Annoyance Model) which is capable of overlaying distributions of aircraft noise level (footprints) on the population distributions of any U.S. airport community. A recently developed psycho-physical relationship between noise exposure level and subjective response (annoyance) (Schultz, 1978), is then invoked to predict the overall impact of airport noise on the surrounding community, based on the number of individuals exposed to various levels of noise. A single-number description of noise impact is computed using the Fractional Impact Method, as described in the 1977 report of CHABA Working Group 69 entitled "Guidelines for Preparing Environmental Impact Statements on Noise." Outputs of the program include a prediction of the number of residents expected to be "highly annoyed" with the airport noise, as well as several demographic variables listed as a function of noise level, including population, population density, and population growth rate. The ALAMO model can be used to quantify the degree of noise impact reduction which can be achieved by various candidate noise abatement strategies. For example, a number of runway selection alternatives might be compared with the imposition of a night curfew to see which strategy results in the greatest reduction of highly impacted residents. Various fleet mix and land-use alternatives can be assessed in a similar manner.

Summary of Findings: The feasibility of assessing noise impact in terms of human subjective response for arbitrarily selected airport communities has been demonstrated.

Where Findings Published:

DeLoach, Richard, "An Airport Community Noise-Impact Assessment Model." NASA TM-80198, November 1979.

Period of Performance: 1977-1981.

Investigator: R. DeLoach, NASA Langley Research Center, Hampton, VA; I.D. Jacobson and G. Cook, University of Virginia, Charlottesville, VA; L. Frair, Virginia Polytechnic Institute and State University, Blacksburg, VA.

Agency Contact: R. DeLoach, NASA Langley Research Center, Hampton, VA

Fiscal Year Funding ($1000):

1977	1978	1979	1980
60	90	80	70

NOISE CONCOMITANT WITH VIBRATION

Title: MODEL OF PASSENGER RESPONSE TO COMBINED NOISE AND VIBRATION

Objective: To develop a generalized model for the estimation of passenger subjective discomfort response to combined interior noise and vibration environments.

Description: The development of this model required laboratory and field testing of approximately 2,500 test subjects during which subjective reactions to various vibration and/or noise stimuli were elicited. The ranges of noise and vibration stimuli included the amplitudes and frequencies known to most influence passenger comfort.

Summary of Findings: The resultant ride comfort model accounts for the effects of combined axis vibrations (up to three axes simultaneously) and includes corrections for the effect of vibration duration and interior noise. The output of the model consists of an estimate of the passenger discomfort produced by a given noise and/or vibration environment. This discomfort estimate is measured along a continuous scale that spans the range from below discomfort threshold to values of discomfort that are far above the discomfort threshold. The model has been implemented in a user-oriented computer program, and provides a unique tool for use by design engineers in the development of new and improved transportation vehicles.

Where Findings Published:

1) Leatherwood, J.D.; Dempsey, T.K.; and Clevenson, S.A., "A Design Tool for Estimating Ride Quality Within Complex Ride Environments." To be published in Human Factors (HFJ #6306) Vol. 22, No. 4, August 1980.

2) Dempsey, T.K.; Leatherwood, J.D.; and Clevenson, S.A., "Development of Noise and Vibration Ride Comfort Criteria." J. Acoust. Soc. Amer., 65(1), January 1979.

3) Dempsey, T.K.; Leatherwood, J.D.; and Clevenson, S.A. "Discomfort Criteria for Single Axis Vibrations." NASA TP-1422, May 1979.

Period of Performance: 1974-1981.

Investigator: T.K. Dempsey, J.D. Leatherwood, S.A. Clevenson, NASA Langley Research Center, Hampton, VA.

Agency Contact: T.K. Dempsey, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000): No special programmatic funding.

Title: AIRCRAFT NOISE-INDUCED BUILDING VIBRATIONS

Objective: To determine the building vibrations resulting from aircraft and nonaircraft events.

Description: Vibrations of windows, walls, and floors were determined for aircraft including conventional jets, supersonic transports (Concorde), propeller vehicles, and helicopters as well as ground vehicles and common household events.

Summary of Findings: The results of these measurements indicated that vibration levels resulting from aircraft overflights were directly proportional to unweighted sound pressure levels and were independent of other noise source differences. In general, vibration levels due to aircraft noise were lower than vibration levels due to common domestic events and well below established structural damage critera. Results of subjective measurements conducted as part of this program indicated that noise levels in excess of about 100 dB (unweighted) induced floor vibration levels above the human detection threshold.

Where Findings Published:

1) Langley Research Center, "Noise-Induced Building Vibrations Caused by Concorde and Conventional Aircraft Operation at Dulles and Kennedy International Airports." Final Report, NASA TM-78769, August 1978.

2) Stephens, D.G., and Mayes, W.H., "Aircraft Noise-Induced Building Vibration." Community Noise, ASTM Special Technical Publication 692. R.J. Peppin and C.W. Rodman (ed.), Philadelphia, PA, May 1978.

Period of Performance: 1976-1979.

Investigator: In-house, NASA Langley Research Center, Hampton, VA.

Agency Contact: D.G. Stephens, NASA Langley Research Center, Hampton, VA (804/827-3561).

Fiscal Year Funding ($1000):

1977	1978	1979	1980
50			

NATIONAL SCIENCE FOUNDATION

NATIONAL SCIENCE FOUNDATION

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: EFFECTS OF ACOUSTIC TRAUMA ON SINGLE AUDITORY NEURONS

Objective: To determine how various types of noise-induced cochlear pathologies alter hearing performance and the activity of single auditory nerve fibers in the chinchilla. Behavioral conditioning techniques are used to estimate the magnitude and type of hearing loss, and cochlear pathologies are evaluated from surface preparation and thick sections of the organ of Corti.

Description: Chinchillas were exposed to octave bands of noise that produced an asymptotic temporary threshold shift and some permanent threshold shift as determined by behavioral conditioning techniques. Afterward, thresholds, tuning curves, spontaneous activity and poststimulus time histograms were obtained from single auditory nerve fibers. Finally, the cochlea of each animal was fixed, embedded in plastic and analyzed by light microscopy.

Summary of Findings: The threshold shifts observed in single auditory nerve fibers generally paralleled those measured behaviorally; however, in some cases, the threshold shifts in the fibers were considerably larger than one would expect from the audiometric data. The tuning curves of units in the noise-exposed animals generally showed a greater loss in sensitivity near the characteristic frequency than in the tail of the tuning curve so that the bandwidth was wider than normal. In addition, some units showed an improvement in threshold in the tail of the tuning curve so that the tuning curve was "W"-shaped. The response latencies of units from normal and noise-exposed animals were the same when plotted in terms of absolute intensity of click stimulation; however, the latencies were shorter in pathological units when plotted in terms of intensity relative to threshold. The poststimulus time histograms obtained with tone bursts were not significantly altered by the noise exposure. Furthermore, the rates of spontaneous activity were generally the same in normal and noise-exposed animals. Regions of the cochlea with missing hair cells were always associated with units having elevated threshold and broad tuning curves; however, some units had elevated threshold and broad tuning curves without significant hair cell loss. The later group of units were frequently associated with other structural abnormalities in the cochlea.

Where Findings Published:

1) Salvi, R.J., Hamernik, R.P., and Henderson, D., "Discharge Patterns in the Cochlear Nucleus of the Chinchilla Following Noise-Induced Asymptotic Threshold Shift." Exp. Br. Res., (32):301-320, 1978.

2) Salvi, R.J., Henderson, D., Hamernik, R.P., "Single Auditory Nerve Fiber and Action Potential Latencies in Normal and Noise-Treated Chinchillas," Hearing Res. (in press).

3) Salvi, R.J., Hamernik, R.P. and Henderson, D., "Auditory Nerve Activity and Cochlear Morphology After Noise Exposure." Arch. Otorhinolaryngol. (224):111-116, 1979.

NSF (Cont'd)

Period of Performance: 1977-1981.

Investigator: Richard Salvi, State University of New York, Upstate Medical Center, Syracuse, NY (315/473-5573).

Agency Contact: Terry Dolan, NSF (202/634-1624).

Fiscal Year Funding ($1000):	1977	1978	1979	1980	1981
	40.6	41.7	38	36	

BEHAVIORAL, SOCIAL, AND PERFORMANCE EFFECTS

Title: PHYSIOLOGICAL, MOTIVATIONAL AND COGNITIVE EFFECTS OF AIRCRAFT NOISE ON CHILDREN*

Objective: To study the generality of laboratory effects of noise on behavior in a naturalistic setting and to examine the course of adaptation to noise over a one year period.

Description: The project consists of a longitudinal study designed to assess the impact of noise on attentional strategies, feelings of personal control and physiological processes related to health. Children were tested on the same measures twice with a one year interval between sessions. The study compares elementary school children under the corridor of a busy metropolitan airport to a matched group of children living in relatively quiet neighborhoods. This longitudinal data is used to determine whether children adapt to the aircraft noise over the one year period and to assess the effectiveness of noise abatement interventions introduced in a number of noise impacted classrooms. Cross-sectional data provides evidence of the effects of noise on the entire sample (the attrition rate was about 33%) and provides further information on the utility of noise abatement.

Summary of Findings:

Cross-sectional data - The entire sample: In general, the results were consistent with laboratory work on physiological response to noise and on uncontrollable noise as a factor in helplessness. Thus children from noisy schools had higher blood pressure than those from matched control (quiet) schools. Noise school children were also more likely to fail on a cognitive task and were more likely to "give up" before the time to complete the task had elapsed. The development of attentional strategies predicted from laboratory and previous field research was, on the whole, not found. Noise abatement had small ameliorative effects on performance of a cognitive task and on a standardized test of school achievement.

Longitudinal Data - The attrition sample: In general, there was little evidence for adaptation to noise over the one year period. Noise abatement affected childrens' ability to hear their school teachers but had relatively little impact on other tasks. (School achievement data were not available one year later and thus were not included in this analysis.) Children from noisy schools who had high blood pressure were likely to move out of the neighborhood within a two year period after the original testing. This was not true of children with high blood pressure from quiet neighborhoods.

* Project also listed under NIEHS, p. A-204.

Where Findings Published:

1) Cohen, S. et al., "Physiological, Motivational and Cognitive Effects of Aircraft Noise on Children: Moving from the laboratory to the Field." American Psychologist, 35(3), 231-243, 1980.

2) Cohen, S., and Weinstein, N., "Nonauditory Effects of Noise on Behavior and Health," invited paper, J. Social Issues, (special issue on environmental stress, in press).

3) Cohen, S. et al., "Aircraft Noise and Children: Longitudinal and Cross-Sectional Evidence on Adaptation to Noise and the Effectiveness of Noise Abatement." Under editorial review. Available from author.

Period of Performance: 1977-1980

Investigator: Sheldon Cohen, Department of Psychology, University of Oregon, Eugene, Oregon, 97403 (503/686-4921).

Agency Contact: Robert Baron, Social and Developmental Psychology Program, NSF, (202/357-9485).

