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SUMMARY OF NOISE PROGRAMS IN THE FEDERAL GOVERNMENT

DECEMBER 31, 1971

U.S. Environmental Protection Agency
Washington, D.C. 20460

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

CONTENTS

INTRODUCTION

Title IV of the Clean Air Amendments of 1970 (PL-91-604) required the Administrator of the Environmental Protection Agency (EPA) to prepare a report on noise for submission to the President and Congress. This document is the basis for the section of that report devoted to Federal noise abatement and control programs over the past two or three years.

To collect the necessary data, the Director of the Office of Noise Abatement and Control on 30 July 1971 issued a request to all Federal agencies for information on their noise programs. A total of 17 agencies responded to the request. The letter of inquiry and report format are exhibited in Appendix A.

It is recognized that this document represents information collected in response to a specific inquiry and is basically a byproduct of the much broader report to the President and Congress. However, in view of the varied and qualitative nature of the collected data, this report was prepared to better inform representataves of government and the private sector as to the significant achievements and directions of Federal noise programs.

SUMMARY

There is, at present, extensive ongoing activity by various Federal agencies in noise abatement and control. Federal noise programs are the responsibility of a number of agencies, with the main thrust residing within the Department of Defense, National Aeronautics and Space Administration, Department of Health, Education and Welfare, Department of Housing and Urban Development, and, now, the Environmental Protection Agency. There are continuing efforts by many individual agencies to accomplish short and long range objectives, commensurate with their mission.

For the purpose of this document, responses of the other agencies will be discussed in three groups on the basis of:

1. The extent of their authority and impact upon the field of noise abatement and control.
2. The extent of their response to the report format.

In addition to the Environmental Protection Agency, departments performing a significant effort in the field of noise abatement are:

The National Aeronautics and Space Administration
Department of Defense
Department of Transportation
Department of Health, Education and Welfare
Department of Commerce
Department of Housing and Urban Development
Department of Labor

Agencies having more moderate programs are:

Department of Agriculture
General Services Administration
Department of the Interior

National Science Foundation
The Postal Service Commission

Finally, agencies reporting relatively minor programs were:

Atomic Energy Commission
Federal Power Commission
State Department
Tennessee Valley Authority
Treasury Department

The following portion of this report presents a brief description of the noise activities of other Federal Agencies and is followed by Table 1, which depicts the status of federal noise research activities. The actual responses to the original request for information are presented in Appendix B and are organized according to the extent of their respective efforts.

EFFORTS OF OTHER AGENCIES

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

The NASA (as well as its predecessor, NACA) has been deeply involved in aircraft noise research for many years. The Fiscal Year 1972 program includes contract and in-house research totaling $25 million in the areas of reduction of aircraft noise at the source, noise propagation, effects on receptors, sonic boom, and approach trajectory modification. Of this total, $12.6 million is contracted research, $5.4 million covers test equipment and instrumentation for the in-house research, and $7 million is budgeted for research and program management (chiefly in-house research manpower costs). Construction of a new aircraft noise reduction laboratory is underway at the NASA Langley Research Center, and the laboratory, costing about $5.8 million and scheduled for completion late in 1972, will provide a major expansion of the national capability.

In addition to research activities, NASA provides noise protection for its employees through work site surveillance and audiometric testing, supplemented by general medical protection.

THE DEPARTMENT OF DEFENSE (DOD)

Noise abatement efforts by DOD have been both considerable and long-standing. The armed services particularly are involved in research on noise and noise abatement procedures. The primary DOD thrusts are concentrated in four main areas:

1. Occupational noise control and hearing conservation.
2. Operational aircraft noise abatement.
3. Noise signature elimination in weapons system.
4. Construction specifications for noise control.

At present, noise programs are conducted in the department by each of the three military branches to meet specific operational requirements; that is to say:

Army Noise Efforts

Army noise programs are carried out through the following agencies:

- Office of the Chief of Research and Development, U.S. Army. This office is conducting a study ($82, 000) on noise induced hearing loss and the effects on the efficiency of soldiers' performance.
- Office of Chief of Engineers, U.S. Army. The Corps office conducts research on the control of noise generation and the application of measures to eliminate noise levels that may adversely affect humans. Current investigations include work in establishing criteria for the location of certain military activities relative to residential areas and the identification of causes of noise and control criteria during construction activities. Fiscal support for noise related work within the Corps cannot be determined. No personnel are specifically assigned to noise control programs.
- Army Medical Research and Development Command. This command conducts programs and research concerned with biomedical effects of noise, noise reductions, noise exposure, and the physiological and psychological effects of noise. Current programs include traumatic origins of hearing losses, auditory perception and psychophysics, and the aviation audiometry program. The operating budget for fiscal 1972 is $464, 300.
- Army Environmental Hygiene Agency and Environmental Health Engineering Services. Both agencies conduct programs to assure the health of personnel. Current programs include the Hearing Conservation Program for the surveillance of occupational hearing loss and studies of the effects of noise on individuals at military installations. The operating expenditures for the noise program cannot be determined.

- Army Materiel Command. Under this Command, programs and research are carried out under contract for noise reduction of equipment, rotary wing aircraft noise reduction, and determinations of human capabilities. Expenditures for fiscal 1972 are approximately $650,000.

Air Force Noise Programs

The Air Force conducts research under authority of 10 U.S.C. § 8011. Program activities related to noise include the conservation of hearing program (AFR 160-3; Hazardous Noise Exposure), with an operational expenditure of $509,300 for fiscal 1972. Research programs are conducted at the Aero-Propulsion Laboratory, the Flight Dynamics Laboratory, the 6570th Aerospace Medical Research Laboratory, and the Weapons Laboratory. Contracted research is maintained by the Air Force Office of Scientific Research. There are no laboratories presently devoting full resources to noise research. Less than 3 percent of the total resources of laboratories having noise research programs is allocated to that end. The Office of Scientific Research conducts research on aircraft noise generation processes. Estimated funding for the projects is $80,000. The Flight Dynamics Laboratory is conducting development work on aircraft acoustics, including noise control within vehicle interiors and sonic fatigue, with current expenditures of $290,000. The Aerospace Medical Research Laboratory conducts research on the effects of noise on Air Force personnel. Specializing in bioacoustical research, this Laboratory is unique among Federal noise research programs. Expenditures for such research are $410,000. The Aero Propulsion Laboratory, with expenditures of $475,000, is concerned with noise abatement in aircraft propulsion systems. The Air Force Weapons Laboratory is researching computerized noise exposure forecasting and has expenditures of $80,000. Total expenditures for research are $1,255,000. Additionally, the Air Force has a program for the development and acquisition of sound suppressors for ground runup and jet aircraft engines. This work is done entirely by contract at an expenditure of $4,810,000.

Navy Noise Program

The Navy noise abatement program concerns aircraft and related ground facilities and equipment and is divided into the areas of:

- Noise reduction of operating aircraft.
- Noise suppression for ground runup of engines.
- Noise suppression for overhaul and maintenance testing.

In addition, an exploratory development program concerning a semi-portable noise suppressor for gas turbine engines is underway. A contract for $187,000 has been awarded for the exploratory development program in fiscal 1972.

DEPARTMENT OF HEALTH, EDUCATION AND WELFARE (HEW)

The largest single component of HEW, the Social Security Administration, conducts a hearing conservation program as part of its occupational health activities. Program objectives are to remove hazardous noise sources and otherwise protect employees from adverse noise effects. Other concerns include the isolation and evaluation of noise-producing equipment. Occupational medical guidelines described in PL 79-658 and DOD circular A-71 govern the administration of the program

The Occupational Safety and Health Act provides authority for the National Institute for Occupational Safety and Health to undertake research with the objectives of:

1. Refining occupational noise limits for conserving hearing.
2. Assessing industrial noise effects on overall health, safety, and performance capability.
3. Considering the differential diagnoses of noise-induced hearing loss cases.

4. Training and demonstration projects bearing on industrial noise control and hearing conservation.

Funding for these assorted activities in FY 1972 will be in excess of $400,000.

Likewise, the National Institute of Health (NIH) is vested with authority to conduct research on noise as part of its broad mission. NIH-sponsored studies are being conducted largely on the physiological mechanisms underlying noise-induced hearing loss and aspects of speech perception in noise through grants awarded to various universities and laboratories totaling nearly $1,000,000.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

Noise abatement and control is not a separate program within HUD; however the Secretary has established noise control requirements for HUD programs (HUD Circular 1390.2). HUD is concerned with noise problems arising in housing site selection, structural characteristics of buildings, and land use planning. These areas include development of comprehensive urban noise survey methodologies, metropolitan aircraft noise abatement policy studies, and technical support for operational noise abatement programs in the department. Plans for future consideration include extension of the Comprehensive Urban Noise Survey Program, measurement instrumentation for determining site noise exposure, site noise exposure techniques, development of model ordinances and building code sections, and noise emission ratings for appliances and equipment. Approximately $500,000 has been programmed for noise activities in HUD for FY 1972.

DEPARTMENT OF LABOR (DOL)

The main DOL emphasis on noise is in two areas: The Walsh Healey Contracts Act, which covered health standards for employees engaged in

Federal contracts of over $10,000, and The 1970 Occupational Safety and Health Act, extending coverage to all businesses engaged in interstate commerce. Worker exposure standards under the two acts are identical. There are approximately 80 million Americans composing the work force; the overwhelming bulk of these is somehow engaged in interstate commerce. Hearing loss due to noise is, of course, one of the health considerations covered under the 1970 legislation. The Act contains a rule for limiting noise induced hearing losses at the workplace.

DEPARTMENT OF TRANSPORTATION (DOT)

In accordance with the Department of Transportation Act of 1966 (P.L. 89-670), Section 4, DOT is engaged in research and development relating to transportation noise, particularly aircraft noise. Additionally, P.L. 90-411 provided for noise certification of aircraft. A separate office of Noise Abatement administers the noise program within DOT. It's programs are concerned with: 1) evaluating community response to noise, 2) developing measurement criteria, 3) evaluating noise sources, 4) developing mathematical models for estimating noise and evaluating the impact of noise. The office's many technical research programs include investigation of truck engine noise and jet noise as well as the development of measurement equipment and procedures. Twenty percent of the office's budget ($5,745,000) is spent in the utilization of the technical capabilities of the Transportation Systems Center at Cambridge, Massachusetts as well as those of outside contractors. The Center investigations, amounting to $900,000, include measurement and simulation modeling of community noise levels caused by transportation related sources and research of mechanisms of noise generation in jet engine exhaust V/STOL aircraft, and internal combustion engines.

Included within the DOT research and development effort is that of the Federal Aviation Administration in which aircraft noise suppression and adverse effects of sonic boom are heavily emphasized. Expenditures for this program total $3,150,000.

Finally, the Federal Highway Administration conducts a noise research program whose scope includes traffic noise measurements, evaluation and abatement. Expenditures for this effort total $149,000.

DEPARTMENT OF AGRICULTURE (USDA)

The USDA is engaged in eight specific noise reduction programs. The overall objective of these programs is to determine noise levels emanating from agricultural sources. As a part of this effort, USDA conducts research, through grants to state agriculture experiment stations of $250,000, on noise propagation and attenuation from vegetative screens. Authority for this research is found under the Clark-McNary Act of 1942, the McSweeny-McNary Forest Research Act of 1928, and the Agricultural Experimental Station (Smith-Lever) Act of 1955. Moreover, USDA and the U.S. Air Force participated in a mutual research effort on the effects of noise on chickens, cows, and swine.

DEPARTMENT OF COMMERCE (DOC)

Within DOC, research and measurement programs in acoustics are conducted by both the National Bureau of Standards (NBS) and the National Oceanic and Atmospheric Administration (NOAA). Only programs of the former division, however, are specifically directed toward noise abatement.

Within NBS, the Institute for Basic Standards (IBS) is currently involved in two noise-related projects:

1. An investigation of reverberant sound fields, with an aim of developing new, improved methods for measurement of sound absorption and sound power in reverberation chambers.

2. A study of current methods for measuring the subjective factors of loudness, noisiness and annoyance and the development of new methods for subject measurement.

In addition to these two programs, NBS is also engaged in basic research including the development and standardization of calibration procedures for various sound measuring equipments. NBS has also undertaken research with DOT on truck tire noise and has joined with HUD on a project called "Operation Breakthrough" measuring noise levels at building sites.

NBS is also concerned with passenger car tire noise and has conducted studies on the subjective factors of this particular type of noise. It also tests noise characteristics of toys and of postal mail sorting machines.

Also under NBS, the Institute for Applied Technology is conducting a variety of research programs concerning noise abatement in buildings. The development of improved test methods is emphasized both for measuring sound transmission and for rating and testing the overall acoustical performance of entire buildings.

In addition to these direct research projects, NBS presently has a working budget of about $465,000 for programs sponsored by eight other agencies (including EPA). The current operating budget is $500,000, of which approximately $200,000 is applied directly toward noise abatement research. A $200,000-increase in funding is expected for fiscal 1973, which would allow NBS to expand its efforts in noise control. Contracts totalling $41,000 have been negotiated with two private organizations to obtain data relating to noise in European environments and to gather information concerning the acoustical properties of doors and windows. This latter data is expected to provide architects with valuable information in practical design. DOC has no authority in the area of noise regulation or certification.

GENERAL SERVICES ADMINISTRATION (GSA)

The magnitude of GSA operations requires inclusion in this discussion. Although it has no formal noise abatement program, GSA is developing noise abatement procedures for construction and demolition activities.

Maximum sound level criteria for mechanical building equipment were established in 1970, and are included in specifications for major construction projects. These levels are more stringent than those established by the Department of Labor under the Occupational Safety and Health Act. Constructional noise currently is being monitored at the site of the building now under construction in Philadelphia, Pa., to determine possible criteria for future development of noise abatement standards. As for space already occupied, GSA is continuously developing sound level criteria to improve the acoustical environments of buildings. Finally, GSA is amending procurement specifications to require quieter products. This agency will have a profound impression in noise reduction through its vast purchasing power. Data on funds for support of these activities was unavailable at the time this report was prepared. (GSA's noise abatement program is not budgeted separately.)

DEPARTMENT OF THE INTERIOR (DOI)

This agency is currently involved in conducting three specific noise programs.

1. An FAA-funded project for monitoring the frequency and characteristics of sonic booms in certain national parks.
2. A Bureau of Mines instituted training program for inspectors who will survey noise conditions in mines.
3. A research program instituted by the Bureau of Mines and HEW to study noise problems in mines and related hearing loss suffered by miners. Only the Bureau of Mines program has been specifically budgeted for noise abatement and control. Estimates include $45,000

for research and $19,000 for an acoustical research inventory. Future DOI program plans in the noise field are almost entirely limited to this program.

DOI legislative authority for noise research together with regulations for the further definition of that authority are: The Federal Coal Mine Health and Safety Act of 1969 and the Act of May 28, 1936, and regulations found in 41 CFR 14; 50 CFR 4; 36 CFR1; 30 CFR 1, 43 CFR 2; and 30 CFR 1(F) (70).

NATIONAL SCIENCE FOUNDATION

From 1968 through 1971, the Foundation funded equipment purchases for noise research amounting to $99,200. The Special Engineering Program director and his staff spend about 15 percent of their time on acoustics and noise control. Time is also committed to the noise area in the psychobiology and neurobiology programs. Similarly, a number of projects on noise research are funded through contracts or grants. Total research expenditures for noise projects in fiscal 1971 were $175,000. While no projections for future noise research have been made, the Foundation has stated that it expects to fund additional projects in noise and acoustics.

THE POSTAL SERVICE COMMISSION (PSC)

The newly formed PSC is currently involved in three specific programs designed to reduce noise in the workroom area. Two research projects aimed at identifying existing noise sources, determining noise abatement procedures, and implementing prototype modifications have been initiated. On a trial basis, special Postal Service Specifications have been issued on the development of new equipment to ensure that operator noise levels do not exceed a given level. Expenditures for personnel and contracts amounted to $250,000. PSC has no individual assigned to noise abatement programs on a fulltime basis. Moreover, it reports no legislative requirements and states that future noise control plans will depend largely on the results of current projects.

ATOMIC ENERGY COMMISSION (AEC)

In the process of obtaining licensing for nuclear power plants, the AEC, under procedures issued by the Director of Regulations, provides assurance that noise is considered, as required by Section 102(2)(c) of the National Environmental Protection Act of 1969. Other than this, the AEC has no activities related directly to noise control.

FEDERAL POWER COMMISSION (FPC)

The FPC, in the exercise of its authority for licensing hydroelectric projects and other power-generating sources, considers noise as an environmental factor.

DEPARTMENT OF STATE

The State Department, in its general mission as the institutional representative of this nation to foreign countries, has widespread contacts with foreign governments on environmental matters, including noise. Additionally, State intends to work closely with the GSA in determining and enforcing noise level tolerances for facilities it uses.

TENNESSEE VALLEY AUTHORITY (TVA)

The TVA is planning to undertake a study on the effects of gas turbine generating plants on community noise levels, to be funded from the General Industrial Hygiene budget. TVA intends to develop standards and criteria for use by design and operating organizations in community noise control. An expenditure of $45,000 for fiscal 1971 was reported for community noise efforts and noise measuring instrumentation.

TREASURY DEPARTMENT

The Bureau of the Mint reports three sources of external noise generation causing public complaint:

1. Melting furnace exhausts at the Philadelphia mint.
2. Rolling mills at the Denver mint.
3. Presses at the San Francisco Assay Office, where coins are currently minted.

The Bureau reports a continuing independent (though as yet unsuccessful) effort to solve these problems. No funds have been appropriated for the projects, however, nor have personnel been expressly assigned to the program.

Table 1 depicts the current overall status of Federal noise control research activities.

Table 1

SUMMARY OF FEDERAL NOISE RESEARCH ACTIVITY++

Organization	Activity Statement(s) (Parentheses indicate the number of projects* or programs+ in each activity)	Source		Operating Budget* (FY '72) in thousands	Expenditures (past 3-5 yrs) in thousands	Activity Period (FY) '68 '69 '70 '71	Status	
		In-house	Contract or Sponsored				Continuing	Terminated or Completed
Department of Agriculture	noise source surveys (5)* noise propagation & attenuation by vegetative screens (5)*	x	x	250	–			
Department of Commerce National Bureau of Standards	research & measurements in acoustics and noise abatement and control programs (4)+; reverberant sound fields; loudness, noisiness and annoyance; building acoustics; standardization & calibration of sound equipment	x	x	500	1,410	x x x x	x	
National Oceanic and Atmospheric Administration	atmospheric acoustics and sound propagation (–)+							
Department of Defense Army Corps of Engineers	noise generation control, construction noise criteria (2)+	x		15	63.8	x x x	x	
Research & Development Command	biomedical effects of noise, noise reduction, physiological & psychological effects of noise (3)+	x		352	881.6	x x x	x	

++ This information was extracted from that provided by the respective Federal organizations. Much of the information received was either incomplete or required interpretation; therefore, this cannot be considered as a comprehensive compilation of the status of noise research activity. It does however reflect the areas of emphasis and approximate support.

— Indicates the information was not supplied by the reporting organization, or the information could not be extracted from the information provided to reflect a valid interpretation.

Table 1 (Cont.)

Organization	Activity Statement(s) (Parentheses indicate the number of projects* or programs+ in each activity)	Source: In house	Source: Contract or Sponsored	Operating Budget* (FY '72) in thousands	Expenditures (past 3-5 yrs) in thousands	Activity Period (FY) '68 '69 '70 '71	Status: Continuing	Status: Terminated or Completed
Department of Defense Army (Cont.) Environmental Hygiene Agency & Environmental Engineering Services	hearing conservation program (1)+ noise effects on persons at military installations (1)+	x		47	–	x x x	x	
Materiel Command	equipment noise reduction, rotary wing noise reduction, human capabilities (6)+	x	x	650	627	x x x	x	
Office of Research and Development	biomedical effects of noise in the military environment (1)+		x	–	82	x		x
Air Force Office of Surgeon General	hearing conservation (1)+	x		509	2,614	x x x x	x	
Office of Scientific Research	aircraft noise generation (4)*	x	x	80	298	x x x x	x	
Flight Dynamics Laboratory	aircraft acoustics, sonic fatigue, noise control in vehicle interiors (10)*	x	x	290	1,137	x x x x	x	
Medical Research Laboratory	effects of Air Force generated noise upon its personnel (18)*	x	x	410	1,569	x x x x	x	
Aero-Propulsion Laboratory	noise abatement of aircraft propulsion systems (13)*	x	x	475	794	x x x x	x	
Weapons Laboratory	computer noise exposure forecasting (1)+	x		80	50	x	x	
Suppressor Program	sound suppressors for ground maintenance of aircraft engines (–)+		x	4,810	27,102.5	x x x x	x	

Table 1 (Cont.)

Organization	Activity Statement(s) (Parentheses indicate the number of projects* or programs† in each activity)	Source: In-house	Source: Contract or Sponsored	Operating Budget* (FY '72) in thousands	Expenditures (past 3-5 yrs) in thousands	Activity Period (FY) '68 '69 '70 '71	Status: Continuing	Status: Terminated or Completed
Department of Defense Navy	noise reduction of operating aircraft, noise suppression of ground run-up of engines (–)†; exploratory development program of semi-portable engine noise suppressor (1)†	x	x	–	3,900	x x x x	x	
Environmental Protection Agency Office of Noise Abatement & Control	investigation & study of noise & its effect on the public health & welfare (1)† (report to Congress)	x	x	509.1			x	
Department of Health, Education & Welfare Social Security Administration	health effects & protection against high noise levels hearing conservation (–)†	x		–	–	x x x x	x	
National Institutes of Health	physiological & psychological effects of noise (8)*		x	21	383 (FY 71)	x x	x	
Health Services & Mental Health Administration	hearing loss from nonoccupational noise exposure (1)*; interim criteria for environmental noise control (–)*	x	x			x x x x		x (FY 72)
Department of Housing & Urban Development	noise policy & standards for site selection, structural characteristics, land use, urban noise survey methodology (1)*; metropolitan aircraft abatement policy studies (4)*	x	–	–	–			

Table 1 (Cont.)

Organization	Activity Statement(s) (Parentheses indicate the number of projects* or programs† in each activity)	Source: In-house	Source: Contract or Sponsored	Operating Budget* (FY '72) in thousands	Expenditures (past 3-5 yrs) in thousands	Activity Period (FY) '68 '69 '70 '71	Status: Continuing	Status: Terminated or Completed
Department of the Interior Park Service	monitoring frequency & characteristics of sonic booms in certain National Parks (–)†	x	x	–	–	x		
Bureau of Mines	training program for noise survey inspectors (–)†; noise problems and hearing loss in mines (–)†	x	x	214	45	x		
Department of Labor	occupational noise, noise surveys, criteria and standards (–)†	x		–	–	x	x	
Department of State	none							
Department of Transportation	noise abatement of transportation noise (–)†	x	x	5,745		x x x x		
Transportation Systems Center	community noise caused by transportation sources (–)*			900		x x	x	
Federal Highway Commission	traffic noise measurement & abatement (–)*			149		x x	x	
Federal Aviation Agency	aircraft noise suppression (–)* sonic boom affects (–)*			3,150		x x	x	
Department of the Treasury Bureau of the Mint	control of community noise emitted by mint equipment (3)*;	x		–	–	x		
Secret Service	hearing conservation (–)†	x		–	–	x		
Atomic Energy Commission	none							
Federal Power Commission	none							

Table 1 (Cont.)

Organization	Activity Statement(s) (Parentheses indicate the number of projects* or programs† in each activity)	Source		Operating Budget* (FY '72) in thousands	Expenditures (past 3-5 yrs) in thousands	Activity Period (FY) '68 '69 '70 '71	Status	
		In-house	Contract or Sponsored				Continuing	Terminated or Completed
General Services Administration	procedures for noise abatement of construction & demolition operations (1)*; amending procurement requirements for quieter products (1)*	x		–	–			
National Aeronautical and Space Administration	aircraft noise and noise reduction . . .source noise (35)*; propagation noise (4)*; receptor noise (11)*; sonic boom and approach trajectory modifications (12)*; hearing conservation program (–)†	x	x	2,500	20,887	x x x x		
National Science Foundation	supports meritorious proposals for research on effects of noise, noise control, and acoustics (10)*		x	–	641	x x x x	x	
Post Office Department	noise abatement of postal equipment (2)*; noise standards for new postal equipment (1)†	x	x	170	250	x	x	
Tennessee Valley Authority	community noise effects and noise measuring instrumentation (–)†	x		–	45	x		
Total				22,475.1	62,778.9			

Appendix A

LETTER OF INQUIRY AND REPORTING FORMAT

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

July 30, 1971

TO:

Title IV of the Clean Air Act of 1970 requires this office to prepare a report to the Congress concerning noise and its effects on the public welfare.

Attached is an outline of the section of the report dealing with Federal activities in noise effects, abatement and control. It is requested that you supply the information called for in the outline as it applies to your agency. In order to meet the report deadline of December 31, 1971, it is necessary that we have your replies by August 30, 1971.

There is a continuing requirement that we maintain current information on Federal noise programs. This office should be routinely informed of changes in the information supplied in response to this inquiry. It is suggested that you establish a procedure to insure that we have the most up-to-date information concerning your noise program. In the course of fulfilling the requirements of Section 402(c) of Title IV, we will request that you conduct a survey to identify your activities which are now producing objectionable noise. This will amount to essentially an emission inventory of major noise sources owned, sponsored or controlled by the Federal Government. Guidance in this matter will be given to you in the near future.

If specific questions arise, we will be pleased to meet with you to discuss your programs on an individual basis. Our agency's contacts regarding this matter are Mr. R.M. Marrazzo and Captain J.B. Bomar at 254 - 7424.

Sincerely yours,

Alvin F. Meyer, Jr.
Director
Office of Noise Abatement and Control

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEDERAL NOISE PROGRAMS INFORMATION

I. Organizational

   A. Parent Agency, Department, etc.

   B. Legislative Requirements and Authority for Noise Function and Funding

II. Functional

   A. Overall Program Objectives

   B. Specific Programs and Research (List individual projects)

      1. Description

      2. Objectives

         a. Is program meeting desired objectives?

         b. What criteria are used to evaluate the program?

   C. Procedures

      1. Identification of problem areas and research needs -- How are priorities assigned?

      2. Specific actions to abate and control noise

      3. Procedures for coordination with other Federal agencies

      4. Extent of inhouse capability -- include consultant usage

      5. Proposed new procedures to upgrade programs

   D. Future Program Proposals and Objectives

III. Fiscal

   A. Current Program

      1. Real property value of facilities and equipment used for noise programs

      2. Current operating budget (FY 72)

         a. Direct operating costs

         b. Indirect-estimate overhead and maintenance

3. Personnel

   a. Current authorizations by type and classification

   b. Salary totals for program operation and contract management

4. Contracts, grants, loans and subsidies (see Sec. II B)

   a. Percent completion

   b. Funding by project

   c. Total research expenditures

B. Past and Future Programs

1. Past programs

   a. Expenditures for past 3 to 5 years

   b. Facilities aquisitions for past 3 to 5 years

2. Future program plans

   a. Projected facilities costs

   b. Projected personnel levels

IV. Regulation and Certification

A. Authority and Responsibilities

B. Actions Taken to Implement Regulation and Certification Requirements

Appendix B

DETAILED AGENCY RESPONSES

TO INQUIRY

THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF: PA

August 30, 1971

Dr. Alvin F. Meyer, Jr.
Director
Office of Noise Abatement and Control
Environmental Protection Agency
Washington, D. C. 20480

Dear Dr. Meyer:

In response to your letter of July 30, 1971, I have enclosed material descriptive of the various noise abatement and control programs of the National Aeronautics and Space Administration. This should fulfill the requirements of the questionnaire.

Although the NASA is not an environmental agency, among its missions* is the development of aeronautics technology. One program in this category is an aircraft noise research program having the objective of improving the technology of aircraft noise reduction. This program is composed of five elements; Source Noise Research (by far the largest), Propagation Noise Research, Receptor Noise Research, Sonic Boom Research, and Approach Trajectory Modification. Each of these programs is described in Enclosure 1, which also includes the corresponding funding figures and a list of contractual efforts.

Enclosure 2, minutes of the February 25, 1971, meeting of the Noise Research Panel of the Interagency Aircraft Noise Abatement Program, contains a more detailed description of many of the program elements, along with material descriptive

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*The National Aeronautics and Space Act of 1958, as amended (P.L. 85-568, 72 Stat. 426).

of the corresponding programs of the Department of Transportation, the military services, and a number of industrial firms. Enclosures 1 and 2 provide NASA funding data for the three fiscal years 1970, 1971, and 1972, except that Enclosure 2 does not include data for Sonic Boom Research. Furthermore, the Approach Trajectory Modification program is included in the category, Propagation Research, in both Enclosures 2 and 3. Enclosure 3 provides a broader look at the Federal aircraft noise research program, and FY 1970 Sonic Boom Research funding data are available here.

Definition of the FY 1973 noise research program is impossible at this time because we are just beginning the budget cycle. In general, however, we expect no major change in either scope or funding of the program.

In-house noise research programs are carried out in a number of NASA facilities. Those facilities devoted exclusively or primarily to noise research are listed in Enclosure 4, and their total capitalized cost (facilities and special-purpose equipment) is approximately $5 million. We have recently let design contracts leading to the eventual construction of the Aircraft Noise Reduction Laboratory, likely to go into operation in late 1972. This facility, with construction and equipment estimated to cost about $5.8 million, will provide a research facility capable of directly attacking the problem of noise created by aircraft, including fundamental research in the generation and physical measurement of noise, human reactions to noise, and techniques for noise reduction.

In addition to the noise research program, NASA maintains an agency-wide hearing conservation program for the protection of all employees at NASA installations. The overall agency effort devoted to work place surveillance, audiometric testing, and medical attention is approximately 1 to 1.5 man-years. All NASA installations utilize conventional survey and recording equipment along with audiometers and sound control booths. For the most part, this effort is executed by professional industrial hygienists, industrial nurses, and physicians.

The damage risk criteria used in NASA to determine hazard to personnel exposed to noise are the Walsh-Healey criteria. There is also an agency handbook which provides procedural information on the subject of "Hearing Conservation in Noise Exposure."

I hope the information provided here will meet your requirements. If additional information is necessary, please let me know.

Sincerely yours,

Nathaniel B Cohen

Nathaniel B. Cohen
Director, Policy Analysis

Enclosures (4)

8/16/71

ENCLOSURE 1

NASA AIRCRAFT NOISE RESEARCH

The NASA conducts a continuing research and development program to improve the technology of aircraft noise reduction. The noise reduction program is very broad, covering the areas of source noise, propagation noise and receptor noise. In addition the program covers research on sonic boom and on approach trajectory modification. The program is centered around a large in-house effort conducted at the various NASA Centers. The in-house effort is supplemented by a contractual program effort involving many universities and industrial organizations. The noise research program is described in some detail in the minutes of the meeting of the Noise Research Panel of the Interagency Aircraft Noise Abatement Program (IANAP), February 25, 1971. The IANAP has been a major source for coordination of noise research being conducted within the United States. For convenience a summary of the programs underway is given below along with a list of contractual efforts. Following that is a discussion of the resources allocated to the noise program.

Source Noise Research

Rotating blade noise: - The generation and prediction of rotating blade noise is important for various propulsion units such as propellers, helicopter rotors, fans, compressors, and turbines. Tests of a multistage laboratory compressor to determine noise loads on the compressor case near the rotors and propagation of noise through the blade rows is being supplemented with analytical studies to predict oscillating pressure loads and the effects of inflow angle on noise generation. Both small-scale and full-scale fan tests are being conducted to provide information on fan noise generation and its alleviation.

Acoustic Treatment: A broad experimental and theoretical research program is underway to determine the basic behavior of duct lining materials, their application to aircraft, and associated operating problems. Materials with suitable acoustical, structural, and aerodynamic properties are being studied, along with special flow control methods such as inlet flow choking by either variable geometry or localized injection of fluids for flow control. Flight programs have demonstrated noise reductions of up to 15 EPNdB through the use of fan duct acoustic treatment, and this technology is being expanded to the turbine exhaust region.

Jet Noise: Jet exhaust noise research involves both nozzle configurations and flow considerations. The basic acoustic characteristics of slot nozzles of the type used in ground effect machines are being studied. Other devices and methods include flow shielding to radically change the noise radiation pattern, and the addition of various substances to the jet flow to alter the noise generation and radiation characteristics.

Quiet Engine: An Experimental Quiet Engine program is being conducted for the NASA Lewis Research Center by the General Electric Company under Contract NAS3-12430. The scope of the program is to design, construct and test two experimental full-scale turbofan engines using advanced design features for noise reduction. The goal is to achieve 15 to 20 EPNdB less noise than existing engines of the same size (e.g. the Pratt & Whitney JT3D engines in the Douglas DC-8 and Boeing 707 aircraft).

Component tests that have been made to date have shown that the noise design goals are likely to be achieved. The first engine has now been assembled and testing has begun. Following performance and acoustic tests by the contractor, the engine will go to Lewis Research Center where additional noise tests will be made both with and without a nacelle designed to achieve the final part of the noise reduction goal. The tests at Lewis will begin in the Spring of 1972.

Propagation Noise Research

Studies are being conducted to closely correlate fly-over noise data recordings, aircraft position information and atmospheric propagation losses over the audible frequency range. Meteorological studies of the lower 1000 meters of the atmosphere in several representative locations in the U.S.A. are underway to provide a statiscal representation of temperature, humidity, and wind gradients.

Receptor Noise Research

The NASA is sponsoring research to determine noise induced inner ear damage using frequency, intensity and exposure time as variables. It is also studying whether or not aircraft noise induces performance degradation to aircrews and the influence of subsonic aircraft noise on sleep.

Sonic Boom Research

The Ames and Langley Research Centers are engaged in a coordinated program involving both theoretical and experimental studies of the effects of airplane configuration and flight conditions on the production of sonic boom and on methods for their minimization. The general objective is to develop criteria which can be used to design high performance supersonic and hypersonic aircraft which will generate low sonic boom pressures on the ground in the vicinity of the flight path.

A broad program of investigation of the effects of atmospheric nonuniformities, wind, turbulence, etc., on sonic boom wave forms and also on means of producing a realistic and repeatable sonic boom environment for test purposes is underway.

The sonic boom affects both people and structures, and research is underway to understand these effects, to determine possible deleterious effects, and to develop efficient methods of protecting both people and structures from such effects.

Approach Trajectory Modifications

The NASA and FAA have demonstrated the noise reduction potential of steep two-segment approaches for current jet transports. NASA is planning research in this area to establish the feasibility of adopting such approaches and the avionics required. The noise reduction potential and feasibility of alternate approaches will also be studied.

Contract Efforts

Following is a list of contracts and grants that form a part of the NASA noise reduction program. An indication of funding in FY 70 and FY 71 is given. The determination of contracts to be awarded in FY 72 is subject to change and can be provided at a future time.

SUMMARY OF NASA-OART NOISE RESEARCH

The resources (funding and professional manpower) required to carry out the program just described are given in the following table: The funding consists of Research and Development dollars and R&PM (i.e. Research and Program Management) dollars. In turn the R&D dollars are spent in-house for purchase of test equipment and instrumentation, and for research contracts.