Fiscal Year Fundings ($1000):	1977	1978	1979	1980	
	44	15			(NSF)
			30	30	(NIEHS)

DEPARTMENT OF TRANSPORTATION

DEPARTMENT OF TRANSPORTATION

INDIVIDUAL AND COMMUNITY RESPONSE

Title: HIGHWAY NOISE CRITERIA - A PSYCHOACOUSTIC STUDY*

Objective: To 1) identify and quantify important physical parameters which effect human response to time-varying traffic noise associated with varying densities of both free-flowing highway traffic and stop-and-go traffic; 2) investigate and compare various measures and computational procedures for rating time-varying traffic noise and to investigate which method (or methods) best predicts the subjective response of people to the noise from various types of traffic situations; 3) develop, if necessary, improved procedures for rating time-varying traffic noise in terms of measurable parameters of the noise; and 4) formulate procedures by which the most useful of the above rating procedures may be related to other commonly used environmental noise descriptors.

Description: Data has been collected and analyzed on the time histories and spectra of traffic noise from different traffic situations as has data on how traffic sounds are received in a building. Laboratory investigations are underway on the human response to the time-varying noises in the data base described above. From analysis of the data collected in these experiments and in conjunction with the analysis done on the physical data base, it will be possible to evaluate existing rating schemes and, if necessary, develop an improved rating procedure. A questionnaire and measurement plan will be developed to assess occupants' reactions to highway noise based on the key parameters identified in the project just described. The questionnaire and measurement plan will be made available for validating the results of the work done at NBS.

Summary of Findings: Analysis of psychoacoustic experiments on time-varying highway noise is now in progress.

Where Findings Published:

Interim analyses of the data base are published "Highway Noise Criteria Study: Traffic Noise Data Base," (NBS 1113-1), Washington, D.C.

Period of Performance: 1977-1981.

Investigator: Simone L. Yaniv, Building and Community Acoustics Group, National Bureau of Standards, Washington, DC 20234 (301/921-3704).

Agency Contact: F.M. Romano, DOT/FHWA, Washington, DC 20590.

Fiscal Year Funding ($1000):

1977	1978	1979	1980	1981	1982	
75	75	75	75	75	75	(FHWA)
12.5	12.5	12.5	12.5	12.5	12.5	(NBS)

* Project also listed under Department of Commerce, p. A-11.

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: EFFECTS OF COCKPIT NOISE (IN SELECTED AIRCRAFT) ON HUMAN HEARING

Objective: To investigate the effects on human hearing of noises considered to be characteristic of those found inside the cabins and cockpits of existing aircraft types (i.e., subsonic CTOL jet) and of a future generation of aircraft (i.e., STOL aircraft).

Description: This will be done by recording and/or synthesizing noises representative of twin-engine business jets, 2-, 3-, and 4-engine jet powered STOL aircraft. The spectra for these recordings and syntheses shall be determined along with exposure levels of the noises expected for cabin and cockpit occupants. This information shall be used in conjunction with research results from studies of noise-induced hearing loss to derive proposed damage risk criteria (DRC) for exposure to the above described noises. These DRC shall be similar to and shall account for the same assumptions used in derivation of the DRC of the Committee on Hearing, Bioacoustics and Biomechanics (CHABA) of the National Academy of Sciences, for generalized noise exposures.

Period of Performance: 1980-1981.

Investigator: Sanford Fidell, Bolt, Beranek and Newman, Inc., Los Angeles, CA 91305 (213/347-8360).

Agency Contact: William Shepherd, FAA Office of Environment and Energy (202/755-9027).

Fiscal Year Funding ($1000):	1978	1979	1980	1981
			20	15

BEHAVIORAL, SOCIAL AND PERFORMANCE EFFECTS

Title: EFFECTS OF FREEWAY NOISE ON HEARING LEVEL AND ACADEMIC ACHIEVEMENT OF CHILDREN

Objective: To determine a noise level limit inside classrooms that will preclude adverse effects on the learning of elementary school children.

Description: About 90 classrooms in 15 schools of a single school district were observed for about 3 days each. The schools (noisy and quiet) were matched on a number of socioeconomic variables. Observations included tape-recorded noise levels and concurrent indices of disruption of classroom behavior. These indices included acts such as inability of the observer to hear the teacher or student, a call to order of the class or a child, interruption of a teacher's lecture, and others. Standard Reading and Mathematics achievement scores constitute the dependent variables. Measurements of noise levels in communities providing children for each school were also obtained.

Summary of Findings: The data are currently being analyzed.

Period of Performance: 1977-1980.

Investigator: J.S. Lukas, California Department of Health, Office of Noise Control, Berkeley, CA (415/843-7900).

Agency Contact: Mas Hatano, California Department of Transportation (916/739-2413).

Fiscal Year Funding ($1000):	1977	1978	1979	1980	
	3	239	107	81	(FHWA)

NOISE ENVIRONMENT DETERMINATION AND EXPOSURE CHARACTERIZATION

Title: ASSESSMENT OF LOCOMOTIVE CREW IN-CAB OCCUPATIONAL NOISE EXPOSURE

Objective: To assess the noise environment in locomotive cabs.

Description: Operational duty cycle and in-cab sound level data were presented for 18 test runs made on 16 different locomotives used in a wide range of operational modes (e.g., through freights and local transfer freights), varied terrains (mountainous, undulating and flat) and varied trip lengths (6 to 12 hours).

Summary of Findings: The general conclusion of this study is that there does not appear to be a widespread problem of overexposure to noise based on the same type of evaluation as currently used by OSHA (only 1 out of 18 test runs exceeded the criteria). The noise exposure is within acceptable limits because the operational duty cycle is such that the sources which generate high sound levels (horn and brake) are operating only for short periods of time and because the locomotive spends a great deal of time in idle (diesel engine sound levels below 90 dB) waiting to get into or out of yards and on sidings for other trains to pass. However, there was one test run for which an overexposure to noise was measured. To pinpoint such cases where overexposure to noise may occur, a simplified testing procedure was developed. This test consists of making in-cab sound level measurements of engine notch 8 (no load), horn sounding and brake application with the locomotive stationary. With these three sound level measurements and an estimate of the time that the locomotive is operating on-line, the inservice noise dose can be estimated and a pass/fail assessment made of whether the noise exposure might exceed acceptable limits.

Where Findings Published: Final report to be published in the summer of 1980.

Period of Performance: 1976-1980.

Investigator: Roger D. Kilmer, National Bureau of Standards, Department of Commerce, Washington, D.C.

Agency Contact: D.A. Vaughn, DOT/FRA, Washington, DC 20590.

Fiscal Year Funding ($1000):	1977	1978	1979	1980	
	103	44.9	15		(FRA)

VETERANS ADMINISTRATION

VETERANS ADMINISTRATION

NONAUDITORY PHYSIOLOGIC RESPONSE

Title: CONCEPT IDENTIFICATION IN STRESS

Objective: To examine the effects of noise stress and antecedent failure on the psychophysiological functioning and concept identification performance of young men with two different types of behavior patterns.

Description: One hundred-two young, paid, volunteer men exhibiting Type A (coronary-prone) and Type B (nonprone) behavior patterns were selected and studied for this project. They were subjected to various noise bursts while performing a variety of cognitive tasks.

Summary of Findings: Type A men demonstrated early disruptions in task performance due to initial exposure to uncontrollable noise burst. Type B men showed disrupted performance only after extended exposure to take failure and loud noise exposure. The Type A men show autonomic reactions indicative of stress reactions to the noise and failure, suggesting the presence of stress responses that could lead to cardiopathology. Extreme A's showed reliably higher serum cholesterol levels than B's, both prior to and after stress, while A's who had been exposed to loud noise showed higher post-stress serum triglyceride levels than those exposed to room noise. B's showed no such difference. Other autonomic measures differentiated the groups as well. A's and B's showed similar levels of skin conductance and rate of nonspecific response output while at rest. However, during work on the cognitive tasks, A's were significantly higher in both of these indices. A's showed higher resting levels of cutaneous vasoconstriction than B's, but the group did not differ during work on the tasks.

Where Findings Published:

1) Lovallo, W.R., "The Role of Stress in the Development of Heart Disease: Theory and Research," Biological Psychology Bulletin, 5:70-95, 1979.

2) Lovallo, W.R., and Pishkin, V., "A Psychophysiological Comparison of Type A and B Men Exposed to Failure and Uncontrollable Noise," Psychophysiology, 17:29-36, 1980.

3) Lovallo, W.R., and Pishkin, V., "The Effects of Initial and Extended Uncontrollability in Type A and B Coronary-Prone Men," Paper presented at the 26th Annual Meeting of the Southwestern Psychological Association, San Antonio, TX, 1979.

4) Lovallo, W.R., and Pishkin, V., "Performance of Type A (Coronary-Prone) Men During and After Exposure to Uncontrollable Noise and Task Failure," J. Personality & Social Psychology: Personality Processes and Individual Differences, (In Press).

5) Lovallo, W.R., and Pishkin, V., "The Relationship of Autonomic Activity in Type A Men to a Measure of Self-Involvement and to the Traits of Neuroticism and Extraversion," Psychosomatic Med. (In Press).

Period of Performance: 1978-1980.

Investigator: Vladimir Pishkin, Behavioral Sciences Laboratories, Veterans Administration Medical Center, Oklahoma City, OK (405/272-9876).

Agency Contact: William R. Lovallo, Veterans Administration Medical Center, Oklahoma City, OK.

Fiscal Year Funding ($1000): No special programmatic funding.

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: HEARING IMPAIRMENT AMONG RESIDENTS OF A VETERANS ADMINISTRATION NURSING HOME CARE FACILITY

Objective: To attempt to determine the incidence of hearing loss in a population of nursing home care facility residents. Attempts were also made to determine the types of audiological recommendations, to evaluate what was needed for audiologic rehabilitation, and to estimate staff needs, facilities, equipment, and costs involved.

Description: An initial audiological screening test was administered to 100 residents in the Nursing Home Care Unit. The residents ranged in age from 35 to 91 years, the average age being 71 years. Those who failed initial screening were later given a complete audiological evaluation.

Summary of Findings: Sixty-nine residents (61%) failed hearing screening. An additional 20% failed at the higher frequency (4000 Hz). When a complete audiological evaluation was administered to the 69 residents, 53 (76%) had sensori-neural losses with the remaining 17 (24%) having a mixed loss. Audiological recommendations most frequently made were: hearing aid evaluation, medical management, and audiological rehabilitation.

Where Findings Published: A thesis submitted to the Department of Communicative Disorders, University of Alabama.

Period of Performance: 1978.

Investigator: Judith Scott Charlton, Graduate Student, University of Alabama, Tuscaloosa, AL.

Agency Contact: Lars Peterson, Chief, Psychology Service, Veterans Administration.

Fiscal Year Funding ($1000): No special programmatic funding.

VA (Cont'd)

Title: A QUESTIONNAIRE SURVEY OF THE ATTITUDES OF WEARERS OF IN-THE-EAR BINAURAL HEARING AIDS

Objective: To identify the possible differences between the subjective opinions of hearing aid wearers relative to the advantages and disadvantages of the In-the-Ear and Behind-the-Ear hearing aid arrangements in a questionnaire study.

Description: Sixty bilaterally hearing-impaired, male adults who were issued binaural hearing aids through the Veterans Administration were used as subjects. The subjects were divided into three groups. Group I included 20 inexperienced subjects who were issued true binaural Behind-the-Ear hearing aids. Group II included 20 inexperienced subjects who were issued true binaural In-the-Ear hearing aids. Group III included 20 experienced wearers whose true binaural Behind-the-Ear hearing aids were replaced by true binaural In-the-Ear hearing aids. Two questionnaires, that contained the same items, were designed to gather responses relative to improvements in the subjects' abilities to understand speech in quiet and in noise and to localize sounds with their various hearing aid arrangements, as well as comfort and/or convenience of the different hearing aids. The subjects responded to the 24 situations described in the questionnaires by marking a point on a scale which best reflected the magnitude of positive or negative differences between listening experiences with present hearing aid arrangements and past unaided or aided listening experiences. The subjects were asked to respond to five open-ended questions that pertained to all four areas.

Summary of Findings: All three groups of hearing aid wearers reported improvements in their abilities to understand speech in quiet and in noise and their ability to localize. They all responded favorably, indicating that they are satisfied with their present hearing aid arrangements. The results of this study suggested that wearers of true binaural In-the-Ear hearing aids receive more benefit from their hearing aid arrangements when listening to two or more people in the presence of background noise than wearers of true binaural Behind-the-Ear hearing aids. The results of this study also suggested that wearers of true binaural Behind-the-Ear hearing aids were more often bothered by wind-noise than wearers of true binaural In-the-Ear hearing aids. This distraction may interfere with the wearers' ability to understand speech in noise. It was found that inexperienced and experienced In-the-Ear hearing aid wearers favored the appearance of their hearing aids more than Behind-the-Ear hearing aid wearers.

Period of Performance: 1979.

Investigator: Cynthia H. Davis, Masters Thesis, University of South Florida, FL.

Agency Contact: Frank X. Frueh, Veterans Administration (FTS 826-6265).

Fiscal Year Funding ($1000): No special programmatic funding.

Title: HEARING LOSS PATTERNS IN DIFFERENT GROUPS OF NOISE-EXPOSED VETERANS

Objective: To evaluate the hearing loss patterns in various groups of noise-exposed veterans. An attempt was made to determine if certain types of noise tended to produce certain hearing loss configurations.

Description: This study was undertaken in 1976 as part of the routine hearing assessment procedures at the Veterans Administration Medical Center, Indianapolis, Indiana. The study was completed in 1979 with a total of 138 subjects. Subjects were selected on the basis of a set of rigorous criteria insuring as much as possible that the hearing loss exhibited was due to noise exposure. The following primary noise-source groups were identified: 1. Aircraft engine exposure; 2. Frequent small-arms fire exposure; 3. High-level industrial noise exposure; 4. Frequent artillery fire exposure; 5. Multiple exposure (could not be placed into a single exposure category); 6. Noise trauma. Pure tone results obtained at 250, 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz for each subject were categorized into six general hearing loss configuration groups and related to the noise-source groups. The six general hearing loss configurations which emerged were: 3000 Hz notch; 4000 Hz notch, 6000 Hz notch; 3000-4000 Hz notch; 4000-6000 Hz notch; and 3000-6000 Hz notch.

Summary of Findings: The results indicate that the different primary noise sources produce relatively different hearing loss patterns. The veterans exposed to aircraft noise and those who experienced acoustic trauma had a higher incidence of 6000 Hz and 4000-6000 Hz notches than the other groups, while they had a lower incidence of 3000 Hz notches. The veterans exposed primarily to industrial type noise, those exposed primarily to small-arms fire, and those exposed primarily to artillery noise had a higher incidence of 3000 Hz and 3000-4000 Hz notches while they had a lower incidence of 6000 Hz and 4000-6000 Hz notches than the other groups. The multiple noise exposure group had a higher incidence of multi-frequency notches than the other primary noise source groups.

Where Findings Published:

1) Unpublished paper presented at the American Speech and Hearing Association Convention, 1977 "Hearing Loss From Noise in a Group of Veterans" (with William T. Brandy).

2) Poster session at American Speech and Hearing Association Convention, 1979 "Hearing Loss Patterns in Different Groups of Noise-Exposed Veterans" (with William T. Brandy).

Period of Performance: 1976-1979.

Investigator: Henry A. Raymond, VA Medical Center, Indianapolis, IN; William T. Brandy, VA Medical Center, Danville, IL.

Agency Contact: Henry A. Raymond, Audiologist, VA Medical Center, Indianapolis, IN 46202 (317/635-7401).

Fiscal Year Funding ($1000): No special programmatic funding.

VA (Cont'd)

Title: PSYCHOMETRIC FUNCTIONS FOR NORMAL HEARING LISTENERS AND LISTENERS WITH NOISE-INDUCED HEARING LOSS: THE EFFECT OF TONE DURATION AND FREQUENCY

Objective: To determine whether the slopes of psychometric functions for listeners with noise-induced hearing loss differ from slopes obtained from normal hearing listeners with respect to tone duration and frequency. This information is essential to the determination of those factors which differentiate auditory function in listeners with noise-induced hearing loss from listeners with normal auditory function.

Description: Eight listeners, 4 with normal hearing and 4 with noise-induced hearing loss were trained a minimum of 10 hours on a Two Interval Forced Choice (2IFC) protocol. 2IFC psychometric functions were obtained from each listener for 500- and 20-msec tones at 250, 1000, and 4000 Hz. Slope of the psychometric functions was determined and an analysis of variance (2 groups x 2 durations x 3 frequencies).

Summary of Findings: The slope of psychometric functions for listeners with noise-induced hearing loss (NIL) differ from the slopes for normal hearing listeners (NH), but such differences are dependent on frequency and duration. For instance, the slope for NH and NIL listeners at 250 and 1000 Hz did not differ significantly from one another while at 4000 Hz significant differences were noted. More specifically, NIL listener slopes for 20-msec tones at 4000 Hz (11%/dB increment) differ significantly from slopes for NH listeners at 4000 Hz (7.5%/dB increment), whereas 500-msec slopes for the two groups at 4000 Hz were identical (7.5%/dB increment). It appears that listeners with noise-induced hearing loss at this juncture of the auditory system respond differently to short duration tones in the region of the hearing loss than they do to long duration tones.

Where Findings Published: These results are being prepared for publication in the Journal of the Acoustical Society of America.

Period of Performance: 1979-1980.

Investigator: M.W. Valerio, VAMC Audiology Service, Syracuse, New York (315/476-7461).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000): No special programmatic funding.

Title: RELATIONSHIP BETWEEN TYMPANOMETRY AND AIR-BONE GAP

Objective: To investigate the relationships among parameters of acoustic impedance audiometry with the presence of an air-bone gap at 250, 500 and 1000 Hz. This information would be helpful in developing screening programs and in developing techniques for predictory presence and degree of hearing loss in subjects who are either unable or unwilling to respond to traditional methods.

Description: Tympanogram type, peak pressure point of tympanogram and static compliance measurements were independent variables and in a regression equation to predict presence of air-bone gap in 84 adult males. The tympanograms were obtained with a commercially available impedance meter with a probe tone of 220 Hz at 95 dB SPL.

Summary of Findings: Knowledge of the "type" or shape of tympanogram is the best predictor of air-bone gap in this study, followed by peak pressure point and then compliance. About 40% of the variability of the regression equation was accounted for by these variables.

Where Findings Published: Submitted for presentation to Annual Convention of the American Speech and Hearing Association, to be held in Detroit, Michigan, November, 1980.

Period of Performance: 1979-1980.

Investigator: E.L. Goshorn, VA Medical Center, Memphis, TN; D. Wark, Memphis State University, Memphis, TN.

Fiscal Year Funding ($1000): No special programmatic funding.

VA (Cont'd)

Title: RELATIONSHIP BETWEEN THE HEARING HANDICAP SCALE AND THE SPEECH DISCRIMINATION ABILITY OF HEARING AID USERS

Objective: To obtain a more qualitative measurement of the handicap imposed upon the individual by a physical hearing loss.

Description: The Hearing Handicap Scale (HHS), Form A, followed by four tests of speech discrimination were administered to 19 adult male hearing aid users. Recorded speech stimuli were presented in the sound field at 50 dB HTL while subjects wore their hearing aids. Noise, a generally unintelligible babble, was presented at plus 10 dB signal-to-noise ratio.

Summary of Findings: HHS scores correlated significantly with all speech tests: Speech Reception Threshold Test, CID W-22 word test in quiet and in noise, and the CID Everday Sentence Lists in quiet and in noise. The CID W-22 word tests in quiet and in noise were the speech discrimination tests found to be most consistent with the HHS. For both words and sentences, the noise conditions were more closely correlated to the HHS than were the quiet conditions. The HHS was found to be a useful instrument for measuring the communicative function of hearing aid users when presented in the context of aided hearing ability. The scale can provide the audiologist with insight into the specific communication needs and difficulties of the individual client and can be used to assess the effects of aural rehabilitation therapy and the client's adjustment to amplification.

Period of Performance: 1978-present.

Investigator: J.J. Karp, Veterans Administration, Boston, MA.

Fiscal Year Funding ($1000): No special programmatic funding.

Title: CHARACTERISTICS OF HEARING AID EFFECTIVENESS

Objective: This study is being undertaken to isolate those characteristics of hearing aid amplification that are most highly correlated to the needs of the hearing impaired. This information is essential to permit the proper selection of acoustic output characteristics needed to compensate maximally for hearing loss.

Description: For a four-year period, veterans receiving hearing aids were included in the study. Statistical analyses were generated by computer of the relationships between the residual hearing characteristics of the ear to be fit with a hearing aid, the output characteristics of the two best hearing aids as selected by the veteran, and his answers to a questionnaire concerned with obtaining his opinion of the relative importance of the performance characteristics of the selected hearing aid.

Summary of Findings: The first phase of this long-term study has been completed. The statistical analyses did not reveal any significant findings. The statistical techniques utilized to define the important variables and their functional relationships are unique and have been submitted to a professional journal for publication. A second study is in the final planning stages. This study has the same goal as the first study.

Period of Performance: 1973-present.

Investigator: M. Engelberg, Audiology & Speech Pathology Service, VAMC, Cleveland, OH.

Agency Contact: Marvin Engelberg, VA 126W (FTS 294-7348).

Fiscal Year Funding ($1000): No special programmatic funding.

Title: ELECTROPHYSIOLOGICAL CORRELATES OF NOISE AND DRUG-INDUCED THRESHOLD SHIFTS

Objective: To investigate the interaction of noise and various drugs to elucidate the mechanisms by which intense sound and ototoxic agents produce cochlear dysfunction.

Description: The basic methodology involves the correlation of electrophysiological and audiometric measures of hearing sensitivity with light and electron microscopic evaluation of cochlear structures.

Summary of Findings: Current work has described a potentiative interaction between the aminoglycoside antibiotic kanamycin and a level of noise exposure which, by itself, produces only a temporary threshold shift. Preliminary work has also shown that a history of temporary threshold shift can enhance the ototoxicity of kanamycin, even when no permanent alteration in hearing sensitivity is present. On the other hand, a pre-existing kanamycin-induced hearing loss does not appear to lower the threshold of noise-induced cochlear damage.

Further work concerning the interaction of noise exposure and in vivo staining for NADH-cytochrome C reductase indicates that noise-induced cochlear damage involves both alteration of hair cell membrane permeability and the disruption of oxidative phosphorylation. Similar work with kanamycin damage indicates that hair cell loss due to this ototoxic antibiotic is related to alterations in membrane permeability.