	FUNDING ($,K)	
	FY 1971	FY 1972
In-House R&D Funding	3,336	5,400
Contract R&D Funding	11,146	12,600
Source Noise	9,694	
Propagation Noise	45	
Receptor Noise	543	
Approach Trajectory	270	
Sonic Boom	594	
Total NASA/OART Noise R&D Funding	14,482	18,000
Total NASA R&PM Funding (Est. at 70K per PMY)	6,405	7,000
Total R&D and R&PM Funding	20,887	25,000

LANGLEY RESEARCH CENTER

Source Noise

Contractor Contract Number	Title	Start Date	Estimated Completion Date	Funding, $ FY 70	FY 71
Lockheed Marietta, Georgia NAS 1-10472	Measurement of Sound Propagation in and Radiation from Finite-Length, Lined, Annular Ducts with Non-Uniform Mean Flow	11/70	7/72	$ 0	$175,000
Loughborough Univ. Loughborough, Leicestershire, England	Studies of Broadband Noise from Rotating Blades	1/71	1/74	$ 0	$ 33,000
Grant: NGR-52-140-002 - Cost sharing with British Ministry of Technology					
Univ. of Southampton Inst. of Sound & Vibration Southampton, England Grant: NGR 52-025-002	The Noise of High-Speed Lifting and Propulsion Rotors	12/65	12/71	$ 0	$ 14,000
Bolt, Beranek, & Newman Canoga Park, Calif. NAS 1-9559-6	Jet Noise Reduction Study	8/70	11/70	$ 0	$ 5,000
Old Dominion Univ. Hampton, Virginia NAS 1-9434	Study, Design, and Fabrication of Ejector Models and Werodynamic Duct Work Models	11/69	7/71	$23,000	$ 3,000
Lockheed Burbank, Calif. N00123-70-C-0906 (Navy Contract)	Airframe Noise	1/70	4/70	$22,000	$ 0

LANGLEY RESEARCH CENTER

Source Noise

Contractor Contract Number	Title	Start Date	Estimated Completion Date	Funding, $ FY 70	 FY 71
LTV Anaheim, Ga. NAS 1-10021	Tone Burst Impedence Tube	5/70	7/71	$81,000	$ 0
J. Kriegler Langley, Va. L-50150	Propeller Theory	4/70	12/70	$ 2,000	$ 0
Boeing Seattle, Washington NAS 1-9622	Tailpipe Treatment	3/70	5/71	$371,000	$ 0
Boeing Seattle, Washington NAS 1-7129	Nacelle Acoustic Treatment	5/68	5/70	$186,000	$ 0
Syracuse Univ. Syracuse, N.Y. NGL 33-022-082	Supersonic Jet Noise	6/68	5/72	$102,000	$ 0
New York Univ. New York, N.Y. NGL 33-016-128	Jet Additives	12/67	6/72	$100,000	$ 0
Dynatech Corp. Cambridge, Mass. NAS 1-9309	Liquid Injection	3/70	2/71	$ 39,000	$ 0
Bolt, Beranek, & Newman Canoga Park, Calif. NAS 1-9383	Fluctuating Rotor Forces	3/70	5/71	$105,000	$ 0

LANGLEY RESEARCH CENTER

Source Noise

Contractor Contract Number	Title	Start Date	Estimated Completion Date	Funding, $ FY 70	FY 71
Penn State Univ. NGL 39-009-121	Jet Noise	1/69	1/73	$70,000	$ 0
Univ. of Tenn NGL 43-001-075	Jet Flap Noise Suppression	1/69	1/73	$34,000	$ 0
Univ. of Virginia NGR 47-005-147	Quasi-Linearization Techniques for Analysis of Compressor Noise	5/70	5/71	$13,000	$ 0

LANGLEY RESEARCH CENTER

Propagation Noise

Contractor Contract Number.	Title	Start Date	Estimated Completion Date	Funding, $ FY 70	FY 71
Bolt, Beranek, & Newman Canoga Park, Calif. NAS 1-9559-3	Duct Noise Propagation	4/70	8/70	$ 2,000	$ 0
Bolt, Beranek, & Newman Canoga Park, Calif. NAS 1-9559-8	Test Plan for Sound Propagation	10/70	1/71	$ 0	$ 9,945
Boeing Seattle, Washington NAS 1-10272	Noise Propagation Analysis	10/70	5/71	$ 0	$35,000
ESSA Silver Spring, Md. L-37584	Atmospheric Effects	10/69	3/71	$15,000	$ 0
Allied Research Baltimore, Md. NAS 1-9837	Atmospheric Effects	3/70	6/71	$43,000	$ 0
Bolt, Beranek, & Newman Canoga Park, Calif NAS 1-6168	Air to Ground Propogation	6/68	2/70	$ 9,000	$ 0

LANGLEY RESEARCH CENTER

Receptor Noise

Contractor Contract Number	Title	Start Date	Estimated Completion Date	Funding, $ FY 70	FY 71
University of Ill. Urbona, Illinois NGL 14-005-074	Studies on Auditory and Vestibular End Organs and Brain Stem Nuclei	10/70	9/73	$140,000	$140,000
Indiana University P.O. Box F Bloomington, Ind. NGR 15-003-077	Experimental Study of Hearing Loss and Inner Ear Damage after Exposure to Sounds	7/69	6/71	$ 30,000	$ 30,000
Sikorsky Aircraft Stratford, Conn. NAS 1-10144	Study of Effects of Noise	7/70	9/71	$ 0	$ 60,000
Tracor Inc. Austin, Texas NAS 1-10216	A study of Community Reaction to Jet Noise Around Small City Airports	8/70	11/71	$ 0	$187,000
North Carolina State Univ. Raleigh, N.C. Grant: NGL 34-002-055	Human Factors Aspect of Noise and Vibration	2/67	6/73	$30,000	$ 40,000
North Carolina State Univ. Raleigh, N.C. Grant: NGL 34-002-095	Acoustic Energy Effects on Sleep and Human Performance	3/69	8/73	$ 0	$ 51,000
Wyle Laboratories Hampton, Virginia NAS 1-9257	Study of Evaluation and Refinement of Aircraft Noise Rating Techniques	7/69	12/70	$ 0	$ 14,000

LANGLEY RESEARCH CENTER

Receptor Noise

Contractor Contract Number.	Title	Start Date	Estimated Completion Date	Funding, $. FY 70	FY 71
Audio Shuttle Norwalk, Conn. NAS 1-10418	Audiometric Room - Design and Purchase	10/70	3/71	$ 0	$ 21,000
Amer.Inst.for Res. Pittsburgh, Pa. NAS 1-9854	Performance Battery	3/70	3/71	$100,000	$ 0
Stanford Res.Inst. Menlo Park, Calif. NAS 1-10017	Comparison of Field & Lab Noise	5/70	11/71	$178,000	$ 0
Stanford Res.Inst. Menlo Park, Calif. NAS 1-6855	Overflight Subjective Response	12/66	6/69	$ 16,000	$ 0
William & Mary Williamsburg, Va. NAS 1-9461	Noise Effects on Vision	8/69	8/72	$ 25,000	$ 0
Boeing, Vetrol Philadelphia, Pa. NAS 1-10,044	VTOL Noise Acceptability	5/70	7/71	$ 85,000	$ 0

LEWIS RESEARCH CENTER

Source Noise

Contractor Contract Number	Title	Start Date	Estimated Completion Date	Funding, $ FY 70	FY 71
General Electric Evendale, Ohio NAS 3-12430	Experimental Quiet Engine	7/69	5/73	69 - 4,500,000 70 - 4,900,000 71 - 7,000,000 72 - 4,700,000 73 - 300,000	
Boeing Wichita, Kansas NAS 3-14321	Suppressors for Quiet Engine	7/70	12/71	$381,000	$350,000
Pratt & Whitney Hartford, Conn. NAS 3-10483	Research on the Aerodynamics and Acoustic Problems of High-Load, Low-Speed Fans	6/67	6/71	$389,000	$71,000
General Electric Evendale, Ohio NAS 3-14404	Study Program for Integral Lift Fan Engine	6/70	6/71	$243,000	$100,000
General Electric Evendale, Ohio NAS 3-14406	Study Program for Remote Lift Fan Engine	9/70	9/71	$ 0	$284,000

AMES RESEARCH CENTER

Source Noise

Contractor Contract Number	Title	Start Date	Estimated Completion Date	Funding, $ FY 70	FY 71
General Electric Evendale, Ohio NAS 2-5462	Lift Fan Noise Reduction	3/71	1/73	$400,000	$493,000
Bolt, Beranek and Newman Canoga Park, Calif. NAS 2-6206	Measurement of Noise in Wind Tunnels - Determine Free-Air Corrections	11/70	5/71	$ 10,000	$ 19,000
Bolt, Beranek, and Newman Canoga Park, Calif. NAS 2-5974	Fundamental Study of Aero-dynamic Airfoil Noise with Serrated Leading Edges	5/70	5/71	$ 44,000	$ 55,000
Stanford University Palo Alto, Calif. and UCLA, Los Angeles, Calif. Grants in Preparation	Graduate Student Support for Fundamental Noise Research, Leading to PhD Thesis	Start FY 71	Estimated Compl. 3 years	$ 0	$245,000
Nielson Eng. & Res. Mountain View, Calif. NAS 2-6010	Study of Dynamic Pressures	6/70	9/71	$ 0	$ 62,000
BBO Associates Los Angeles, Calif. In negotiation	Rotor Stator Acoustic Interaction	1971	12 months	$ 0	$ 50,000

AMES RESEARCH CENTER

Source Noise

Contractor Contract Number.	Title	Start Date	Estimated Completion Date	Funding, $ FY 70	FY 71
Boeing Aircraft Seattle, Washington NAS 3-6344	Augmentor Wing Aircraft Design with Emphasis on Low Noise Generation	1/71	3/72	$ 0	$480,000
Dr. El Sum Burlingame, Calif. In Negotiation	Assess Use of Acoustic Holography to Define Aircraft Noise	4/71	9/71	$ 0	$ 20,000
RAO Associates Los Angeles, Calif. NAS 2-5730	Leaned Vane Research	11/69	3/71	$35,000	$ 0

AMES RESEARCH CENTER

Propagation Noise

Contractor Contract Number	Title	Start Date	Estimated Completion Date	Funding, $ FY 70	FY 71
American Airlines Tulsa, Oklahoma	Acoustic Signatures - Steep Decent Flight Programs Aircraft Lease	FY 71	3 months	$ 0	$270,000

Procurement in process

APPENDIX

NASA NOISE RESEARCH GRANTS AND CONTRACTS

HEADQUARTERS

Source Noise

Contractor Contract Number	Title	Start Date	Estimated Completion Date	Funding, $ FY 70	FY 71
General Electric Schenectady, N.Y. NASw-1784	Supersonic Jet Exhaust Noise	7/26/68	8/31/71	$35,000	$35,000
General Electric Evendale, Ohio NASw-1922	Noise Generation From Large Fans	10/15/69	6/30/72	$49,000	$40,000
Stanford Res. Inst. Palo Alto, Calif. NASw-1938	Study of the Structure of Jet Turbulence Producing Jet Noise	8/05/69	6/31/71	$58,000	$40,000
University of Mass. Amherst, Mass. NGR22-010-063	Real Fluid Effects in Compressor Noise	6/01/70	5/31/71	$15,000	$15,000
United Aircraft Hartford, Conn. NASw-1908	Broadband Noise of Axial Compressor	7/11/69	6/30/72	$ 0	$40,000
Stanford University Palo Alto, Calif. NGL05-020-275	Fluid Mechanics of Edgetones	1/01/70	12/31/72	$25,000	$25,000
California Inst.Tech. Pasadena, Calif.	Jet Noise Generation and Suppression	6/30/71	5/31/72	$ 0	$40,000
Cornell Aeronautical Lab. Ithaca, N.Y. NASw-2091	Analysis of Transonic Compressor Flow	9/30/70	8/31/71	$34,000	$ 0

APPENDIX

NASA SONIC BOOM RESEARCH GRANTS AND CONTRACTS

Langley Research Center

Source Research

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	Funding ($K) FY 70	FY 71
Aerospace Corp. Los Angeles, Calif. (NAS1 - 10051)	A Study of the Validity of the Heat Field Concept of Sonic Boom Alleviation	6/70	9/71		108

The purpose of this study is to determine if the release of large quantities of heat which would alleviate the sonic boom can be practically applied.

Path Research

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	Funding ($K) FY 70	FY 71
E.G.&.G. Co. Albuquerque, N. Mex. (NAS1 - 9284)	Propagation of Sonic Boom Through Turbulence	6/69	11/70		4

This study attempts to extend the scattering theory of Crow by use of a multiple scattering theory. Included will be an evaluation of the theory of Tatarski with modifications as necessary.

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	Funding ($K) FY 70	FY 71
Mass. Inst. of Tech. Cambridge, Mass. (NGL 22-009-334)	Atmospheric Effects on Sonic Boom Pressure Wave Forms	9/70	9/71	40	

A theory is being investigated which relates spikes on boom signatures to a mechanism consisting of simultaneous focusing and diffraction due to an inhomogeneous atmospheric layer. The potential of explaining signature rounding by this mechanism is also being investigated.

Langley Research Center

Path Research

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	Funding ($K) FY 70	FY 71
Mt. Auburn Res. Assoc., Inc. Cambridge, Mass. (NAS1 - 10276)	A Numerical Method to Determine the Pressure in a Sonic Boom Focus	12/70	3/72		96

Studies have just gotten underway to examine in detail the sonic boom focus phenomena.

General American Transportation Corp. Niles, Illinois (NAS1 - 9252)	Sonic Boom Simulation	6/69	8/70	10	

Receptor Research

Stanford Res. Inst. Menlo Park, Calif. (NAS1 - 10528)	Comprehensive Study of the Psyco-physiological Reactions to Sonic Booms and their Effects on Sleep and Startle	2/71	3/72		82

Tests subjects will be evaluated by motor performance testing while performing under varied acoustic background including aircraft noise and simulated sonic booms. In addition, the effects of the same noises on the sleep of subjects will be studied in a specially designed sleep test room.

Langley Research Center

Receptor Research

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	Funding ($K) FY 70	FY 71
General Applied Sci. Lab., Inc. Westbury, N. Y. (NAS1 - 9594)	Acoustic Response to Various Wall and Room Configurations	11/69	12/70	95	

The principal direction of these studies is to determine the effects on structures of low-level repeated sonic boom exposures.

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	Funding ($K) FY 70	FY 71
Mass. Inst. of Tech. Cambridge, Mass. (NGL 22-009-135)	Response of Building Structures to Environmental Noise of Seismic, Acoustics, and Aerodynamic Origin	10/70	9/71	35	

The object of this investigation is to develop an analytical procedure for predicting the random response of plate-like structures resting on soil and subject to seismic noise of aerodynamic origin.

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	Funding ($K) FY 70	FY 71
J. H. Wiggins Co. Palos Verde, Calif. (Pending)	Theoretical Study of Window Glass Breakage with Sonic Boom Loads				80

APPENDIX

NASA SONIC BOOM RESEARCH GRANTS AND CONTRACTS

Ames Research Center

Source Research

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	Funding ($K) FY 70	FY 71
Aerophysics Res. Corp. Bellevue, Washington (NAS2 - 4880)	Studies of Sonic Boom and Drag Optimization	9/69	12/70	70	15

This study is directed toward the development of an analytical method for calculating supersonic flow-fields about arbitrary configurations. The method features a three-dimensional distribution of singularities on the configuration.

Path Research

Aerophysics Res. Corp. Bellevue, Washington (Pending)	Development of Hypersonic Theory for the Sonic Boom				10

The purpose of this study is to extend sonic boom theory into the hypersonic range.

APPENDIX

NASA SONIC BOOM RESEARCH GRANTS AND CONTRACTS

NASA Headquarters

Source Research

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	Funding ($K) FY 70	FY 71
New York Univ. New York, NY (NGL 33-016-119)	Investigation of Optimum Aircraft Configuration for Sonic Boom Reduction	8/70	7/71	55	55

The purpose of this investigation is to determine whether or not substantial reductions in sonic boom may be obtained by novel aircraft configurations, to evaluate effects of atmospheric conditions and diffraction of sonic boom signatures from structures and topographical configurations.

Path Research

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	FY 70	FY 71
Columbia Univ. New York, NY (NGL 33-008-098)	Theoretical Study of the Superboom	8/70	8/71	37	29

The objective of this research is to understand the basic mechanism of the superbooms caused by nonuniform motions of the aircraft and refractive effects of temperature gradients in the atmosphere.

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	FY 70	FY 71
Cornell Univ. Ithaca, NY (NGL 33-010-054)	Analysis of Turbulence Effects on Sonic Boom Transmission	9/70	8/71	30	30

This sonic boom investigation comprises a theoretical investigation into the validity of the basic theory, the extent of the mid-field region, atmospheric effects and sonic booms of hypersonic aircraft.

NASA Headquarters

Path Research

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	Funding ($K) FY 70	FY 71
Princeton Univ. Princeton, NJ (NGL 31-001-119)	Investigation of Nonlinearity, Caustic and Diffraction in Wave Propagation	10/70	10/71	30	30

A number of theoretical problems associated with sonic boom prediction will be investigation; specifically, the nonlinear behavior of an N-wave at a caustic, the extension of nonlinear theory to geometrical acoustics and sonic boom signatures within a shadow region.

Contractor Contract No.	Title	Starting Date	Estimated Completion Date	Funding ($K) FY 70	FY 71
Aeronautical Res. Inst. of Sweden Bromma, Sweden (NGR 52-120-001)	Investigation of Nonlinear Effects on Sonic Boom Generation	2/71	2/72	60	45

The purpose of this work is to further understanding of nonlinear effects on the generation of sonic booms by means of theoretical and experimental investigations.

ENCLOSURE 4

NASA FACILITIES & EQUIPMENT DEVOTED EXCLUSIVELY OR PRIMARILY TO NOISE RESEARCH

LANGLEY RESEARCH CENTER, Hampton, Virginia

High Intensity Noise Facility (Bldg. 1221)
Low Frequency Noise Facility (Bldg. 1221A)
Psycho-acoustic Lab & Anachoic Noise Facility (Bldg. 1218 & 1218A)
Rotor Test Tower
Instrumentation Vans
Jet Engine Noise Test Stand

LEWIS RESEARCH CENTER, Cleveland, Ohio

Quiet Fan Facility (Bldg. 90)
Aircraft Noise Laboratory (Bldg. 4)

DEPARTMENT OF DEFENSE

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

HEALTH AND
ENVIRONMENT

13 SEP 1971

Dr. Alvin F. Meyer, Jr.
Director, Office of Noise Abatement and Control
Environmental Protection Agency
Washington, D. C. 20460

Dear Doctor Meyer:

The Department of Defense is pleased to submit the attached information requested in your letter of 30 July 1971 on "Federal Noise Programs". Each of the Military Departments have followed the format you requested where possible. Specific questions concerning the attachments should be referred to the appropriate Military Department.

Sincerely,

M.G. Patton

M.G. Patton, M.D.
Acting Deputy Assistant Secretary
(Environmental Quality)

3 Attachments
a/s

DEPARTMENT OF THE ARMY

NOISE PROGRAMS INFORMATION

The noise programs being accomplished within the Department of the Army are reflected by the following information. Those sections of the suggested format not applicable to the activities of the agencies were omitted, and slight modifications of format were performed where desirable for clarity.

1. I. Organizational

A. Agency - Office of the Chief of Research and Development.

B. Authority for Funding - Contract # DAHC19-70-C-0022.

II. Functional

A. Study Objective - The Federation of American Societies for Experimental Biology (FASEB), a nonprofit group, is under OCRD contract to conduct a review of the adverse effects of noise in the military.

B. Specific Research

1. Description - The FASEB effort, "A Review of the Adverse Biomedical Effects of Sound in the Military Environment," is a study of the problem area by an ad hoc group. This is a one-time contract with all funds paid from FY 70 appropriations. Primary emphasis is being placed on noise-induced hearing loss and the many variables that may affect the onset, nature, and severity of such hearing loss. Consideration is being given to the adverse effects of noise on the efficiency of the soldier in performing his duties. The potentially adverse effects of excess sound on other than hearing loss are also being considered.

2. Objectives.

a. The objectives of this study are to review current state-of-the-art knowledge concerning the adverse effects of sound in the military, to identify gaps in knowledge in this area, and to recommend future Army research to minimize the adverse effects of sound on the soldier. The study is on schedule and meeting desired objectives. A draft of the final report is now being prepared for distribution to participants in the study for their comments. A final report is expected by 30 December 1971.

b. No formal criteria are being used to evaluate the study; however, in addition to the OCRD contracting officer, representatives of various governmental and civilian agencies, who are considered experts in the field of hearing, provided informal input of pertinent information and opinions and systematic evaluation of these data during the course of the study.

C. Procedures

1. Priorities were assigned based upon hearing problems identified in the military. Priorities were revised when necessary based upon results received during the study.

2. Coordination with other Federal agencies was accomplished by participation of representatives of appropriate agencies in the ad hoc meetings.

III. Fiscal

A. Current Program - Awaiting final report on study in December 1971.

B. Past and Future Programs

1. Past expenditure: one-time expenditure of $82,000 from FY 70 funds.

2. Future program plans depend upon the results of this study. When completed, this study will integrate the opinions of experts and outstanding workers in the field of hearing. It is expected to provide information and guidance for future research by the Army in biomedical and behavioral sciences, as well as protective equipment in the development of improved weapons systems, communications systems, military vehicles, and aircraft.

2. I. Organizational

A. Agency - Office of the Chief of Engineers.

B. Legislative Requirements and Authority for Noise Function and Funding.

It is not anticipated that special legislation or funding will be required. The current practice is to include noise control as needed in our program with the authority and funding in the general program authorizations.

II. Functional

A. Overall Program Objectives

To perform the design and construction operations of the Corps of Engineers in a manner that noises generated will not be of such a magnitude or intensity as to adversely impact on the project workers or inhabitants of the surrounding area. Apply control measures to eliminate noise levels which could be expected to cause nuisances or adversely affect the physiological or psychological health of the area occupants.

B. Specific Programs and Research

Project No. 1

1. Description - Research Work Unit Entitled: Sound and Vibration Tolerance Limits Residential Areas. The objective of this research is to establish criteria for the location of artillery and other weapons firing ranges, test facilities and military airfields relative to residential areas in order to attenuate sound and vibration effects to tolerable levels. Attenuation techniques will also be developed.

2. Objectives

a. The program was just initiated in July 1971. To date it is meeting desired objectives.

b. The criteria used to evaluate work are:

(1) New or improved criteria developed.

(2) New or improved techniques for attenuation developed.

(3) Timeliness.

1. Description - Research Work Unit Entitled: Environmental Protection During Construction Activities. This research seeks to identify causes and effects of pollution (including noise) during and as a result of construction operations and to provide economical and reliable control criteria and methods for incorporation into Corps contract specifications and construction supervision.

2. Objectives

a. The program has been underway approximately 9 months and is continuing. A survey of the state-of-the-art in environmental protection during construction has been completed. The program is meeting objectives.

b. The criteria used to evaluate work are:

(1) New or improved contract criteria developed.

(2) New or improved techniques developed.

(3) Timeliness.

C. Procedures

1. Identification of problem areas and research needs -- How are priorities assigned?

Problem areas and research needs are determined by a Corps wide system (which system includes users and customers of the Corps) of problem identification and evaluation that is pursued continually with a complete re-evaluation of all research performed annually. Priorities are arrived at through a series of research priority questionnaires completed by Corps District and Division offices, OCE, and customers. Also taken into account are Department of Defense and national needs and priorities as stated formally and discerned informally. This activity is conducted by the Office, Plans Research and System Directorate of Military Construction.

2. Specific actions to abate and control noise.

The Corps of Engineers is responsible for the design and construction of installations and facilities for the Department of the Army, Department of the Air Force, Department of Defense Agencies and other government departments or agencies when requested to do so. Noise abatement and control is an integral part of the site planning, engineering design and construction practices in the performance of this responsibility. The methods of noise abatement and criteria for minimizing its effect are established in appropriate Army Regulations, Technical Manuals and Guide Specifications. Facilities which produce objectionable noise levels that cannot be effectively muted are sited in areas that are isolated from the built-up portion of the installation and adjoining residential developments. Noises generated by the operation of motors, engines, air compressors and other similar equipment are controlled by insulated housing, mufflers, sound absorption barriers and operating speed design. Construction noises are likewise controlled by the use of sound absorption barriers, equipment sheathing and other sound suppression devices. The effects of pile driving and blasting are minimized by the application of energy absorbers or dissipators or by performing these operations at such times that the nuisance effect will be minimized.

3. Procedures for coordination with other Federal agencies

By participation in the program development of the Federal Construction Council of The Academy of Science and thru exchange of information with the Environmental Protection Agency, customer agencies and interdepartmental committees.

4. Extent of inhouse capability -- include consultant usage

The inhouse capability with particular expertise in noise abatement is limited. When unusual or complex noise problems arise consultant service from other government agencies or from the private sector is obtained.

5. Proposed new procedures to upgrade programs.

No major alterations to our current noise abatement program are planned until the Office of Noise Abatement and Control of the Environmental Protection Agency establishes standards and provides guidance concerning methods of implementation.

D. Future Program Proposals and Objectives

No action planned until guidance is obtained from the Office of Noise Abatement and Control of the Environmental Protection Agency.

III Fiscal

A. Current Program

1. Real property value of facilities and equipment used for noise programs.

The facilities and equipment provided for noise control are included in the overall cost of providing operating facilities and no estimate of the value of the noise control portion can be provided. A portion of the $25,000 described in IIIA2 will be allocated to this category.

2. Current operating budget (FY 72)

a. Direct operating costs $15,000 - Research described in II B.

b. Indirect-estimate overhead and maintenance $10,000 - as described in II B.

3. Personnel

a. Current authorization by type and classification.

No personnel specifically assigned to noise control.

b. Salary totals for program operation and contract management

None.

4. Contracts, grants, loans and subsidies.

None in the current program.

B. Past and Future Programs

1. Past programs

a. Expenditures for past 3 to 5 years.

(1) For Technical Manual, TM 5-805-9, Power Plant Acoustics issued December 1968 - cost $33,866.

(2) For Technical Manual, TM 5-805-4, Noise Control for Mechanical Equipment issued September 1970 - cost $30,000.

b. Facilities acquisitions for the past 3 to 5 years.

No identifiable costs for noise control.

2. Future program plans

a. Projected Facilities cost.

No specific budgeted costs.

b. Projected personnel levels.

No personnel with primary assignment to noise control program.

IV. Regulation and Certification

A. Authority and Responsibilities

It is not expected that additional authority will be required. It will be our responsibility to provide facilities and a program to abate noise in accord with the requirements established by the Office of Noise Abatement and Control of the Environmental Protection Agency.

B. Actions Taken to Implement Regulation and Certification Requirements - None until required to implement noise control regulations.

3. I. Organizational

A. Agency - US Army Medical Research and Development Command, Office of The Surgeon General.

B. Authority - AR 705-5 and AR 70-9.

II. Functional

A. Overall Program Objectives - To study the problem of noise in the US Army in terms of sources of noise, biomedical effects of noise, the populations at risk, and the means of reducing noise production, noise exposure, and advance physiological and psychological effects of noise.

B. Specific Programs and Research

1. Descriptions of Specific Programs

a. "Traumatic Origins of Hearing Loss" - The purpose of this project is to provide information that may allow a more precise screening of noise-susceptible individuals at the time of their induction and to evaluate devices and techniques for the protection of Army personnel during normal military operations.

b. "Auditory Perception and Psychophysics" - The purpose of this project is to identify and assess those factors which enhance or degrade the soldiers ability to attend to, perceive, and respond to simple and complex signals in the presence of various masking sounds; and to assess and improve the predictive value of certain models of the processes involved in the communication of auditory information and to use these models to predict auditory performance in military tasks.

c. "Army Aviation Audiometry Program" - The purpose of this program is to perform precision audiometric tests on a large sample of Army personnel to determine their status of hearing; to aid in the establishment of a more reliable audiometer calibration program, to support introduction of an MOS for operators of audiometer equipment, and to assist in development of a training program for these specialties.

d. "Acoustical Environment of Army Aviation Personnel" - This project has as its objectives the determination of noise levels, durations, and spectra of noise in which maintenance personnel are required to perform their duties and to maintain a record of the military noise environment with special emphasis on Army aviation.

e. "Effects of Distortion in Military Communication Systems" - The purpose of this investigation is to study distortion in these systems as it relates to type of microphone, environmental noise level, and intelligibility of military communication systems. Theoretical limits with idealized systems will be determined as well as recommended methods to improve present systems.

f. " Hearing Protection Devices Evaluation" - This study is to result in maintenance of readily available data, recorded under ASA standardized procedures, of the attenuation offered by standard helmets, earmuffs and ear plugs used by various personnel; and to estimate the protective properties of prototype equipment that will be considered for use by Army personnel.

g. "US Army Aircraft Vibrations Study" - The objective of this study is to make a survey of the vibration spectra in US Army aircraft as they are affected by noise reduction characteristics of soundproofing material.

h. "Determination of the Extent of Noise Induced Hearing Loss in the Army" - The purpose of this project is to determine how extensive decreased auditory acuity is among US Army personnel, as it relates to age, sex, race, MOS, history of noise exposure, and other factors. This will greatly facilitate better execution of the Hearing Conservation Program under the auspices of The Surgeon General.

2. Objectives

a. All programs are meeting desired objectives. These are principally on going programs requiring continued input as missions, materials, and other factors change with time. For example, as new aircraft are developed, each must be evaluated for noise hazards. Each successive segment of the various program has met desired objectives.

b. These programs are evaluated by continual internal review by the investigators and their superiors; by review by the headquarters monitoring officers, and by repeated exposure of protocols and results to such external means of review as publications in the open literature, presentations at scientific meetings, liaison with the NAS-NRC Committee on Hearing Bio-Acoustics, and Biomechanics; and coordination with the NATO Advisory Group on Aerospace Research and Development.

c. Procedures

(1) Problem areas and research needs are identified primarily through determination of operational requirements. Priorities are then assigned principally in consonance with operational priorities.

(2) Specific actions to abate and control noise sources are the primary responsibility of agencies other than the Medical Research and Development Command. Medical guidance is provided these agencies to the fullest possible extent consistent with established policies, directives and other controls. Direct medical action has, therefore, been aimed at control of exposure rather than limitation of noise production, although noise abatement at the source is the ultimate goal. The medical programs to limit exposure are functions of OTSG agencies other than USAMRDC on an informal basis between various investigators and laboratory commanders and through such means as the NAS-NRC Committee on Hearing, Bioacoustics and Biomechanics.

(3) Capability for in-house research in bioacoustics is excellent. Facilities, equipment, and expertise

are on hand to determine the parameters of the noise hazardous environments, the psychological and pathophysiological effects of these hazards, the effects on operational capability, and the evaluation and operational impact of hearing protective devices. Nationally and internationally recognized specialists in bioacoustics are available through various means, including formal liaison with the NAS-NRC Committee on Hearing Bioacoustics and Biomechanics.

(4) Future Program Proposals and Objectives - Future research plans and objectives will be designed to meet operational requirements. Anticipated work will attempt to further evaluate the hazards, the populations at risk, and the preventive, protective, and therapeutic measures of greatest value in combating noise hazardous environments.

III. Fiscal

A. Current program

1. Real property value of facilities and equipment, $525,000.

2. Current operating budget (FY 72).

a. Direct Costs - $352,400.

b. Indirect Costs - $111,900.

3. Personnel

a. Current authorizations

1 GS-15, Specialist in bioacoustics.

2 GS-13, Research psychologists (Code 180).

1 GS-07, Research Assistant.

2 04 Research psychologist, (MOS 8430).

6 enlisted Science and Engineering research assistants.

b. Salary totals (Civilian personnel), $95,000.

4. Contracts and related items: "Development of a New Generation Noise Cancellation Microphone". Objective: to reduce the noise level in Army Communications Systems.

Eighty percent complete. Funding level, $40,000.

B. Past and Future Programs

1. Past programs

a. Expenditures: FY 69 - $283,000
FY 70 - $271,900
FY 71 - $327,700

2. Future Program Plans

a. Projected facilities Costs: $400,000

b. Projected personnel levels: Increase of present personnel levels by 100%.

IV. Regulation and Certification

A. Authorities and Responsibilities - AR 705-5 assigns to The Surgeon General responsibility for RDTE of Medical Material and related items, and for medical aspects of other developments in the total RDTE program.

B. Actions taken to Implement Regulation and Certification Requirements - The RDTE responsibilities of The Surgeon General are fulfilled through the activities of the US Army Medical Research and Development Command and its subordinate units by means of continuing research activities which are designed to meet operational requirements and subjected to continual review at all levels of command to insure proper fulfillment of all commitments.

4. I. Organizational

A. Agency - Army Environmental Hygiene Agency and the Environmental Health Engineering Services, Office of The Surgeon General.

B. Authority

1. AR's 40-4 and 40-5.

2. Title 5, United States Code, Sec, 150 - Army Federal Civilian Employee's Health Service.

II. Functional

A. Overall Objectives

1. Assure that all eligible personnel (military and civilian) are physically, mentally, and psychologically suited to their work, and that their physical and mental health and well-being are maintained during service or employment.

2. Determine that the work environment for noncombatant areas is safe, hygienic, and wholesome.

3. Reduce the economic loss occasioned by physical inefficiency, sickness, and injury of military personnel and civilian employees.

B. Specific Programs

1. Hearing Conservation Program - The objective of the Army's Hearing Conservation Program is to prevent occupational loss of hearing due to noise. The primary sources of noise in the military environment being impulsive noise from the firing of small arms and artillery and steady noise from aircraft, combat vehicles, power generators and other industrial or military activities. The program involves:

   a. The identification, measurement and evaluation of noise hazards.

   b. The reduction of noise at its source by engineering, or operational controls.

   c. The use of hearing protective devices to attenuate noise levels before they reach the inner ear whenever noise levels exceed 90 dB for steady noise and 140 dB for impulsive noise.

   d. Audiometric surveillance of exposed personnel.

   e. Command emphasis, supervision, and health education. Further discussion of the conservation of hearing program is contained in the TB Med 251, Noise and Conservation of Hearing.

2. Objectionable Noise - To determine the nature and extent of noise levels to evaluate the environmental impact from various US Army sources. These studies consider the effects of noise to individuals on military installations and the surrounding environments. A limited

number of studies have been conducted in this area to include an alleged community annoyance problem associated with gunfire noise from the Wildflecker training Area, West Germany and an evaluation of environmental impact of noise from aircraft operations at Fort Hood, Texas.

C. Procedures

1. Problem areas are identified through studies, staff visits, and complaints received by the various elements of the Army Medical Department. Priorities are assigned on the basis of need.

2. Specific actions to abate and control noise include the technical review and evaluation of nonmedical material to determine possible existence of health hazard due to noise. This is done in part by the review of military and federal specifications and Material Needs documents. In addition, sound level measurements and evaluations are made of equipment used or proposed for use by the Army and recommendations are made for the engineering and operational control of noise exposure. Coordination is made with Army Materiel Command and Combat Developments Command with regard to the control of noise in equipment which may be procured or developed.