In order to provide an additional model of noise-induced threshold shifts, the sensitivity of the mongolian gerbil (Meriones unguiculatis) to temporary and permanent threshold shifts due to noise was characterized at three intensities of exposure. Preliminary work with a stimulant of oxidative phosphorylation suggests that it is possible to increase the rate of recovery from noise-induced temporary threshold shifts.

Period of Performance: 1977-1978.

Investigator: R.C. Bone and A.F. Ryan, Veterans Administration, San Diego, CA.

Fiscal Year Funding ($1000): No special programmatic funding.

COMMUNICATION INTERFERENCE

Title: THE EFFECT OF ALCOHOL ON INTENSITY DISCRIMINATION ABILITY

Objective: To investigate (1) the relationship between auditory intensity discrimination and chronic alcoholism, and (2) the relationship between impairment and the return to full or partial auditory intensity discrimination function following hospital medical treatment.

Description: Sixteen chronic alcoholics were evaluated both before and after standard V.A. Hospital detoxification therapy. Ten non-alcoholic, normal hearing listeners were evaluated by the same test techniques. Tests consisted of procedures to measure difference limens (DL) for intensity and critical bandwidths (CBW).

Summary of Findings: Impairment in DL and CBW were seen in chronic alcoholics in the form of increased threshold signal-to-noise (S/N) ratios. Following one week of detoxification therapy, DL returned to normal at 40 dB SPL masker levels and closer to normal at 55 and 70 dB SPL masker levels. Following one week of detoxification therapy, no return towards normal CBW was observed in post-treatment alcoholics. It was concluded that efferent pathology resulted in an impairment in both DL and CBW. This was reflected in the size of both the difference limen and the critical band. Results indicate that results obtained on audiometric procedures involving either DL or CBW techniques should not necessarily be compared to previously determined norms based upon a non-alcoholic population.

Where Findings Published: Currently submitted for presentation at the 1980 American Speech Language and Hearing Association (ASHA) Convention.

Period of Performance: 1976-1979.

Investigator: Marsha S. Schwartz and Robert L. Zimmerman, Veterans Administration.

Agency Contact: Principal Investigators.

Fiscal Year Funding ($1000): No special programmatic funding.

VA (Cont'd)

Title: THE DIFFERENTIAL EFFECT OF BONE CONDUCTED BROAD BAND NOISE ON TEMPORAL SUMMATION IN NORMAL HEARING AND HEARING IMPAIRED LISTENERS

Objective: To examine how bone conducted noise affects temporal summation and to relate these findings to other clinical audiometric and medical information both from listeners with normal hearing and listeners with hearing loss of different etiologies.

Description: The parameters under study were type of listener (normal hearing, hearing impaired), listening condition (masking noise not present), frequency (250, 500, 1000, 2000, and 4000 Hz), and tone duration (500- and 20-msec). Among the hearing impaired listeners, veterans with noise-induced hearing loss were compared with those who had hearing loss of different etiologies. Ten normal hearing and fifty hearing impaired listeners participated in the investigation.

Summary of Findings: For normal hearing listeners, temporal summation is not affected in a simple manner by bone conduction masking noise. More specifically, the effect of masking between listeners is greater than that within listeners. Furthermore, masking affects thresholds for long tones in a different way than it affects thresholds for short tones. Finally, thresholds for high frequency tones, regardless of tone duration, are influenced to a greater extent than low frequency tones. In general, the addition of noise appears to affect hearing impaired listeners in the same manner as noise influences thresholds in the normal hearing listener. Among the hearing impaired listeners, veterans with noise-induced hearing loss show the greater reduction in temporal summation ability when compared to listeners with hearing loss due to other etiologies. The data at this time imply that it may be necessary to develop specific norms which account for the effect of bone-conducted masking noise (i.e. the clinical Sensory Neural Acuity Level test - SAL) on the threshold for different duration tones.

Period of Performance: 1978-present.

Investigator: M.W. Valerio, Louis M. Di Carlo, and P.L. McGrath, VAMC Audiology Service, Syracuse, New York (315/476-7461); H.N. Wright, Upstate Medical Center, Department of Otolaryngology and Communication Sciences, Syracuse, New York.

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000): No special programmatic funding.

Title: AUDITORY DISCRIMINATION AND AZIMUTH POSITIONS

Objective: To experimentally determine the ability to discriminate the position of a sound source at different azimuth locations. The aim of this project is to obtain data with normal hearing subjects in order to serve as a base line condition for later evaluation of hearing impaired patients on ability to localize.

Description: Ten subjects with normal and symmetric audiograms will be presented with a noise stimulus in a free-field situation at 4 azimuths (0, 90, 180, 270 degrees). The error of localization and the minimum audible angle (M.A.A.) will be measured by a method of limits technique. Differences in error and M.A.A. measures for the 4 azimuth positions will be evaluated statistically in a repeated measure analysis of variance design.

Period of Performance: 1978-present.

Investigator: M.W. Altshuler, Chief, Audiology and Speech Pathology Service, Department of Otorhinolaryngology, Hahnemann Medical College and Hospital, Philadelphia, PA; P.E. Comalli, Department of Psychology, Temple University, Philadelphia, PA.

Agency Contact: M.W. Altshuler, VA Medical Center, 1421 Cherry Street, Philadelphia, PA 19102 (215/597-7187).

Fiscal Year Funding ($1000): No special programmatic funding.

Title: EFFECTS OF ACOUSTIC ENVIRONMENT ON SPEECH DISCRIMINATION IN APHASICS

Objective: To isolate the specific effect of background noise as a potential cause of impaired verbal receptive ability in aphasic patients. To this end, the effects of acoustic environment on the speech discrimination ability of aphasic patients were studied.

Description: A closed-set word recognition task designed for aphasic patients was mixed with binaurally recorded cafeteria noise and administered to 8 adult aphasics and 8 normal subjects. The test was divided into 7 subtests of 20 words each with each subtest presented binaurally. Six of the seven conditions consisted of speech presented diotically or lateralized to the right or left at a +10 or 0 signal-to-noise ratio; the seventh condition was a diotic presentation in quiet. Aphasic subjects were identified as mild or moderate as measured by the Understanding portion of the "Functional Communication Profile."

Summary of Findings: An analysis of the mean response latencies revealed a midline preference for both mild ($p=.004$) and moderate ($p=.035$) aphasics. As the noise increased the number of errors made by aphasic subjects increased. The mild group made an increased number of phonemic discrimination errors, while the moderate aphasics made an increased number of phonemic discrimination errors and an increased number of referent category errors. There is some clinical evidence for increased attention in the presence of noise. This is seen in the normals' performance with a decrease in latency as the intensity of noise increased in the midline conditions and might account for some of the performance of the aphasic subjects in the midline conditions; although in the lateralized listening conditions it appeared that noise caused processing difficulties for the aphasics, particularly for stimuli lateralized to the ear contralateral to the sight of lesion.

Period of Performance: 1977-1978.

Investigator: Kate Whittington and J.C. Malone, Audiology and Speech Pathology Service, VA Medical Center, Durham, NC (919/286-0411).

Agency Contact: R.G. Paul, VAMC, 558/126.

Fiscal Year Funding ($1000): No special programmatic funding.

Title: AUDITORY PROCESSING DEMANDS DURING A HEARING AID EVALUATION

Objective: To study effects of hearing aid use, speech intelligibility, and age upon auditory processing demands of hearing impaired persons. Previous research focused primarily upon speech intelligibility as the major indicator of differential benefit from hearing aid use. Yet, hearing aid users often report notable differences in listening effort required to achieve similar speech intelligibility scores. This study is conducted in an attempt to identify meaningful differences in listening effort required under various aided listening conditions.

Description: The experiment involves a minimum of 30 audiometrically confirmed hearing impaired listeners participating in hearing aid evaluations. The primary task consists of speech intelligibility testing wherein subjects repeat words presented in a background of competing speech. This task is performed with and without hearing aid use. As the listener repeats test words (primary task), he also watches for the periodic onset of a small light and presses a button to turn off the light as quickly as possible (secondary task). As the effort required to correctly repeat test words increases, so does the subject's reaction time to the light or secondary task.

Summary of Findings: The secondary reaction time task was found to be a useful measure of the listening effort required in a speech intelligibility task. Coupled with scores indicating understanding for speech, such a measure of listening effort enables the audiologist to predict the degree of listening comfort one might enjoy with one hearing aid versus another instrument.

Where Findings Published:

Presented to the American Speech, Language, and Hearing Association, Atlanta, Georgia, November 1979.

Period of Performance: 1977-1978.

Investigator: M.A. Crum, M.E. McClellan and D.W. Downs, Veterans Administration Medical Center, Albuquerque, NM (505/265-1711).

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000): No special programmatic funding.

VA (Cont'd)

Title: COMFORTABLE EFFORT LEVEL: AN EXPERIMENTAL VARIABLE

Objective: To answer the experimental question, "How constant are speaker utterances from one experimental session to another when speakers are asked to repeat speech samples at a comfortable effort level?" The term comfortable effort level implies that there is a level of vocal or speech output which for the speaker is natural and/or optimum when repeating an utterance. It would seem important, especially to investigators involved in acoustical or physiological studies of speech behavior, to understand more exactly a speaker's behavior when asked to produce a vocal or a speech utterance at a comfortable effort level.

Description: Sixteen subjects, eight males and eight females were required to repeat vocal and speech utterances at the same time of day for five successive days. During each session, the subjects were asked to sustain the vowels /a/ and /i/ three times each for approximately five seconds. They were also asked to repeat the phrases: "say /a/ again," "say /e/ again," three times each. Measures of vocal intensity and speaking fundamental frequency were obtained from the tape recordings. Relative sound pressure level values and speaking fundamental frequency values were obtained through appropriate graphic level or visicorder analyses. Care was taken to retain the speaker's head in a fixed position using a rig consisting of a steel rod attached to a microphone which allowed for the speaker's head to remain fixed.

Summary of Findings: The results of the analysis indicate that subject-to-subject variability in both vocal intensity (SPL) and speaking fundamental frequency (SFF) was significantly greater than variability from day to day within speakers. This was true for all utterances. In addition, the variation which occurred from day to day over the five day period was significantly greater than the variation which occurred within each day over the three repetitions for all utterances for both and SPL and SFF. Any experimenter involved in the study of a particular physiological/aerodynamic factor must be aware of the potential variability in a speaker's utterance. This is especially true if the experimenter expects or assumes vocal frequency or intensity to remain essentially constant. Finally, in view of the present findings, variations in SPL and SFF over the five day period in a relatively noise-free environment suggest that the term "comfortable effort level" must be considered an experimental variable.

Where Findings Published:

Murry, Thomas, "Comfortable Effort Level: An Experimental Variable." J. Acoust. Soc. Amer., 60:696-699, 1976.

Period of Performance: 1975-1978.

Investigator: Thomas Murry, Veterans Administration.

Agency Contact: Principal Investigator.

Fiscal Year Funding ($1000): No special programmatic funding.

Title: COMPRESSION AMPLIFICATION AND SPEECH INTELLIGIBILITY IN NOISE

Objective: To investigate the influence of various methods of compression amplification on speech intelligibility, and to evaluate the effectiveness of compression amplification in reducing tolerance problems for loud sounds. The three types of compression amplification systems under study were the AVC, the fixed ratio (2 to 1), and the variable ratio compression. Comparisons were also made between the compression and the conventional linear amplification system.