3. Coordination with other Federal agencies is accomplished through informal contact by individuals of the Medical Department.

4. There are 85 individuals working in the Army's occupational health program at the US Army Environmental Hygiene Agency and the Environmental Health Engineering Services. It is estimated that they devote approximately 5% of their time in various aspects of hearing conservation. In-house consultants in acoustical engineering, bioacoustics, industrial hygiene, human engineering, audiology, otolaryngology and occupational medicine in the conduct of the program. Other resources include NAS-NRC and civilian consultants.

5. The hearing conservation program and noise abatement program have been a major effort in the Army for many years and will continue to be a major effort. The directives AR 40-5 and TB Med 251 are under revision. DA Cir 40-79 on Command Emphasis in Hearing Conservation

Programs has recently been distributed to the field. A bioacoustics division was established at USAEHA last year to assist commanders in establishing comprehensive hearing conservation programs, to assist in identifying noise hazardous equipment, and to contribute to the development of equipment which presents less of a noise hazard. It should be noted that 2,000,000 pairs ear plugs were issued last year to personnel.

D. Future Program Proposals and Objectives - Included in the Occupational Health Program Change Request (PCR) for FY 73-77, submitted on 5 February 1971, was a request for funds to expand the US Army Hearing Conservation Program by strengthening the Bio-Acoustics Division, US Army Environmental Hygiene Agency. It appears that these funds will be made available. This request provides for an increase of five persons for the Bio-Acoustics Division. Expansion of the USAEHA hearing conservation and noise abatement program also takes into account requirements for implementation of the program at installation level. To accomplish this, efforts are being made to assign an audiologist to each Class I installation where a preventive medicine officer is assigned, with primary responsibility for the maintenance of the installation hearing conservation program. This plan would require an addition of six audiologists each year until this staffing level is reached.

III. Fiscal

A. Current Program for US Army Environmental Hygiene Agency and the Environmental Health Engineering Services does not include the personnel and resources such as Armed Forces Examining and Entrance Stations, Federal Health Services, Ear, Nose and Throat Clinics and hospitals for which statistics are not currently available.

1. Real property value of equipment - $71,000.

2. Current operating budget (FY 72)

   a. Direct Costs - $47,000.

   b. Indirect Costs - $117,900.

3. Personnel - current authorizations include preventive medicine, occupational health, sanitary engineers, environmental sanitarians, and audiologists which total 85.

5. I. Organizational

A. Agency - US Army Materiel Command.

B. Legislative Requirements and Authority for Noise Function and Funding.

1. This command is unaware of any legislative requirements.

2. Authority for funding is from Department of the Army, Department of Defense and Congress, based on Army's missions and functions.

II. Functional

A. Overall Program Objectives

1. To lessen detection time and distance.

2. To improve communications, fire accuracy, operator capability.

3. To improve health conditions and minimize annoyance to personnel.

B. Specific Programs and Research - The following military projects are for noise reduction:

1. Noise Reduction for the D-7 Crawler Tractor (Commercial Item) Under Product Improvement Project 1-68-9-27:

$205,000 for in-house and contract efforts. (Contract to Caterpillar Co.).

2. Silencing systems for the 10 KW Turboalternator Program under Project 1G664717D589:

FY 71 - $99,000 Contract; $10,000 In-house; FY 72 - $10,000 In-house.

3. Sound Suppression for the 30 KW Gas Turbine Generator Set Under Project 1G663702DG11:

FY 71 - $6,000; and FY 72 - $6,000.

4. Silencing Provisions for MIL STD Generator Sets Under Project 1G664717D589:

FY 70 - $63,000 Contract; $50,000 In-house; FY 71 - $29,000 Contract; $50,000 In-house and FY 72 - $15,000 In-house.

5. Product Improvement for Compressor, Air 600 CFM, 100 PSI. Funds have been requested as shown:

   FY 73 - $100,000; FY 73 -$162,000 and FY 74 - $168,000.

6. Basic Research on Human Capabilities, Army Human Factors Engineering - FY 72 - $75,000.

7. Rotary Wing Aircraft Noise Reduction (To minimize aircraft detection time and distance):

   FY 71 - $320,000; FY 72 - $350,000; FY 73 - $400,000;
   FY 74 - $400,000; FY 75 - $400,000 and FY 76 - $400,000.

C. Procedures

1. Identification of Problem Areas and Research Needs - Priorities are assigned based on military needs.

2. Specific Actions to Abate and Control Noise.

   a. Control basic design.

   b. Muffle.

   c. Insulate.

   d. Baffle.

   e. Warning signs.

3. Procedures for Coordination with Other Federal Agencies.

   a. Routine liaison is maintained with Air Force and Navy:

   b. Selection and dissemination of pertinent publications.

D. Future Program Proposals and Objectives - See above listing of projects (Future programs would be revised to comply with future Federal legislation).

III. Fiscal

A. Current Program

1. See above listing of projects.

2. The number of personnel engaged in sound control work is estimated at one man year per $40,000 expenditure.

IV. Regulation and Certification

A. Army regulatory documents are:

1. Section III of Army Regulation, AR 40-5, Hearing Conservation Program.

2. HEL Standard S-1-63B.

3. TB Med 251.

Compliance with these documents is mandatory within Army. (Copies of these publications are enclosed for your information).

3 Incl
as

U. S. ARMY

HEL STANDARD S-1-63B

(Supersedes HEL Standard S-1-63A, June 1964)

MAXIMUM NOISE LEVEL FOR ARMY MATERIEL COMMAND EQUIPMENT

Technical Specifications Office
Systems Research Laboratory

June 1965

HUMAN ENGINEERING LABORATORIES

ABERDEEN PROVING GROUND, MARYLAND

HEL Standard S-1-63B
(Supersedes HEL
Standard S-1-63A, June 1964)

MAXIMUM NOISE LEVEL FOR ARMY MATERIEL COMMAND EQUIPMENT

Robert F. Chaillet
Technical Specifications
Office

Georges R. Garinther
Acoustical Research
Branch

APPROVED: [signature]
JOHN D. WEISZ
Technical Director
Human Engineering Laboratories

U.S. Army Human Engineering Laboratories
Aberdeen Proving Ground, Maryland

I. INTRODUCTION

1. The data contained within this standard reflect the official position of the U.S. Army Human Engineering Laboratories and supersede all other data from these laboratories pertaining to the subject of this standard.

2. Human Engineering Laboratories (HEL) standards are issued for use by the major subordinate commands of the Army Materiel Command (AMC) in the area of human factors engineering.

3. HEL standards provide guidance to the major subordinate commands of AMC for the inclusion of human factors engineering requirements in research and development or procurement contractual documents.

4. HEL standards will serve as the basis for a human factors engineering evaluation by the Human Engineering Laboratories in accordance with AMCR 10-4.

II. SCOPE

1. This standard establishes the maximum noise level permitted at personnel occupied spaces of equipment designed, developed or procured by AMC.

2. This standard establishes the testing requirements for determining conformance to the maximum noise level permitted.

3. This standard is not intended for application as an industrial standard. Its use shall be limited to military equipment.

4. This standard is not to be considered as a hearing damage risk criterion.

III. APPLICABLE DOCUMENTS

1. The documents cited in this section form a part of this standard to the extent specified herein.

a. ASA Z24.10-1953 Octave-Band Filter Set for the Analysis of Noise and Other Sounds

b. ASA S1.1-1960 Acoustical Terminology

c. ASA S1.6-1960 Preferred Frequencies for Acoustical Measurements

d. ASA S1.4-1961 General Purpose Sound Level Meters

2. Applications for copies of these documents should be addressed to:

American Standards Association
10 East 40th Street, New York 16, New York

VI. DEFINITIONS

1. Definitions of acoustical terms that do not appear in this section are in accordance with ASA S1.1-1960.

2. Decibel (dB) Reference Level is 0.0002 microbar.

3. Impulse Noise is a non-periodic variation in atmospheric pressure which may completely be described by its pressure vs time history. It has a positive pressure envelope duration of less than 1,000 milliseconds and a peak to root mean square value greater than 10 dB.

4. Positive Peak Sound Pressure Level is the highest instantaneous pressure achieved (expressed in dB or in PSI).

5. Positive Pressure Duration is the time required for the pressure wave to rise to its first positive peak and to return momentarily to ambient.

6. Positive Pressure Envelope Duration is the time required for the pressure wave to rise to its highest positive peak and to decrease to and remain 20 dB below this highest peak.

7. Small Arms - all arms, including automatic weapons, up to and including caliber .60 and shotguns.

8. Steady State Noise is a periodic or random variation in atmospheric pressure at audible frequencies which has a positive pressure envelope duration in excess of 1,000 milliseconds.

V. GENERAL REQUIREMENTS

1. Equipment operating, training, or maintenance tasks shall not require personnel to be exposed to noise that exceed the levels specified in Table 1 or 2 and Figure 1.

2. Noise reduction principles and techniques shall be applied to the equipment to achieve a minimum noise level at personnel occupied spaces.

3. The degree or extent of application of noise reduction principles and techniques to equipment shall be determined by the procuring activity.

4. Noise reduction shall not be accomplished by specifying ear protective devices as mandatory for use by system personnel unless:

   a. The cost of reducing the noise level to or below the noise levels stated herein is prohibitive.

   b. Systems effectiveness is degraded by reducing the noise level to or below the noise levels of this standard.

5. The provisions of paragraph 4 (Section V) shall be determined by the procuring activity.

VI. STEADY STATE NOISE REQUIREMENTS

1. An octave-band analysis of the steady state noise produced by the equipment shall be made. The analysis may be made using the commercial frequencies (ASA Z24.10-1953) and their respective noise levels (Table 1) or the preferred frequencies (ASA S1.6-1960) and their respective noise levels (Table 2).

TABLE 1

Maximum Steady State Noise Level for Army Materiel Command Equipment

(Commercial Frequencies [ASA Z24.10-1953])

Octave Band Limits (cps)	Center Frequency (cps)	Noise Level (dB)
37.5 - 75	53	120
75 - 150	106	115
150 - 300	212	109
300 - 600	425	101
600 - 1200	850	93
1200 - 2400	1700	89
2400 - 4800	3400	89
4800 - 9600	6800	91

TABLE 2

Maximum Steady State Noise Level for Army Materiel Command Equipment

(Preferred Frequencies [ASA S1.6-1960])

Octave Band Limits (cps)	Center Frequency (cps)	Noise Level (dB)
44 - 87	63	119
87 - 175	125	114
175 - 350	250	107
350 - 700	500	99
700 - 1400	1000	91
1400 - 2800	2000	89
2800 - 5600	4000	89
5600 -11200	8000	91

2. A steady state noise level reading at each octave band shall be determined for the following situations and combinations thereof; to be taken at the head position of:

a. Each operator position under all normal operating conditions.

b. Each instructor and trainee position where training is conducted.

c. Each maintenance personnel position where maintenance is conducted with the equipment operating.

d. Note: Personnel will not be used in these positions during the measurement program unless it is essential to the conduct of the test.

3. Where personnel other than an operator, instructor or maintenance man may be present in or on the equipment, readings shall be made at representative positions occupied by these personnel in accordance with the conditions expressed in paragraph 2 (Section VI).

4. The sound level meter and microphone used to measure the noise level, including calibration requirements for each, shall be in accordance with ASA S1.4-1961. The octave band analyzer used shall meet the requirements of ASA Z24.10-1953.

5. When pure tones, or narrow bands of noise, are present in any octave band, the sound pressure level of that octave band shall be reduced from the level shown in Tables 1 or 2, by 5 dB for frequencies above 1,000 cps and 10 dB for the frequencies below 1,000 cps.

6. Where the steady state noise level exceeds that specified in Tables 1 or 2, the distance from the source at which the noise level is equal to or below that specified in Tables 1 or 2 shall be determined.

7. At the discretion of the procuring activity, provision shall be made for operation of the equipment from the distance at which the noise level is equal to or below that specified in Tables 1 or 2.

8. When the noise level of the item of equipment exceeds that specified in Tables 1 or 2, the equipment shall be conspicuously marked as follows: "Warning, ear protection required within ___ feet when equipment is operating." The number of feet specified in the warning will be the result of measurements made in response to paragraph 6 (Section VI).

9. The warning marking specified in paragraph 8 (Section VI) shall be legible from the distance determined in paragraph 6 (Section VI).

10. Where the equipment steady state noise level exceeds the limits of Tables 1 or 2, training, operating, and maintenance manuals, both preliminary and final, will cite the warning and distance stated in paragraph 8 (Section VI).

VII. IMPULSE NOISE REQUIREMENTS

1. The impulse noise limits expressed in Figure 1 are the criteria of acceptability for small arms. Other weapons which fall within the limits of Figure 1 are acceptable. Weapons larger than small arms that do not meet the limits of Figure 1 must be reviewed for adequacy on an individual basis.

2. To be acceptable, positive peak sound pressure level vs. positive pressure duration shall be below limit "A" of Figure 1 and positive peak sound pressure level vs. positive pressure envelope duration shall be below limit "B".

3. Where positive peak sound pressure level measurements are made in pounds per square inch (PSI) Figure 2 shall be used for conversion to dB.

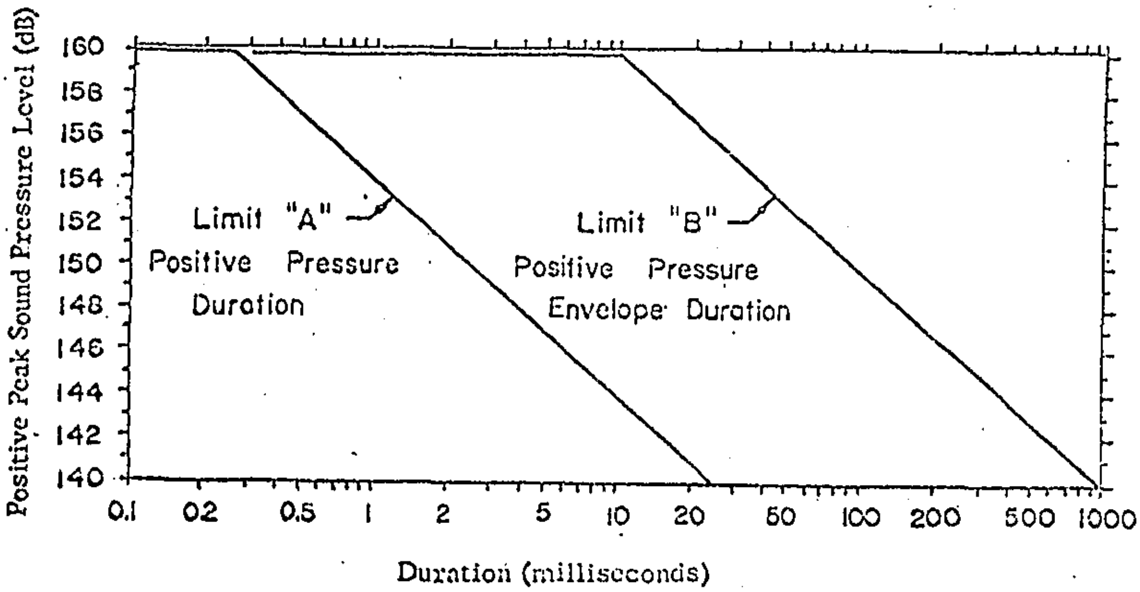

Fig. 1. Maximum Acceptable Impulse Noise Parameters for Army Materiel Command Small Arms

4. For measurement purposes, shoulder fired or hand-held weapons will be mounted with the barrel at least 40 inches above and parallel to the ground and with no large reflecting surfaces, including personnel, closer than 30 inches to the muzzle or the transducer. All other weapons will be measured in the physical position and in the system location from which they are normally fired.

5. Three pressure vs time histories shall be made of the impulse noise produced by the firing of three rounds, one round at a time.

6. The average of the three pressure vs time history measurements will be determined. The average of the three measurements will be sufficient if the positive peak sound pressure level does not vary more than $\pm$ 1 dB. Ten measurements will be averaged if this tolerance is exceeded.

7. Pressure vs time histories shall be obtained using an oscilloscope and a transducer possessing the following minimum requirements:

a. Amplitude distortion - less than 1.5 dB at the pressure being measured.

b. Ringing and overshoot - less than 1.5 dB at the pressure being measured.

c. Rise time - 10 microseconds or less at the pressure being measured.

8. Two of the three pressure vs time history measurements shall be made as follows: one at an oscilloscope sweep speed of 50 microseconds/cm and one at 1 millisecond/cm sweep speed.

9. The transducer shall be placed at the point, relative to the weapon, where the left ear of a right handed shooter or operator would be positioned.

10. Transducers shall be oriented at an angle to prevent a pressure increase due to reflection on the transducer face.

Given: 1 psi = 6.895×10^4 dynes/cm^2 and

$$db = 20 \log_{10}\left(\frac{p}{0.0002\ d/cm^2}\right),$$

then

$$db = 20 \log_{10}\left(\frac{psi \cdot 6.895 \times 10^4}{2 \times 10^{-4}}\right) = 20 \log_{10}\left(psi \cdot 3.4475 \times 10^8\right).$$

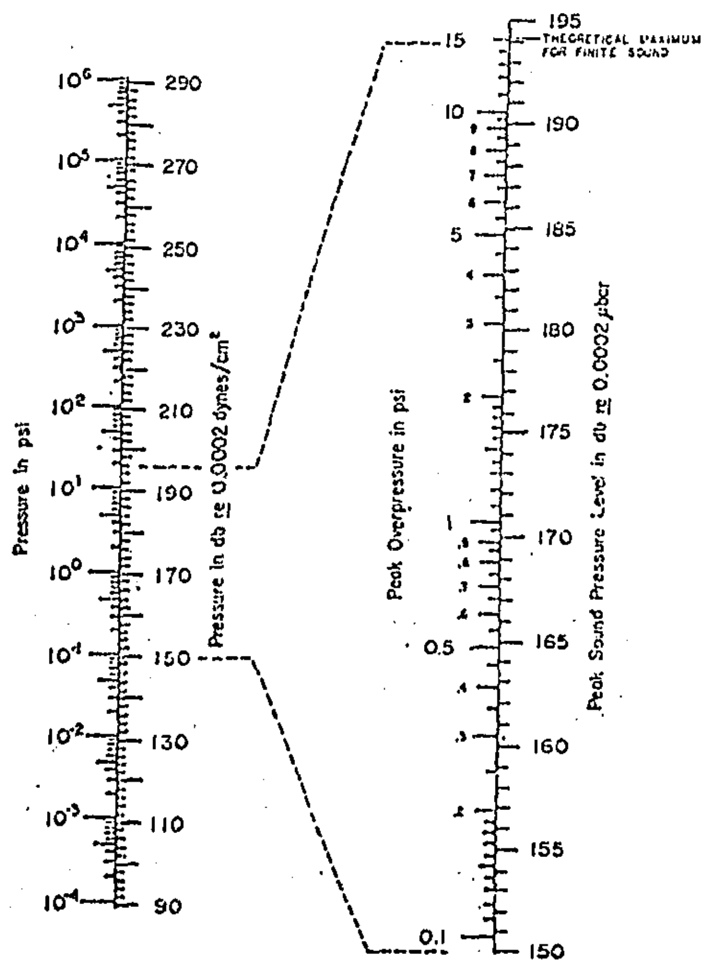

Fig. 2. Conversion of Pounds Per Square Inch to Decibels

VIII. COMMUNICATIONS

1. Where continuous person to person (non-electrically aided) communication of information is a system requirement, the steady state noise levels should not exceed those expressed in Tables 3 or 4.

2. Measurements shall be made in accordance with the requirements of Section VI paragraphs 1, 2a, 2d and 4.

TABLE 3

Maximum Steady State Noise Level for Non-Electrically Aided Person to Person Communication

(Commercial Frequencies ASA Z24.10-1953)

Octave Band Limits (cps)	Center Frequency (cps)	Noise Level (dB)
37.5 - 75	53	79
75 - 150	106	73
150 - 300	212	68
300 - 600	425	64
600 - 1200	850	62
1200 - 2400	1700	60
2400 - 4800	3400	58
4800 - 9600	6800	57

TABLE 4

Maximum Steady State Noise Level for Non-Electrically Aided Person to Person Communications

(Preferred Frequencies-ASA S1.6-1960)

Octave Band Limits (cps)	Center Frequency (cps)	Noise Level (dB)
44 - 87	63	77
87 - 175	125	72
175 - 350	250	67
350 - 700	500	63
700 - 1400	1000	61
1400 - 2800	2000	59
2800 - 5600	4000	58
5600 - 11200	8000	57

IX. NOTE

1. Technical guidance concerning the provisions contained in this standard may be obtained from:

Acoustical Research Branch
Engineering Research Laboratory
U.S. Army Human Engineering Laboratories
Aberdeen Proving Ground, Maryland.

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

NOISE AND CONSERVATION OF HEARING

Headquarters, Department of the Army, Washington, D.C.
25 January 1965

1. Introduction. *a.* It has long been recognized that continuing exposure to loud noises may result in permanent impairment of hearing, which may affect combat efficiency and which is a recognized physical disability under many laws in this country. That this is a disability which can, in many instances, be prevented, has been likewise well established. Surgeons of military organizations and industrial physicians in the employ of the Army should, therefore, be familiar with the effect of noise on hearing and with measures which will prevent loss of hearing from such cause. It is the responsibility of these medical officers not only to be familiar with this subject but to identify noise hazards which may exist in the environment of personnel for whom they have health responsibilities, and to initiate hearing conservation programs when indicated.

b. This bulletin summarizes some important facts relating to noise and its effect on the ear, and outlines the essential features of a preventive program which has as its aim the conservation of hearing. Its purpose is to alert medical officers and other physicians in the Army to this problem, and provide guidance in those circumstances where a problem of potentially hazardous noise exposure exists, either among military or civilian personnel. Although the problem is important among both military and civilian personnel, it has been better recognized in industrial-type installations employing civilians. Hearing conservation programs have been in operation in some of these installations for years. Any orientation of this document toward such installations is not to be construed as emphasizing the importance of the program among civilian employees alone. Such orientation is merely a reflection of experience to date. The principles and methods apply equally well to military organizations.

2. Important Facts Relating to Noise and its Effect on the Ear. *a.* Noise may be defined as any undesired sound. Sound is vibrational energy capable of being heard and normally is transmitted to the ear through air. Under certain conditions, noise may injure the hearing mechanism. Two dimensions of sound have an important bearing on whether any given sound may be hazardous to hearing. These are frequency and intensity. Other factors include the nature of the sound (i.e., impulse or steady, intermittent or continuous); the length of exposure of the ear to the sound; and the relative sensitivity of the ear (*c* below).

b. Hearing loss caused by noise may be temporary or permanent. Permanent hearing loss from exposure to loud noise is generally the result of damage to the end organ of hearing, or organ of Corti,

*This publication supersedes TB MED 251, 11 May 1956.

ear known ... at.

c. The ears of some individuals are more easily injured by noise than are the ears of others. Further, noise usually causes more impairment of hearing for high-pitched tones than for low-pitched tones; and, in the beginning, most of the impairment is above the pitch ranges important to the understanding of speech. Therefore, early damage is not noticed by the individual. Detection of losses in these ranges by the physician is important, for these losses may be regarded as danger signs of potential further hearing losses. Continued exposure will cause progression of damage including involvement of the speech frequencies which, if allowed to reach an advanced stage, will cause severe handicap. Deafness caused by noise can be prevented by reducing to a safe level the intensity of the sounds that actually reach the inner ear.

d. In many instances where injuriously loud noises are associated with an individual's occupation, the intensity of noise cannot be reduced to a safe level by any practical method of "sound treatment" of walls, machines, and the working environment.

e. Wearing cotton in the ears does not generally sufficiently reduce the amount of noise reaching the inner ear. Several kinds of ear protectors are available, which when properly fitted and worn, reduce many injuriously loud sounds to a level safe for the inner ear. The Army Medical Service procures and issues ear plugs which have been demonstrated by tests to be effective.

f. An individual's ability to hear separate tones from the lowest to the highest can be measured accurately with a pure-tone audiometer. The sound pressure level of noise is measured with a sound level meter, and its frequency composition is determined by means of an octave band analyzer.

3. Definitions. a. Loudness is that attribute of an auditory sensation in terms of which sound may be ordered on a scale extending from soft to loud. Loudness depends primarily upon the intensity of the sound stimulus.

b. The decibel (db) is a term borrowed from electrical communication engineering, and represents a relative quantity. When it is used to express noise levels, a reference level is implied. Usually, this reference level is a sound pressure of 0.0002 dyne per sq cm, and can be referred to as "0 decibels." This starting point of the scale of noise levels is about the level of the weakest sound that can be extremely quiet location. ... pressure level in a large office usually is between 60 and 70 decibles.

c. Pitch is that attribute of an auditory sensation in terms of which sounds may be ordered on a scale extending from low to high. Pitch depends primarily upon the frequency of sound stimulus.

d. Tone is an acoustic stimulus whose pressure varies in a perfectly periodic manner. If there is only one component whose pressure varies in a simple sinusoidal manner, it is termed a "pure tone;" if it is analyzable into several such components, it is termed a "complex tone."

e. Noise in the most general sense is defined as any unwanted sound, be it pure tone, a complex of tones, or unwanted speech or music. The term noise is usually applied, however, to sounds that have a complex character acoustically; i.e., containing a large number of separate frequency components that extend over a wide range of frequencies and which are not normally generated to convey meaning or information.

f. Steady noise is noise that does not significantly change in level or spectrum.

g. A spectrum of sound is the pattern of the distribution of energy or sound pressure present at different points or areas along the scale of audible frequencies. It is common practice to measure the spectrum of a single complex sound or noise by means of filters that extend over an area along the frequency scale that is one octave in width; i.e., the band from 150 to 300 c.p.s., 300 to 600 c.p.s., 600 to 1,200 c.p.s., etc. The results of a spectrum analysis made with octave band filters is called the octave band spectrum of that noise.

h. Impulse or impact noise is characterized by a sharp rise in intensity followed by a rapid decline in intensity, such as that produced by gun fire. It can not be measured accurately with an ordinary sound level meter.

i. The audiogram is a record of the individual's hearing sensitivity in each ear for each of a number of pure tone test frequencies. The measure of hearing sensitivity is the individual's threshold of hearing, which is the lowest intensity of a given tone that he hears.

j. The audiometer is the instrument used to obtain an audiogram.

k. The hearing level of an ear at a specified frequency is the amount, in decibels, by which the threshold of audibility for that ear exceeds, or is less than, the standard audiometric threshold.

Essentials of a Hearing Conservation Program. The prevention of hearing loss from exposure to noise involves the coordinated application of engineering control measures, personal protective measures, and medical control measures, supplemented by health education, supervision, and discipline of personnel. Wherever feasible, such a program should be preceded by a noise survey. However, the institution of a hearing conservation program is indicated in the absence of a noise survey whenever persons have difficulty in communicating by speech while they are in the noise area, hear noises or ringing in their ears after working in the noise area for several hours, or have temporary loss of hearing that muffles speech and certain other sounds after several hours of exposure to the noise. In certain borderline cases, however, a noise survey is a prerequisite.

a. The Noise Survey.

(1) *Noise measurement.* An assessment should be made of the location and extent of noise-hazardous areas and personnel exposure. At all locations where noise makes it difficult for two persons with good hearing to converse at close range, tests should be made with a sound level meter, if feasible. The average overall level is determined by several meter readings made at each location. In general, where it is necessary to shout in order to be heard intelligibly at a distance of 1 foot, the noise level is at least and probably well over 90 db. Because steady noises from different sources, which vary in their composition and spectra, are related to the production of hearing loss, it is essential in conducting a survey that the noise be analyzed. This can be done by use of the octave band analyzer with the sound level meter. Noise levels should be measured at the approximate position of the worker's more exposed ear. Repeated measurements should be made to take account of variations in noise levels produced by changes in operating schedules or work procedures. Equally important in assessing noise exposure is the manner in which the noise is distributed in time throughout a typical workday. Whether the noise is continuous or intermittent, steady or impulse, should be determined during the survey since these characteristics have an important bearing on the question of hazard in a given noise situation. Some areas and operations common to many installations which usually are sources of hazardous noise are the interiors of tanks, personnel carriers, and truck cabs; field electrical generator sets; machine shops; carpenter shops; sheet-metal shops; engine repair and testing shops; weapons-firing ranges; any area where air-driven tools are used; aircraft in operation on the ground and in flight; and aircraft engines operated on stands. An inventory should be kept of all hazardous noise areas. A suggested format for recording the data gathered from the noise survey is available from the Commanding Officer, U.S. Army Environmental Hygiene Agency, Edgewood Arsenal, Md. 21040.

(2) *Noise exposure and hearing conservation.* The current knowledge of the relationship of noise exposure to hearing loss does not permit establishing definitive standards demarcating safe and hazardous noise exposure. It is possible, however, to point to certain noise levels that indicate when it is advisable to initiate hearing conservation programs. If the noise analysis reveals levels for the various octave bands in excess of those listed in table I the initiation of a hearing conservation program is indicated:

Table I

Octave band in cps	150-300	300-600	600-1200	1200-2400	2400-4800	4800-9600
Sound pressure level in db	92	85	85	85	85	85

These levels apply to exposure to relatively steady broad-band noises with relatively flat spectra (noises having about equal peak levels in 2 or more octave bands), and do not apply to impulse or narrow-band noises. For pure tones and narrow-band noises the presence of which is indicated by relatively higher (5 db or more) levels in a single octave compared to adjacent bands, the levels at which a hearing conservation program should be initiated are 5 db less than those in table I. In the absence of octave band analysis, hearing conservation measures must be instituted in all areas where the overall noise intensity is 90 db or greater, if damage to the ear is to be prevented.

(3) *Impulse noise.* It appears that repeated exposure to impulse noise exceeding 140 db could result in significant loss of hearing in some individuals. Data obtained on the firing of small arms indicate that exposures to noise levels in excess of 140 db result upon firing any of the common small arms. The wearing of adequate ear protective devices by all personnel so exposed is mandatory if damage to the ear is to be prevented. Exposure of personnel to impulse noise below 140 db may also be hazardous to some very sensitive ears, depending on the extent of such exposure and the intensity of the noise. When such exposures exist, a determination of the need for ear protection should be made by competent persons based on these factors.

b. Engineering Control Measures. The environmental control of noise exposure may involve the solution of complex noise reduction problems. Many such projects should be undertaken only with the help of acoustical engineers or consultants in noise control. The following methods of noise control are mentioned, however, since thay may feasibly be applied to certain situations: reducing the amount of noise produced by the source, reducing the amount of noise transmitted through air or building structures, and revising the operating procedures. Examples of noise source reduction include: substituting new equipment for that now in use, periodically performing repairs to and properly maintaining equipment, and making changes in processing methods. Examples of reducing noise transmission include: increasing the distance between work areas and noise sources, providing acoustical barriers between work areas and noise sources, reducing reverberation by sound-treating work area room surfaces, and installing vibration isolation mounts under equipment. Examples of operating procedure changes include: providing acoustical observation booths, providing sound-isolated remote control positions; changing job schedules, and rotating personnel.

c. Personal Protective Measures for Personnel not on an Electronic Communication Network.

(1) These consist of wearing ear plugs, ear muffs, or both. Whichever device will be worn consistently by the exposed individuals is an important determining factor in their selection. In exposures to extremely high steady-state noise levels (120 db and above), plugs and muffs must be worn together.

(2) Well-designed and properly fitted ear plugs or ear muffs will provide attenuation of noise reaching the inner ear of from 15 db in the lower frequencies to 35 db in the higher frequencies. Wearing ear plugs and ear muffs together, however, does not provide attenuation equal to the sum of that provided by wearing ear plugs or ear muffs separately. The combination of plugs and muffs provides from 35 db to 40 db noise attenuation at most frequencies. Regular use of ear protective devices is mandatory for all individuals exposed to noise in excess of the levels outlined in *a*(2) and (3) above. Little difficulty is experienced by persons with normal hearing in understanding speech when ear plugs or muffs are worn if the voice is raised slightly above the level of ordinary conversation. Actually it is easier for a person to hear and understand auditory signals, such as speech, in a sufficiently noisy environment with ear protection than without it. A simple demonstration may be useful in discussing this problem with other personnel. Put the tip of a finger firmly into each ear canal while conversing in a noisy environment. It will be noted that conversation can be understood more easily.

(3) Properly fitted ear plugs will not cause damage to the normal ear canal if ear plugs are kept reasonably clean. Plugs should be fitted individually for each ear under medical supervision. Occasionally the separate ear canal in the same individual will require plugs of a different size. A good seal between the ear plug and the ear canal is also very important so that no leak develops. Some initial discomfort may be noted with a good seal. If ear muffs are chosen in preference to ear plugs, the headband must be properly adjusted to insure a snug fit. When eyeglasses are worn with ear muffs it is important that the flange of the muff fits well around the temple of the glasses because even a small "leak" will completely

[illegible] ear plugs, tend to work loose as a result of talking and chewing. Therefore, they must be reseated from time to time during the workday. The best ear protector is one that is worn. Personnel must be impressed with the importance of ear protection, because hearing damage becomes worse every day of exposure.

(4) Listed below are the ear plugs available through medical supply channels:

(a) Plug, Ear, Noise Protection, (size), 24s. (V–51–R).

1. FSN 6515–664–7858 Extra small

2. FSN 6515–299–8290 Small

3. FSN 6515–299–8289 Medium

4. FSN 6515–299–8288 Large

5. FSN 6515–664–7859 Extra Large

(b) FSN 6515–082–2675 Plug, Ear, Neois Protection, Regular, Triple Flange, 24s. (Plastic Sterilizable).

(c) FSN 6515–082–2676 Plug, Ear, Noise Protection, Small, Triple Flange, 24s. (Plastic Sterilizable).

(d) FSN 6515–721–9092 Plug, Ear, Noise Protection, Cotton, Impregnated, Disposable, 100s.

(e) FSN 6515–299–8287 Case, Ear plug, 12s. (This case holds one pair of any of the above mentioned ear plugs.)

(5) Listed below are the ear muffs available through regular supply channels:

(a) FSN 4240–861–3612 Aural Protector, Sound, High Performance, Noisefoe Mark II, Mine Safety Appliances Co.

(b) FSN 4240–991–1910 Aural Protector, Sound, High Performance, M258, Willson Co.

(c) FSN 4240–226–6016 Aural Protector, Sound, High Performance, M1200, American Optical Co.

(d) FSN 4240–856–6650 Aural Protector Sound, High Performance, M19A, David Clark Co.

d. Medical Control Measures.