Description: A wearable master hearing aid with switch-selectable controls was designed and built by a hearing aid manufacturer for this study. The hearing aid was housed in a pocket-sized package which was connected via a miniature cable to a post-auricular module. This module contains a forward-facing omnidirectional microphone and a receiver. The frequency response of the master aid was designed to approximate that of a typical commercial hearing aid. Measurements of the electroacoustic characteristics of the master aid were obtained using the 1976 ANSI standard. Furthermore, the amplitude non-linearities of the four systems were measured using three different distortion measurements; harmonic, difference-frequency, and intermodulation distortion. Twenty-four subjects with mild-to-moderate bilateral sensorineural hearing losses were included. The master aid was worn in the aided ear and the test words (N.U. No. 6) were presented at 70 and 85 dB SPL with a S/N of 6 dB calibrated to a point representing the middle of the subject's head. The volume control of the hearing aid was set separately to a most comfortable listening level for each amplification system. The order of presentation of test materials as well as experimental conditions was counterbalanced.

Summary of Findings: The compression amplification system was found to improve the listener's discrimination ability in noise. Especially at the loud speech level, the observed difference reached 24%. Among the three types of compression amplification, the 2 to 1 fixed ratio compression was found to exhibit the best performance at both presentation levels. Furthermore, the compression amplification system was found to increase the aided dynamic range and thus effectively reduce the tolerance problem for patients with sensorineural hearing loss. High level of DF (Difference-Frequency) and IM (Intermodulation) distortions along with reduced aided dynamic range were the likely factors that caused the decreased discrimination scores for the linear amplification system.

Where Findings Published: Results being prepared for publication.

Period of Performance: 1976-1977.

Investigator: Richard (Jing) J. Sung, Veterans Administration Medical Center, Pittsburgh, PA 15240 (412/281-4233).

Agency Contact: Veterans Administration, Department of Medicine and Surgery, Rehabilitative Engineering Research and Development Service, Washington, DC 20420; Veterans Administration, Research Center for Prosthetics, 252 Seventh Avenue, New York, NY 10001.

Fiscal Year Funding ($1000):	1976	1977	1978
	5	5	5

INDEX TO

PROJECTS BY

RESEARCH CATEGORY

KEY TO AGENCY ABBREVIATIONS USED IN THIS LISTING

Abbreviation	Agency
Forest Service	DEPARTMENT OF AGRICULTURE (Forest Service)
NBS	DEPARTMENT OF COMMERCE (National Bureau of Standards)
	DEPARTMENT OF DEFENSE
Air Force	Air Force
Army	Army
Navy	Navy
Education	DEPARTMENT OF EDUCATION
DOE	DEPARTMENT OF ENERGY
EPA	ENVIRONMENTAL PROTECTION AGENCY
	DEPARTMENT OF HEALTH AND HUMAN SERVICES
NIMH	National Institute of Mental Health
NIOSH	National Institute for Occupational Safety and Health
NHLBI	National Heart, Lung, and Blood Institute
NICHHD	National Institute of Child Health and Human Development
NIEHS	National Institute of Environmental Health Sciences
NINCDS	National Institute of Neurological and Communicative Disorders and Stroke
FDA	Food and Drug Administration
HSA	Health Services Administration
BOM	DEPARTMENT OF THE INTERIOR (Bureau of Mines)
DOL	DEPARTMENT OF LABOR
NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NSF	NATIONAL SCIENCE FOUNDATION
DOT	DEPARTMENT OF TRANSPORTATION
VA	VETERANS ADMINISTRATION

NONAUDITORY PHYSIOLOGIC RESPONSE

NOISE EFFECTS ON SLEEP

INDIVIDUAL AND COMMUNITY RESPONSE

ICR (Cont'd)

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

NIHL (Cont'd)

NIHL (Cont'd)

NIHL (Cont'd)

BEHAVIORAL, SOCIAL AND PERFORMANCE EFFECTS

COMMUNICATION INTERFERENCE

NOISE ENVIRONMENT DETERMINATION AND EXPOSURE CHARACTERIZATION

NEDEC (Cont'd)

HUMAN RESPONSE TO NOISE CONCOMITANT WITH VIBRATION

APPENDIX B

STATE, LOCAL, AND PRIVATE NOISE EFFECTS RESEARCH

STATE, LOCAL, AND PRIVATE RESEARCH

NONAUDITORY PHYSIOLOGIC RESPONSE

Title: AGE-RELATED CHANGES IN BRAIN RNA LEVELS IN MICE SUBJECTED TO NOISE STRESS - A PILOT STUDY

Objective: To perform cytophotometric analyses of auditory cortical RNA changes in 10-week and 40-week-old mice subjected to high levels of noise.

Description: Mice were subjected to a 30-minute interval of continuous noise stimulation (100 dB, 0.35 to 20 kHz). Treatment groups consisted of young and old noise-exposed mice killed at 0-, 1-, and 4-hour intervals after cessation of noise stimulation. Corresponding groups of control mice were not subjected to noise stimulation. Quantification of neuronal RNA changes was made on an individual cell basis using scanning-integrating microdensitometry of azure B-stained brain sections.

Summary of Findings: In noise-stimulated groups, it was found that auditory cortical neurons from older mice exhibited increased RNA levels which were comparable to those of younger mice. The similarity and extent of RNA augmentation in old and young mice after sensory stimulation sugggests there is no marked age-related impairment in the capacity of cerebrocortical cells to synthesize RNA.

Where Findings Published:

1) Anthony, A., Zerweck, C., "Scanning-Integrating Microdensitometric Analysis of Age-Related Changes in RNA Content of Cerebrocortical Neurons in Mice Subjected to Auditory Stimulation," Experimental Neurology, 65:542-551, 1979.

2) Anthony, A., Brister, N.W., Colurso, G.J., "Cytochemical Bioassay and Radioimmunoassay of ACTH in Noise Stressed Rats," Journal of Histochemistry and Cytochemistry, 27(10):1380-1381, 1979.

Period of Performance: 1978-1980.

Investigator: A. Anthony, R. Mitchell, C. Zerweck, Penn State University, University Park, PA (814/865-4562).

Sponsor: Dept. of Health and Human Services, Administration of Aging.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			2	2

INDIVIDUAL AND COMMUNITY RESPONSE

Introduction: The following four studies were all part of a "Community Noise Impact Evaluation of Norfolk, Virginia," conducted by Norfolk's Health Department. These evaluative studies were undertaken to define, quantitatively and qualitatively, the specific attributes of the city's noise environment. Each study is detailed separately below.

Title: CITIZENS ATTITUDES ABOUT NOISE IN THEIR ENVIRONMENT - A SURVEY

Objective: To determine, through a questionnaire study, if the citizens of Norfolk viewed noise as a problem.

Description: To get this information in a usable form "a fixed response, environmentally-oriented questionnaire" was developed which allowed the citizen to make choices among six groups of common pollutants which he or she might encounter. Based on the reply, if noise was defined as a pollutant, a second, subsequent "Noise Source Questionnaire" was given. From these replies, across the city, an attitudinal profile was developed for the citizens. To avoid bias, and to obtain equivalent information across the city, each planning district was surveyed if there were ten (10) or more residential blocks in it. As a result, 69 planning districts, represented by 680 households were identified. Five hundred forty-nine (549) single family and 131 multiple family dwellings were randomly chosen from the 69 planning districts and sample household groups were queried in each of the four seasons of the year. Of the six hundred eighty households, 100% responded and were included in the study. Of this number, 37% (or 252 families) identified noise as the primary pollutant in their neighborhood in the initial questionnaire. Of the 252 families replying, aircraft, automobiles, trucks, and motorcycles were defined as the major noise sources.

Summary of Findings: In Norfolk, noise is viewed by a significant (37% of responses) segment of the population as a negative environmental factor; as a serious detraction from it's attractiveness as a place to live; and as being more detrimental in Spring and Summer than in other seasons. Based on these findings, a quantitative evaluation of Norfolk's noise levels was deemed necessary.

Where Findings Published:

Norfolk Health Department, "Community Noise Impact Evaluation of Norfolk, VA." Norfolk, Virginia, 1978.

Period of Performance: 1976-1978.

Investigator: Norfolk Health Department, Division of Environment and Protection staff.

Sponsor: Norfolk Health Department; U.S. EPA/ONAC.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	9*	8*	(approx.)	

*-These amounts include funding for all four studies.

Title: AN ATTITUDINAL ASSESSMENT OF NOISE IMPACT UPON PUBLIC SCHOOLS NORFOLK, VA - A SURVEY

Objective: To determine the effect of this impact on the teaching/learning process, since investigation revealed that many of the city's 65 public schools were being excessively impacted by jet aircraft noise from both military and civilian airports.

Description: A "fixed response" questionnaire was sent to all teachers in the public schools by the school system's Information Office. Of the 2,064 teachers polled, the office received 1,727 (84%) replies which could be evaluated. This "fixed response" questionnaire permitted choices which measured the amount of noise and the intensity of feelings about the intrusion of that noise for both "on" and "off" premise sources." Sixty-five schools (100%) participated in the survey.

Summary of Findings: As a result of the attitudinal survey among Norfolk school teachers, it was found that indeed noise interfered with learning, (a) due to the creation of time gaps, (b) due to interference with phonetic recognition, (c) due to the creation of a disturbance of "real time" utilization of oral communication, and (d) due to breaks in attention span. Teacher responses identified 17 schools with unusually high noise impact effects on the learning process. These schools had a 75% response rate by teachers to a single noise in the "off school ground noise source" category. Eleven schools were classified as having a high impact because of the influence of aircraft noise. Six schools were impacted by other types of transportation noise. All schools had some learning disruption identified due to the effects of student mobility. Schools with high noise impact showed a significant shift in the response curve toward verbal complaints to the high noise levels identified.

Where Findings Published:

Norfolk Health Department, "Community Noise Impact Evaluation of Norfolk, VA." Norfolk, Virginia, 1978.

Period of Performance: 1976-1978.

Investigator: Norfolk Health Department, Division of Environment and Protection staff.

Sponsor: Norfolk Health Department; U.S. EPA/ONAC.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	9*	8*	(approx.)	

*-These amounts include funding for all four studies.

ICR (Cont'd)

Title: SUMMARY OF PHYSICAL SURVEY - NORFOLK SCHOOLS

Objective: To define the noise pollution problem more exactly, a physical monitoring survey was initiated in five of the most seriously noise-impacted schools.

Description: The initial moniitoring was performed at four elementary schools and one junior high school. Monitoring was carried out using the Bruel & Kjaer precision tape recorder which has the capacity of taping simultaneously the indoor and outdoor noise environments. By recording on magnetic tapes, these two environments would be compared in order to find the primary source of noise intrusion, its level, and its apparent impact. Indoor taping was performed in occupied classrooms to obtain an estimate of the daily noise exposure of the students, and to record teacher/student reactions to specific noise events emanating from within and outside the classroom. Further taping was done in unoccupied classrooms to correlate outdoor with indoor ambient noise levels.