(1) *Preemployment or preassignment hearing evaluation.*

(a) Audiograms should be made a part of the preplacement physical examination. In military units, the duties associated with certain MOS numbers involving exposure to high noise levels and preassignment evaluations should be undertaken for all so designated. Audiometric tests should be made by adequately trained personnel. (A course of instruction in audiometric testing is given at the Army Audiology and Speech Center, Walter Reed Army Medical Center, Washington, D.C. 20012). This baseline or reference audiogram should be made at least 40 hours after the last exposure to high intensity noise. For the purposes of a hearing conservation program, only air conduction tests are required. An audiogram is made by presenting pure tones of variable levels of intensity until each tone is barely heard. This is the threshold for each tone. Only one ear is tested at a time, although both ears are covered by earphones which serve to reduce the effects of room noise. Recommended test frequencies are 250*, 500, 1000, 2000, 3000, 4000, 6000, and 8000* cycles per second. An audiogram may be considered within normal limits if there is no hearing loss in excess of 15 db at any one of the frequencies tested. Audiograms showing loss in excess of 15 db at any one or more of the test frequencies, but no greater than 20 db, are encountered frequently if testing conditions are not proper. These findings may or may not be significant, but such audiograms should be repeated. Losses in excess of 20 db indicate the need for referral to a physician for otological study of the individual. A suggested format (Hearing Conservation Data Card for recording the results of the audiometric examination and other pertinent hearing conservation data is available from the Commanding Officer, U.S. Army Environmental Hygiene Agency, Edgewood Arsenal, Md. 21040.

*Tests at these frequencies are optional and generally will not be conducted unless a specific requirement exists. Additionally, few rooms are sufficiently insulated to conduct valid tests in the 250-cycle frequency.

The accuracy of the [illegible] be checked at least once a week, by tests made on several young persons who have no history of previous ear disease or hearing loss. Such a procedure not only checks the accuracy of the instrument, but also the effectiveness of sound isolation in the test room. The average threshold for these individuals should be within 10 db of the zero of the instrument at each test frequency. Failure to obtain such a result indicates either incorrect audiometer calibration or excessive room noise, or both. It is recommended that the audiometer be calibrated periodically (at least semiannually) by appropriate medical equipment repair facilities.

(2) *Criteria for assignment to hazardous noise duty.*

(a) Assignment to hazardous noise duty shall be made only if the loss of hearing in at least one ear (the better one)—

1. averages in the speech range (500, 1000, and 2000 cps), approximately 20 dbs, or less, or

2. is less than 50 dbs at the 4000 cps frequency.

(b) Even if the better ear is normal, assignment to such "noise exposure" duty shall not be made if the loss of hearing in the other ear (the poorer one)—

1. averages in the speech range (500, 1000, 2000 cps) 30 or more dbs, or

2. is 65 dbs or more at the 4000 cps frequency.

(c) Pathology of the inner ear resulting from noise exposure is considered as a type of acute or chronic ear disease and thus justifies assignment of the H3 profile, as specified in appendix VIII, AR 40-501.

(3) *Periodic hearing evaluation.*

(a) Routine periodic audiograms made on all personnel working in areas having high intensity noise are necessary to detect beginning changes in hearing acuity, since the individual may be unaware of any hearing change. The first periodic audiogram should be made at the beginning of the workday, approximately 60 days after the beginning of the worker's exposure to high noise levels. If any change [illegible] noted at this time, the worker should be removed from the high intensity noise area regardless of the protective measures which have been employed, since this may mean that the individual is highly susceptible to ear damage. If no significant change in hearing acuity is noted, subsequent audiograms should be made approximately every 12 months. Personnel exposed to excessively high noise levels (e.g., gun crews and weapons instructors) should be tested more frequently. These audiograms should be made at least 40 hours after the last exposure to hazardous noise. This time interval will allow for self correction of any temporary hearing threshold shifts.

(b) In all cases of suspected altered hearing acuity, not less than three audiograms should be made under similar conditions on different days, and at the same time of day, before considering the altered hearing acuity as valid.

(c) All personnel should be encouraged to report for evaluation if symptoms of progressive hearing loss or progressive tinnitus develop. This is imperative since timely action may prevent a permanent hearing loss.

(4) *Disposition of personnel with progressive hearing loss.*

(a) If on any of the followup audiograms, a notable progression of hearing loss is discovered (15 db in any one frequency, or 10 db in two or more frequencies, as compared with a preplacement audiogram or most recent annual audiogram), the person should be referred without delay to the local ENT facility so that an organic reason for the progression, such as middle ear infection, may be ruled out. If there is evidence that the loss is noise-induced, the person should be immediately relieved of all duties that may require further exposure to injurious noise levels. The audiogram should then be repeated after an additional 24 hours or more for verification, thus allowing a total of at least 60 hours for reversal of any short-duration temporary threshold shift.

[illegible] need to [illegible] of [illegible] con[illegible] an audiogram, the person should be relieved of his "noise exposure" duty for a minimum of 7 days, and should be retested at that time. If this 7-day test reveals hearing still acceptable for hazardous noise duty ((2) above), the essentials of hearing conservation should be reviewed with the person, and his personal protective devices should be refitted. He may then be returned to duty.

(c) If the test at the end of the 7-day period reveals hearing unacceptable for hazardous noise duty ((2) above), the person should be relieved of all duties that may involve further exposure to injurious noise for a minimum of 30 days. If at the end of this period the hearing has not improved to acceptable levels, the person should be permanently removed from any duty exposing his ears to injurious noise levels. If this 30-day test reveals hearing acceptable for hazardous noise duty, a review of the essentials of hearing conservation should be made with the person, and his personal protective devices should be refitted. He may then be returned to duty.

5. Diagnosis. Hearing loss caused by noise is difficult to differentiate from that resulting from such other factors as systemic disease, toxicity from infection, effect of drugs, and presbycusis. All reasonable methods of differential diagnosis should be used before establishing the diagnosis of hearing loss caused by noise. This includes a careful investigation of the worker's history with special reference to any previous hearing tests, a general physical examination, accurate pure tone bone and air conduction audiometric tests, and complete speech and discrimination tests. Trained personnel under the supervision of a physician or a qualified audiologist may measure hearing. The physician, however, is responsible for determining and evaluating the degree of hearing loss.

6. Health Education, Supervision, and Discipline. This is one of the most important features of a hearing conservation program, especially when reliance is to be placed on the use of personal protective devices. Personnel so exposed should be taught the nature of the hazard from noise, how to their protective equipment. This instruction should be integrated with a continuing program of on-the-job supervision. The supervisory and command personnel should be fully indoctrinated in the general aspects of the preventive program and charged with appropriate responsibilities to assure its success, including disciplinary action if required.

7. The Testing Room. Hearing tests should be made in a room located in as quiet an environment as possible. The room should be readily accessible, preferably away from outside walls, elevators, heating and plumbing noises, waiting rooms, and noisy hallways. The noise levels within the testing room should not exceed those stated in the appendix. Where enough persons require audiometric testing to warrant the expense involved, the acquisition of a prebuilt audiometry booth, or the construction of a special testing room may be justified.

a. Prebuilt Audiometry Booths. Prebuilt audiometric testing booths usually are more satisfactory and may be less expensive than either specially constructed rooms or sound-treated rooms. The following standard audiometric testing booth is available through medical supply channels: FSN 6515-065-9600 Booth, Audiometric examination, Left-hand or Right-hand door, Prefabricated.

b. Special Rooms.

(1) Such rooms should measure at least 8 x 8 feet in plan and have some means of ventilation that does not reduce the efficiency of the sound isolation. This is a difficult problem and the following methods of ventilation are suggested: low velocity baffled air ducts, fans operated by door switches, or air-conditioning units with properly baffled ducts. If the ventilating equipment raises the sound level above acceptable limits, it should be turned off during hearing tests. The painting of acoustical tile can interfere with the sound-absorbing characteristics of the material and is therefore not recommended.

(2) The best results in sound treatment of the testing room are obtained through the services of an acoustical engineer. If these services are not available, the following practical methods of sound isolation are suggested: after a quiet room has been selected, false walls and ceiling of plasterboard, or similar material, should be erected within this space. The inside

floor measurements be not less than 6 x 6 feet in plan.

(3) When the room-within-a-room technique cannot be employed, the inside walls and ceilings of the selected room should be treated with a standard sound-absorbing material, and a soft floor surface installed. The door frames should be fitted with a positive closing [illegible]. If the room contains windows, these should be blocked.

8. Special Assistance. Request for special assistance in conducting noise surveys or establishing hearing conservation programs should be submitted to The Surgeon General, ATTN: MEDPS-PO, Department of the Army, Washington, D.C. 20315.

APPENDIX

SUGGESTED ALLOWABLE BACKGROUND NOISE LEVELS FOR HEARING CONSERVATION AUDIOMETRY ROOMS

The American Standards Association criteria for "Background Noise in Audiometer Rooms" are as follows:

Table II

Audiometric test frequency (cps)	125	250	500	1000	1500	2000	3000	6000
Octave bands (cps)	75 150	150 300	300 600	600 1200	1200 2400	2400 4800	2400 4800	4800 9600
Maximum acceptable level, each octave band, in decibels (dbs) (C scale, re 0.0002 dyne/cm²).	40	40	40	40	42	47	52	62

By Order of the Secretary of the Army:

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AIR FORCE
NOISE PROGRAMS INFORMATION

The Air Force noise programs can be separated into three areas for specific consideration. These are: (1) the Conservation of Hearing Program; (2) research programs into the effects of noise, its characteristics and reduction; and (3) the development and acquisition of sound suppressors for ground runup of jet aircraft engines. Information in the format of the request follows for these three program areas.

Section 1
(Conservation of Hearing)

1. Organizational

a. Department of the Air Force

b. Authority

The Department of the Air Force does not, in general, carry out its programs in consonance with statutory authority, but rather by prescribing regulations. Section 8012, Title 10, U.S. Code, authorizes the Secretary of the Air Force to conduct all affairs of the Department of the Air Force "necessary or appropriate for the training, operations, administration, logistical support and maintenance, welfare, preparedness, and effectiveness of the Air Force, including research and development; and such other activities as may be prescribed by the President or the Secretary of Defense as authorized by law" and "to prescribe regulations to carry out his functions, powers, and duties under this title."

Thus, through Department of Air Force publications, Executive Orders, and implementation of DOD issuances, Air Force programs concerning activities relating to noise effects, abatement and control, are established.

2. Functional (Conservation of Hearing)

a. The overall program objective is to assure no impairment of performance, health, or safety among aerospace ground and flight crews, resulting from acoustical stresses and to provide adequate communications capability, despite acoustical and other environmental conditions peculiar to the missions.

b. Conservation of Hearing

(1) Description. The implementing Air Force Regulation (AFR 160-3, Hazardous Noise Exposure) assigns responsibility for the program and provides guidance for carrying it out, including specific noise exposure limits; special hearing tests for noise-exposed persons; a decision-management procedure based on these tests, to include criteria for final disposition of persons that develop adverse responses to their noise exposures.

(2) Objective. To control the ill effects of noise that can lessen hearing sensitivity and cause other effects harmful to health, efficiency, and well being.

(a) This program, which is designed to detect early hearing loss, is effective.

(b) Because of the Conservation of Hearing Program, personnel with hearing loss are detected early and either removed from noise exposure or protected prior to the occurrence of significant hearing loss. Evaluation of the efficiency of the program is accomplished by comparison with statistical data of other Federal agencies and by comparison of the number of persons removed from duty, involving noise exposure, with the total number of persons in the Air Force program. Comparison with Veterans Administration data reveals that of the total number of personnel receiving compensation for hearing loss, the Air Force comprises the smallest group. For the year for which the latest comparable HEW figures are available, in the 30 to 40-year group, noise-exposed USAF personnel had less noise-induced hearing loss than did a comparable non-occupationally noise-exposed population. Within the USAF, approximately 12,000 audiograms are accomplished each month, with some 150 military and/or civilian personnel being removed from noise exposure for administrative or medical disposition. The cost to the USAF of replacing a trained jet engine mechanic with 6 years experience is approximately $48,000. If, through the Conservation of Hearing Program, an incipient loss can be detected, the loss of a valuable employee, as well as significant money, can be averted. It is to this basic end that the program is directed.

c. Procedures

(1) Evaluation of the environment to determine if excessive sound pressure levels are present is considered to be one of the first steps in the control process for noise pollution. Without proper engineering evaluation of the source, appropriate control methods cannot be devised. Monitoring of the hearing acuity of Air Force personnel potentially exposed to hazardous noise often reveals an unexpected or previously undetected source of excessive noise. Such a disclosure obviously results in control procedures being instituted. The administrative and technician time to perform monitoring audiometry is therefore considered as being indirectly related to the control of noise. Air Force Bioenvironmental Engineers, Preventive Medicine Technicians, and the USAF Environmental Health Laboratories are involved in the evaluation of noise sources.

Research needs are many; however, a few of the salient proposed projects are as follows:

(a) Evaluate the use of A weighted sound levels as an indicator of biomedical significance of noise sources unique to the Air Force.

(b) Determine the correlation of auditory loss patterns with various types of acoustical insults. The identification and definition of patterns of hearing loss, as they relate to acoustic insults, with the intent of predicting characteristics of hearing loss from knowledge of the noise source or vice versa, will result from this study.

(c) Study of high frequency auditory acuity in personnel with mild noise-induced hearing loss. This program is designed to improve the status of differential diagnosis used to identify and substantiate sensory-neural hearing impairment that results from noise and to investigate the feasibility of initiating high frequency audiometry for screening individuals who are entering career fields involving exposure to hazardous noise.

(2) In addition to the actions, described elsewhere in this report, which are designed to control the noise at the source, the Air Force controls noise by reducing the level at the ear canal. Protective devices (ear plugs, muffs, helmets) are issued to personnel routinely exposed to noise.

(3) Noise is classified as an environmental pollutant by AFR 161-22, "Environmental Pollution Control." Standards and criteria are the responsibility of the USAF Surgeon General, who also interfaces with other standards-setting Federal and State agencies. In this regard, the responsibility for interfacing with other agencies rests with the Surgeon General.

(4) In-house capability is extensive. Primary management of the Conservation of Hearing Program rests with the Surgeon General and his national consultants. The USAF school of Aerospace Medicine conducts training and provides technical consultation, as well as being responsible for maintaining the Hearing Conservation Data Repository. All Bioenvironmental Engineers and Preventive Medicine Technicians receive formal training in noise-measuring equipment, theory of sound, and conduct and management of the hearing conservation program. The USAF Environmental Health Laboratories (Kelly and McClellan AFBs) and the USAFE Environmental Health Laboratory in Europe maintain specialized noise-measuring, recording and calibration equipment for use in particularly difficult problem areas. Some of the specialized equipment used in this program includes graphic level recorders, reciprocity calibrators, real time analyzers, sonagraphs, and anechoic and reverberation chambers.

(5) Basic guidance to the working level is being completely revised to include new standards which will not only reflect the latest scientific thinking in regard to industrial type noise, but will also promulgate standards for infra- and ultrasonics. Improved patient disposition guidance and reporting forms will be used.

d. The function and consultation responsibilities of the Hearing Conservation Data Repository will be expanded. The objective of this new and improved effort is to promote a more efficient hearing conservation program in the USAF and thus reduce losses of valuable, trained, and experienced personnel.

3. Fiscal

a. Current Program

(1) Facilities do not exist exclusively for conduct of the Conservation of Hearing Program. The total number of individual pieces of equipment used to monitor the environment

and conduct audiometry and the total investment in hearing protective devices cannot be determined with any degree of accuracy. Cost for various new pieces of equipment and devices has been determined to be for FY 72--$987,500.

(2) Current Operating Budget (FY 72)

(a) In addition to the cost of the items identified as equipment, direct operating costs are $509,300.

(b) Overhead, estimated at 50% of the operating budget, is $254,650.

(3) Personnel

(a) There are 191 Bioenvironmental Engineers; 664 Preventive Medicine Technicians; and 1 Audiologist.

(b) Salary total of $972,339 is based on the percent of time each specialty actually performs in the Conservation of Hearing Program.

(4) Contracts

No contracts are in force specifically for the Conservation of Hearing Program.

b. Past and Future Programs

(1) Past Programs

(a)

	Equipment	Operation
FY 68	959,687	533,777
FY 69	1,653,422	550,023
FY 70	1,201,359	575,300
FY 71	1,032,000	455,700
FY 72	987,500	509,300

(b) No facilities have been acquired for operation of the Conservation of Hearing Program in the past 3 to 5 years.

(2) Future Program Plans

(a) No facilities are programmed.

(b) Personnel levels are expected to remain relatively constant.

4. Regulation and certification of noise sources and control devices are not a function of this program.

Section 2
(Research Programs)

1. Organizational (see Section 1)

2. Functional (Research Programs)

a. Air Force noise research programs are conducted at the Air Force Aero-Propulsion Laboratory (AFAPL), the 6570th Aerospace Medical Research Laboratory (AMRL), and the Air Force Flight Dynamics Laboratory (AFFDL). The Air Force Office of Scientific Research also maintains programs of contracted research.

Air Force Office of Scientific Research: Strategic bombardment, tactical operations, and logistic support are Air Force functions which require the use of high performance flight vehicles. The operation of such vehicles produces intense noise from sources associated with propulsion systems and from noise and pseudonoise sources associated with flight through the atmosphere. This noise causes degradation in human performance, reduced reliability of structural and equipment subsystems, and increased maintenance. Because of a lack of a basic understanding of the physical behavior of high intensity sound, rational noise control and avoidance is difficult. The Air Force Office of Scientific Research maintains basic research programs aimed at achieving a better understanding of aircraft noise generation processes.

Air Force Flight Dynamics Laboratory: The Air Force Flight Dynamics Laboratory is conducting exploratory and advanced development work in aircraft acoustics, including noise control within vehicle interiors and sonic fatigue. The Laboratory has an extensive capability in theoretical acoustics, data management and analysis techniques, and experimental methods. Aircraft acoustics efforts include evaluation and prediction of sound field characteristics encountered by flight vehicles; design, development, operation, calibration, and maintenance of acoustic instrumentation and data analysis systems; and aural detectability studies related to quiet reconnaissance/surveillance aircraft. The Laboratory also maintains a number of in-house facilities for acoustic research.

Air Force 6570th Aerospace Medical Research Laboratory: The Aerospace Medical Research Laboratory conducts considerable research into all aspects of human response to noise with particular emphasis being placed on the study of Air Force generated noise and its effects on Air Force personnel.

Air Force Aero-Propulsion Laboratory: With the advent of larger and more powerful military aircraft propulsion systems, it becomes increasingly apparent that appropriate steps must be taken to alleviate the noise problem. Engine noise levels must be reduced in order to provide a safe working environment for ground and flight crews, to alleviate the problem of acoustically induced structural fatigue, to reduce the possibility of aural detection during combat operations, and to improve the general community environment around military air bases. In order to achieve the apparently diverging goals of low noise and high performance, continuing research efforts to develop a better understanding of the basic mechanisms of noise generation are required. The Aero-Propulsion Laboratory maintains a comprehensive propulsion acoustics research and development program consisting of contracted and in-house efforts. The overall objective is to develop the technology base necessary to significantly reduce aircraft propulsion system noise with minimum associated performance and weight penalties.

b. Specific Programs and Research

(1) Description. (See Appendix A)

(2) Objective. (See Appendix A)

c. Procedures

(1) Noise research needs and problem areas are identified through system development and operation and are handled within the existing organizational structure, namely, the Air Force Systems Command and its associated laboratories.

(2) Specific actions to abate and control noise can be determined from the required research, and in turn, may be the foundation for a specific regulation. A good example of this is Air Force Regulation 55-34, "Reducing Flight Disturbances that Cause Adverse Public Reactions," which regulates Air Force supersonic flight activities to reduce the effects of sonic booms.

(3) The research and development described above is coordinated with the programs of other government agencies through the National Academy of Sciences, the Federal Aircraft Noise Abatement Program, and the Environmental Protection Agency.

(4) The in-house capability for noise research is extensive and therefore no important problems, likely to arise, relating to Air Force operations and concern are outside the capabilities of the existing Air Force research structure.

d. Future Program Proposals and Objectives

There are no future program proposals other than the continuation of present programs; the objectives remain essentially the same.

3. Fiscal (Research Programs)

a. Current Program

(1) There are no major Air Force laboratories devoting their full resources to noise research. Noise research programs utilize something less than 3% of the resources of the laboratories having noise research programs. The real property values of these laboratories and equipment are:

	AFFDL	AMRL	AFAPL
Real Prop (Million $)	22.900	11.387	13.091
Equip (Million $)	18.427	21.806	13.612

(2) Current Operating Budget (FY 72)

(a) Direct operating costs (see Appendix A, page 24).

(b) Overhead is estimated at 50% of the operating budget.

(3) Personnel

(a) Current authorization

	AFFDL	AMRL	AFAPL
Military Ph.D.	10	27	3
Civilian Ph.D.	2	26	5
Military Prof.	82	80	52
Civilian Prof.	338	96	170
Military Non-Prof.	6	46	6
Civilian Non-Prof.	288	70	161
Total	714	292	389

(b) Since it is nearly impossible to estimate the number of man hours spent on noise research alone, a salary total of between $300,000 and $400,000 is given.

(4) Contracts

(a) About 40% of all noise research is performed by firms and institutions on contract to the Air Force.

(b) Funding by project is itemized in Appendix A.

(c) The total for the projects itemized in the appendix is $1,255,000 (FY 72).

b. Past and Future Programs (Research Programs)

(1) Past Programs

(a)

	Funding
FY 68	800,000
FY 69	904,000
FY 70	992,000
FY 71	1,337,000
FY 72	1,255,000

(b) Facilities Acquisition

Dynamic Pressure Chamber (AMRL) $432,168

(2) Future Program Plans

(a) No facilities are programmed.

(b) Personnel levels are expected to remain relatively constant.

4. Regulation and certification of noise sources and control devices are not a function of this program.

Section 3
(Sound Suppressors)

1. Organizational (see Section 1)

2. Functional (Sound Suppressors)

a. The Air Force program for the development and acquisition of sound suppressors has the following objectives:

(1) Protect maintenance personnel performing test and trim operations from sound intensities of over 135 decibels.

(2) Eliminate the hearing damage risk for personnel without ear protection working up to eight hours a day at 250 feet or more from the power check pad or jet engine test stand.

(3) Provide a communication environment inside a frame building, with windows and doors partly open, equivalent to that normally experienced in shop areas with moderately noisy machinery or in hangars used for routine aircraft maintenance when operated at 500 feet from such a building.

(4) Provide sufficient suppression so that essentially no complaints would be expected from a residential community 2500 feet from the power check pad or jet engine test stand while making up to five single engine runs per day of more than five minutes duration between the hours of 0700 and 2200.

(5) Allow continuous around the clock operations one mile from a residential community.

b. The following programs have been initiated to provide demountable and portable noise suppression equipment for use during ground maintenance runup operations of turbine-powered aircraft and engines on test stands.

(1) Thirteen demountable AF32A-13 noise suppressor systems for use with F-111 aircraft are being procured from Industrial Acoustics Company, Inc., under Contract No. F33657-69-C-1302. The total amount of this contract, which was awarded in June 1969, is $2,630,244. The first article installation at McClellan AFB, California, was tested with F-111A and FB-111 aircraft in July-August 1970, and the contractor is proceeding with the fabrication and delivery of the remaining production units.

(2) Koppers Company is proceeding with the manufacture of twenty-two demountable AF32A-14 noise suppressor systems for use with F-4 aircraft. These units are being procured under Contract No. F33657-69-C-1195 which was awarded in June 1969 at a price of $3,121,166. The first article installation was successfully tested at MacDill AFB, Florida, in August 1970.

(3) Contract No. F33657-70-C-1154 was awarded to Koppers Company in June 1970 for the delivery of two AF32T-2 and ten AF32T-3 demountable engine test stand noise suppressor systems at a price of $2,137,470. The T-2 system is for operation with TF30, TF41, J75, J57, and J79 engines, and the smaller T-3 system is for operation with only J57 and J79 engines.

(4) A sole-source contract for $87,325, was awarded to Koppers Company in September 1970 to satisfy an urgent requirement for a demountable AF32A-19 noise suppressor system for use with A-7 aircraft. An IFB has gone out to four firms, having acceptable technical proposals, for the procurement of eleven additional A-19 systems.

(5) Technical proposals have been evaluated and the IFB is about to be released to two firms for the procurement of fifteen demountable AF32A-18 noise suppressor systems for use with T-38 aircraft.

(6) A Request for Technical Proposals was sent out to industry in September 1970 for the procurement of demountable noise suppression equipment to be used at Air National Guard bases. These include three AF32A-16 noise suppressor systems

for use with F-100 aircraft and J57 engines on a portable test stand and four AF32A-15 noise suppressor systems for use with F-101 aircraft and J57 engines on a portable test stand.

(7) Acceptance testing of the demountable AF32A-17 noise suppressor system installed at McGuire AFB, New Jersey, took place in March 1971. This system was manufactured by Industrial Acoustics Company under Contract No. F33657-69-C-0890 and is designed for operation with F-105 aircraft and J75 engines on a portable test stand.

(8) Final testing of the portable A/M32A-77 exhaust muffler and A/M32A-80 intake muffler with a C-141 aircraft is scheduled for McGuire AFB in April 1971, and final testing of the portable A/M32A-78 exhaust muffler and A-80 intake muffler with a C-135B aircraft is scheduled for Tinker AFB in May 1971. These prototype R&D units were designed and manufactured by Industrial Acoustics Company under Contract No. F33657-68-C-0047.

(9) Future efforts during the coming fiscal year include the provision of additional demountable noise suppression equipment for use with the F-105 aircraft and new demountable equipment for use with the F-15 aircraft.

c. Procedures (This question is addressed in the previous sections.)

d. This continuing program evaluates new methods for sound suppression leading to further development and ultimately to the acquisition of new sound suppressors.

3. Fiscal

a. Current Program

(1) Real property value of sound suppressors and site preparation listed by fiscal year since 1967.

FY 67	$ 167,000
FY 68	$ 630,000
FY 69	$ 3,026,500
FY 70	$ 6,295,000
FY 71	$ 9,924,000
FY 72	$ 7,060,000
Total	$27,102,500

(2) Current Operating Budget (FY 72)

(a) Direct operating cost (see funding by project).

(b) Overhead and maintenance funding is $67,138.

(3) Personnel

Salary total for the sound suppressor program is $135,492.

(4) Contracts

(a) Acquisition of sound suppressors is entirely by contract.

(b) Funding by project. Sound suppressor acquisition by contract (FY 72), $4,810,000.

b. Past and Future Programs

(1) Past Programs - (FY 67-72) $27,102,500.

(2) Future Program Plans

(a) Projected facilities costs

FY 73 $6,290,000

(b) Personnel levels are expected to remain relatively constant.

4. Regulation and certification of noise sources and control devices are not a function of this program.

1 Attachment
Appendix A

SUMMARY

1. Air Force Office of Scientific Research

Program Element: 61102F

Project/Task/Work Unit	Description
9781/02	Dynamics of Flow Fields
9781/02/001	Aerodynamically Generated Sound
9781/02/002	High Intensity Sound
9781/02/003	Noise Generation by a Transonic Compressor Row

2. Air Force Flight Dynamics Laboratory

Program Element: 62201F

Project/Task/Work Unit	Description
1471/02	Prediction and Control of Aircraft Noise
1471/02/003	Helicopter Acoustic and Vibration Surveys
1471/02/009	Noise from Deflected Jet VTOL Aircraft
1471/02/010	Noise Prediction from VTOL Aircraft
1471/02/011	Noise from Linear Array of Large Turbojet Engines
1471/02/012	Aircraft Design for Minimum Noise
1471/02/013	Radiated Noise from Sailplanes
1471/02/014	Low Speed Aerodynamic Noise Generation
1471/02/015	Aural Detectability of Light Reconnaissance A/C
1471/02/019	Acoustic Tests of Noise Suppression Panels

3. Air Force 6570th Aerospace Medical Research Laboratory

Program Element: 62202F

Project/Task/Work Unit	Description
7231	Biomechanics of Air Force Operations
7231/03	Effects of Operational Noise on AF Personnel
7231/03/015	Control of Human Exposure to Acoustic Energy
7231/03/016	Auditory Responses to Acoustic Energy
7231/03/017	Whole Body Effects of Air Force Noise on People
7231/03/018	Effects of Acoustic Stimulation of the Vestibular System
7231/03/019	Voice Communication During AF In-Flight and Ground Operations
7231/03/020	Simultaneous Exposure to Acoustic Energy and Other Stressors
7231/03/021	Human Orientation During Intense Noise Exposure

Project/Task/Work Unit	Description
7231/03/022	Effects on the Vestibular System of Acoustic Energy
7231/03/023	Effects of Air Force Noises
7231/03/024	Cell Changes Associated with Temporary Hearing Loss
7231/04	Measurement of Noise and Vibration Environments
7231/04/011	Dynamic Pressure Chamber
7231/04/017	Mechanisms of Noise Generation, Propagation, and Reception
7231/04/018	Bioacoustic Environments of USAF Aerospace Systems
7231/04/020	Vibration Environments
7231/04/023	Data Acquisition System for Noise Measurement

4. Air Force Aero Propulsion Laboratory

Program Element: 62203F

Project/Task/Work Unit	Description
3066/12	Propeller Technology
3066/12/001	Study of Propeller Vortex Noise
3066/12/002	Propeller Acoustics Test Facility
3066/12/005	Performance and Acoustic Testing of a Variable Camber Propeller
3066/12/006	Quiet Propeller Design Procedure
3066/12/007	Propeller Acoustics Research
3066/12/008	Quiet Propeller Concept Evaluation
3066/14	Propulsion Acoustics
3066/14/001	Small Turbine Engine Noise Reduction
3066/14/002	Supersonic Jet Exhaust Noise - Program 1
3066/14/003	Supersonic Jet Exhaust Noise - Program 2
3066/14/004	Supersonic Jet Exhaust Noise - Program 3
3066/14/005	Jet Noise Reduction for Military R/S Aircraft

5. Air Force Weapons Laboratory

Program Element: 63723F

Project/Task/Work Unit	Description
683M	Computer Noise Exposure Forecasting

1. Air Force Office of Scientific Research

Program Element: 61102F

Project: 9781
Task: 02
Title: Dynamics of Flow Fields

Strategic bombardment, tactical operations, and logistic support are AF functions which require the use of high performance flight vehicles. The operation of such vehicles produces intense noise from sources associated with propulsion systems and from noise and pseudonoise sources associated with flight through the atmosphere. This noise causes degradation in human performance, reduced reliability of structural and equipment subsystems, and increased maintenance. Because of a lack of a basic understanding of the physical behavior of high intensity sound, rational noise control and avoidance is difficult. The Air Force Office of Scientific Research maintains basic research programs aimed at achieving a better understanding of aircraft noise generation processes.

Project: 9781
Task: 02
Work Unit: 001
Organization Performing R&D: University of Toronto, Toronto, Canada
Title: Aerodynamically Generated Sound

This research is directed toward developing a comprehensive physical model of jet noise which covers generation, convection, refraction, and spectrum properties. Research is being conducted in the areas of aerodynamically generated sound and subsonic aerodynamics. In the area of sound the following projects are being conducted:

a. correlation of sound with hot wire measurements in a jet. A direct correlation between the turbulence (the cause) and the sound (the effect) is being attempted.

b. shielding flap scheme of jet noise suppression. The effectiveness of a wing as a shield for jet noise is being examined experimentally.

c. wind noise in vehicles. An experiment is being conducted to determine the relation between the jet flow over a cavity and the noise generated by the flow,

d. model of Mach wave noise emanating from the lip of a supersonic jet. A mathematical analysis is being made to delineate the mechanisms of noise generation of a rocket nozzle, and

e. extended near-field concept for sonic boom alleviation. The possibility of delaying the transition of the near field signature to the far field pressure signature is being examined. In the area of subsonic aerodynamics the lift distribution and moment of a wing cutting obliquely through a simulated trailing-vortex of another airplane is being determined.

Project: 9781
Task: 02
Work Unit: 002
Organization Performing R&D: University of Texas, Austin, Texas
Title: High Intensity Sound

This research is concerned with investigating the behavior of high-intensity sound and applying the understanding gained to problems of interest to technology such as sonic boom, propagation of intense noise from jet engine compressors, underwater propagation, etc. This is a theoretical and experimental efforton high-intensity sound and its interaction with a real media. The purpose of the work is to study the phenomena that distinguish nonlinear acoustics from linear acoustics and to apply the knowledge gained to physical problems. Specific topics being studied are:

a. stability of the acoustic boundary layer. The object is to predict the threshold at which a transition from laminar to turbulent flow takes place. The frequency dependence of this threshold is of particular interest.

b. standing waves of finite amplitude. Chester's theoretical predictions are being checked by experiments.

c. quasi-plane-wave mode for finite-amplitude waves in a tube. Experimental tests are being conducted to check past theoretical solutions.

d. finite-amplitude waves in relaxing media.

e. electrical transmission-line analogs of acoustical propagation problems, such as progressive waves in relaxing media, randomly in homogeneous, turbulent media, or nonlinear media.

Project: 9781
Task: 02
Work Unit: 003
Organization Performing R&D: Cornell Aeronuatical Laboratory Inc.
Buffalo, New York

Title: Noise Generation by a Transonic Compressor Row

The Air Force is presently and will continue to be in the foreseeable future a large user of high subsonic jet aircraft. The principal means of propulsion of such aircraft is the high bypass-ratio turbofan engine. An undesirable byproduct of these engines is the generation of noise which causes such adverse effects as degradation in human performance, reduced reliability of structural and equipment subsystems, and increased maintenance cost. The design of vehicle parts and soundproofing which alleviate these effects requires accurate definition of the intensity and occurrence of the noise. In order to partially fulfill this requirement a theoretical study of the problem of fan-noise generation in a high bypass-ratio turbofan engine is being made. The main emphasis in this study is the noise aspects of the three-dimensional, transonic flow through a single blade row. A linear acoustic theory for the case of non-lifting blades is being applied to the problem of noise generation. An effort is being made to extend the theory to lifting blades and to examine the effect of more realistic duct geometries.

2. Air Force Flight Dynamics Laboratory

Program Element: 62201F

Project: 1471
Task: 02
Title: Prediction and Control of Aircraft Noise

The Air Force Flight Dynamics Laboratory is conducting exploratory and advanced development work in aircraft acoustics, including noise control within vehicle interiors and sonic fatigue. The Laboratory has an extensive capability in theoretical acoustics, data management and analysis techniques, and experimental methods. Aircraft acoustics efforts include evaluation and prediction of sound field characteristics encountered by flight vehicles; design, development, operation, calibration, and maintenance of acoustic instrumentation and data analysis systems; and aural detectability studies related to quiet reconnaissance/surveillance aircraft. The Laboratory also maintains a number of in-house facilities for acoustic research.

Large Sonic Fatigue Facility

The test chamber of this facility has average physical dimensions of 42 x 56 x 70 feet and can be operated in either reverberant mode or progressive wave mode. Full scale specimens can be tested in sound fields up to 162 decibels (re. .0002 dynes/cm^2). Smaller specimens or reduced surface areas can be exposed to sound pressure levels up to 174 decibels. The facility includes a complete data acquisition and analysis capability.

Wide Band Noise Facility

This facility is powered by a 12 kilowatt wide band siren, capable of producing a continuous spectrum over a frequency range of 50 Hz to 12,000 Hz, approximating the noise field of a jet or rocket engine. A maximum overall sound pressure level of 160 decibels can be attained at the siren horn mouth.

Mobile Dynamics Data Acquisition and Analysis Facility

This mobile facility permits accurate and detailed measurements of complex environmental noise fields. The facility is particularly useful for field data acquisition on flight lines, test stands, and in remote areas such as rocket motor test sites. The mobile facility can simultaneously acquire five continuous channels of FM-FM telemetry data and thirty-nine continuous channels of wide band FM data via landlines. Thirty-six 1500 feet long landlines are contained on power-driven cable reels.