Summary of Findings: All of the L90 (background) levels measured exceeded the highest EPA recommended levels for occupied classrooms. These levels were attained before the specific noise source impacting these schools were present. These levels by themselves are not considered indicative of a potential for noise-induced hearing loss but they are at a level which interferes with verbal communication. In one school the levels reached 108 dBA which is 18 dBA louder than is permitted in a steel mill unless hearing is protected by ear plugs. The evidence derived from these five schools was subsequently replicated by studies in the remaining 12 schools. By student, teacher and equipment evaluation, Norfolk's schools were found to be extremely noisy. In 17 schools, the noise caused the loss of up to one hour per day in teaching time according to teacher logs kept to give an estimate of the "real time" lost to learning due to noise. Some of the noise reached levels for short periods of time potentially damaging to hearing.

Where Findings Published:

Norfolk Health Department, "Community Noise Impact Evaluation of Norfolk, VA." Norfolk, Virginia, 1978.

Period of Performance: 1976-1978.

Investigator: Norfolk Health Department, Division of Environment and Protection staff.

Sponsor: Norfolk Health Department; U.S. EPA/ONAC.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	9*	8*	(approx.)	

*-These amounts include funding for all four studies.

Title: ASSESSING CONSUMER REACTION TO PRODUCT SOUND

Objective: To explore the use of psychophysical measurement techniques, already in use by the consumer industry in areas other than sound, in determining the acceptability of machine sounds and the perceived quality of the machine that produced the sound. Reaction to machine sounds has been concerned with negative impacts identified with loudness, annoyance, and hearing damage potential. Substitution of materials and new product designs related to energy usage imply changes in the sound quality of familiar products (automobiles, vacuum cleaners, sewing machines) that may affect consumer acceptance that is more related to the quality of sound rather than its intensity.

Description: A sewing machine was used as the test vehicle. The various mechanisms of the machine were operated separately (with simulated loads) and their sound recorded on multi-track magnetic tape. Composed machine sounds were then presented to a jury and judged according to acceptability (of the sound) and perceived quality (of the machine).

Summary of Findings: It was possible to identify particular mechanisms (not necessarily the loudest ones) for which noise reduction would be quite beneficial, and other mechanisms (not necessarily the quietest ones) where little benefit would be derived from noise reduction.

Where Findings Published:

R.N. Fleischman, "Acceptability and Perceived Quality: Study of Machinery Noise Components Using Psychophysical Methods," M.Sc. Thesis, Massachusetts Institute of Technology, Department of Mechanical Engineering, Cambridge, MA, January 1980.

Period of Performance: 1978-1979.

Investigator: Richard H. Lyon and Rebecca N. Fleischman, Massachusetts Institute of Technology, Cambridge, MA.

Sponsor: Massachusetts Institute of Technology, Department of Mechanical Engineering, Cambridge, MA.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
				35 (approx.)

ICR (Cont'd)

Title: THE HOME/NEIGHBORHOOD NOISE SURVEY

Objective: To provide a method of collecting precise local information in the largest noise-source area affecting the general public, community noise. The noise sources identified in this survey affect people in the one environment in which they should have the most control, the home/neighborhood area.

Description: The Home/Neighborhood Noise Survey is a study of primarily residential area noise disturbances offering generalities of approach that can be applied in various community noise assessment situations. The survey data was collected from carefully selected neighborhoods of Montclair, New Jersey in order to collect representative, controlled and thus more reliable data. A three-page questionnaire (which was mailed to neighborhood households) was designed with simplicity and ease of completion considered as important prerequisites. The design of the Home/Neighborhood Noise Survey is intended not only to identify the particular noise sources that are most disturbing to the greatest number of people, but also to confirm: a) that present methods of controlling noise disturbances in the municipality are inadequate; b) that the number of noise complaints received is not a reliable indicator at all of the frequency of disturbance or of the degree of annoyance; and c) that other variables inhibit people from attempting solutions on their own or from using existing methods of noise control presently offered by the municipality.

Summary of Findings: The sample survey, which was distributed to a total of 80 residents, received a 25 percent response rate. The successful rate of return in a situation where there was no accompanying town-wide effort or publicity indicates an even greater expected rate of return when a full-scale program is launched.

Where Findings Published:

Staniszewska, M., "The Extent of Noise Disturbance and the Awareness of Noise Intrusion in the Home/Neighborhood." Research Paper, Montclair State College, January 1979.

Period of Performance: 1979.

Investigator: M. Staniszewska, State of New Jersey Office of Noise Control, West Trenton, NJ (609/292-7697).

Sponsor: State of New Jersey Office of Noise Control, West Trenton, NJ.

Fiscal Year Funding ($1000): No special programmatic funding.

Title: COMMUNITY NOISE ATTITUDINAL ASSESSMENT OF SALT LAKE CITY, UTAH

Objective: To 1) provide Salt Lake City-County Health Department's Noise Control Program with an estimate of individual and group variation in attitudes and responses toward noise; 2) identify noise control measures supported by community members; 3) assess the effectiveness of current noise control programs; 4) determine the health and welfare effects of noise on residents; and 5) view residents' perceptions of noise as an environmental hazard in the community.

Description: The survey was based on the comprehensive community attitudinal questionnaire developed for the Environmental Protection Agency by UCLA Institute for Social Science Research.

Summary of Findings: Findings indicate that Salt Lake residents who are annoyed by noise in their neighborhoods, particularly surface transportation noise, often take their own personal actions to reduce noise in their homes, support stronger noise reduction efforts, but are not aware that noise can affect physical and emotional health. Based on survey data, certain geographical locations and noise zones were identified as in need of program strategy changes in the areas of public awareness, land use planning and enforcement. A report on the survey results is available from the sponsoring agency upon request.

Period of Performance: May 1979-September 1979.

Investigator: Patti T. Fricks, Salt Lake City-County Health Department, Noise Control Program, 610 South 200 East, Salt Lake City, Utah 84111 (801/532-2002, Ext. 249).

Sponsor: Salt Lake City-County Health Department; U.S. EPA.

Fiscal Year Funding ($1000):	1977	1978	1979	1980	
			10		(EPA)
			4		(Salt Lake City)

ICR (Cont'd)

Title: NOISE ANNOYANCE SURVEY - JET AIRCRAFT

Objective: To determine if high peak level, short duration sound levels created by jet engines were as annoying as surface transportation and other surface annoyances.

Description: Three hundred individual survey questionnaires were distributed within the northeast heights of Albuquerque. Seven questions were about degrees of annoyance with the eighth leaving space and encouragement to write in comments.

Summary of Findings: Citizens indicate that jet airplane overflights, at this point in time, are not a significant annoyance. Four percent indicate some kind of annoyance during overflights and 96 percent were seldom or never annoyed. Twenty-four percent, however, indicated they would like to have flights over the northeast heights discontinued, but 76 percent did not want or did not care if flights were discontinued.

Where Findings Published:

"Albuquerque International Airport Noise Level Survey," Albuquerque Environmental Health Department, Albuquerque, NM, 1979.

Period of Performance: 1976-1979.

Investigator: Miles B. Orton, Manager, Noise Control Program, Albuquerque, NM (505/766-7435).

Sponsor: Albuquerque Environmental Health Department, Albuquerque, NM.

Fiscal Year Funding ($1000): No special programmatic funding.

Title: PERSONAL AND FAMILY ADJUSTMENT TO URBAN NOISE

Objective: To 1) describe the initial short-term effects of urban noise; 2) describe the level of adjustment achieved several months later; 3) test and develop hypotheses about the factors which influence individual differences in sensitivity to noise; and 4) test and develop hypotheses about the relationship between different coping mechanisms and eventual adaptation.

Description: This is a longitudinal study investigating the psychological impact on, and reactions of, individuals to the noise of a newly-constructed highway. One hundred and sixty-six individuals will be interviewed three times: before the highway is completed, shortly after it opens and six months after it has been completed. The information gathered will then be coded and analyzed.

Period of Performance: 1976-1979.

Investigator: N.D. Weinstein, The Rutgers State University of New Jersey, New Brunswick, NJ 08903.

Sponsor: New Jersey State Government, Trenton, NJ; National Institute of Mental Health.

Fiscal Year Funding ($1000): Data not available.

ICR (Cont'd)

Title: QUIET COMMUNITIES PROGRAM: SPOKANE COUNTY HEALTH DISTRICT COMMUNITY NOISE REPORT

Objective: To promote the physical and mental health of all citizens throughout the City and County of Spokane by the containment and abatement of harmful noise.

Description: The Spokane County Health District's Quiet Communities Program is a local community noise program designed to be tailiored to the needs of the City and County of Spokane. Both an attitudinal and acoustical survey were conducted to assess the impact of noise in the community, assess noise control needs, and as a basis to launch an active informational and awareness campaign. Along with this, a clearinghouse concept is being established to handle noise complaints and concerns. Development of an educational package for use in schools is also being considered as part of the Quiet Communities Program. An evaluation of current ordinances and enforcement policies will be considered along with zoning and land use approaches in the design of an effective noise control program.

Summary of Findings: The survey results indicate that a community noise control program for Spokane County has broad-based public support. Spokane County citizens overwhelmingly favor various courses of action to reduce specific noise problems. These include efforts to quiet noise sources, planning and zoning, building codes, curfews, fines, barriers, traffic planning and public information campaigns. A majority of Spokane County citizens further believe that the problem of noise control is the responsibility of local government. A majority also favors a noise control program in concept and declare a willingness to pay additional taxes in support thereof.

Where Findings Published:

Perdue, W.D., Coates, R., Noise: Attitudes and Action, Center for Social Research, Eastern Washington University, August 1979.

Period of Performance: 1979-1981.

Investigator: Spokane County Health District, West 1101 College Avenue, Spokane, WA 99201.

Sponsor: EPA/ONAC.

Fiscal Year Funding ($1000):	1978	1979	1980	1981
			40	40

Title: A QUANTITATIVE ASSESSMENT OF NORFOLK'S OUTDOOR NOISE ENVIRONMENT - A SURVEY

Objective: To create a noise profile for the city, for each site in each mobility period. This permits Norfolk to plan for, modify, or treat areas of high noise impact and to protect, adjust, or create areas of low noise impact.

Description: In the 1971, Tidewater Regional Health Planning Council "Needs Study" on the Tidewater's environment, a statistical sampling grid was made for each community, including Norfolk, This grid was so constructed that it identified different types of urban, suburban, and rural populations, activities and conditions. Among the items identified were transportaion routes and housing groupings. Using this grid as a base, the Norfolk noise study group developed a random sampling which equally samples the human population of each of the planning districts in the city. This grid identified 102 monitoring sites. These sites were then divided into (a) residential, (b) commercial/industrial, (c) transportation hub, and (d) public land use areas. The sub-sets permitted definition of noise impact on different categories of population as well as giving a means of cross referencing and replication. Each of the 102 sites was sampled at four different time periods during each 24 hour period and on two different days. This resulted in 816 visits to 102 sites resulting in 81,600 noise samplings across the city.

Summary of Findings: In summary, based on this study it was found that Norfolk's overall city wide Ldn noise average index was 77.8 dBA. Specifically, Norfolk, based on it's average noise level would be classified as a "very noisy urban residential community" which should have a population density exceeding 63,000 people per square mile. In fact Norfolk's population density is 5,600 people per square mile yet, as mentioned, it's noise is equivalent to that of 63,000 persons/sq. miles.