Project: 1471
Task: 02
Work Unit: 003
Organization Performing R&D: AFFDL/Army
Title: Helicopter Acoustic and Vibration Surveys

The objective of this effort is to determine flight and gunfire induced environments of helicopters for (a) developing and verifying vibration and acoustic prediction methods applicable to rotor powered aircraft, (b) establishing realistic test methodologies for avionics and electronic equipment for VTOL aircraft, (c) developing methods of structural vibration damping, and (d) obtaining human environmental data. Measurements have been taken with microphones installed on top of the fuselage to measure the downwash acoustic environment directly under the rotor, on the pilot's and co-pilot's helmets, and in passenger and equipment compartments. Data were obtained on sound pressure levels and frequency spectra at these microphone locations during various flight conditions, gunfire, rocket and grenade launch. Analog data were recorded on tape to permit acoustic and vibration transmission and correlation studies.

Project: 1471
Task: 02
Work Unit: 009
Organization Performing R&D: AFFDL (In-house)
Title: Noise from Deflected Jet VTOL Aircraft

The noise environment in the field on a P-1127 aircraft has been measured with the aircraft fixed on a vertical thrust stand. The data have been analyzed and used to develop a method to predict the acoustic environment as a function of engine parameters. These results are being prepared for publication.

Project: 1471
Task: 02
Work Unit: 010
Organization Performing R&D: Wyle Laboratories, El Segundo, California
Title: Noise Prediction from VTOL Aircraft

The objective of this effort is to develop methods to predict the near-field noise environment associated with VTOL aircraft. The contractor has developed a method of predicting the near-field noise of propellers. A preliminary analysis of undeflected jets has been completed. The analysis correlates normalized near-field octave band levels in terms of a Strouhal frequency with a normalized distance parameter based on jet diameter and axial position relative to the length of the potential core. Future emphasis will be placed on near-field prediction methods for rotors, fans and compressors. The effects of solid boundaries will be accounted for in the prediction methods.

Project: 1471
Task: 02
Work Unit: 011
Organization Performing R&D: AFFDL (In-house)
Title: Noise from Linear Array of Large Turbojet Engines

The purpose of this program is to determine the interaction effects of multiple turbojet exhaust noise sources in determining the near-field acoustic environment. Data were obtained in the form of sound pressure levels and frequency spectra at various microphone locations. Analog data were recorded on tape for later analysis.

Project: 1471
Task: 02
Work Unit: 012
Organization Performing R&D: Bolt, Beranek, and Newman Inc., Cambridge, Massachusetts
Title: Aircraft Design for Minimum Noise

The objective of this effort is to conduct a comprehensive investigation of aircraft and propulsion design relative to minimum noise generation and to establish the methodology and design information required to design an aircraft from the standpoint of minimum aural detection.

Project: 1471
Task: 02
Work Unit: 013
Organization Performing R&D: AFFDL (In-house)
Title: Radiated Noise from Sailplanes

The objective of this effort is to identify the noise associated with a powerless aircraft and to relate this noise to area and velocity parameters of the aircraft. The flyby noise from three sailplanes, Schweizer 2-32, Schweizer 2-33, and Libelle, has been recorded on tape and one-third octave and overall bandwidth analyses obtained. The noise levels from each of the sailplanes follows a sixth power of the velocity and appear to be directly proportional to the turbulent area on the wing. A test report has been prepared which presents the results obtained to date.

Project: 1471
Task: 02
Work Unit: 014
Organization Performing R&D: University of Tennessee Space Institute
Tullahoma, Tennessee
Title: Low Speed Aerodynamic Noise Generation

The objective of the effort is to conduct an investigation of the noise associated with flight and to determine methods of suppressing the noise radiated from these sources. Presently available analytical expressions describing the noise produced by the aircraft in flight will be evaluated. Modes of quiet flight found in nature will be studied and their mechanisms analyzed. Those techniques which appear most promising will be further investigated by suitable experimental means from the results of the above studies. Recommended techniques will be developed for application to the design of aircraft from the viewpoint of aural detection.

Project: 1471
Task: 02
Work Unit: 015
Organization Performing R&D: Bolt, Beranek, and Newman Inc.
Cambridge, Massachusetts
Title: Aural Detectability of Light Reconnaissance A/C

The objective of this effort is to develop aural detection criteria for evaluating the detectability of light reconnaissance/surveillance type aircraft. Factors affecting the aural detection of light aircraft will be defined and series of psychoacoustic experiments on the detectability of synthesized aircraft noise signatures in the presence of various background noise environments will be conducted and from the results of these experiments aural detection criteria will be developed. These criteria will then be applied to recorded data from light aircraft fly-over in a second series of psychoacoustic experiments and will confirm or suggest refinements to the aural detection criteria.

Project: 1471
Task: 02
Work Unit: 019
Organization Performing R&D: Aeronca Inc., Middletown, Ohio
Title: Acoustic Tests of Noise Suppression Panels

This effort was initiated to compare the acoustic performance of various brazed broadband resonators and thereby provide design guidelines for full-scale engine hardware. The resonators are to be used as absorptive linings in engine ducts to attenuate the fan and compressor noise. The acoustic performance, noise reduction and insertion loss, were measured in a duct facility for frequencies from 500 to about 8000 Hz and for SPL's up to 160 dB. The broadband resonators consisted of honeycomb panels fabricated from various combinations of core height, cell size, and facing material. The facing material consisted of perforated sheet and fiber metal construction.

3. Air Force 6570th Aerospace Medical Research Laboratory

Program Element: 62202F

Project: 7231
Task: 03
Title: Effects of Operational Noise on Air Force Personnel

Noises experienced by Air Force personnel are the most severe in existence, creating potential problems for hearing, voice communication, performance and other body functions which threaten mission accomplishment. Noises from sources such as large rocket boosters, aircraft engines and ground support equipment continue to increase in number and intensity. The primary objective is to control acoustic exposures of Air Force personnel and neighbors within safe and acceptable limits through research directed to definition of hazardous noise, determination of effects on body function and on performance, establish principles and devices to counteract adverse effects and specify exposure limits in the form of tolerance criteria to control overexposure. Major emphasis is on in-house research with minimal supplemental efforts by contract. Coordination occurs with the Army, Navy, NASA, FAA and DOT.

Project: 7231
Task: 03
Work Unit: 015
Organization Performing R&D: AMRL (In-House)
Title: Control of Human Exposure to Acoustic Energy

The objective of this program is to investigate all avenues of potential value for controlling personnel exposures in the wide variety of usual and unusual acoustic environs of Air Force operations, and to control, within acceptable limits, the intrusion of noise into residential areas neighboring on Air Force activities. The continuous growth of Air Force noise problems, currently reflected in higher levels of intensity and more frequent exposures, significantly increases exposures of persons on or near Air Force activities to possible adverse effects of the acoustic energy. This effort is to provide the principles, devices and procedures necessary to control, within safe and acceptable limits, human exposures to the many types of noise encountered in Air Force activities. Personal sound protective devices including earmuffs, helmets, pressure and noise suits are evaluated and developed. Criteria and exposure guidelines for defining risk associated with various noise exposures will be established. Procedures for estimating reactions of individuals and communities to noise exposure will be developed. The comparative individual annoyance of particular sounds that appear to be either approaching or moving away from the observer has been evaluated in three successive phases of an overall study of acceptability. Investigations have been completed on effectiveness of new personal sound protectors; the effect of wearing eyeglasses on earmuff attenuation, attenuation effectiveness of flight helmets for VSTOL aircraft and the acoustic features of the special purpose Paramedic Helmet. Attenuation provided by a whole body sound protection suit is being investigated. Work on a negative-pressure earplug has jet been initiated.

Project: 7231
Task: 03
Work Unit: 016
Organization Performing R&D: AMRL (In-house)
Title: Auditory Responses to Acoustic Energy

The objectives of this program are to examine various characteristics of human hearing such as resistance to noise, temporary hearing loss, recovery from hearing loss, relative effects of frequency, intensity, duration and intermittency of hearing loss, high frequency hearing (above 8000 Hz), and long term low level effects in order to establish general principles of behavior of the human ear in noise and to determine the potential hazard of specific Air Force problem noise environs and provide means for minimizing or eliminating these effects. One of the most prevalent and serious effects of noise in Air Force operations is overexposure of the human auditory system, resulting in impairment of hearing. Effective preventive and control measures must be based upon the definition and understanding of the functioning of the human auditory system in the presence of noise. This work is related to the infrasound program and assessment of damage risk criteria for infrasound. Bone conduction hearing, noise induced hearing loss, drum membrance retraction, and electrostatic hearing are specific auditory effects studied. Effects of acoustic signals below 20 Hz at sound pressure levels of 120-140 db on auditory acruity and tympanic membrane retraction are measured. A study of the response of the auditory system to internal infrasound was recently initiated.

Project: 7231
Task: 03
Work Unit: 017
Organization Performing R&D: AMRL (In-house)
Title: Whole-Body Effects of Air Force Noise on People

A wide range of intense Air Force noise environments not only effect hearing but may interfere with motor performance, physiological functioning, thought processes and contribute to fatigue in personnel. This effort investigates types of noises and exposure conditions in which accomplishment of the Air Force mission may be threatened because of these adverse whole-body effects. Results are used to formulate exposure limitations and establish specifications for use by Air Force activities responsible for assuring that personal noise exposures are non-hazardous. The approach is to measure effects of the many kinds of noises (infrasound, audio frequencies, impulses) on a battery of standard performance tasks; on circulation in the peripheral members (fingers) and other physiological processes and on mental tasks such as memory. Findings are used to establish exposure limits beyond which undesirable effects may occur. Much of this work is possible only because of the unique laboratory sound generators available at AMRL. Infrared thermography is being used as an indirect indicator of peripheral circulation changes induced by whole body noise exposure. Pre-test arrangements have been completed and data collection from human subjects will begin in the immediate future. Ongoing efforts continue to measure performance on a wide variety of tasks and on short term memory. A study of the effect of whole body exposure vs auditory exposure to the same noise field has been initiated.

Project: 7231
Task: 03
Work Unit: 018
Organization Performing R&D: AMRL (In-house)
Title: Effects of Acoustic Stimulation on the Vestibular System

Subjective complaints of nausea and disorientation from individuals exposed to intense noise and to motion in Air Force environments continue to be reported and to interfere with mission accomplishment. This effort investigates sensitivity thresholds and tolerance to noise and motion of Air Force operations and their effect on vestibular function as related to control of disorientation and other performance decrements.

Various measures of vestibular functioning including equilibrium, perception of the vertical, counterrolling of the eyes, caloric nystagmus and nystagmus produced by electrical stimulation are examined during exposure to various types of acoustic energy consisting of discrete frequencies, broadband jet noise, infrasound, and pressure. Research involves responses of both humans and laboratory animals to vestibular excitation.

Data on effects of broadband jet noise and pure tone on human equilibrium have been reported in two technical reports (AMRL TR 66-85; AMRL TR 68-7) and two manuscripts to be published. Three experiments have been completed in which no consistent alteration in the perception of the vertical was observed as a result of broadband jet noise or pure tone exposure. Electrical stimulation of the vestibular system was found to have little influence on the perception of periodic linear acceleration. Mathematical modeling of otolith-semicircular canal interactions and of adaptation to sustained angular acceleration is proceeding for refinement and updating of the electro-mechanical model of the human vestibular system.

Project: 7231
Task: 03
Work Unit: 019
Organization Performing R&D: AMRL (In-house)
Title: Voice Communication During Air Force In-Flight and Ground Operations

Noise continues to be a major factor limiting or interfering with voice communications in the Air Force, creating serious command and control problems and safety hazards during routine as well as emergency operations. Other elements such as vibration, windblast and reduced pressure may also reduce speaker and listener performance. These studies evaluate voice communication to identify interfering factors, to determine biological limitations and to consider conventional as well as unique approaches to specific operational problems. Results will be applied to design of future military communications systems for use in high noise environments.

Adverse Air Force noise environs are simulated in the laboratory to define the nature of specific interference effects, and to provide recommendations and solutions which will minimize and eliminate the problems.

Findings are applied directly to requests for consultation from the field and are incorporated into Mil Specs for communications systems, operating procedures and voice communication criteria.

Plans are underway for a program to evaluate the relative performance of lightweight communication systems in the noises of T-39, C-130, C-135, C-141, etc., cargo aircraft at the request of the Life Support SPO. A portable 12 station, high quality listening system for use in voice communication research has been completed and a performance evaluation will be accomplished soon. A Helium Speech Processor, which was developed recently will be evaluated in-house. A technical article on speech in artificial atmospheres appeared in J. Aerospace Med., February 1969.

Project: 7231
Task: 03
Work Unit: 020
Organization Performing R&D: AMRL (In-house)
Title: Simultaneous Exposure to Acoustic Energy and Other Stressors

Acoustic exposure in the Air Force rarely occurs in the absence of other stresses; consequently, resulting behavior is due to the combined effects of noise and other stressful stimuli. The most efficient formulation of personnel protective measures requires that the contributions of the individual stimuli and their interactions be defined. This effort investigates physiological and psychological responses of humans exposed to acoustic energy occurring in combination with other stressful stimuli in order to provide measures for minimizing adverse effects of simultaneous exposure to multiple stresses in Air Force activities.

Temporary threshold shift (TTS) due to controlled acoustic exposures is predictable and the mechanisms involved in the response are well understood. This approach will cimbine controlled acoustic exposures with mechanical whole body vibration of observers to determine among other things, if TTS under the multiple stress is different from that resulting from the single acoustic stress.

An initial investigation of the effects of exposure to combined noise and vibration stimuli on temporary threshold shift has been completed. Although results were not statistically significant, a very consistent trend in the average data indicates that TTS under the combined stress conditions was slightly but consistently greater than from the acoustic stimulation only. This investigation continues with minor alterations in the experimental design and in the parameters to be observed.

Project: 7231
Task: 03
Work Unit: 021
Organization Performing R&D: Space Sciences Incorporated, Waltham, Mass.
Title: Human Orientation During Intense Noise Exposure

Equilibrium and orientation may be disturbed for AF personnel during inflight operations and intense noise exposure. Present preventive measures are only partially adequate because of a limited understanding of the complex system which maintains balance. This research provides an analytical study of the mechanism of equilibrium and will provide a mathematical model for other systems involved, such as vision. The technical objective is to provide a basis for a working model of the sensors of balance and motion to better understand how human equilibrium is disturbed by motion and noise encountered in the Air Force.

Under the present effort, the contribution of other biological systems (such as vision) to equilibrium and orientation is being defined to determine if they should be included in the electromechanical model. Those systems which improve the operation of the model and are significant to military operations will be included. The model will be used to define man's response to equilibrium and orientation problems and provide means for minimizing and eliminating such problems in Air Force applications.

Project: 7231
Task: 03
Work Unit: 022
Organization Performing R&D: Miami University, Oxford, Ohio 45056
Title: Effects on the Vestibular System of Acoustic Energy

This research on the effects of acoustical energy on vestibular functioning provides information important for understanding the conditions, and manner in which high intensity noise affects equilibrium and produces disorientation in Air Force crewmembers.

The research consists of two phases. In Phase I, observations are made on guinea pigs, rabbits, and monkeys. Acoustical effects on vestibular functioning are observed by recording head movements, postural adjustments, and eye movements. Phase II consists of an attempt to correlate vestibular responses obtained in Phase I to movement of the stapes, pressure changes in the perilymph and endolymph. Examination of the thermal changes induced by acoustical energy is investigated during this phase.

It has been demonstrated that the vestibular system can be stimulated by static pressures; the process by which this stimulation occurs has been postulated. The vestibular system pathology observed and responses elicited confirm suspected effects of acoustic energy on the system.

Project: 7231
Task: 03
Work Unit: 022
Organization Performing R&D: Battelle Memorial Institute, Columbus, Ohio
Title: Effects of Air Force Noises

Aviation noise environments generate well defined psychological responses and little defined physiological responses of people. The objective is to investigate in the laboratory the acceptability of specific approaching vs receding aircraft noises, and accompanying physiological responses that may occur. Approaching noises are much less acceptable than non-approaching sounds, yet this difference has not been quantified. This effort will quantify the psychological judgments of acceptability and identify the presence or absence of simultaneous physiological changes. Results will be utilized in the revision and updating of land use planning documents.

The approach is to measure physiological responses (heart rate, pulse, EKG, etc.) and subjective responses to noises that appear either to be approaching or not approaching observer. Exposures and responses will be documented and utilized relative to problem acoustical environments and to noise exposure and tolerance criteria for preventive and protective action.

Two studies have just been completed and data are being analyzed. One study involved the psychological aspects of subjective judgments of relative noises. The second study subject was the physiological responses to relative noises. The follow-on Phase to independently quantify any differences and determine significance will be undertaken upon completion of current data analysis.

Project: 7231
Task: 03
Work Unit: 024
Organization Performing R&D: Ohio State University Research Foundation
Columbus, Ohio
Title: Cell Changes Associated with Temporary Hearing Loss

This effort is to investigate the cause of damage to the inner ear occurring when Air Force personnel are exposed for long periods to high noise levels. It is known that at certain exposure levels there is damage to inner ear cells accompanied by permanent hearing loss; at lesser levels impairment of hearing is temporary. However, there is some evidence that continued exposure to these lesser levels may result in permanent damage. This research investigates the possibility that the inner ear cells are temporarily impaired in function because normal chemical reactions within the cells are disturbed, but this disturbance is not sufficient to destroy the cell unless prolonged. If this is the mechanism then specific drug treatment may be developed on a rational basis.

The normal distribution of oxidative enzymes in the inner ear of animals with normal hearing is determined by electron microscopy. Animals are trained to establish individual hearing thresholds and then exposed to 90 db of sound for up to 48 hours and their Temporary Threshold Shift (TTS) measured. Electron microscopy examinations are made at various time intervals following exposure. In this way the biochemical changes in the inner ear can be correlated with changes in the animal's performance.

Equipment and procedures have been completed for training chinchillas as experimental animals. A small group of animals are being trained. The technique of tissue preparation for demonstrating the chemical reactions using electron microscopy has been completed and normal tissues are in preparation. Results are expected to guide future human research on setting hearing conservation criteria for continuous exposures (more than 8 hours per day) of Air Force personnel to noise.

Project: 7231
Task: 04
Title: Measurement of Noise and Vibration Environments

Air Force weapon systems and equipment produce high noise levels in areas where man must function (e.g., flight crews, maintenance crews, workers in offices adjacent to flightline, residents in surrounding communities). These high noise levels frequently cause serious bioacoustic problems such as hearing loss, interference with speech, work, or sleep, and general annoyance. The magnitude and character of the offensive noise environments must be known to evaluate and resolve such problems. Primary objective of this task is to define these bioacoustic environments by measurements whenever practical or by estimating using analytical means which must be developed. Secondary objective is to simulate these environments in the lab in support of research under Task 7231/03. Electrical, pneumatic and hydraulic systems are developed and used to generate the different types of noise fields required. Some Air Force systems also produce high vibration levels at crew stations which can be hazardous or interfere with performance. Third objective of the task is to define the vibration at crew stations of Air Force aircraft flying low-altitude, high-speed (LAHS) profiles and to analyze and interpret data on clear air turbulence and runway induced vibration in support of Task 7231/01. Coordination occurs with many organizations in AFSC, SAC, TAC, Hq USAF, MAC, ATC, AFLC, NASA, FAA, American National Standards Institute, aerospace industry and the scientific community.

Project: 7231
Task: 04
Work Unit: 011
Organization Performing R&D: Textron Electronics Inc, MB Electronics Division, New Haven, Connecticut
Title: Dynamic Pressure Chamber

The objective of this program is to develop and install a Dynamic Pressure Chamber for accommodating one human subject. The chamber will serve two basic purposes: (1) the simulation of the very intense infrasonic noise from rocket boosters and large jet engines for determinations of human safety, tolerance and performance in such noise fields; and (2) the measurement of basic biodynamic characteristics of the body in its response to airborne vibration, blast, and decompression.

Project: 7231
Task: 04
Work Unit: 017
Organization Performing R&D: AMRL (In-House)
Title: Mechanisms of Noise Generation, Propagation, and Reception

Many USAF operations (e.g., aircraft on the ground and inflight, engine test stands, escape systems, auxiliary equipment) produce high noise levels in areas where man must function. These levels frequently cause serious problems concerning communication, hearing loss, annoyance and performance. This work unit provides: (1) basic knowledge and engineering methods necessary to calculate these environments; and (2) quantitative information on the physical mechanics involved in the generation of speech and man's response to acoustic energy (in support of task 7231 03).

The approach employed is to conduct theoretical and experimental studies on: (1) the basic mechanisms by which acoustic energy is generated, (2) the means by which this energy is propagated, and (3) the physical response to such energy. Statistical analyses of experimental data are performed, and theoretical models are developed to arrive at generalized relationships between noise source characteristics and the aerodynamic, mechanical or thermodynamic characteristics of the source using such techniques as dynamic-similarity models or electromechanical-acoustical analogs.

Primary emphasis to date has been placed on a series of studies to measure and understand the effects of the ground plane on the noise produced at varying distances from a noise source such as an aircraft during groud runup. This effort has included a substantial literature search, several model and full scale experiments and the development of a new procedure for calculating these effects. These results are very valuable for making accurate estimates of noise fields and are being used in engineering procedures for extrapolating noise data (e.g., the current AMRL study on the C-5A aircraft) under work unit 7231 04 018. A study on the attenuation of sound by the atmosphere has been essentially completed; these results provide attenuation data applicable for different temperature and humidity ranges.

Project: 7231
Task: 04
Work Unit: 018
Organization Performing R&D: AMRL (In-house)
Title: Bioacoustic Environments of USAF Aerospace Systems

The objective of this program is to measure, define and simulate the acoustic environments produced by aircraft, rocket engines and other Air Force aerospace systems as required for the evaluation of bioacoustic problems, such as personnel protection, communication, siting of noisy facilities and community annoyance. The engineering approach used under this program is to measure, record, process, analyze and simulate the noise environments produced in flight and on the ground by aircraft, rocket engines, ground support equipment and other Air Force noise sources using high-quality analog and digital electronic instrumentation, and apply established theoretical and empirical procedures and information on source characteristics, atmospheric sound-propagation, structural noise reduction, etc., to extrapolate and predict acoustic power spectra, sound pressure spectra, perceived noise levels, speech interference levels, peak pressure levels and other such measures of acoustic phenomena.

Project: 7231
Task: 04
Work Unit: 020
Organization Performing R&D: AMRL (In-house)
Title: Vibration Environments

The objective of this program is to define the low frequency vibration environment at crew/passenger stations of USAF aerospace systems in order to ensure that laboratory simulations for the determination of human biomedical tolerance and performance criteria are applicable to operational systems. For the rigid fighter, rigid bomber, and flexible bomber classes of aircraft this endeavor will determine the crew station in-flight vibration environment during low-altitude, high-speed flight. Such data are required for tolerance studies and the development, evaluation and testing of restraint and support systems using a variety of motion devices.

Data acquisition systems are installed onboard aircraft to measure the crew station vibrations experienced in the X,Y,Z, roll, pitch and yaw axes during low-altitude, high-speed flight. Analog and/or digital techniques are used in the laboratory to determine the amplitude probability characteristics and frequency composition of the data.

Project: 7231
Task: 04
Work Unit: 023
Organization Performing R&D: Systems Research Laboratories, Inc.
Dayton, Ohio
Title: Data Acquisition System for Noise Measurement

The objective of this effort is to develop a portable, multichannel data acquisition package that can be used to measure and record acoustic and/or vibration environments on a non-interference basis. Using state of the art components and technology with a ruggedized magnetic tape recorder, the contractor will design and develop a portable, battery operated acquisition package to measure and record multiple channels of acoustic and/or vibration data.

4. Air Force Aero Propulsion Laboratory

Program Element: 62203F

Project: 3066
Task: 12
Title: Propeller Technology

Significant propeller system technology advancement is an area of major importance for V/STOL and light aircraft. The propeller technology task consists of three areas: (a) lightweight propeller and propeller/gearbox development; (b) improvement of propeller aerodynamic performance and analytical prediction techniques; (c) prediction and reduction of propeller and gearbox system noise. More specifically, near term areas of concern are: decreasing propeller/gearbox system weight through the use of high strength-to-weight ratio materials and composites; improving propeller system performance through the application of cyclic pitch and variable geometry; improving basic airfoil design for optimum performance; determining accurate static thrust prediction methods; improving noise prediction techniques through improved basic noise source theory; and improving propeller noise scaling techniques and noise reduction through utilization of unique propeller designs based on noise source theory information.

Project: 3066
Task: 12
Work Unit: 001
Organization Performing R&D: Wyle Laboratories, Huntsville, Alabama
Title: Study of Propeller Vortex Noise

This exploratory research program is directed toward developing the technology to design effective quiet propeller configurations for tactical light aircraft. The specific technical objectives of the effort are to determine the dependence of vortex noise on aerodynamic and geometric propeller blade parameters, to develop an analytical model to accurately predict propeller vortex noise, and to develop specific recommendations for the design of minimum vortex noise propeller configurations. The original experimental work of Yudin on vortex sound from rotating rods and the more recent work of Ollerhead and Lowson are being reviewed and extended to account for modern propeller airfoil shapes.

Project: 3066
Task: 12
Work Unit: 002
Organization Performing R&D: AFAPL (In-house)
Title: Propeller Acoustics Test Facility

Current requirements for quiet aircraft have generated considerable interest in the areas of propeller and rotor acoustics. Most of the experimental data generated over the past two decades was taken on simplified rigs employing engines as the propeller drive mechanism. Further investigations have indicated that these engines can have a drastic influence on the generated propeller noise spectrum.

The objective of this program is to develop a propeller acoustic test capability to measure near-field propeller noise utilizing the Air Force Aero Propulsion Laboratory's electric whirl rigs. An automated instrumentation system for acquisition, analysis, and presentation of near-field acoustic data has been developed. Performance and acoustic tests of the Lockheed YO-3A and the Allison variable camber propellers were successfully completed. These tests were used to verify the effective operation of the test facility.

Project: 3066
Task: 12
Work Unit: 005
Organization Performing R&D: AFAPL (In-house)
Title: Performance and Acoustic Testing of a Variable Camber Propeller

The objectives of this program are to determine the performance and near-field acoustic characteristics of a variable camber propeller for V/STOL applications, and to determine the advantages and disadvantages of the flapped blade concept versus the tandem blade concept for obtaining variable camber. The engineering approach employed in this program is to conduct static whirl rig performance and acoustic tests on an Allison variable camber propeller using the movable flap concept. These results will be compared with existing performance and acoustic data on the Hamilton Standard tandem blade variable camber propeller.

Project: 3066
Task: 12
Work Unit: 006
Organization Performing R&D: Hamilton Standard Division of United Aircraft
East Hartford, Connecticut
Title: Quiet Propeller Design Procedure

During the past few years considerable interest has been generated in the area of minimum noise propellers for reconnaissance/surveillance and special operations aircraft. Since these aircraft generally have low wing loading, operate at minimum acceptable flight speeds, and require moderately low propulsive power, their propellers can be operated at reduced tip speeds thereby generating less noise. However, further propeller noise reductions are necessary in order to achieve aural non-detectability at relatively low altitudes. The objective of this program is to develop a reliable design procedure to aid in the development of advanced quiet propellers. The specific technical objectives of this effort are to develop a computerized procedure for the prediction of propeller performance, noise, and detectability, and to experimentally verify the effectiveness and reliability of the procedure by fabricating and testing a representative quiet propeller.

Project: 3066
Task: 12
Work Unit: 007
Organization Performing R&D: AFAPL (In-house)
Title: Propeller Acoustics Research

The general objectives of the Aero Propulsion Laboratory's propeller noise research program are to conduct analytical and experimental investigations into the mechanics of propeller noise generation, to review existing methods of propeller noise prediction and develop improved methods where a requirement exists, and to evaluate practical methods of propeller noise reduction. The AFAPL propeller acoustics test facility will be used to obtain representative performance and acoustic data for various propeller configurations. During the current year, tests will be conducted on the Hamilton-Standard variable camber, the Lockheed QRC-Star, and the Curtiss-Wright X-19 propellers.

Project: 3066
Task: 12
Work Unit: 008
Organization Performing R&D: AFAPL (In-house)
Title: Quiet Propeller Concept Evaluation

The objective of this program is to evaluate the noise characteristics of various propeller configurations to determine the noise reduction potential of various new designs. A series of performance and acoustic tests will be conducted using the AFAPL propeller acoustics test facility. Variables to be investigated include number of blades, blade to hub phasing angles and blade length. The technology gained from this program will be used to develop quiet propellers and rotors for quiet aircraft and helicopters respectively.

Project: 3066
Task: 14
Title: Propulsion Acoustics

With the advent of larger and more powerful military aircraft propulsion systems, it becomes increasingly apparent that appropriate steps must be taken to alleviate the noise problem. Engine noise levels must be reduced in order to provide a safe working environment for ground and flight crews, to alleviate the problem of acoustically induced structural fatigue, to reduce the possibility of aural detection during combat operations, and to improve the general community environment around military air bases. In order to achieve the apparently diverging goals of low noise and high performance, continuing research efforts to develop a better understanding of the basic mechanics of noise generation are required.

The Aero Propulsion Laboratory maintains a comprehensive propulsion acoustics research and development program consisting of contracted and in-house efforts. The overall objective is to develop the technology base necessary to significantly reduce aircraft propulsion system noise with minimum associated performance and weight penalties. The work efforts under this task are directed toward two apecific goals:

a. development of quiet propulsion for reconnaissance/surveillance and special operations aircraft, and

b. reduction of propulsion system noise to support current government noise abatement efforts.

Project: 3066
Task: 14
Work Unit: 001
Organization Performing R&D: Garrett Corporation, Phoenix, Arizona
Title: Small Turbine Engine Noise Reduction

The purpose of this program is to develop the technology base necessary to effectively reduce the noise signature of existing samll turbo-prop and turbofan engines. Although the program is primarily aimed at light aircraft propulsion, the technology generated is directly applicable to auxilliary power unit silencing. The specific technical objectives of the effort are to accurately predict the radiated acoustic signature and aural detectability of existing turboprop and turbofan propulsion systems in the 80 to 1000 shaft horsepower class for turboprops and the 400 to 5000 pound thrust class for turbofans, to develop effective methods to minimize pro-pulsion system aural detectability, and to determine the engine performance and weight penalties associated with the various suppression methods.

Project: 3066
Task: 14
Work Unit: 002
Organization Performing R&D: Bolt, Beranek, and Newman, Inc.
Los Angeles, California
Work Unit: 003
Organization Performing R&D: General Electric Company, Evendale, Ohio
Work Unit: 004
Organization Performing R&D: Lockheed Georgia Company, Marietta, Georgia
Title: Aircraft Engine Noise Reduction - Supersonic Jet Exhaust Noise

In order to provide the technology base required to design and develop low noise, high performance turbine engines for future military air-craft systems, a series of exploratory research programs are planned. The objective of these programs is to develop an accurate turbine engine perfor-mance/noise analytical model to determine the aero-mechanical design trades in performance that are necessary to obtain satisfactory noise reductions. The overall effort includes a thorough investigation into the fundamental mechanisms of turbine engine noise generation and will rely heavily on the results of current Department of Transportation and National Aeronautics and Space Administration engine noise reduction programs. The initial effort in this series is directed toward afterburning supersonic jet exhaust systems with operating conditions typical of supersonic transport (SST) and long range strategic (B-1) aircraft propulsion systems.

The current supersonic jet exhaust noise effort consists of three programs directed toward developing the technology to significantly reduce supersonic aircraft propulsion system noise with minimum associated performance and weight penalties. The primary objectives of these initial programs are to investigate competing mathematical models to accurately describe the aerodynamic, acoustic and performance characteristics of super-sonic jets, to determine critical noise generating mechanisms for the B-1 strategic aircraft system, and to experimentally demonstrate the advanced instrumentation required to verify the analytical models being studied. Based on the results of these programs, a follow-on effort will be initiated with the following specific technical objectives:

a. The development of a thorough qualitative and quantitative understanding of supersonic jet noise processes including the interrelationship of the distribution, level, and spectra of acoustic power and the spectra and directivity of near and far-field radiated sound with the turbulent structure, local flow properties, and nozzle performance parameters.

b. The determination of the effects of internal fluctuating forces in the nozzle on the jet noise production process. These internal force fields include turbulence and unsteady combustion due to afterburning, turbomachinery, and primary combustion.

c. The formulation of specific techniques to significantly reduce supersonic jet exhaust noise with minimum associated performance and weight penalties.

Project: 3066
Task: 14
Work Unit: 005
Organization Performing R&D: Bell Aerospace Corporation, Buffalo, New York
Title: Jet Noise Reduction for Military Reconnaissance/Surveillance Aircraft

The objective of this program is to evaluate and experimentally demonstrate a unique quiet propulsion concept for advanced quiet aircraft systems. The performance and acoustic characteristics of the total propulsion system will be assessed under this effort.

5. Air Force Weapons Laboratory

Program Element: 63723F
Project: 683M
Organization Performing R&D: Aerospace Medical Research Laboratory
Wright-Patterson AFB, Ohio
Title: Computer Noise Exposure Forecasting

The objective of this project is to revise the methods in AFM 86-5, land use planning with respect to aircraft noise to predict local community response to changes in noise levels resulting from Air Force aircraft operations. Future application of these new methods will allow the locating of new aircraft to bases and the controlling of other aircraft operations in a manner to minimize noise disturbances. The approach taken will be to modify the Federal Aviation Administration's computerized noise exposure forecast (NEF) technique to allow it to predict the effect on the local community of noise caused by Air Force aircraft operations. Thus far AFRL has advertised for qualified researchers and is in the final stages of completing a procurement package. Coordination is being accomplished to conduct AMRL in-house noise measurements on Air Force Aircraft in operation.

PROGRAM ELEMENT
PROJECT/TASK FUNDING SUMMARY
($ x1000)

PROGRAM ELEMENT	PROJECT/TASK	FY 68	FY 69	FY 70	FY 71	FY 72	FY 73	FY 74
61102F	9781/02	70	74	73	81	80	85	85
62201F	1471/02	280	280	287	290	290	310	320
62202F	7231	350	450	348	421	410	415	410
62203F	3066/12	-	-	160	75	125	125	100
	3066/14	100	100	124	470	350	400	425
63723F	683M	-	-	-	50	80	-	-
TOTAL		800	904	992	1337	1255	1335	1330

NAVY

FEDERAL NOISE PROGRAMS INFORMATION

A. Overall Program Objectives

Noise abatement of aircraft and related ground facilities and equipments.

B. Specific Programs and Research

1. Description

a. The Navy aircraft noise abatement program is divided into three general areas:

(1) Noise reduction of operating aircraft.

(2) Noise suppression for ground run-up of engines, installed in aircraft, during test operations and pre-flight checks.

(3) Noise suppression for ground post overhaul/maintenance testing of out-of-airframe engines at Naval Air Rework Facilities and Fleet Intermediate Maintenance Activities.

b. An Exploratory Development program is underway to develop a light weight, semi-portable noise suppressor for gas turbine engines based on the application of "Coanda Jet Deflection" and the phenomena of noise suppression of "Acoustic Noise Refraction" by temperature and velocity gradients in a jet flow. This development program will be useful in advancing the state of the art of noise suppression technology particularly for ground run-up of engines installed in aircraft and for post-maintenance test of engines out of airframe.