Where Findings Published:

Norfolk Health Department, "Community Noise Impact Evaluation of Norfolk, VA." Norfolk, Virginia, 1978.

Period of Performance: 1976-1978.

Investigator: Norfolk Health Department, Division of Environment and Protection Staff.

Sponsor: Norfolk Health Department; U.S. EPA/ONAC.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
	9*	8*	(approx.)	

*-These amounts include funding for all four studies.

NOISE-INDUCED HEARING LOSS AND HEARING CONSERVATION

Title: INTERACTION OF NOISE WITH TWO REVERSIBLY OTOTOXIC DRUGS

Objective: To shed light on the mechanism whereby intense sound influences the structure and function of the hearing end-organ, the cochlea. This knowledge may expedite further research into the prevention of intense noise-induced hearing loss.

Description: The three tasks to be completed in the first year of this investigation were to: 1. examine the recovery of the alternating current (ac) cochlear potential and the compound action potential of the VIII Nerve (AP) from exposure to intense sound and an administration of saline; 2. examine the recovery of the ac cochlear potential and the AP from intravenous administrations of aminooxyacetic acid (AOAA) and ethacrynic acid (EA); and 3. examine the recovery of the ac cochlear potential and the AP from a combined-drug and intense sound-exposure treatment.

Summary of Findings: A protocol was developed to record both the ac cochlear potential and the AP from chronic control and experimental guinea pigs during an initial surgical period and at 48 hours post-surgery.

Period of Performance: January 1978-December 1978.

Investigator: R.P. Bobbin, Louisiana State University, School of Medicine, 1542 Tulane Ave., New Orleans, LA 70112.

Sponsor: Deafness Research Foundation, New York, NY 10017.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
		10		

Title: HEARING AID USAGE IN NOISE

Objective: To determine limiting noise levels as function of configuration and amount of hearing level as part of an ongoing problem of evaluating hearing aid fitting procedures.

Description: A critical review of the literature in this field, establishment of criteria and evaluation of them in laboratory and real life situations.

Summary of Findings: Based primarily on the summary paper of Plomp (Journal of the Acoustical Society of America, 66:533-549, 1979), a tentative flow chart relating speech frequency hearing levels with noise levels was presented as part of paper S1 (JASA, 66(Supplement 1:S37, 1979), at the Salt Lake City meeting in November 1979. In essence, hearing aid users are limited to noise levels below about 55 dB. The greater the hearing levels the less the acceptable noise levels (down to 35 dBA). Evaluation of these levels for NTID students is yet to be accomplished.

Period of Performance: 1978-1981.

Investigator: J.C. Webster and D. Sims, National Technical Institute for Deaf, Rochester Institute of Technology, 1 Lamb Drive, Rochester, NY 14623 (716/475-6418).

Sponsor: National Technical Institute for the Deaf.

Fiscal Year Funding ($1000): No special programmatic funding.

Title: PLASMA CORTISOL LEVELS AND AUDITORY FUNCTIONING IN HUMANS EXPOSED TO SHORT AND PROLONGED DURATIONS OF NOISE

Objective: To investigate audiometric and hormonal effects of noise exposure in male and female subjects exposed to a moderately intense noise.

Description: Subjects were exposed to various noise stimuli (85 dBA, broadband, pink noise) for short (1/2 and 1 hour) and prolonged (4, 8, and 16 hour) durations.

Summary of Findings: It was established that noise exposure results in a decreased ability to detect pure tones (threshold shifts), and increased ability to detect changes in loudness (recruitment phenomena), and a decreased ability to detect tones in the presence of background noise (discrimination impairments). Increasing the duration of noise exposure caused a progressive increase in the magnitudes of temporary threshold shifts, level of initial masking shifts, and loudness discrimination index shifts. Female subjects generally exhibit smaller noise-induced shifts than males at corresponding exposure durations. None of the subjects exhibited any alterations in circulating plasma cortisol levels before, during, and after any of the short or prolonged exposure durations. The overall data indicate that exposure of humans to a sound pressure level of 85 dBA causes relatively marked alterations in the three auditory parameters (i.e., threshold detection, loudness discrimination, and level of initial masking). On the other hand, exposure to 85 dBA noise is not significantly stressful so as to cause measureable elevations in adrenocortical activity in humans.

Where Findings Published:

Bennett, T.E., "Plasma Cortisol Levels and Auditory Functioning in Humans Exposed to Short and Prolonged Durations of Noise." Ph.D. Dissertation in Physiology, The Pennsylvania State University, August 1979 (adviser, A. Anthony).

Period of Performance: 1976-1978.

Investigator: A. Anthony, P.L. Michael, T. Bennett, G. Bienvenue; Environmental Acoustics Laboratory, Penn State University, University Park, PA (814/865-4562).

Sponsor: Rockefeller Foundation, New York, NY.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
	25	25	25		

Title: THE EFFECTS OF CARBOGEN INHALATION ON NOISE-INDUCED THRESHOLD SHIFT

Objective: To investigate the parameters involved in the inhalation of Carbogen as associated with noise exposure.

Description: Human and animal (chinchilla) subjects are administered Carbogen gas (95 percent 02 and 5 percent CO2) for designated periods before, during or after high level sound exposure. Their threshold shifts are then measured and the recovery process is monitored for several hours or days following the exposure. Some animals were histologically prepared to investigate the cell damage caused by noise stimulation. In all cases, control subjects and/or conditions were used. The comparisons made were between control subjects/ conditions and Carbogen inhalation conditions.

Summary of Findings: Inhalation of Carbogen immediately before, during, or after noise exposure resulted in generally less TTS. The more remarkable finding was that Carbogen-treated subjects showed a more rapid recovery rate from TTS than was seen with control subjects. In histology studies, the amount of sensory cell damage in the cochlea was consistently less in Carbogen-treated animals as compared to controls.

Where Findings Published:

1) Joglekar, S., Lipscomb, D., and Shambaugh, G., "Effects of Oxygen Inhalation on Noise-Induced Threshold Shifts in Humans and Chinchillas," Arch. Otol., 103:574, 1977.

2) Lipscomb, D., and Witter, H., "The Effects of Carbogen on Modifying the Impact of Noise Exposure," Third International Congress on Noise as a Public Health Hazard, Freiberg, Germany, 1978.

3) Witter, H., Deka, R., Lipscomb, D., and Shambaugh, G., "Effects of Pre-Stimulatory Carbogen Inhalation on Noise-Induced Temporary Threshold Shifts in Humans and Chinchillas." In press, scheduled publication April 1980, Am. J. Otolaryngology.

4) Harris, G., Witter, H., and Lipscomb, D., "Effects of Post-Stimulatory Carbogen Inhalation on Noise-Induced BSER Thresholds in Chinchilla." Submitted to J. Acoust. Soc. Amer.

Period of Performance: 1976-ongoing.

Investigator: D.M. Lipscomb, University of Tennessee, Knoxville, TN (615/974-4123), and George Shambaugh, Chicago, IL.

Sponsor: Locally funded with budget provided by the Noise Research Laboratory of the University of Tennessee Department of Audiology and Speech Pathology through monies donated by individuals and industries.

Fiscal Year Funding ($1000): No special programmatic funding.

Title: INTER-INDUSTRY NOISE STUDY: STEADY-STATE NOISE (PHASE I); INTERMITTENT NOISE (PHASE II)

Objective: This project is being undertaken in two phases. The primary objective of Phase I was to study "continuous" exposure, that is, exposure during the whole of the working day, every day of the working year, in a range of 82 dBA to 92 dBA, with no more than a five dBA range. Also (insofar as practical industrial operation permits), the noise was limited to steady noise with a relatively smooth spectrum, that is, to noise with no sharp peak of sound pressure in any narrow frequency band. Phase II of the study, which commenced in 1977, deals with the relationship between hearing loss and work-place exposure to intermittent noise. It is hoped that the resulting data from both phases will provide a sound and valid basis for general agreement on a national occupational noise exposure standard which will protect employees from occupational hearing loss without requiring wasteful or unnecessary expenditures.

Description: The Phase I study was done over a three-year period and involved 610 male and female workers. The study was carefully designed and controlled to avoid the pitfalls of earlier studies, and to produce scientifically valid data. The Phase II study involved collecting and analyzing exposure data on over 400 subjects exposed to intermittent noise in a broad range of industries. This is particularly relevant to real-world situations, since intermittent noise is much more common in industrial settings than previously studied continuous noise.

Where Findings Published: The study protocol is discussed in detail in the publication listed below.

Yerg, R.A., "Protocol of the Inter-Industry Noise Study." Journal of Occupational Medicine, 17(12):760-770, December 1975.

Period of Performance: 1974-1977 (Phase I);
1977-1981 (Phase II).

Investigator: Joseph Sataloff, Jefferson Medical College, Philadelphia, PA.

Sponsor: Supported by a number of trade associations and industries.

Fiscal Year Funding ($1000):

	1974	1975	1976	1977	1978	1979	1980	1981	
Phase I	50	50	50	50					
Phase II					50	50	50		(approx.)

Title: EVALUATION OF INSERT HEARING PROTECTOR PERFORMANCE AT THE BEGINNING AND END OF A 3-HOUR USE PERIOD

Objective: To determine if certain types of hearing protectors work loose with time.

Description: Ten subjects are being tested four times each as follows: Open Ear Test; Occluded Ear Test; 3-hour Usage; Occluded Test; and The Open Ear Test. Devices tested will be the E-A-R Plug, a V-51R type insert and perhaps others.

Period of Performance: 1979-1980.

Investigator: Elliott H. Berger, E-A-R Corporation, Indianapolis, IN (317/293-1111).

Sponsor: E-A-R Corporation, Indianapolis, IN.

Fiscal Year Funding ($1000): No special programmatic funding.

Title: CORRELATION OF A SUBJECTIVE AND AN OBJECTIVE HEARING PROTECTOR ATTENUATION TEST

Objective: To develop a better artificial head for measuring insert protector attenuation.

Description: Six sets of foam ear plugs of varying characteristics are being measured for attenuation in an artificial head, using an ANSI S3.19 procedure on five human subjects.

Period of Performance: January 1980-June 1980.

Investigator: Elliott H. Berger, E-A-R Corporation, Indianapolis, IN (317/293-1111).

Sponsor: E-A-R Corporation, Indianapolis, IN.

Fiscal Year Funding ($1000): No special programmatic funding.

Title: APPROXIMATING THE REAL WORLD PERFORMANCE OF HEARING PROTECTOR DEVICES VIA LABORATORY REAL-EAR ATTENUATION TESTS

Objective: To develop better subject selection, subject instruction and device preparation methods for performing ANSI S3.19 tests.

Description: A large number of subjects (over 75) are being tested on a one-time basis. They are being administered a battery of four audiogram type tests, with both open and occluded ears. Ear canal sizes are also being recorded.

Summary of Findings: Preliminary findings indicate significantly lower (at least 10 dB) performance than is found by standard (manufacturer-sponsored) ANSI S3.19 testing. Agreement with some current field attenuation studies appears good.

Period of Performance: 1979-1980.

Investigator: Elliott H. Berger, E-A-R Corporation, Indianapolis, IN (317/293-1111).

Sponsor: E-A-R Corporation, Indianapolis, IN.

Fiscal Year Funding ($1000): No special programmatic funding.