2. Objectives

a. The present state of technology in operating aircraft engine noise abatement does not permit adequate noise suppression in high performance jet engines to satisfy increased stringency in noise regulations. Since it is a problem common to the entire aviation field, FAA and NASA are taking the lead with military departments and industry providing cooperation in advancing noise reduction technology.

b. Navy maintenance activities and Naval Air Rework Facilities (NARF's) have full power aircraft ground run-up spaces. Only 12 of approximately 225 aircraft run-up pads have been provided noise suppressors. The majority of activities perform run-ups totally unabated. Design of univeral/all purpose aircraft ground run-up suppressors are not achieveable due to various aircraft configurations --- suppressors must be close-coupled to the aircraft and must not interfere with the check and test of the aircraft stablizer, flaps, flying tail, dive brakes and tailhook. It is anticipated that approximately 75% of the 225 run-up pads will be required with suppressor units.

c. Out-of-airframe testing of gas turbine engines in engine test cells at NARF's is not a problem since these test cells already have sound suppressors. Abatement of smoke and chemical emissions is expected to provide additional noise reduction -- a nucleation scrubber prototype at NARF Jacksonville indicates such reduction.

d. The Navy has 153 out-of-airframe engine test systems in use or planned for use by Fleet Intermediate Maintenance Activities. Approximately 23 of the inventory are acoustically treated including all of the turbo jet/fan permanent/demountable test systems. Noise abatement of 75% of all test systems is an objective. These involve the portable turbo jet/fan systems and the turbo shaft and turbo prop test systems.

C. Procedures

1. Identification of Program Areas and Research Needs

A Navy "Noise Abatement Committee" has been established consisting of representatives of NAVAIR, BUMED, NAVFACENGCOM and a NARF to identify problem areas and to determine requirements and priorities.

2. Specific Actions to Abate and Control Noise

a. Noise specifications for new aircraft engines are under revision to incorporate best known design requirements consistent with the state-of-noise technology.

b. Specifications for specific aircraft ground run-up noise suppressors are being developed. Suppressors for the A-7, F-4, A-4, and T-2C aircraft already have been developed.

c. "Acoustic Enclosure" designs have been developed for the turbo-shaft/prop test systems. Three prototype acoustical enclosures for different turbo shaft test systems are scheduled for erection, test and evaluation in the fall of 1971. Two semi-acoustical enclosures for turbo prop test systems were constructed in 1968/1969. Engineering design/prototype development of demountable turbo jet/fan test systems are being conducted.

d. A time-phased program plan is being prepared to support budget requirements for the development and acquisition of un-attenuated aircraft ground run-up pads and out-of-airframe test systems.

3. Procedures for Coordination with Other Federal Agencies

a. Liaison with the Air Force on noise abatement programs for aircraft run-up pads and out-of-airframe test systems is being conducted.

b. FAA, NASA, military departments and industry are cooperating in advancing noise reduction technology.

c. Liaison with EPA is being conducted on development of and compliance with standards.

4. Extent of In-House Capability

NAVAIRSYSCOM has qualified personnel to administer, manage, design, test and procure equipment to support an aircraft noise abatement program. This includes personnel at NAVAIR Headquarters, the Naval Air Engineering Center, Philadelphia, and the Naval Air Propulsion Test Center, Trenton.

D. Fiscal

1. Real Property Value of Facilities and Equipment Used for Noise Programs

Estimated average replacement value for facilities/equipment at various Naval Air Stations:

a. Gas Turbine Engine Test Cells (total value including noise suppression) at NARF's and Fleet Activities - $57.2 Million

b. Aircraft Ground Run-up suppressors at NARF's and Fleet Activities - $2.60 Million

2. Research Contracts

a. A contract was awarded to Boeing Company, Wichita in August 1971 to accomplish scale model development of the Coanda Jet Deflection system.

b. Total research and technology funding for FY 70 and FY 71 amounts to $186 Thousand.

3. Past Programs (3-5 years)

a. Aircraft Ground Run-up noise suppression in NARF's and Fleet Activities - $2.0 Million

b. Acoustically treated out-of-airframe engine test cells in Fleet Activities - $1.93 Million

4. Future Facility Costs

a. It is anticipated that about $23 Million will be required through the FY 76 time-frame to equip a minimum of 75% of the 225 Navy run-up pads with suppressor units.

b. Approximately $10.2 Million will be required through FY 75 to provide noise abatement for out-of-airframe engine test cell acoustic enclosures.

c. These cost requirements will be supplemented by Marine Corps requirements as they are developed.

DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

September 20, 1971

Dr. Alvin F. Meyer, Jr.
Director, Office of Noise
Abatement and Control
Environmental Protection Agency
Washington, D. C. 20460

Dear Dr. Meyer:

Enclosed are the Department of Health, Education, and Welfare activities related to noise effects, abatement and control. These activities are associated with the health effects and protection against high noise levels.

If any additional information is required, please contact me at Area Code 202--962-2241.

Sincerely yours,

Robert D. Lanza

Robert D. Lanza
Special Assistant to the
Assistant Secretary for
Health and Scientific Affairs

Enclosures

FEDERAL NOISE PROGRAMS INFORMATION

I. Organizational

A. Department of Health, Education and Welfare, Social Security Administration, Baltimore, Maryland

B. Social Security Administration's Employee Health Service has used the occupational medical guidelines as described in Public Law 658, 79th Congress. Also the Bureau of Budget Circular A-71 directs heads of agencies to establish occupational health programs.

II. Functional

A. Overall program objectives relate to hearing conservation services as part of a total occupational health program. These include the objective of assessing and removing or protecting employees against environmental hazards such as noise.

B. Specific Programs and Research

1. The hearing conservation effort includes:

a. Identification of work areas where elevated noise levels are a problem and determining operating schedules.

b. The obtaining of entrance on duty audiograms and noise exposure history on all employees assigned to work areas of 90 dB(A) or over.

c. Reduction in noise levels by isolating and attenuating noise producing equipment in order to reduce noise at its source and when indicated, limiting duration of exposures.

d. Periodic audiometric review of all employees assigned to work areas with elevated noise levels. Should threshold shifts be greater than 15 decibels, employees from noisy areas are reevaluated, hearing protection checked for fit and use, and repeat audiograms obtained following at least 15 hours of noise-free exposure. Should loss persist, reassignment is considered.

e. Personalized fitting of ear protection equipment for those employees working in areas of 90 dB(A) or more.

f. Supervisory and employee health education pointed to use of hearing protection equipment and proper use of sound attenuating enclosures.

2. Objectives

a. The program is moving in the direction of desired objectives. However, full long-range impact of the the program has not been assessed.

b. Evaluation criteria consists of:

(1) Periodic review of serial audiograms.

(2) Repeat orientation instructions for supervisory and line personnel.

(3) Follow-up of those employees evaluated or reassigned because of hearing loss.

C. Procedures

1. Problem areas are identified through continuous inspection tours of work areas. The health folders of employees who have demonstrated hearing loss are evaluated in terms of noise levels at work sites.

2. Specific actions to abate and control noise include:

a. Sound absorbing media installations (ceilings, walls) to noisy areas.

b. Sound attenuating high noise level producing machines and equipment.

c. Evaluating new equipment prior to ordering in order to avoid high noise levels. Consult with manufacturers in the design of such equipment.

3. Coordination with other agencies is achieved through professional affiliations such as Federal Council of Medical Directors and contacts in the American Industrial Hygiene Association.

4. Inhouse capability is supplemented by consultants from both the construction and the Industrial Hygiene Specialists.

5. New procedures will include utilization of more sophisticated noise level determination equipment so as to include authentic duration exposures and to assure the most appropriate type of hearing protection equipment.

D. Future program proposals will include a more pointed coordination across agency and professional lines and indoctrination of nursing and medical staff who come in contact with employees who work in areas of high noise levels.

III. Fiscal

A. Current Program

1. Real property value of facilities and equipment used for noise programs:

Audiometer (purchased in 1966)	$1,400
Audiometers (2) FY 1971	3,700
Hearing Booth (purchased in FY 1971)	2,200
Walsh Healey Noise Exposure Meter and attachments	1,670
Sonic Ear Valves	50
Silicone Earmold Kit	375
Total	$9,395

The purchase of 3 audiometers for field is projected for FY 1972 at a cost of $1,850 each.

Maintenance of Audiometer during FY 1971	$200
Projected estimate for repair for FY 1972	$200

FEDERAL NOISE PROGRAM INFORMATION

I. Organizational

A. Department of Health, Education, and Welfare, Health Services and Mental Health Administration, National Institute for Occupational Safety and Health

B. Public Health Service Act

II Functional

1. A. Threshold Shift in Hearing from Nonoccupational Noise Source

B. This project is primarily a completion of an earlier commitment with Federal Aviation Administration to supervise a reimbursable contract study of aircraft noise effects on residents in an airport neighborhood. In addition, the final phase of a study of the effects of recreation and entertainment noise on individuals is being completed.

C. Previous commitments are being completed. Both contract and in-house studies involve primarily audiometric testing with some source measurements.

2. A. Interim Criteria for Environmental Noise Control

B. This project is the completion of an earlier commitment to draft interim noise criteria or acoustic requirements for the outdoor urban and community environment and for the indoor home environment with relevant considerations of noise effects on health, performance, safety, and comfort.

C. This objective is to be obtained through technical review and consultation.

III Fiscal

A. There is no real property or equipment devoted exclusively to these two projects. The operating budgets of these two projects (exclusive of previously funded reimbursable contracts) is about $21,000 of which about $17,000 is personnel cost and $4,000 related expenses of operation. Both projects will be completed during FY 72.

B. These projects were initiated in FY 69 and FY 70, respectively. Total expenditures exclusive of the $50,000 reimbursable contract in prior years amounts to $69,000 and there are no projected activities after FY 72.

IV. Regulation and Certification

Not applicable

FEDERAL NOISE ABATEMENT PROGRAMS

I. A. Department of Health, Education, and Welfare; Food and Drug Administration

B. Federal Food, Drug and Cosmetic Act.

II. Some activities associated with the noise level of percussion toy caps as related to toy safety. Problems encountered during the 1970 toy survey have been resolved.

III, & IV. Not applicable.

FEDERAL NOISE ABATEMENT PROGRAMS

I. A. Department of Health, Education, and Welfare; National Institutes of Health.

B. 42 U.S.C.

II. A. Research into the pathological and physiological effects of noise (not directly applicable to request).

B. Attached 200 word Research Project summaries.

III, & IV. Not applicable.

NOV 3 1969

Prepared for the Science Information Exchange.
Not for publication or publication reference.

U. S. Department of
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

NOTICE OF RESEARCH PROJECT

INB-3782-9

PROJECT NO. (DO NOT USE THIS SPACE)
~~5 R01~~ NS 03782-09

~~OHS~~

TITLE OF PROJECT

Histopathology of Temporal Bones

GIVE NAMES, DEPARTMENTS, AND OFFICIAL TITLES OF PRINCIPAL INVESTIGATORS OR PROJECT DIRECTORS AND ALL OTHER PROFESSIONAL PERSONNEL ENGAGED ON THE PROJECT.

Rutledge, Lewis J., M.D., Principal Investigator, Department of Otolaryngology
Gonzalez, Gerardo, M.D., Co-Investigator, Department of Otolaryngology
Tabb, Harold G., M.D., Professor and Chairman, Department of Otolaryngology
Rubin, Wallace, M.D., Asso. Professor, Department of Otolaryngology
Istre, Clifton O., Jr., Ph.D., Medical Audiologist, Department of Otolaryngology

NAME AND ADDRESS OF APPLICANT INSTITUTION

Tulane University School of Medicine, 1430 Tulane Avenue, New Orleans, La. 70112

SUMMARY OF PROPOSED WORK • (200 words or less — Omit Confidential data.)

In the Science Information Exchange summaries of work in progress are exchanged with government and private agencies supporting research in the bio-sciences and are forwarded to investigators who request such information. Your summary is to be used for those purposes.

This research project is proposed to procure valuable pathologic human temporal bones for surface preparations or histologic serial sectioning and careful microscopic evaluation. The study is designed to correlate abnormal ante mortem auditory and vestibular disturbances with post mortem histopathologic changes in the inner ear.

In animals, the effects of rocket noise and the streptomyces drugs will be evaluated by electrical audiometry and surface preparation or step sections.

— Not Pd. 1971

Period for this NRP
1-70 to 12-70
mo yr mo yr
Sub-group

PROFESSIONAL SCHOOL (medical, dental, etc.) WITH WHICH THIS PROJECT SHOULD BE IDENTIFIED	SIGNATURE OF PRINCIPAL INVESTIGATOR	DATE
Medical	Lewis J. Rutledge	10/21/69

Period	Amount	Period	Amount
1/70-12/70	$28,766		

PUBLICATION REFERENCE

1730 M STREET, N.W. PHONE 202-381-5511
WASHINGTON, D.C. 20036

1NB-3856-9

NOTICE OF RESEARCH PROJECT

SUPPORTING AGENCY:

HEALTH EDUCATION AND WELFARE
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTES OF HEALTH
NATIONAL INSTITUTE OF NEUR. DIS.& STROKE

AGENCY'S NUMBER(S):

NS 03856-09

SUBGROUP P01

TITLE OF PROJECT:

AUDITORY COMMUNICATION AND ITS DISORDERS

PRINCIPAL INVESTIGATOR, ASSOCIATES AND DEPARTMENT/SPECIALTY:

HIRSH, IRA J

KIND AWARD G
DATE 700514 DISTR

RECIPIENT INSTITUTION:

CENTRAL INSTITUTE FOR DEAF
RESEARCH
SAINT LOUIS MISSOURI 63110

PERIOD FOR THIS NRP:

BEG 7010 END 7109
FY 71 FUNDS 00393224

SUMMARY OF PROJECT:

006000 CONTINUATION
007004 818 S. KINGSHIGHWAY BLVD. ST LOUIS, MISSOURI 63110
009001 DIRECTOR OF RESEARCH

Principal Investigators: I. J. Hirsh (Director); H. Davis (Electroencephalography); D. H. Eldredge (Electrophysiology); J. D. Miller (Animal Behavior and Psychology); A. F. Niemoeller (Electrical Engineering); and C. S. Watson, J. H. Mills, D. A. Ronken, L. P. Swisher, N. P. Erber, P. L. Divenyi, D. G. Drescher, G. S. Gordon, H. S. Lane, F. R. Kleffner, and A. A. Simmons.

Present studies include the following: Clinical application of evoked cortical potentials and relation of potentials to different sensory inputs; electrophysiological studies of cochlear patterns and of auditory-nerve coding; behavioral, physiological and anatomical measures of temporary and permanent hearing loss in animals following exposure to noise; temporal aspects of auditory perception and of auditory masking; pitch perception of sounds with changing frequencies; detection of signals in noise; discriminability of complex tonal patterns; analysis of lipreading by deaf subjects; psychological and linguistic effects and aspects of impaired hearing; development of special wireless group hearing aids and of equipment for measuring hearing-aid performance.

09 yr. 10/1/70 - 9/30/71
393.224

RCP
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SUB

NOV 1 1970

PUBLICATION REFERENCE

SMITHSONIAN INSTITUTION
1730 M STREET, N.W. PHONE 202-381-5511
WASHINGTON, D.C. 20036

LNG-4403-9

NOTICE OF RESEARCH PROJECT

SUPPORTING AGENCY:

HEALTH EDUCATION AND WELFARE
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTES OF HEALTH
NATIONAL INSTITUTE OF NEUR. DIS.& STROKE

AGENCY'S NUMBER(S):

NS 04403-09

SUBGROUP R01

TITLE OF PROJECT:

THE DETERMINATION OF SUSCEPTIBILITY TO HEARING LOSS

PRINCIPAL INVESTIGATOR, ASSOCIATES AND DEPARTMENT/SPECIALTY:

WARD, W DIXON

KIND AWARD G
DATE 700514 DISTR

RECIPIENT INSTITUTION:

MINNESOTA UNIVERSITY OF
MEDICAL SCHOOL
OTOLARYNGOLOGY DEPT.
MINNEAPOLIS MINNESOTA 55455

PERIOD FOR THIS NRP:

BEG 7012 END 7111
FY 71 FUNDS 00029626

SUMMARY OF PROJECT:

006000 CONTINUATION
007004 303 ADMINISIRATION BLDG MINNEAPOLIS, MINNESOTA 55455
009001 RESEARCH PROFESSOR

W. Dixon Ward, Ph. D.; Professor, Department of Otolaryngology
Ar..t J. Duvall, III, M. D.; Professor, Department of Otolaryngology
Da..d A. Nelson, Ph. D.; Research Associate, Department of Otolaryngology

This research will examine in the chinchilla the relations among (1) the temporary changes in auditory sensitivity caused by severe but subtraumatic exposures to noise, (2) the permanent changes in sensitivity produced by a more severe noise exposure, and (3) the structural and ultrastructural changes observed in the affected cochleae. Behavioral testing is accomplished by means of conditioned-avoidance techniques. Particular attention will be paid to possible histological sequelae of noise exposure that are not associated with a loss of auditory sensitivity. The fundamental question, however, is: Can individual differences in temporary effects of noise be used to predict individual differences in resistance to permanent effects from more severe exposures?

FEB 9 1971

09 yrs. 12/1/70 - 11/30/71
\$ 29,626

~~ACY~~
~~RCP~~
~~SG~~
SUB
~~GRP~~

PUBLICATION REFERENCE

SMITHSONIAN INSTITUTION
1730 M STREET, N.W. PHONE 202-[illegible]-5511
WASHINGTON, D.C. 20036

NOTICE OF RESEARCH PROJECT

INB-5083-8

SUPPORTING AGENCY:

HEALTH EDUCATION AND WELFARE
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTES OF HEALTH
NATIONAL INSTITUTE OF NEUR. DIS.& STROKE

AGENCY'S NUMBER(S):

NS 05083-08

SUBGROUP R01

TITLE OF PROJECT:

INFLUENCE OF THE TYMPANIC MUSCLE INTEGRITY

PRINCIPAL INVESTIGATOR, ASSOCIATES AND DEPARTMENT/SPECIALTY:

HAYDEN, ROYAL C, JR

KIND AWARD G
DATE 700514 DISTR

RECIPIENT INSTITUTION:

HENRY FORD HOSPITAL - NON-AFFL.

OTOLARYNGOLOGY DEPT.
DETROIT MICHIGAN 48202

PERIOD FOR THIS NRP:

BEG 7101 END 7112
FY 71 FUNDS 00012111

SUMMARY OF PROJECT:

005000 CONTINUATION
007004 2799 W GRAND BLVD DETROIT, MICHIGAN 48202
009001 OTOLOGY CONSULTANT CO-DIR, OTOLOGICAL RES LAB

Royal C. Hayden, Jr., M.D.
Otology Consultant
Co-Director, Otology Res. Lab.
Henry Ford Hospital and
Adjunct Assistant Professor,
Otolaryngology Dept., Wayne
State University Medical School

Donald N. Elliott, Ph.D.
Director, Otology Res. Lab.
Henry Ford Hospital and
Professor of Psychology
Department of Psychology
Wayne State University

Larry A. Frazier, M.A.
Assistant Director and
Research Associate
Otology Research Lab.
Henry Ford Hospital

The purpose of this project is to continue the work previously carried out in evaluating the effects of integrity of middle ear muscles and the effect of tympanic membrane elevation and rehealing on stimulation induced temporary and permanent hearing threshold shifts. Specifically, the behavioral audiograms of conditioned monkeys after exposure to high intensity low frequency noise, impulse noise, and combination of the two will be compared before and after elevation of the tympanic membrane, as well as sectioning the middle ear muscles. Recovery curves of the hearing loss will be followed in their return to a normal or permanent hearing loss state. The temporal bones of all animals will be removed and histologically processed for microscopic study.

FEB 9 1971

08 yr. 1/1/71 - 12/31/71
$ 12,111

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[illegible]
GRD

NOT FOR PUBLICATION OR PUBLICATION REFERENCE

SCIENCE INFORMATION EXCHANGE
SMITHSONIAN INSTITUTION
1730 M STREET, N.W. • PHONE 202-381-5511
WASHINGTON, D.C. 20036

SIE NO.
S
1NB-5785-6

NOTICE OF RESEARCH PROJECT

SUPPORTING AGENCY:

HEW H EDUCATION AND WELFARE
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTES OF HEALTH
NATIONAL INSTITUTE OF NEUR. DIS.& STROKE

AGENCY'S NUMBER(S):

NS 05785-06

SUBGROUP P01

TITLE OF PROJECT:

CAUSES OF DEAFNESS

PRINCIPAL INVESTIGATOR, ASSOCIATES AND DEPARTMENT/SPECIALTY:

LAWRENCE, MERLE

KIND AWARD G
DATE 700514 DISTR

RECIPIENT INSTITUTION:

MICHIGAN UNIVERSITY OF
MEDICAL SCHOOL
OTORHINOLARYNGOLOGY DEPT
ANN ARBOR MICHIGAN 48104

PERIOD FOR THIS NRP:

BEG 7009 END 7108
FY 71 FUNDS 00355576

SUMMARY OF PROJECT:

006000 CONTINUATION
007004 ADMINISTRATION BUILDING ANN ARBOR, MICHIGAN 48104
009001 DIR, KRESGE HEARING RES INST & PROF OF OTORHINOL

This grant supports the basic activities of the Kresge Hearing Research Institute. It supports the salaries of many of the principal investigators and trained personnel. Technical help and other items specific to a particular research area are provided for by other grants.

The areas of study within the Institute at the present are as follows: General Psychoacoustics, general auditory physiology (electrical potentials and fluid exchange); Cytoarchitecture of the organ of Corti (phase and electron microscopy); comparative psychoacoustics (behavioral determinations of hearing in animals before and after experimental procedures); neurophysiological correlates of hearing; laryngeal transplantation and facial nerve physiology; histopathology of the temporal bone; psychoacoustics, and vestibular physiology.

Carbon dioxide diffusion across the tympanic membrane: A spec... phometric analysis of carbon dioxide diffusion across the tympanic ... brane has been developed. Additional cases with differing ear pathol... are being studied to learn the significance of CO_2 diffusion.

Viral localization in the inner ear: Surface preparations are be... prepared to study if and where viruses localize in the inner ear.

Cleft palate and otitis media: All patients with cleft palate ar... being evaluated for middel ear disease. Clinical-operative correlatio... of ear disease are being made. Cytologic analysis of the middle ear fluid is performed also.

Alfred L. Nuttall, M.S.E.E. - This research on the middle ear muscles involves examination of the dynamics of the guinea pig middle ear transfer function to provide the data for formulating a middle ear model that incorporates the muscle activity. Toward this end, much of this past years' work has been concerned with the design, construction, and calibration of the necessary instrumentation.

A solid state phase angle meter, capable of reading the relative phase of a signal over a 360 degree range, is ready for use. Between the frequency limits of 10 Hz to 20 kHz the signal can have a dynamic amplitude range of 50 dB.

An electromechanical vibrator, for the direct application of mechanical displacement to the stapes has been constructed. Longitudi... displacements of less than 100 Å are possible over the frequency range of 50 Hz to 2500 Hz. The displacement is calibrated for magnitude and phase.

Experiments on guinea pigs this year have resulted in the success... direct electric stimulation of the stapedius and tensor tympani muscles with metal bipolar electrodes. The transfer function magnitude and ph... changes, caused by muscle contraction, are being recorded.

James L. Werth, M.D. - The magnitude of the air pressure waves produce... by modern industrial and military explosions is several times larger than the pressures that ordinarily stimulate the human ear. It can be anticipated that these high pressures will produce middle ear damage and inner ear disturbances.

In this investigation test animals were subjected to a single air pressure wave ranging from 15-45 psi. Specimens have been collected from animals immediately following subjection to the test wave and from other animals several weeks following the injury. Histological study of several specimens has been completed. The most profound damage found in the specimens studied has been in the basal turn of the cochlea.

BEHAVIORAL

David B. Moody, Ph.D. - Our research during the past year has concentrated on the study of experimentally produced hearing losses in primates. These losses have been produced by both

Prepared for the Science Information Exchange.
Not for publication or publication reference.

U. S. Department of
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

NOTICE OF RESEARCH PROJECT

PROJECT NO. (DO NOT USE THIS SPACE)
~~5 R01~~ NS 07908-05
~~CMS~~

TITLE OF PROJECT

NOISE INDUCED DEAFNESS - MASKING AND SPEECH PERCEPTION

GIVE NAMES, DEPARTMENTS, AND OFFICIAL TITLES OF PRINCIPAL INVESTIGATORS OR PROJECT DIRECTORS AND ALL OTHER PROFESSIONAL PERSONNEL ENGAGED ON THE PROJECT.

Kryter, Karl D., Ph.D.	Sensory Sciences Research Center	- Director
Becker, Richard W., M.S.	" " " "	- Research Psychologist
Bell, Donald W., Ph.D.	" " " "	- Research Psychologist
Clarke, Frank R., Ph.D.	" " " "	- Sr. Research Psychologist
Hecker, Michael H.L., M.S.	" " " "	- Sr. Research Engineer
Kreul, E. James, Ph.D.	" " " "	- Sr. Research Audiologist

NAME AND ADDRESS OF APPLICANT INSTITUTION
Stanford Research Institute
333 Ravenswood Avenue
Menlo Park, California 94025

SUMMARY OF PROPOSED WORK - (200 words or less — Omit Confidential data.)

In the Science Information Exchange summaries of work in progress are exchanged with government and private agencies supporting research in the bio-sciences and are forwarded to investigators who request such information. Your summary is to be used for these purposes.

The general objective is the understanding of the performance characteristic of the normal human ear and the ear that suffers from hearing loss, primarily noise-induced deafness. The principal research approaches to be used to meet this objective are:

1. To study and explore, by means of perceptual tests, under controlled laboratory conditions, the relative capacities of the normal and deafened ear to detect and discriminate simple and complex acoustical signals. The tests will be designed to define and delineate most probable underlying neuro-physiological mechanisms involved in such discriminations in the normal and deafened ear.

2. To study the ability of persons with normal hearing and persons with deafness to understand speech that has been narrow-pass-band filtered and processed in various ways. It is hypothesized that the speech may be made more understandable to the deafened ear as the result of processing and "packaging" the speech signal in either or both the frequency-amplitude and time domains in ways that might best match the remaining performance characteristics of the deafened ear.

3. To test and evaluate the knowledge gained in the proposed research for the alleviation of hearing loss sustained in industry and elsewhere due to exposure to excessive noise.

Period for this NRP
5-70 to 4-71
mo yr to mo yr
Sub-group

06 yr. 5/1/71 - 4/30/72
$125,287

PROFESSIONAL SCHOOL (medical, dental, etc.) WITH WHICH THIS PROJECT SHOULD BE IDENTIFIED

SIGNATURE OF PRINCIPAL INVESTIGATOR
Karl D Kryter

DATE
25 Feb 1970

No.	Period	Amount	Proj. No.	Period	Amount
	5/70-4/71	$123,018	6		$81,279 *
			7		84,051 *
					*
					*
					*
					*
*Commitment					*

DHEW NOISE RESEARCH AND RELATED ACTIVITIES
FOR 1971 AND PLANS FOR 1972

I. National Institute for Occupational Safety and Health

A. Projects listed below were conducted during FY 71 and are planned to continue into FY 72. Contract funding information is shown in Table I.

1. Occupational Noise and Hearing Survey: This is a continuing study aimed at establishing relationships between representative types of industrial noise conditions, years of exposure, and hearing levels of workers as a basis for documenting criteria for safeguarding hearing. An additional aim is to ascertain prevalence of hearing impairment in different worker groups. All work performed on this project for FY 71 was conducted in-house, including noise surveys and hearing evaluations on 600 workers engaged in jobs connected with road repair, printing, steel product manufacturing, and transportation services. With regard to the latter, FY 72 plans will include in-house noise and hearing studies of trucking operations which may have some bearing on DOT proposed noise limits for the driver compartments of commercial vehicles. FY 72 plans also include two contracts, one calling for an evaluation of serial audiometric data available on workers who have been exposed six to twelve years to known levels of mining noise; another contract may deal with hearing losses among workers exposed to intermittent noise conditions.

2. Threshold Shifts in Hearing from Non-Occupational Noise Exposures: This is a continuing project seeking to assess risk of hearing loss caused by exposures to off-job noise conditions. Accomplishments in FY 71 included in-house surveys of sound levels in nine separate rock-and-roll sessions with pre- and post-exposure hearing measurements on a total of 44 teenage musicians and 162 teenage spectators. Via an interagency arrangement with FAA and by means of a contract, audiograms together with a noise history questionnaire and

otoscopic check are being obtained on residents in a noise impacted neighborhood bordering L.A. Airport. Similar information is being collected on residents in a control neighborhood 30 miles away. In addition, measurements of background and intrusive noise levels from aircraft are being made in both communities. A contract study is presently being negotiated which will furnish hearing data on 100 or more young adults engaged in noisy recreational activities such as rock-and-roll music playing, drag strip racing, cycling, shooting. Hearing measurements here will include thresholds at high frequencies much beyond the conventional audiometric range.

3. Industrial Noise and Medical-Safety-Attendance Data on Workers: This project seeks to determine if there is any evidence coupling severity of occupational noise conditions to the occurrence of extra-aural physical and behavioral disturbances in workers. Accomplishments during FY 71 on this project was to plan a contract study to uncover this information through comparing entries in the existing medical, safety, and attendance records of at least 500 workers employed in noisy jobs and 500 in quiet ones. FY 71 funds will cover this contract. Contingent on the possible inadequacies found in existing medical records of in-plant workers to furnish needed health information on this project, it may be necessary to perform clinical examinations for this purpose. Plans to obtain such data via contracts have been noted in FY 72 project planning.

4. Aspects of Noise and Psycho-Physiologic Response: This research project attempts to clarify physiologic and subjective reactions elicited by sounds which differ greatly in acoustic quality, perceived meaning and purposefulness. Specific questions to be considered in this project include the following:

a. Do aversive types of sounds cause distinctively different physiological changes from those of a more neutral nature?

b. What is the degree of correlation between physiologic reactions to these different sounds and subjective ratings of their annoyance?

c. Is there adaptation of both physiologic and subjective reactions to these sounds with repeated or prolonged exposures or does the time course of these reactions differ?

d. How may positive or negative associations given a certain sound affect resultant subjective and underlying physiologic responses?

During FY 71 a study plan was prepared to research these questions via contract. Contract negotiation is now underway and this project is expected to be funded by the end of FY 71 and to be conducted in FY 72. Expanded effort in this area will be dependent upon the results of the first contract study.

5. Interim Criteria for Environmental Noise Control: The intent of this project is to formulate interim noise criteria or acoustic requirements for the workplace, for the outdoor urban or community environment, and for the indoor or home environment within the frame work of existing knowledge of noise effects on health, work efficiency and safety, comfort, and well-being. During FY 71, an outlined approach to this project was drafted by DHEW and reviewed by CHABA scientists selected to assist in this task. Progress on the part of DHEW in attempting to prepare a first whole draft of this document has been delayed owing to the imposition of administrative assignments. New attempts will be made in FY 72 to follow through on this project.

6. Aspects of Noise Disturbance to Sleep: This study was an exploratory investigation of the effects of noise on sleep and post-sleep behavior in two 25, 50, and 70 year old males. FAA supplied $55,000 for this project which was supervised by DHEW under an interagency agreement and carried out via contract with the University of Cincinnati. During FY 71, the study was completed and a technical report summarizing results prepared for publication.

7. Advisory-Consultative-Training Services on Noise Problems and their Control: Under this project, staff offers consultation to state and local agencies in development of needed noise control programs and plans and directs training programs, workshops dealing with evaluation, recognition and control of noise. It also supplies technical and general information on noise to government agencies and the general public.

B. The projects listed below represent new activities planned for FY 72. Contract funding levels for these projects are shown in Table I.

1. Survey of High Frequency Noises in the Work Environment: This study will (a) inventory types of industrial processes and equipment which emit noises with high frequency concentrations of acoustic energy (above 10 KHz); (b) describe instrumentation and procedures for defining worker exposures to such sound energy, and (c) obtain representative measurements in work areas where the operating equipment is in use. It is planned to conduct this work via contract during FY 72.

2. Survey of Hearing Conservation Programs in Industry: The aim of this project is to survey hearing conservation practices in various industries. Data will be sought reflecting the number of programs presently in operation and specific procedural details such as audiometers used, their maintenance, audiometric testing procedures, aspects of personal protection and engineering control efforts. In addition, on-site inspections and calibration of audiometers in use, noise measurements of test areas, will be made in a selected number of companies for purposes of adding depth to the information gathered from the questionnaire. This questionnaire survey is designed to begin early in FY 72 and will be strictly an in-house activity.

3. Impact-Type Noise Exposure and Control in Industry: Via an FY 72 contract, an attempt will be made (a) to identify types of manufacturing-construction equipment and processes which generate strong impact-type sounds, (b) to prescribe instrumentation and procedures for best describing such sounds, and (c) to obtain field data representative of worker exposures to these impact noise sources. Subsequent to the results of this contract effort, another contract study will consider available means for reducing impact noise generations at the source, and demonstrate on select industrial machines or equipment the amount of quieting achieved through application of these treatments. The latter contract work will be funded in FY 73.

4. <u>Noise Effects on Non-Auditory Sensory Functions and Performance</u>: This project is designed to evaluate in the laboratory certain measures of visual, tactile, thermal, kinesthetic and vestibular functions that may be effected by industrial-type noises and aspects of response accommodation with continued exposure to such noise. In addition, an assessment will be made of performance or safety implications of these noise-induced changes through study of simulated job tasks incorporating specific function or functions affected. This work will be done on a contract basis beginning in FY 72.

5. <u>Temporary Threshold Shift in Hearing from High Level Noise Exposures</u>: This project for FY 72 will involve two studies to be undertaken on an in-house basis. One will be a laboratory study to determine the degree of temporary threshold shift resulting from high level low frequency noise exposure in normal listeners. The intent of this work will be to evaluate the adequacy of dBA sound level measures in rating hearing loss risk from industrial noises with prominent low frequency energy. A second study will involve the use of groups of workers exposed to high level noise in their work environments whose hearing will be tested both before and after work each day for two weeks so as to determine the growth and decay of noise-induced temporary threshold shifts in hearing under normal work conditions. Hearing testing here will include frequencies in the conventional audiometric range as well as at select high frequencies. The latter testing will be done in different work situations sampling a variety of exposure conditions.

6. <u>Aspects of Ear Tolerance to Noise</u>: A first study included in this project will seek to identify at least 100 workers whose ears, while unprotected, show little if any hearing loss despite 10 or more years exposure to industrial noise of high level. Such workers will be subjected to clinical exams, otologic and related evaluative tests seeking to uncover distinctive factors which may explain their resistance to ear damage from noise. This study will be conducted during FY 72 on a contract basis.

7. Guides to Noise Control: Via contract, two guides for noise control will be prepared. One is to summarize information on materials for industrial noise control purposes and a second is to offer basic principles of noise control and cite case histories of implementation and effectiveness. This work is to be handled by two contracts to be negotiated during FY 72.

- -

C. The projects listed below are supported by grants through the National Institute for Occupational Safety and Health. FY 71 and projected FY 72 funding levels are noted in Table I.

1. Damage Risk Criteria for Intermittent Noise Exposure (W.D. Ward, University of Minnesota): Research will evaluate growth and recovery of temporary noise-induced threshold shifts in hearing for intermittent noise exposures over an 8-hour period. Determination of noise levels, duty cycles which cause threshold shifts subject to complete recovery in the 16-hour period between two successive 8-hour exposures will define occupational noise limits for intermittent exposures.

2. Training Program in Acoustic Environmental Control (K. Stewart, University of Pittsburgh): Pre-doctoral inter-disciplinary program aimed at developing acoustic specialists in handling noise problems in industry, housing, transportation, schools, hospitals and the community at large.

3. Behavioral Toxicity of Noise in Immature Mice (W.B. Iturrian, University of Georgia): Investigation of sensitization of immature mice to audiogenic seizure and to assess the effects of high level sounds on pesticide toxicity, drug effectiveness and on their overall behavior.

4. Effects of Three Sound Environments on Human Behavior (H.D. Warner, University of Missouri): Evaluation of three representative noise conditions on realistic work tasks for time periods resembling actual work situations.

5. <u>Responses of the Pre-Damaged Ear</u> (P.N. Herman, University of Oregon Medical School): Study to evaluate the effects of acoustic over-stimulation on animal ears which have already been subject to temporary or permanent threshold shifts due to noise.

6. <u>An Objective Method for Evaluating Ear Protectors</u> (P. Michael, Penn State University): Study to cross-compare and evaluate objective and subjective procedures for establishing attenuation properties of both insert and earmuff protectors.

- -

D. Also supported by the National Institute for Occupational Safety and Health are three noise projects dictated by requirements of the Federal Coal Mine Health and Safety Act. These projects deal with development of health standards for controlling noise hazards in mining, establishment of noise survey and monitoring procedures for mining operations, and promotion of methods for engineering noise control in mining equipment. For FY 72, it is planned to negotiate at least two contracts in these subject areas totalling $105,000.

II. <u>Health Services and Mental Health Administration</u> (National Institute for Mental Health)

This agency is supporting one research grant, "Physiologic and Psychologic Adjustment to Noise" (K.D. Kryter, F.R. Clarke, Stanford Research Institute) which is in its second year of work. Funding for the period 6/1/70 - 5/30/71 was $45,394. For the next twelve month period 6/1/71 - 5/30/72, funding is expected to be $73,000. Essence of study is to monitor noise effects on performance and underlying physiologic measures on a long-term basis. Subjects varying in age, sex, sensitivity to noise will be involved in this effort as will samples of everyday noises.

III. National Institutes of Health (National Institute for Neurologic Diseases and Stroke (NINDS)

NIH through NINDS supports grant research related in part to sound and noise as it may affect speech perception and hearing. Attachment A contains a listing of active research grants in these areas spanning the FY 71 - FY 72 time period. Actual or expected funding levels are listed. The list includes 18 active grants whose current awards total $1,874,471.

TABLE I

FY 71 AND PROJECTED FY 72 CONTRACT AND GRANT FUNDS FOR NOISE PROJECTS IN NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

	In-House or Contract Project	FY 71	FY 72
1.	Occupational Noise and Hearing Survey	in-house	75K
2.	Threshold Shifts in Hearing from Non-Occupational Noise Exposures	75K*	---
3.	Industrial Noise and Medical-Safety-Attendance Records on Workers	60K	150K
4.	Aspects of Noise and Psycho-Physiologic Response	45K	---
5.	Interim Criteria for Noise Control	in-house	in-house
6.	Aspects of Noise Disturbance to Sleep	completed	
7.	Advisory-Consultative-Training Services on Noise Problems and Control	in-house	in-house
8.	Survey of High Frequency Noises in Work Environment	---	60K
9.	Survey of Hearing Conservation Programs in Industry	---	in-house
10.	Impact-Type Noise Exposure and Control in Industry	---	60K
11.	Noise Effects on Non-Auditory Sensory Functions and Performance	---	75K
12.	Temporary Threshold Shift in Hearing from High Level Noise Exposures	---	in-house
13.	Aspects of Ear Tolerance to Noise	---	50K
14.	Guides to Noise Control	---	73K

* 50K obtained via interagency agreement from FAA.

TABLE I (continued)

	Research or Training Grant	FY 71	FY 72
1.	Damage Risk Criteria for Intermittent Noise Exposure	40K	33K
2.	Training Program in Acoustic Environmental Control	102K	100K
3.	Behavioral Toxicity of Noise in Immature Mice	10K	---
4.	Effects of Three Sound Environments on Human Behavior	---	7K
5.	Responses of Pre-Damaged Ear	---	26K
6.	An Objective Method for Evaluating Ear Protectors	30K	30K

ATTACHMENT A

ACTIVE NINDS RESEARCH GRANTS--KEYDEXED (Indexed) on NOISE

*(NS 3782 and NS 6459 also on Sound Trauma Deafness)

5/24/71

TYPE	GRANT NUMBER PROGRAM CLASS	GRANT PERIOD	PRINCIPAL INVESTIGATOR, INSTITUTION LOCATION, PROJECT TITLE	IRG	FY PD		FUNDS
5	R01 NS 03451-10 20 -F1-C	01-01-71 12-31-71	SINGLETON, GEORGE T UNIVERSITY OF FLORIDA GAINESVILLE FLORIDA RANDOM NOISE ANALYSIS IN VESTIBULAR EVALUATION	CMS	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	31,721 20,790 30,647 0 0
* 5	R01 NS 03782-09 20 -A5-C	01-01-70 04-30-71	GONZALEZ, L GERARDO TULANE UNIVERSITY NEW ORLEANS LOUISIANA HISTOPATHOLOGY OF TEMPORAL BONES	CMS	70	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	20,766 0 0 0 0
3	R01 NS 03782-09S1	01-01-70 01-07-71	GONZALEZ, L GERARDO TULANE UNIVERSITY NEW ORLEANS , LOUISIANA HISTOPATHOLOGY OF TEMPORAL BONES	CMS	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	0 0 0 0 0
	20 -A5-C						
5	R01 NS 05464-07 201-F1-C	01-01-71 12-31-71	PICKETT, JAMES M GALLAUDET COLLEGE WASHINGTON DIST OF COL PERCEPTION OF COMPLEX AUDITORY STIMULI BY THE DEAF	CMS	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	66,896 53,870 60,944 0 0
* 5	P01 NS 06459-06 2C -E4-C	02-01-71 01-31-72	MOORE, PAUL UNIVERSITY OF FLORIDA GAINESVILLE FLORIDA A COMMUNICATION SCIENCES RESEARCH PROGRAM	NSPB	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	225,339 218,234 0 0 0
5	R01 NS 06940-06 201-F1-C	12-01-70 11-30-71	GREEN, DAVID M UNIV OF CALIFORNIA SAN DIEGO SAN DIEGO CALIFORNIA MASKING MECHANISMS	CMS	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	44,355 0 0 0 0
2	P15 NS 07790-04 201-E3-C	01-01-71 12-31-71	BILGER, ROBERT C PITTSBURGH-UNIVERSITY OF PITTSBURGH PENNSYLVANIA AUDITORY DYSFUNCTION THE COCHLEA	NSPB	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	89,461 73,037 73,759 75,097 77,371
5	R01 NS 09029-02 [illegible]2-E6-C	01-01-71 12-31-71	SCHUBERT, EARL D STANFORD UNIVERSITY STANFORD CALIFORNIA LISTENER CHARACTERI[illegible]S IN AUDITORY DETECTION	CMS	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	43,420 0 0 [illegible] [illegible]

ACTIVE NINDS RESEARCH GRANTS--KEYDEXED (Indexed) on SOUND TRAUMA DEAFNESS 5/24/71

(NS 3782 and NS 6459 also on Noise)

TYPE	GRANT NUMBER PROGRAM CLASS	GRANT PERIOD	PRINCIPAL INVESTIGATOR, INSTITUTION LOCATION, PROJECT TITLE	IRG	FY PD	FUNDS	
5	R01 NS 02167-12 282-B3-C	09-01-70 08-31-71	SIMMONS, F BLAIR STANFORD UNIVERSITY STANFORD CALIFORNIA CORRELATIONS OF ELECTROPHYSIOLOGICAL MEASURES OF HEARING	CMS	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	50,752 41,895 0 0 0
* 5	R01 NS 03782-09 28 -A5-C	01-01-70 04-30-71	GONZALEZ, L GERARDO TULANE UNIVERSITY NEW ORLEANS LOUISIANA HISTOPATHOLOGY OF TEMPORAL BONES	CMS	70	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	28,766 0 0 0 0
3	R01 NS 03782-09S1	01-01-70 01-07-71	GONZALEZ, L GERARDO TULANE UNIVERSITY NEW ORLEANS LOUISIANA HISTOPATHOLOGY OF TEMPORAL BONES	CMS	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	0 0 0 0 0
	28 -A5-C						
5	P01 NS 03856-09 281-E3-C	10-01-70 09-30-71	HIRSH, IRA J CENTRAL INSTITUTE FOR DEAF SAINT LOUIS MISSOURI AUDITORY COMMUNICATION AND ITS DISORDERS	NSPB	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	393,224 420,335 440,162 460,770 0
5	R01 NS 04403-09 281-A5-C	12-01-70 11-30-71	WARD, W DIXON MINNESOTA UNIVERSITY OF MINNEAPOLIS MINNESOTA THE DETERMINATION OF SUSCEPTIBILITY TO HEARING LOSS	CMS	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	29,626 28,275 0 0 0
5	R01 NS 05065-08 28 -A5-C	01-01-71 12-31-71	HAWKINS, JOSEPH E, JR MICHIGAN UNIVERSITY OF ANN ARBOR MICHIGAN MICROSCOPIC STUDIES OF THE INNER EAR	CMS	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	53,396 40,667 0 0 0
5	R01 NS 05083-06 281-E3-C	01-01-71 12-31-71	HAYDEN, ROYAL C, JR HENRY FORD HOSPITAL DETROIT MICHIGAN INFLUENCE OF THE TYMPANIC MUSCLE INTEGRITY	CMS	71	CURR AWARD 1ST FUT YR 2ND FUT YR 3RD FUT YR 4TH FUT YR	12,111 0 0 0 0

ACTIVE NINDS RESEARCH GRANTS--KEYDEXED (Indexed) on SOUND TRAUMA DEAFNESS 5/24/71

* (NS 3782 and NS 6459 also on Noise)

TYPE	GRANT NUMBER PROGRAM CLASS	GRANT PERIOD	PRINCIPAL INVESTIGATOR, INSTITUTION LOCATION, PROJECT TITLE	IRG	FY PD		FUNDS
5	P01 NS 05705-06 281-A5-C	09-01-70 08-31-71	LAWRENCE, MERLE MICHIGAN UNIVERSITY OF ANN ARBOR MICHIGAN CAUSES OF DEAFNESS	NSPA	71	CURR AWARD	355,576
						1ST FUT YR	367,512
						2ND FUT YR	0
						3RD FUT YR	0
						4TH FUT YR	0
* 5	P01 NS 06459-06 2C -E4-C	02-01-71 01-31-72	MOORE, PAUL UNIVERSITY OF FLORIDA GAINESVILLE FLORIDA A COMMUNICATION SCIENCES RESEARCH PROGRAM	NSPB	71	CURR AWARD	225,339
						1ST FUT YR	210,234
						2ND FUT YR	0
						3RD FUT YR	0
						4TH FUT YR	0
5	R01 NS 07900-05 281-F1-C	05-01-70 04-30-71	KRYTER, KARL D STANFORD RESEARCH INST MENLO PARK CALIFORNIA NOISE-INDUCED DEAFNESS--MASKING AND SPEECH PERCEPTION	CMS	70	CURR AWARD	123,010
						1ST FUT YR	81,299
						2ND FUT YR	84,051
						3RD FUT YR	0
						4TH FUT YR	0
5	R01 NS 08000-03 282-C3-C	04-01-70 03-31-71	MATSCHINSKY, FRANZ M WASHINGTON UNIVERSITY SAINT LOUIS MISSOURI ENERGY METABOLISM OF AUDITORY SENSORY STRUCTURES	CMS	70	CURR AWARD	31,302
						1ST FUT YR	0
						2ND FUT YR	0
						3RD FUT YR	0
						4TH FUT YR	0

GRANT NUMBER PROGRAM CLASS	GRANT PERIOD		PRINCIPAL INVESTIGATOR, INSTITUTION LOCATION, PROJECT TITLE	IRG	FY PD	FUNDS	
1 NS 02974-10	02-01-71	01-31-72	STEVENS, S SMITH	CMS	71	CURR AWARD	41,315
2-F1-C			HARVARD UNIVERSITY			1ST FUT YR	0
			CAMBRIDGE MASSACHUSETTS			2ND FUT YR	0
			PSYCHOPHYSICS AND HEARING			3RD FUT YR	0
						4TH FUT YR	0

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
WASHINGTON, D. C. 20410

OFFICE OF THE UNDER SECRETARY

IN REPLY REFER TO:

SEP 27 1971

Dr. Albert F. Meyer, Jr.
Director
Office of Noise Abatement
and Control
Environmental Protection Agency
Washington, D. C. 20460

Dear Dr. Meyer:

This is in reply to your request of July 30, 1971, for information on HUD's Noise Control and Abatement activities.

The involvement of HUD in the noise control and abatement areas stems largely from its support of the national goal of "a decent home in a suitable environment for every American family." This goal appeared first in the National Housing Act of 1949. It has been reaffirmed in the interim years and reinforced by the Department of Housing and Urban Development Act of 1965 and the National Environmental Policy Act of 1969.

Pursuant to this goal, HUD has been interested in noise policy and standards regarding:

1. site selection for the housing HUD insures or subsidizes;
2. structural characteristics and components of housing HUD insures or subsidizes;
3. land use planning; and
4. other forms of assistance that support the concept of a decent home in a suitable environment.

Noise control and abatement is not a separate and distinct program within HUD but rather, an ingredient in the environmental considerations of all HUD programs and activities.

In this context, HUD has recently consolidated, simplified and extended various noise control requirements relating to the several HUD programs into a single Department-wide Circular 1390.2, published August 4, 1971. We attach a copy. Prior to publication, this circular was reviewed by the Environmental Protection Agency, the Department of Health, Education and Welfare and numerous other Federal, State, and local groups and private citizens. Although HUD's interim standards have been found appropriate by reviewers, the Department plans to consider revision after a reasonable period of experience. The Department also has a continuing research activity in this area.

In order for the HUD Circular to be fully effective, it is necessary that builders and the State and local comprehensive planning agencies have knowledge of the HUD noise control policies and standards -- we are providing a direct mail out to planning agencies on this -- and also that they have a convenient way of getting reliable, objective calculations of noise levels around airports, major highways, and other sources of high noise.

Although we had earlier hoped that the Department of Transportation would provide Noise Exposure Forecasts to HUD as well as to the comprehensive planning agencies across the Nation free of charge, it now appears to DOT that the calculations can be provided to planning agencies only on a "cost reimbursement basis." Although we understand DOT's views, the result is to limit severely the role and initiatives of the local planning agencies in assessing and controlling noise and in improved land use planning as regards noise.

Accordingly, we believe it highly desirable for EPA to consider providing Noise Exposure Forecasts and other noise control data as part of its coordinative role in protecting the noise environment.

Sincerely yours,

Charles J. Orlebeke
Deputy Under Secretary

Enclosures

FEDERAL NOISE PROGRAM INFORMATION

I. Organizational

Department of Housing and Urban Development (see cover letter)

II. Functional

A. Objectives (see cover letter)

B. Specific Research

1. On-Going Projects

a. Technical Background for Noise Abatement in HUD Operating Programs

(1) Description and Objectives:

This project provides the technical support to assist in implementation of the Departmental Circular 1390.2.

(2) Products Include:

(a) Site assessment techniques that do not require the use of acoustical measurement instrumentation for preliminary screening of applications to determine suitability of the site with regard to noise exposure.

(b) Interim procedures for the measurement of noise exposure at proposed housing sites.

(c) A technical support document for use as a reference by field personnel.

(d) Training materials, including a demonstration tape recording.

b. Development of Comprehensive Urban Noise Survey Methodology

(1) Description

This is the initial phase of a cost-shared research project with the City of New York which is designed to assist the

Department with obtaining factual information that may be used in the conduct of its programs in a large city as well as to provide New York City with tools whereby it can deal with its urban problems.

(2) Objectives

The objective of this first phase is to develop a statistically valid methodology for objectively obtaining information by which to characterize the baseline noise climate of the City of New York.

c. Metropolitan Aircraft Noise Abatement Policy Studies

J.F. Kennedy International Airport, New York, N.Y.
Tri-State Transportation Commission;

O'Hare International Airport, Chicago, Illinois,
Northeastern Illinois Planning Commission;

Bradley International Airport, Windsor Locks, Connecticut,
Capitol Region Planning Agency;

Cape Kennedy Regional Airport, Melbourne, Florida,
East Central Florida Regional Planning Commission

(1) Description

These four studies, funded jointly by HUD and the Department of Transportation, are currently in their final stages of completion. Each of the four planning agencies examined the problem of aircraft noise in the communities located near its airport. Various land-use-related measures were evaluated for their potential for alleviating existing problems and preventing future problems from arising in the environrons of the study airports.

(2) Objectives

The objectives are to provide in-depth case studies of the airport noise/community conflicts in specific airport areas to represent a range of potential noise alleviation strategies.

d. Summary of MANAPS and Development of a Planning Guidelines Manual

(1) Description

This is presently being negotiated as a follow-up study to the four original MANAPS. It will summarize the findings of the MANAPS and other similar studies, and evaluate each of the remedial and preventive measures for broader application over the nation. This, along with a discussion of the compatibility of different land uses to various levels of noise exposure, will be included in a planning guidelines manual to be used by planning officials.

(2) Objectives

The follow-up study is intended to make the information gathered by the MANAPS more useful to local officials concerned with airport noise. It is also intended to incorporate the knowledge gained in other studies into the MANAPS.

2. Projects About to be Contracted for or Under Active Consideration for F.Y. 1972

a. HUD Community Noise Handbook

(1) Description

A practical reference handbook for use by HUD personnel, planners, civic officials, developers and builders.

(2) Objectives

The objective is to provide a practical handbook that will be useful to the non-specialist. It will deal with feasibility of alleviating existing problems and guide planning to avoid creation of future noise problems.

b. Comprehensive Urban Noise Survey

(1) Description and Objectives

Upon satisfactory completion of Phase I development of the methodology, Phase II will assist New York City in conducting the comprehensive survey to document the baseline noise climate as well as to provide the HUD Regional Office with detailed objectives information of the City of New York.

c. Urban Noise Survey Methodology for Intermediate-Size City

(1) Description and Objectives

The purpose of this study is to review and evaluate the methodology developed for use in New York City to determine its applicability to much smaller cities. Necessary revisions will be made and tested in an actual noise survey.

d. Development of Noise Exposure Measurement Instrumentation

(1) Description and Objectives

The purpose of this project is to modify existing or develop new instruments suitable for easy use in determining site noise exposure pursuant to the interim standards of HUD Policy Circular 1390.2.

e. Engineering Guidelines for "Suitable Noise Control Feasures"

(1) Description

In some instances, mitigating circumstances may cause the Regional Administrator to make exceptions for sites that would be found "normally unacceptable." In those cases, noise control features must be included in the site design and building construction.

(2) Objectives

The objective is to provide HUD field personnel with technical guidelines for techniques of minimizing adverse impact of environmental noise on sites proposed for participation in HUD programs.

f. Evaluation of Site Noise Exposure Assessment Techniques

(1) Description and Objectives

The objectives are to evaluate, improve and augment the non-instrumental techniques for screening proposed housing sites with respect to their noise exposure.

g. Development of Model Ordinances and Building Code Sections

(1) Description and Objectives

(a) One purpose is to develop model ordinances, zoning and others for noise abatement and control that would avoid incompatible land use with respect to noise.

(b) Another purpose is to develop building code sections that would be used as models for specifying the performance of buildings in providing acoustical privacy.

h. Noise Emission Ratings for Appliances and Equipment

(1) Description and Objectives

The purposes of this study are (a) to foster the creation of a national mechanism to provide noise emission ratings for kitchen appliances and other equipment for single- and multifamily structures, and (b) to develop HUD noise emission standards for approving the use of such appliances and equipment in HUD-insured and HUD-assisted housing.

C. Procedures (refer to HUD Circular 1390.2)

1. Problem areas and research needs are identified by field personnel who implement the Departmental programs and HUD Circular 1390.2. Research priorities are assigned fundamentally on the basis of incidence of problem, need and overall benefit to the community.

2. Specific actions to abate and control noise mainly deal with efforts to avoid exposure of new residential areas and to provide a suitable auditory environment both outside and within residential buildings.

3. Procedures for coordination with other Federal agencies include participation in the Interagency Aircraft Noise Abatement Program, where HUD chairs the Land Use/Airports Panel and the Structures Panel.

Coordination and cooperation with other agencies on research efforts is accomplished through direct communication between principals responsible for research in the respective agencies. Further coordination is provided through development and review of environmental impact pursuant to Section 102(2)(c) of P.L. 91-190, National Environmental Policy Act of 1969.

4. In-house technical capability consists of several professionals in acoustics in HUD's research office and planning in HUD's Office of Community Planning and Management. Consultants are used by Central and field offices as required.

5. Proposed new efforts to upgrade noise abatement and control includes a training session for all HUD personnel responsible for environmental matters. The training program will assist in the implementation of the Departmental policy 1390.2 by including instruction in the use of site assessment procedures as well as in fundamental noise measurement instruments and procedures.

D. Future Program Proposals and Objectives

Future program proposals include development of better methodologies and techniques for determining community response to noise; improved performance of structures; significant investigations of air rights structures; economic and social aspects of noise abatement and control related to HUD operating programs.

U. S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

TRANSMITTAL NOTICE

1390.2

8/4/71

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1. This Notice transmits the following:
   Departmental Circular 1390.2, Noise Abatement and Control: Departmental Policy, Implementation Responsibilities, and Standards.

2. Explanation of Material Transmitted:
   This Circular establishes noise exposure policies and standards to be observed in the approval or disapproval of all HUD projects. This Circular supersedes those portions of existing program regulations and guidance documents which have less demanding noise exposure requirements. The Circular (see paragraph 3) calls for prompt administrative actions both by Assistant Secretaries to incorporate new noise policies and standards in their program regulations and other central office instructions, and by Regional Administrators to identify existing problem cases.

3. Filing Instructions:
   Insert:
   1390.2

UDE:DISTRIBUTION: W-1, W-2, W-3, W-4
R-1, R-2, R-3, R-4, R-5

CIRCULAR

1390.2

8/4/71

SUBJECT: Noise Abatement and Control: Departmental Policy, Implementation Responsibilities, and Standards

1. PURPOSE AND AUTHORITY. It is the finding of the Department of Housing and Urban Development (HUD) that noise is a major source of environmental pollution which represents a threat to the serenity and quality of life in population centers. Noise exposure may be a cause of adverse physiological or psychological effects as well as economic losses. Accordingly, it is the purpose of Departmental policy to call attention to this threat, to encourage the control of noise at its source in cooperation with other Federal departments and agencies, to encourage land utilization patterns for housing and other municipal needs that will separate uncontrollable noise sources from residential and other noise-sensitive areas, and to prohibit HUD support to new construction on sites having unacceptable noise exposures.

   This circular thus provides policy to guide the exercise of discretion afforded in legislation on the various HUD programs. The circular is based on authority provided in:

   a. The Department of Housing and Urban Development Act of 1965 (PL 89-174) which provides that the Secretary may make such rules and regulations as may be necessary to carry out his functions, powers, and duties, and sets forth, as a matter of national purpose, the sound development of the Nation's communities and metropolitan areas; and

   b. The National Environmental Policy Act of 1969 (PL 91-190) which directs Federal Agencies to develop procedures to carry out the purposes of this Act.

2. POLICY

   a. Foster Standards and Consumer Protection. It is HUD's general policy to foster the creation of controls and standards for community noise abatement and control by general purpose agencies of State and local governments, and to support these activities by minimum national standards by which to protect citizens against the encroachment of noise into their communities and places of residence.

(1) Planning assistance. HUD requires that noise exposures and sources of noise be given adequate consideration as an integral part of urban environments in connection with all HUD programs which provide financial support to planning. This consideration shall be of a form that provides assurance that new housing and other noise sensitive accommodations will not be planned for areas whose current or projected noise exposures exceed the standards cited herein. In this regard, HUD places particular emphasis on the importance of compatible land use planning in relation to airports, other general modes of transportation, and other sources of high noise, and supports the use of planning funds to explore ways of reducing environmental noise to acceptable exposures by use of appropriate methods. Reconnaissance studies, and, where justifiable, studies in depth for noise control and abatement will be considered allowable costs.

(2) New construction. HUD discourages the construction of new dwelling units on sites which have, or are projected to have, unacceptable noise exposures*, by withholding all forms of HUD's assistance for such dwelling units. This policy applies also to college housing, group practice facilities, non-profit hospitals and nursing homes. (*See paragraph 4, Standards).

(3) Existing construction (including Rehabilitation). HUD considers environmental noise exposure an important factor in determining the amounts of insurance and other assistance. Within cost restrictions, including those set by market forces, HUD encourages modernization efforts for buildings in noisy environments when such efforts improve the noise exposure environments without substantially increasing the life of the structure. When modernization or rehabilitation would substantially increase the life expectancy of the structures, it is HUD's policy to apply noise exposure standards closer to those applicable to new construction.

(4) Grants and allowances. HUD extends such assistance to State and local governments for the alleviation of community noise as may be provided for by the Congress and as appropriate.

(5) Information and guidance (Research and publication). HUD maintains a continuing program designed to provide new knowledge of noise abatement and control to public and private bodies, to develop improved methods for anticipating the encroachment of higher noise exposures and to deal with this encroachment and to foster better understanding of the consequences of noise. Dissemination will be made through appropriate channels.

(6) Construction equipment, building equipment and appliances. HUD encourages the use of quieter construction equipment and methods in population centers, the use of quieter equipment and appliances in buildings and the use of appropriate noise abatement techniques in the design of residential structures and other structures with potential noise problems. In appropriate circumstances, HUD will allow certain additional costs for quieter construction equipment.

(7) Acoustical privacy in multifamily dwellings. HUD encourages the use of building design and acoustical treatment to afford acoustical privacy in multifamily dwellings.

(8) Advice and cooperation. HUD welcomes advice and counsel on improved methods for dealing with the noise problem, and encourages cooperation with other units of government as well as with appropriate private and voluntary organizations.

b. Promulgate Minimum Standards. It is HUD's further general policy to promulgate minimum standards and guidelines with respect to noise abatement and control, to utilize such standards and guidelines as a uniform national policy to guide HUD program decisions, and to support appropriate existing policies and standards of State and local governments designed for noise control and abatement. In this regard, noise exposures will be divided into three groupings (to be defined in "Standards"):

(1) acceptable

(2) discretionary
--normally acceptable
--normally unacceptable

(3) unacceptable

3. IMPLEMENTATION RESPONSIBILITIES

a. Assistant Secretaries. Each Assistant Secretary shall promptly incorporate by reference the Departmental noise abatement and control policy, standards and guidelines into appropriate regulations, guidance documents, and administrative forms and procedures for programs under his jurisdiction, including guidance for A-95 notification and review. Further, each Assistant Secretary shall evaluate the effects of, and compliance with, Departmental policy, and identify program areas under his jurisdiction in which additional noise control and abatement standards or guidelines are needed.

b. Regional Administrators and Area and Insuring Office Directors

(1) One-time Report of Existing Problem Cases. Using this policy statement as a common interpretation of existing HUD program policies, each Regional Administrator based on surveys by Area and Insuring Office Directors, shall identify active and pending applications in his region which are problem cases. Any cases for which the Regional Administrator intends to seek an exception action by the Secretary should be forwarded to the Deputy Under Secretary, along with a draft Environmental Statement. This should be accomplished within 90 days of the effective date of this policy.

(2) General Policy Implementation. Regional Administrators and Area and Insuring Office Directors shall assure that this policy and the prevailing standards and guidelines are implemented in relation to all decisions and recommendations taken in their jurisdiction, effective from the date of this policy, and that specialized noise abatement and control policies now associated with individual HUD programs are conscientiously enforced.

(a) Exceptions to this policy, e.g., the approval of actions in the range of unacceptable noise exposures, are strongly discouraged. Any exception to approve sites with unacceptable noise exposures must be accompanied by a Section 102(2)C Environmental Statement (see para 3c below), and must be concurred in by the Secretary with the advice of the appropriate Assistant Secretary. Such matters should be referred to HUD Headquarters in the earliest possible stage in the decision process. After common interpretation has been established, the possibility of further delegation will be reviewed.

(b) Authority to Approve New Sites. Administratively, decisions with respect to proposed housing sites with clearly acceptable noise exposures should be delegated to the lowest possible levels within field offices. Certain positive decisions to go ahead with sites with intermediate noise exposures are to be concurred in by the Regional Administrator (see para. 4b(1). The Regional Administrator shall use his discretion, and if he is of the opinion that an important precedent or issue of national significance is involved, he shall refer the case, with recommendations, to the Secretary prior to decision. (See also paras. 3c and 4c).

(c) Surveillance of Noise Problem Areas. Regional Administrators, Area and Insuring Office Directors and all field personnel, as appropriate, shall maintain surveillance on possible noise problem areas and advise local officials and planning groups of the unacceptability of sites for noise reasons at the earliest possible time in the decision process. Subsequent to the cleanup of backlog pursuant to paragraph 3b(1) above, it is not anticipated that there will be a need to make exceptions to this policy on the basis that the unacceptable sites have been "in planning" for numerous years.

(d) Assessments and Projections of Sound Exposures. In order to assure adherence to the guidelines and standards, it is the further responsibility of each Regional Administrator to require by appropriate means assessment or authoritative measurement and projections of sound exposures for at least five years (and longer if, there is a factual basis), with respect to applications and projects under review. Recommended measurement and procedures will be provided in the issuance of each new standard or guideline.

(e) Notice to applicants. At the earliest possible stage, HUD program administrators shall determine the suitability of the acoustic environment of proposed projects, and shall notify the applicant, existing or prospective, of any adverse or questionable situations.

(f) Interdepartmental Coordination. Regional Administrators shall foster appropriate coordination with other departments and agencies in the field, particularly the Environmental Protection Administration, the Department of Transportation, military base commanders and the Veterans Administration. The field offices of the Department of Transportation should be consulted for data on existing and projected noise in the vicinity of transportation media, including airports.

c. Environmental Statements. Detailed Environmental Statements, as defined by Section 102(2)C of PL 91-190 and implementing guidelines of the Council on Environmental Quality and this Department, shall be prepared to accompany any request for an exception to this policy circular and its standards and to accompany requests to approve those cases which fall into discretionary noise exposures which are "normally unacceptable." Final Environmental Statements shall be filed with the Council on Environmental Quality 30 days prior to making decisions on the exceptional cases.

d. Office of the Secretary. The Deputy Under Secretary in the Office of the Secretary shall review and coordinate the efforts under Assistant Secretaries, and provide Departmental Evaluation of compliance with this policy.

HUD-Wash., D. C.

4. STANDARDS.

a. Standards, incorporating both technical and policy considerations, will be promulgated on the basis of review of the nature of problem cases identified in the regions pursuant to paragraph 3b(1) above, and advice from consultants, R&D contracts as appropriate and further study by the Departmental Working Group on Noise. Technical noise assessment manuals may be issued by HUD to provide further guidance on noise assessment and measurement to facilitate implementation of this circular.

b. Interim Standards. The following interim standards are established. In applying these interim standards, projected noise exposures shall form the basis for decision. (See Appendix 1 for explanations of terms, definitions, and for background discussion.)

(1) External Noise Exposures: Sites for New Residential Construction (single or multifamily)

(See Chart, External Noise Exposure Standards for New Construction Sites, on following page)

CHART: EXTERNAL NOISE EXPOSURE STANDARDS FOR NEW CONSTRUCTION SITES (Measurements and projections of noise exposures are to be made at appropriate heights above site boundaries)

GENERAL EXTERNAL EXPOSURES dB(A)	AIRPORT ENVIRONS	
	CNR ZONE */	NEF ZONE */
UNACCEPTABLE		
Exceeds 80 dB(A) 60 minutes per 24 hours Exceeds 75 dB(A) 8 hours per 24 hours	3	C
(Exceptions are strongly discouraged and require a 102(2)C environmental statement and the Secretary's approval)		
DISCRETIONARY -- NORMALLY UNACCEPTABLE		
Exceeds 65 dB(A) 8 hours per 24 hours Loud repetitive sounds on site	2	B
(Approvals require noise attenuation measures, the Regional Administrator's concurrence and a 102(2)C environmental statement)		
DISCRETIONARY -- NORMALLY ACCEPTABLE		
Does not exceed 65 dB(A) more than 8 hours per 24 hours		
ACCEPTABLE		
Does not exceed 45 dB(A) more than 30 minutes per 24 hours	1	A

*/ See Appendix 1 for explanations of Composite Noise Rating (CNR) and Noise Exposure Forecast (NEF).

(2) Interior Noise Exposures (for new and rehabilitated residential construction).

(Note: the standards listed below are performance standards. The means required for achieving them will depend on, among other things, the external noise levels, the equipment and layout used in the building, and the noise attentuation characteristics of the building's floors and walls. These standards assume open windows unless other provision is made for adequate ventilation.)

(a) "Acceptable":

Sleeping Quarters. For the present time, HUD field personnel should consider existing and projected noise exposure for sleeping quarters "acceptable" if interior noise levels resulting from exterior noise sources and interior building sources such as heating, plumbing, and air conditioning

--do not exceed 55dB(A) for more than an accumulation of 60 minutes in any 24-hour period, and

--do not exceed 45dB(A) for more than 30 minutes during night time sleeping hours from 11 p.m. to 7 a.m., and

--do not exceed 45dB(A) for more than an accumulation of eight hours in any 24-hour day.

Other Interior Areas. HUD personnel should exercise discretion and judgement as to interior areas other than those used for sleeping. Consideration should be given to the characteristics of the noise, the duration, time of day, and planned use of the area.

(3) Insulation Between Dwelling Units

(a) "Unacceptable"

For multifamily structures, including attached single family units, floors and dividing walls between dwelling units having Sound Transmission Class (STC) of less than 45 are always unacceptable.

(4) Other land uses and existing housing. Until HUD establishes a broader range of noise exposure standards, HUD administration at all levels shall take noise into consideration in the development of policies and guidelines and in the review and decisions on specific projects. Wherever feasible, standards along the lines of the above shall be employed in a manner consistent with proposed uses, densities and construction types.

c. Philosophy in Application of Standards. HUD personnel in the exercise of discretion should be guided by a desire to prevent noise problems from coming into being and by an overall philosophy of encouraging the control of noise at its source. Particular attention should be paid to fostering land utilization patterns for housing and other municipal needs that will separate uncontrollable noise sources from residential and other noise-sensitive areas. HUD personnel should encourage use of the A-95 notification and review processes to detect potential noise problems as early as possible.