NIHL (Cont'd)

Title: STUDY OF POTENTIATING HARMFUL EFFECTS OF LOW LEVEL NOISE AND KANAMYCIN ON GUINEA PIG COCHLEA

Objective: To extend the knowledge of the interaction of noise and kanamycin (an antibiotic) which are known to produce inner ear damage when presented at certain levels. It has been shown that combining these two agents together produces damage at levels which are safe when each is presented alone.

Description: Information about safe levels of noise in such combinations was obtained. The time during which such damage occurs, whether or not this is related to certain periods when levels of the antibiotic are highest in the inner ear, and whether or not animals of different ages are equally susceptible to such damage was evaluated.

Period of Performance: 1977-1978.

Investigator: V.S. Duyal, University of Toronto, 76 Grenville St., Toronto, Ontario, Canada.

Sponsor: Deafness Research Foundation, New York, NY.

Fiscal Year Funding ($1000): Data not available.

Title: SPEECH AND NOISE CHARACTERISTICS OF NTID LEARNING CENTER

Objective: To evaluate noise criteria for classrooms for the handicapped.

Description: Speech and noise levels were measured in representative NTID and RIT classrooms and evaluated in terms of Articulation Index (AI) and Speech Interference Level (SIL) criteria. Noise levels and teachers' speech levels were measured at the beginning and end of hour-length classes in four classrooms at RIT. Two were in NTID in classrooms specifically designed for severely/profoundly deaf college students, and two in RIT in classrooms designed for and used primarily by normal hearing students.

Summary of Findings: Better classrooms at both NTID and RIT had A-weighted noise levels that increased from 44dB to 45dB as the hour progressed. Poorer classrooms increased in noise level from 48 to 50dBA at NTID and from 51 to 53dBA at RIT. Teachers' speech levels averaged 60 + or - 2dBA such that Articulation Indices (AI) dropped from about 0.88 to 0.81 at NTID and from 0.78 to 0.74 at RIT. There was an interaction among AI's, classification of classroom (better/poorer) and school (NTID/RIT). The AI in the better classroom at NTID resisted the drop shown by all other classrooms from the beginning to the end of the hour. However, the largest drop was from 0.86 to 0.68 in NTID's poorer classroom. Not only did the noise level increase, but the speech level decreased. Any AI of 0.68 or greater results in adequate student speech discriminability.

Where Findings Published:

Abstract as submitted to "Acoustics of Educational Buildings," a satellite symposium (in Auckland, New Zealand) of the Tenth International Congress of Acoustics (Sydney, Australia, July 1980).

Period of Performance: 1976-1980.

Investigator: J.C. Webster and Karen Snell, National Technical Institute for the Deaf, Rochester Institute of Technology, 1 Lamb Drive, Rochester, NY 14623 (716/475-6418).

Sponsor: National Technical Institute for the Deaf.

Fiscal Year Funding ($1000): No special programmatic funding.

BEHAVIORAL, SOCIAL AND PERFORMANCE EFFECTS

Title: EFFECTS OF NOISE ON READING COMPREHENSION AND TASK COMPLETION TIME

Objective: To 1) identify and review materials which relate to the evaluation of the effects of noise on the learning process; 2) analyze the extent to which reading comprehension is affected by increasing sound intensity; 3) determine to what extent the time required for the completion of a task is affected by increasing sound intensities; and 4) recommend appropriate considerations for the control of noise pollution in vocational shops and laboratories.

Description: This study will be conducted as a post-test-only control group experiment utilizing a two-times-two factorial design. The design requires randomization of the groups, and therefore provides maximum control of the relevant extraneous internal variables.

Period of Performance: 1977-1978.

Investigator: L.R. Jewell, University of Missouri, Columbia, MO.

Sponsor: Missouri State Government, Jefferson City, MO.

Fiscal Year Funding ($1000): Data not available.

NOISE ENVIRONMENT DETERMINATION AND EXPOSURE CHARACTERIZATION

Title: NOISE ASSESSMENT FOR THE SAVANNAH-CHATHAM COUNTY URBANIZED AREA

Objective: To provide a sound level descriptor for the urbanized area of Chatham County. This work will provide reliable data upon which to base possible action related to a local noise control program. The study will identify specific major noise sources causing noise impacts and noise impacted areas.

Description: The end product will consist of a "Noise Survey Map" which displays the average noise level for various sections of each neighborhood within the urbanized area of Chatham County. The Noise Survey Map will be accompanied by a technical report which discusses the local noise problem at the neighborhood level in relation to noise level standards established by the U.S. Environmental Protection Agency. The first step will be the preparation of a noise survey and assessment manual. This work will be accomplished by the Metropolitan Planning Commission (MPC) staff, with assistance provided by the staff of the Noise Control Division of EPA Region IV. The manual will set forth step-by-step procedures to be followed in conducting the noise assessment. EPA will provide the sound measuring equipment and will train local survey crews in the proper use of the equipment and the recording of the readings on the survey forms. The Noise Survey Map and supporting technical report will be prepared by the MPC staff with technical assistance provided by EPA.

Period of Performance: 1979-1980.

Investigator: Wm. Saxman, Chatham County-Savannah, GA, MPC (912/236-9523).

Sponsor: Chatham County-Savannah, Georgia Metropolitan Planning Commission, with assistance from the U.S. EPA, Region IV.

Fiscal Year Funding ($1000):	1977	1978	1979	1980
			43.2	

NEDEC (Cont'd)

Title: COMMUNITY NOISE SURVEY - ONTARIO, CALIFORNIA

Objective: To 1) define the existing noise levels throughout the City; 2) define intrusion standards for similar noise zones of land use development categories; and 3) acquire a good technical background for a noise ordinance.

Description: The survey was one of the initial steps recommended by the California Office of Noise Control and Office of Planning and Research for the update of the Noise Element of the Ontario General Plan. Monitoring was performed in finite acoustical zones of the City in accordance with the methodology described in the document listed in the Summary of Findings, below. Sound pressure levels were determined in some 900 different locations. Continuous monitoring varied from five minutes up to a full week at each location.

Summary of Findings: The monitoring phase of the program has been completed. The activity was undertaken between June 1977 and November 1979 in accordance with the following document:

> "Test Procedure, Methodology and Data Analysis for Community Noise Survey - Ontario, California," May 31, 1977.

The second phase of the program was completed in December 1979 and was a presentation of the calculated data. This formed the appendix to the pending final program report.

Period of Performance: 1976-1980.

Investigator: City staffers, Ontario, CA (714/986-1151).

Sponsor: City of Ontario, CA.

Fiscal Year Funding ($1000):	1976	1977	1978	1979	1980
	51	15	15	15	15

Title: ANALYSIS AND REDUCTION OF NOISE HAZARDS FROM AGRICULTURAL MACHINES

Objective: To 1) determine sound levels at the operator stations of tractors and other farm equipment; 2) evaluate methods for reducing noise generation, noise transmission, and noise-induced hearing damage; and 3) assist farmers in developing effective hearing protection programs.

Description: Noise levels on representative samples of tractors, implements, and farmstead equipment were determined so projections could be made as to probable operator station noise levels for agricultural machines used in the State of Washington. Data on techniques and materials for the reduction of noise generation and transmission applicable to agricultural machinery were completed. Personal ear protection devices and techniques were analyzed. Noise test results, otolaryngological data, and noise control information were used to initiate an extension program to assist farmers in reducing noise hazards and in initiating adequate hearing protection practices.

Summary of Findings: Operator station noise level tests were made on farm tractors and in a pea processing plant. Noise levels for farm tractors were consistent with previous measurements, with noise levels generally above the 90 dBA level which is acceptable for an exposure duration of 8 hours per day. Of the tractors tested, only the newer tractors with acoustically designed cabs had operator station levels below 90 dBA. Operator station noise levels for the pea processing plant were generally in the 90 dBA range or below, except for the sacking area where a 100 dBA reading was recorded. It cannot be concluded that workers will suffer hearing damage from the measured noise levels since no measurements of exposure times were recorded. As a precaution, however, it would be well for workers to utilize personal ear protection devices while operating tractors, combines, and other self-propelled equipment with engines mounted near operator stations unless the units are equipped with acoustically designed cabs. A similar precaution should be observed for workers in high noise level areas of agricultural processing plants, and near noisy processing equipment.

Period of Performance: 1977-1978.

Investigator: J. Simpson and H. Waelti, Washington State University, Pullman, WA.

Sponsor: Washington State Government, Olympia, WA.

Fiscal Year Funding ($1000): Data not available.

NEDEC (Cont'd)

Title: A SURVEY AND EVALUATION OF THE ACOUSTICAL LEVELS IN CUMBERLAND COUNTY

Objective: To 1) determine sound levels existing in Cumberland County; and 2) from the data collected evaluate the need for a noise ordinance in Cumberland County.

Description: Information was provided by the Noise Section, Environmental Protection Agency, Atlanta, Georgia, as to how such a survey would be most effectively conducted. An EPA Noise representative made periodic visits to Cumberland County to educate operators and monitor progress. The county was divided into .9 square mile sections; a sampling point was located at approximately the center of each section. Areas exempt from monitoring were those unpopulated sections such as forest land and open farm land. Four readings were taken each day at the sampling points. There were a total of 558 sampling points, with a total of 2,232 readings (excluding special readings at industrial and commercial sites). All monitoring was conducted at 10-second intervals up to 100 total readings. Readings were recorded on a Standard Community Noise Measurement Data Sheet, then transferred to an Leq Computational Worksheet where the Leq, L0, L10 and L50 figures were calculated. Other data included time, temperature, weather, wind velocity, date, operators and identifiable noise sources. Care was taken not to monitor in directions where the meter would record obvious reflected sound thus giving a false reading. A detailed map of the sampling point location was drawn on the reverse side of the data sheet to assure all succeeding monitoring would be achieved at the exact location as the original. There were three monitoring teams consisting of two persons each - one monitor and one data recorder. All data was turned over to EPA contacts for evaluation.

Summary of Findings: The completed Leq calculations were interpreted by an EPA representative with respect to the projected needs of the county implied by their findings. The conclusions, expressed in percentages, were ascertained through graphing the percent of total readings in Cumberland County against the overall percentage of occurrence. These included daytime, nighttime and weekend readings. The weekend readings were incorporated into the daytime readings. The primary purpose of the weekend reading was to assure a good sample was taken. The conclusions indicated that: 1) more than 70 percent of the sampling points had Leq's less than 60 dBA; 2) 100 percent of the total daytime and nighttime readings were of 31 dBA or greater; and 3) 7.8 percent of the total nighttime readings in Cumberland County were 55 dBA or greater. These readings included traffic noises. If the readings which can be attributed to traffic were removed, the percentage of total readings occurring at 55 dBA or greater would be even lower. Subsequent to the findings, a noise ordinance was drafted by Environmental Health Department personnel to preserve these lower levels. What must also be noted are the military installations (Ft. Bragg Army Base and Pope Air Force Base) which introduced special acoustical situations or conditions.

Period of Performance: 1979-present.

Investigator: In-house, Environmental Health Division of the Cumberland County Health Department; assisted by U.S. EPA Regional Office, Atlanta, GA (404/581-4861).

Sponsor: Cumberland County Health Department, Fayetteville, NC.

Fiscal Year Funding ($1000): No special programmatic funding.