Richard C. Van Dusen
Acting Secretary

APPENDIX 1. EXPLANATION OF TERMS, DEFINITIONS AND ADDITIONAL BACKGROUND

1. Measurement and Noise Assessment Procedures. Technical definitions of acoustical terminology shall be those contained in the related current documents of the American National Standards Institute (ANSI) and the American Society for Testing and Materials (ASTM). There has been a proliferation of concepts and mathematical techniques relating to sound and human response to sound. Fundamental to most all noise assessment procedures are the physical measurement of sound pressure and the concept of a level expressed in decibels. (See Appendix 2.)

   a. Sound Pressure Level Expressed in Decibels. Noise ("unwanted sound") affects the human ear through physical changes in sound pressure superimposed on the static atmospheric pressure in the presence of sound. Sound pressure has units of force per unit area.

   When a sound level meter is used, Sound Pressure Level can be determined and expressed in decibels, dB. In this case, the decibel is a logarithmic value which is referenced to the faintest sound pressure detectable by the human ear. Those requiring a more precise definition or understanding of these terms are referred to the forthcoming HUD noise assessment manuals for further discussion.

   In this circular, the decibel values, dB(A), are for those sound levels measured using the A-weighting network of a standardized sound level meter. The A-weighting network most closely approximates the response of the human ear to noise.

   Relatively inexpensive and portable metering equipment is available for purchase or, in some cases, rental. Some of the portable metering equipment also permits the accumulation of time for which the noise level at the site exceeds a given decibel setting. Sound level meters shall conform to the specifications set forth in the appropriate documents of the American National Standards Institute.

   The sound level meter is useful for measuring steady state or persistent noise and for identifying maximum sounds of intermittent noise. The A-weighted sound level, dB(A), has also been used as a first approximation in characterizing transportion noise. More sophisiticated evaluations of aircraft noise include some modifications which consider additional factors and are expressed as perceived noise in decibels such as PNdB or EPNdB. These refinements are discussed at greater length in the HUD noise assessment manuals.

b. Noise Exposure. "Noise exposure" as used in this circular is generally a combination of a noise level in decibels and a time duration for that noise level. For example, sites where existing and prolonged noise exposures do not exceed 45 dB(A) for more than 30 minutes in any 24-hour period are acceptable.

c. Composite Noise Rating (CNR). The CNR is a calculated rating for aircraft noise based on maximum sound pressure levels during a flyover, frequency of occurrence, time of day and other variables. It has been adopted by the Federal Aviation Administration (FAA) to describe the noise produced by aircraft operations in the vicinity of airports. In FAA usage, the CNR takes into account the magnitude of the sounds of individual aircraft types, the number of operations of each type on each runway, and the time of day. The numerical value of CNR is related to an expected range of community response.

The FAA has calculated CNR's for a number of domestic airports, and has divided CNR's into three zones -- corresponding to our acceptable discretionary, and unacceptable, respectively -- according to the expected community response, as shown in the following chart:

Chart for Estimating Response of Residential Communities from Composite Noise Rating.

Composite Noise Rating		*Zone*	*Description of Expected Response*
Takeoffs and Landings	*Runups*		
Less than 100	Less than 80	1	Essentially no complaints would be expected. The noise may, however, interfere occasionally with certain activities of the residents.
100 to 115	80 to 95	2	Individuals may complain, perhaps vigorously. Concerted group action is possible.
Greater than 115	Greater than 95	3	Individual reactions would likely include repeated, vigorous complaints. Concerted group action might be expected.

When advice and guidance are required in the analysis of property sites in the vicinity of military airports, the request for existing data and projections should be made initially to the Commander of the military base and subsequently to his designee.

Definition and Calculation of Noise Exposure Forecasts (NEF) or Composite Noise Ratings (CNR) shall be in accordance with the current DOT-FAA practices.

d. Noise Exposure Forecasts (NEF). The NEF is a calculated environmental rating which refines and replaces the CNR calculations for aircraft by including corrections for the presence of pure tone and duration of peak levels within the composite of intermittent noise. As currently used, it has validity only for airports.

The Department of Transportation (DOT) is converting from CNR to Noise Exposure Forecasts (NEF's). DOT has a contract for the calculation of NEF's at some 29 commercial and general aviation airports, and will soon have an intramural capability for producing NEF's for any civil aviation airport. The new NEF ratings for areas around commercial airports should be sought through FAA Airport Regional Offices.*/

The following categories correspond roughly to the categories of community response calculated originally for CNR's (see above).

Noise Exposure Forecasts

Category	Rating	Disposition in HUD
A	less than 30	Acceptable
B	30 to 40	Discretionary
C	more than 40	Unacceptable

For data on anticipated noise levels in the vicinity of military airports, the request should be made initially to the Commander of the base and subsequently with his designee.

*/ Until December 31, 1971, interim requests for NEF's should be made directly to FAA's Office of Environmental Quality (Attention EQ-1, Washington, D. C. 20590. Requests should be limited to applicants' sites within about three miles of a runway during this period.

e. Sound Transmission Class (STC) is a single-number rating which provides an estimate of sound transmission loss performance of a wall or floor as related to airborne sound generated by a limited class of household sound sources. The higher the number the better the performance.

2. Concepts Relating to Adverse Consequences of Noise. Noise is objectionable for commonsense reasons because it destroys the serenity of one's environment. Beyond that there are a number of specific concepts or ideas relating to noise. Current research efforts are directed toward establishing firm findings about certain noise phenomena and their consequences.

a. General Hearing Loss or Damage. High intensity noises even of relatively short duration such as blasts or explosions are known to have destroyed or severely limited the hearing sense. Moreover, highly amplified rock-and-roll music, sports shooting, and other recreational uses might produce sound levels capable of producing hearing loss especially if exposures are prolonged or recurrent. Continuing exposures to levels exceeding 100dB(A) lead to temporary and, eventually, to permanent hearing loss.

b. Impaired Hearing for Speech Communication. Prolonged exposure to less intensive noise is known to impair hearing of speech communications. The following table shows the hearing impairment resulting from 8-hour exposures to industrial noise over a long period.

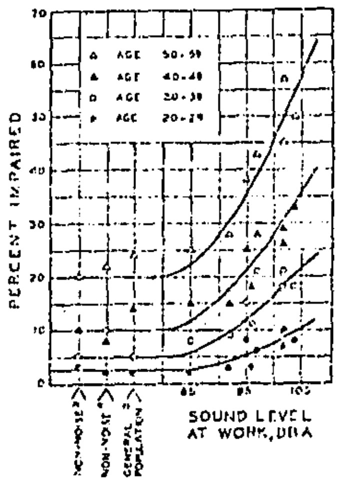


FIG. 1. Prevalence of impaired hearing in various populations. . .Each point indicates on the vertical scale the percentage of individuals having impaired hearing in a group exposed continuously at work to the A-weighted sound level indicated on the horizontal scale.

c. Speech Interference Levels. Background noise above certain levels interferes with one's ability to understand oral communication. The following figure illustrates some current knowledge of this phenomenon.

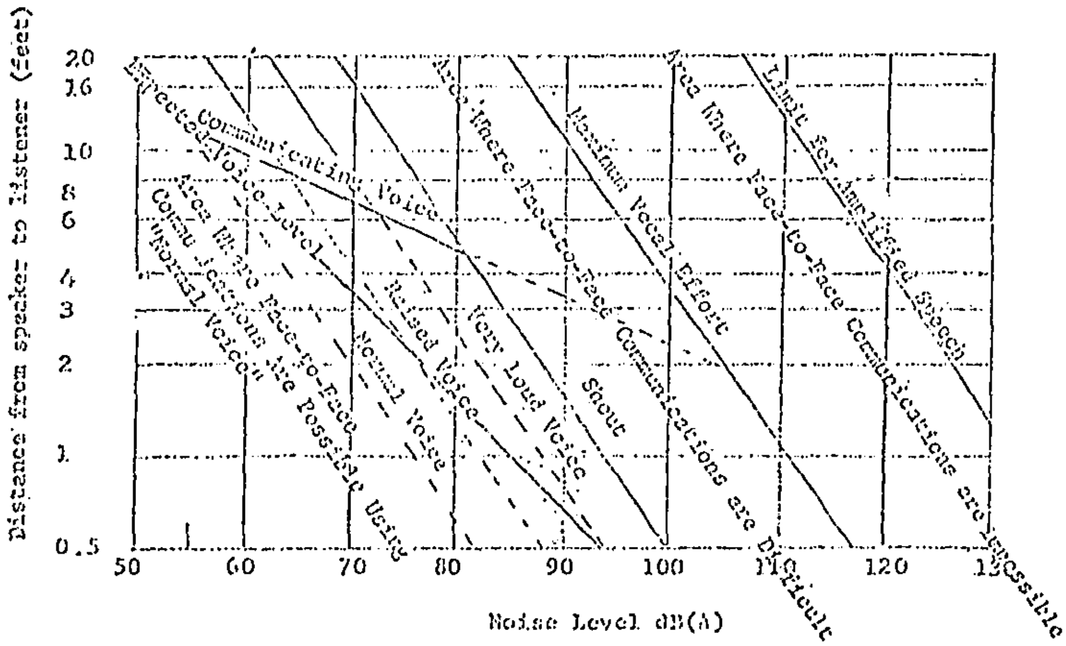


Figure 2 - Voice level and distance between talker and listener for satisfactory face-to-face speech communications as limited by ambient noise. Along the abscissa is the A-weighted sound level meter reading (dB(A)).

(SIL-Past, Present, and Future, J. C. Webster, Sound and Vibration, August, 1969)

d. Sleep Interference. Knowledge is less firm in this area and a series of qualifications is associated with many of the findings, including significant individual difference and becoming inured to certain noise levels (perhaps by hearing loss). Nevertheless, "sleep interference" would seem to have an important impact on the ability of the resident to achieve rest and enjoy his leisure, and hence must be considered.

e. Nervousness and Tension. There is a growing concern that exposure to the higher noise levels of the city might contribute to nervous disorders and tensions, but the findings are still inconclusive.

APPENDIX 2. SOUND LEVELS FOR COMMON NOISES
(Non-technical table for general perspective and background)

	dB(A)
JET PLANE, 100 FT. AWAY	130
PNEUMATIC RIVERTER	
ROCK MUSIC WITH AMPLIFIER	120
THRESHOLD OF FEELING PAIN	
THUNDER; DANGER OF PERMANENT HEARING LOSS	110
INTERNAL COMBUSTION AIRCRAFT ENGINE, 15 FT. AWAY	
BOILER SHOP; POWER MOWER	100
SUBWAY TRAIN PASSING STATION	
ORCHESTRAL CRESCENDO, 25 FT. AWAY; NOISY KITCHEN	90
CITY TRAFFIC (inside car); PNEUMATIC DRILL, 20 FT. AWAY	
PERSISTENT NOISE IMPAIRS HEARING FOR SPEECH COMMUNICATION (85 DECIBELS)	80
BUSY STREET	
INTERIOR OF DEPARTMENT STORE	70
AUTOMOBILE (AVERAGE) AT 35 to 40 M.P.H.	
ORDINARY CONVERSATION, 3 FT. AWAY	60
VACUUM CLEANER, 3 FT. AWAY	
QUIET AUTOMOBILE AT LOW SPEED	50
AVERAGE OFFICE	40
QUIET OFFICE	
CITY RESIDENCE	30
QUIET COUNTRY RESIDENCE	20
WHISPER, 5 FT. AWAY	
RUSTLE OF LEAVES	10
THRESHOLD OF HEARING	0

Sound levels can be measured with a mater and expressed in decibels. When used this way, the decibel is based on a comparison with the faintest sound that can be heard. The decibel scale is logarithmic; decibel levels cannot be added arithmetically. (See Appendix 1 and HUD noise assessment manuals for further discussion.)

DEPARTMENT OF LABOR

U.S. DEPARTMENT OF LABOR
OFFICE OF THE ASSISTANT SECRETARY FOR ADMINISTRATION
WASHINGTON, D.C. 20210

SEP 3 1971

Dr. Alvin F. Meyer, Jr.
Director
Office of Noise Abatement and Control
Environmental Portection Agency
1835 K Street, N. W.
Washington, D. C. 20006

Dear Dr. Meyer:

Your letter of July 30, 1971 to Mr. W. Scott Railton, requesting information regarding Department of Labor noise programs has been referred to me for reply.

The nature of the work performed by the Department does not, for the most part, result in objectionable noise, therefore, it has never had a noise control program. Noise control surveys have been conducted as part of regular safety inspections upon request of the Department safety officer. Rare noise complaints have been responded to with surveys, recommendations, and corrective action.

You have advised that we will be requested to conduct a survey to determine whether any of our activities are producing objectionable noise. Such a survey will be conducted upon receipt of the formal request and the survey guidelines.

Sincerely,

FRANK G. ZARB
Assistant Secretary
for Administration

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration
WASHINGTON, D.C. 20210

October 22, 1971

Mr. L. Justice
Office of Noise Abatement and Control
Environmental Protection Agency
Washington, D. C. 20460

Dear Mr. Justice:

In reply to your recent inquiries on noise control activities, we offer the following information about our compliance activities.

1. Our first noise Standard was published May 20, 1969 in the Federal Register. These were the Walsh-Healey Standards for Federal Supply Contracts over $10,000. Our standards covered many items of safety and health in addition to noise exposure.

2. On May 29, 1971, the U.S. Department of Labor's Occupational Safety and Health Administration published the Safety and Health Standards under the Williams-Steiger Occupational Safety and Health Act of 1970 (copy enclosed). These standards for noise are essentially the same as under the Walsh-Healey Standards of May 20, 1969.

3. I am enclosing a copy of our Bulletin 334 on "Guidelines to the Department of Labor's Occupational Noise Standards." It explains what we mean by "a continuing effective hearing conservation program."

4. We are working to get our field staff of compliance officers equipped to measure noise <u>in</u> workplaces. It is anticipated that we will have about 450 sound level meters in use early in 1972.

5. Our efforts on noise measurement and correction have been extensive since May 29, 1969. We have trained 70 of our key safety engineers and supervisors with the help of the Public Health Service and we plan to train others as time and facilities permit.

6. A number of firms have already been cited for violating our noise requirements. Much progress has been made in noisey plants throughout the country. The impact of our regulations has been felt far and wide as evidenced by the demand for speakers and by the fact that noise control and evaluation has been a favorite subject of many meetings and seminars.

Sincerely,

C. R. McClure

Charles R. McClure
Supervisory Industrial Hygienist
Office of Compliance Evaluation

Enclosures

Bulletin 334
(Revised 1971)

Guidelines To
The Department of Labor's
Occupational Noise Standards

U.S. DEPARTMENT OF LABOR
OCCUPATIONAL SAFETY
AND HEALTH ADMINISTRATION
WASHINGTON, D.C. 20210

GUIDELINES TO
THE DEPARTMENT OF LABOR'S
OCCUPATIONAL NOISE STANDARDS

Introduction

Noise has long been recognized as a cause of occupational loss of hearing. Some companies have for many years taken steps to reduce noise levels and the exposure of their employees to them. In promulgating noise standards under the Walsh-Healey Public Contracts Act, the Department of Labor merely made mandatory minimum standards which have proved both practical and effective in preventing hearing loss in many plants.

Measurement, control, and protection against noise is a somewhat technical subject and one with which plant management, which is responsible for the enforcement of safety regulations, may not be familiar. Therefore, this paper:

> First, explains the terms used in section 50-204.10 and later in section 1910.95 of the Occupational Safety and Health Standards, as amended and first published in the Federal Register on May 20, 1969.
>
> Second, explains just what is expected of the employer in order to be in compliance with the requirements.
>
> Third, specifies certain instruments, equipment, and procedures which will be acceptable as a basis for judging compliance. These latter points are of particular interest to technical personnel, either at the plant or engaged on a consultative basis, to assist them in developing and carrying out the required controls and procedures.

This paper is equally applicable to employers currently covered by the McNamara-O'Hara Service Contract Act and by the Williams-Steiger Occupational Safety and Health Act of 1970.

Determining Sound Level Exposures, and Permissible Limits

Basically, section 50-204.10 and section 1910.95 set maximum permissible noise levels and exposures, and explain the types of corrective action which must be taken if these noise levels are exceeded.

Paragraph (a) of this section states:

> "(a) Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table I of this section when measured on the A scale of a standard sound level meter at slow response . . . ."

Loss of hearing occurs as a result of the cumulative effect of exposure to sound above a maximum intensity and over a maximum duration in a given period of time. For the purpose of this standard, the basic permissible intensity is 90 dBA for a duration of 8 hours out of a day. The amount of sound energy absorbed during such an exposure is considered to be the upper limit of a daily dose which will not produce disabling loss of hearing in more than 20 percent of the exposed population.

Table I indicates the duration of exposure to higher sound intensities which will result in no more damage to hearing than produced by 8 hours at 90 dBA. Employees must not be exposed to steady sound levels above 115 dBA, regardless of the duration.

TABLE I

PERMISSIBLE NOISE EXPOSURES 1/

Duration per day, hours	Sound Level dBA slow
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

1/ When the daily noise exposure is composed of two or more periods of noise exposure at different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C1/T1 + C2/T2 \ldots Cn/Tn$ exceeds unity, then, the mixed exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specified noise level, and Tn indicates the total time of exposure permitted at that level.

The abbreviation dB in the right-hand column of the table stands for decibels, the unit of measurement of sound levels. The A scale is one of several on the sound level meter, a measuring instrument used to determine sound intensity. On this scale, the instrument reacts in much the same way as does the human ear in that it is much less responsive to low pitched tones than to those of higher pitch. The "slow" response is another setting of the instrument which causes it to average out high level noises of brief duration (such as hammering), rather than responding to the individual impact noises.

It is important to note that decibels are measured on a logarithmic rather than a linear scale. Every increase of 10 dB represents an increase of approximately 300 percent in sound pressure. A 100 dB noise is, therefore, 3 times as intense as a 90 dB noise, rather than about 10 percent more intense, as might be expected. Illustrated another way, if one machine produces a sound level of 90 dB, a second machine of the same kind placed next to it will result in a combined noise level of 93 dB, rather than 180 dB, which might be expected.

Exposures at Different Sound Levels

The footnote to Table I describes the method by which several separate exposures to different sound levels during a day are to be treated in determining whether or not the combined exposure is within permissible limits.

As an illustration, assume that an employee works most of the day in an area in which the sound level is 90 dBA, but for 15 minutes out of each of 7 hours, he is in an area of 100 dBA, and for one 15-minute period each day, he is in an area of 105 dBA.

This adds up to 6 hours at 90 dBA: permissible duration of exposure, 8 hours; 1-3/4 hours at 100 dBA: permissible exposure, 2 hours; and 1/4 hour at 105 dBA: permissible exposure, 1 hour. Tabulating it, we have:

	Actual Time	Permissible Time
dBA	C (hours)	T (hours)
90	6	8
100	1 3/4	2
105	1/4	1

Putting these values into an equation, we get:

$$\frac{6}{8} + \frac{1.75}{2} + \frac{0.25}{1} = \frac{6}{8} + \frac{7}{8} + \frac{2}{8} = \frac{15}{8} = 1.87$$

Since this total exceeds unity, the daily exposure is above the permissible limit, even though the total exposure at each sound level is below the permissible duration for that level.

No matter how briefly a person is exposed to higher sound pressure levels, if he spends the remainder of the day at a level of 90 dBA, his exposure will exceed the permissible limit. Only by being in an area having a sound level well below 90 dBA can his exposure to higher levels be compensated.

Assuming that the 6 hours are spent in areas of relatively low sound pressure levels, are the two exposures to higher levels permissible?

The equation becomes:

$$\frac{1.75}{2} + \frac{0.25}{1} = \frac{1.75 + 0.50}{2} = \frac{2.25}{2}$$ or 1.125. This is still greater than unity and, therefore, not permissible. Either the exposure to the 100 dBA level would have to be reduced to 1.5 hours or the exposure to the 105 dBA level to 0.125 hours or 7 1/2 minutes in order not to exceed the permissible total exposure.

$$\frac{1.5}{2} + \frac{0.25}{1} = \frac{2.0}{2} = 1 \text{ or } \frac{1.75}{2} + \frac{0.125}{1} = \frac{2.0}{2} = 1$$

Impulse or Impact Noise

The last sentence of sections 50-204.10 and 1910.95 states:

> "Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level."

This sets the upper limit of sound level to which a person should be exposed, regardless of the brevity of the exposure.

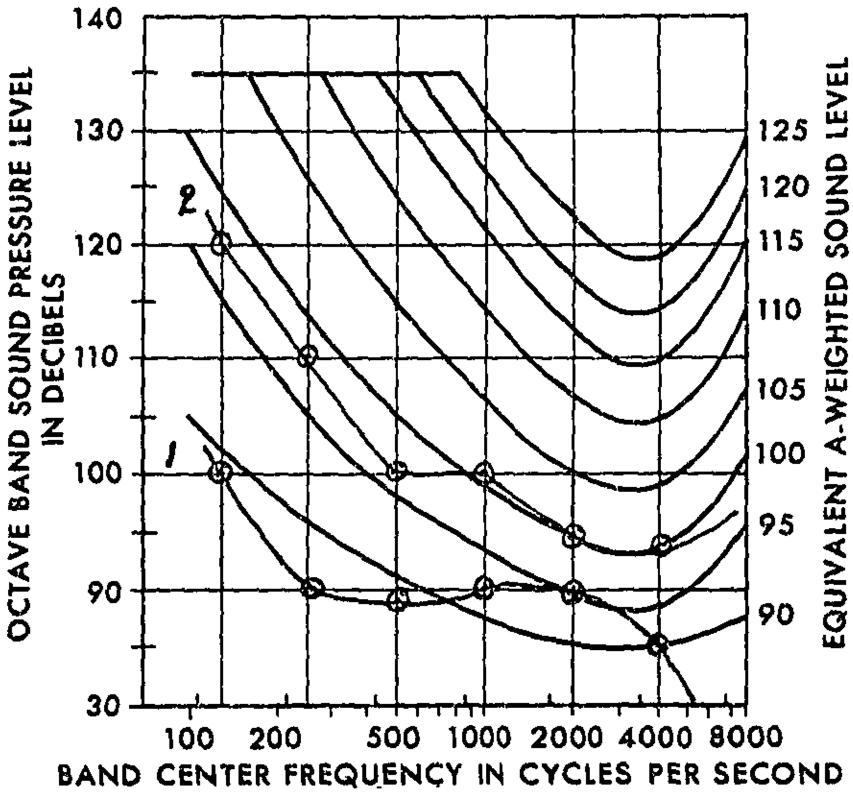
In contrast with the 115 dBA upper limit for steady noise, the higher intensity for impact noise is permissible because the noise impulse resulting from impacts, like hammer blows or explosive processes, is past before the ear has time to react fully. Impact noise levels are to be measured only with an impact meter or an oscilloscope.

Converting Octave Band Analyzer Readings

Many plants have done a great deal of noise control work based on measurements taken with the type of instrument that measures the sound level at each of a number of frequencies, or pitches, of the sounds produced rather than the overall total noise, as measured by the sound level meter. A chart is provided in the regulations to permit readings obtained from an octave band analyzer to be converted to corresponding values as indicated in Table I.

Sections 50-204.10 and 1910.95, paragraph (a), second sentence, state:

> When noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined as follows:



Equivalent sound level contours. Octave band sound pressure levels may be converted to the equivalent A-weighted sound level by plotting them on this graph and noting the A-weighted sound level corresponding to the point of highest penetration into the sound level contours. This equivalent A-weighted sound level, which may differ from the actual A-weighted sound level of the noise, is used to determine exposure limits from Table I.

The above graph illustrates in a general way what was said previously about the response of a sound level meter working on the A scale. It minimizes, as does the ear, the low frequency sounds and emphasizes, as does the ear, the high frequency sound. Thus, a 90 dB reading on the A scale may include as high as 105 dB at 125 cycles per second, but would accept no more than 89 dB at 2,000 and 4,000 cycles per second.

To illustrate use of the graph in converting octave band readings into A-scale sound level meter readings, two sets of values of octave band readings have been plotted. The series numbered 1 shows readings at or below the 90 dBA curve, except at 2,000 cycles per second, where the reading falls on the 95 dBA curve. In this case, the sound level for use of Table I should be taken as 95 dBA. In the series marked 2, all the readings are below the 100 dBA curve, except at 1,000 cycles, where the reading is just on the curve. One hundred dBA would therefore be the value to be used in Table I.

As noted in the explanation of the graph, the actual sound levels measured with a sound level meter on the A scale may differ somewhat from the values determined by plotting the readings from an octave band analyzer on the graph. These differences, for most sounds, are of the same order of magnitude as the errors to be expected in the measurement and are not important. The intention was to provide a simple and relatively accurate means of conversion from one system of measurement to another to accommodate existing, effective plantwide programs.

Variable Noises

Sections 50-204.10 and 1910.95 state the final consideration in determining whether or not a permissible sound level is being exceeded:

> "If the variations in noise level involve maxima at intervals of 1 second or less, it is to be considered continuous."

This means that where the sound level meter on the A scale at slow response moves up from a generally steady reading, say from 88 to 92 dB, at intervals of one second or less, the high reading shall be taken as that to be used in Table I.

As a corollary to this, intermittent sounds of brief duration at intervals greater than one second should, as far as practical, be measured as to intensity and duration and the total duration over a day be ascertained. This total should be entered in the equation given in footnote 1/, Table I, to determine the permissible limit. These intermittent sounds, which can be measured with a sound level meter, should not be confused with impulse sounds of very short duration resulting from impacts or explosions.

Control Measures

Paragraph (b) of sections 50-204.10 and 1910.95 refer to control measures to be taken:

> "(b) When employees are subjected to sound exceeding those listed in the Table of Permissible Noise Exposures, feasible administrative or engineering controls shall be utilized . . . ."

The Department of Labor considers "feasible" to mean the following, as stated in the Oxford English and Merriam-Webster Dictionaries: "Capable of being done, accomplished or carried out; capable of being dealt with successfully."

Engineering Noise Control Measures

Engineering controls are those which reduce the sound intensity either at the source of the noise or in the hearing zone of the workers.

The following are examples:

A. Maintenance

1. Replacement or adjustment of worn and loose or unbalanced parts of machines.
2. Lubrication of machine parts and use of cutting oils.
3. Properly shaped and sharpened cutting tools.

B. Substitution of Machines

1. Larger, slower machines for smaller, faster ones.
2. Step dies for single operation dies.
3. Presses for hammers.
4. Rotating shears for square shears.
5. Hydraulic for mechanical presses.
6. Belt drives for gears.

C. Substitution of Processes

1. Compression for impact riveting.
2. Welding for riveting.
3. Hot for cold working.
4. Pressing for rolling or forging.

D. Vibration Dampening

1. Increase mass.
2. Increase stiffness.
3. Use rubber or plastic bumpers or cushions.
4. Change size to change resonance frequency.

E. Reducing Sound Transmission Through Solids

1. Flexible mountings.
2. Flexible sections in pipe runs.
3. Flexible shaft couplings.
4. Fabric sections in ducts.
5. Resilient flooring.

F. Reducing Sound Produced by Fluid Flow

1. Intake and exhaust mufflers.
2. Fan blades designed to reduce turbulence.
3. Large, low speed fans for smaller, high speed fans.

G. Include Noise Level Specifications When Ordering New Equipment

H. Isolating Noise Sources

1. Completely enclose individual machines.
2. Use baffles.
3. Confine high noise machines to insulated room.

I. Isolating Operator

Provide a relatively sound-proof booth for the operator or attendant of one or more machines.

Controlling noise at the source, as illustrated by A through H1, is the ideal means of preventing noise induced hearing loss. The results are relatively long lasting; the operator of the individual machine is protected, as well as those employees at a distance from it, and there is no need for wearing protective equipment or following prescribed schedules of exposure. The measures listed under H2, H3, and I will, if effective, limit the number of persons exposed to high noise levels, but are unlikely to protect operators and those close to the noise sources.

A number of the listed controls can be accomplished quite inexpensively by plant personnel. Others require considerable expense and highly specialized technical knowledge to ensure the expected results. It is therefore strongly recommended that plants avail themselves of the services of competent acoustical engineers in planning and carrying out their noise control programs.

The Department of Labor expects employers to explore the possibility and practicability of controlling noise by engineering and to take all feasible measures before resorting to use of administrative controls or of personal protective equipment.

Administrative Controls

If noise cannot be reduced to permissible intensities through engineering controls, administrative controls should be developed in order to limit duration of workers' exposure to noise levels above 90 dBA to the times shown in the Table of Permissible Noise Exposures.

The following are examples:

1. Arrange work schedules so that employees working the major portion of a day at or very close to the 90 dBA limit are not exposed to higher noise levels.

2. Ensure that employees who have reached the upper limit of duration for a high noise level, in accordance with Table I, work the remainder of the day in an environment with a noise level well below 90 dBA.

3. Where the man-hours required for a job exceed the permissible time for one man in one day for the existing sound level, divide the work among two, three, or as many men as are needed, either successively or together, to keep individual noise exposure within permissible time limits.

4. If less than full-time production of a noisy machine is needed, arrange to run it a portion of each day, rather than all day for part of the week.

5. Perform occasional high level noise producing operations at night or at other times when a minimum number of employees will be exposed.

Measures such as these can often be instituted at little cost or effort, simply by introducing noise exposure as a factor in production planning. While not as satisfactory as controlling noise at its sources, administrative control measures are more easily enforced, than is the requirement to wear personal protective equipment. For this reason it is preferred.

Personal Protective Equipment

When engineering and administrative controls fail to bring noise levels or duration of exposure to them below permissible levels, the use of personal protective equipment is required, as stated in the second sentence of paragraph (b), sections 50-204.10 and 1910.95:

> "If such controls fail to reduce sound levels within the levels of the table, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table."

The use of personal protective equipment is considered by the Department to be an interim measure while engineering and administrative controls are being perfected. There will be very few cases in which the use of this equipment will be acceptable as a permanent solution to noise problems.

Some methods of control, such as providing an isolation booth for operators, or conducting noisy operations when few employees are in the plant, may require use of personal protective equipment by the operator when he must emerge from his booth to make adjustments, or by those few employees who carry on the noisy operation.

In addition, the regulations require both provision and use of personal protective equipment. How the latter is accomplished is up to the employer. The Department recommends, however, that an educational and promotional program precede initiation of required use of such equipment, and continue as long as necessary to achieve 100-percent acceptance by employees. In the absence of an observable high proportion of use, the Department would consider the lack of a training and promotional program as constituting a violation of the regulation.

Selection of Personal Protective Equipment

Cotton stuffed in the ears has little value and will not be accepted by the Department, because of the relatively small attenuation (reduction of noise level) and the care which must be taken in using it.

Fine glass wool can be used instead of cotton, because the attenuation which can be achieved is very good. It is an acceptable protective device.

Wax impregnated cotton, when properly inserted in the ear, provides protection equivalent to that provided by plugs or muffs. If supervisors can assure that this material is properly used and fresh material is provided daily, then this type of ear protection would be acceptable.

Properly fitted earplugs are essentially equal in attenuating ability to ear muffs; either is acceptable to the Department. Plugs are inexpensive but must be fitted to the individual. In addition, plugs, and any other type of protector inserted into the ear, must be issued by a trained person under the direction of a physician or by the physician himself. Frequent checks must be made to see that the plugs are being properly inserted.

Ear muffs, though relatively expensive, may be issued by any designated person in the plant, as the only fitting required is adjustment of the head band. This makes it very easy for the supervisor to check on proper use of the muffs. Long hair and spectacle or goggle temples will interfere with the seal made by the cushioned edges of the muffs and will correspondingly reduce the actual attenuation, as stated by the manufacturer.

Regardless of the type of ear protector decided upon, its attenuation, as stated by the manufacturer, must be sufficient to reduce the noise level in the worker's ear to the level and for the duration prescribed in Table I. The manufacturer's stated values are determined under ideal conditions, and, therefore, as a precaution, it is wise to assume that the attenuation actually attained in use in the shop will be at least 5 dB less than the stated value. Only those ear protectors which have been tested in accordance with ANSI standard Z24.22-1957, "Method for Measurement of the Real-Ear Attenuation of Ear Protectors at Threshold," are acceptable to the Department.

The Department strongly recommends that any employee who is exposed to high sound levels and requests ear protection be provided with it, even if the duration of exposure is within the limits prescribed by Table I.

Hearing Conservation Program

Sections 50-204.10 and 1910.95 conclude:

> "In all cases where the sound levels exceed the values shown herein, a continuing, effective hearing conservation program shall be administered."

Therefore, where the sound level in a working area has not been reduced to 90 dBA or below by engineering means, and reliance must be placed on administrative controls to limit duration of exposure, or on ear protection to reduce the sound level actually reaching the ear, a hearing conservation program is required. The program will be applied to all those employees whose work brings them either steadily or infrequently into areas in which sound levels exceed 90 dBA.

Definitions

"Continuing" means that the program will be in effect and in use as long as noise levels above 90 dBA occur in the plant.

"Effective" means that exposed employees will not suffer continuing deterioration of hearing acuity because of their exposure, but that incipient loss of hearing will be detected and necessary steps taken to prevent further deterioration before serious hearing loss has occurred.

In a broad sense, "hearing conservation" covers the entire range of actions required by sections 50-204.10 and 1910.95. As used here, however, it refers to audiometry--periodic checks on the hearing ability of individual employees; and noise surveys--periodic checks of the noise level in the areas in which employees are working.

Audiometry

Audiometric tests will be made of all individuals working regularly or ~~in~~frequently in areas in which the noise level is above 90 dBA. The purpose of these tests is to assure that administrative controls in use or ear protection devices provided are being adhered to or properly used and are effective in preventing loss of hearing from the noise levels encountered.

Audiometric tests may be made as frequently as specified by the plant's regular or consulting physician, but only under very special conditions shall they be made less than once a year.

The tests may be made in a doctor's office or elsewhere outside the plant, providing the test facilities, techniques, and records are equal to or exceed the minimum requirements described below.

1. Test Facilities and Procedures

   The test booth or room shall meet criteria of ANSI standard S3.1-1960 (or latest), "Standard for Background Noise in Audiometric Rooms" for testing to a minimum level of 10 dB on the ISO 1964 audiometric scale.

   The booth or room may be either prefabricated or locally built. Doors, gaskets, and other parts of the room or booth which may deteriorate, warp, or crack shall be carefully inspected periodically and necessary repairs or replacements made at once to ensure that successive audiometric tests of each individual are directly comparable and will give a true evaluation of the individual's hearing ability.

The operator of the audiometer should be positioned outside the room or booth but able to see the interior through a window. The person being tested must face away from the operator and the audiometer to ensure that all his responses are based on sound signals alone.

The test shall consist of an air conduction octave band analysis, as described in ANSI standard S3.1, and shall include, at least, 500, 1,000, 2,000, and 4,000 Hz.

The audiometric tests shall be made by a person trained and skilled in audiometric testing.

2. Audiometers

The audiometer used to make these tests shall meet the specifications for limited range, pure tone audiometers in ANSI standard S3.6-1969, "Specifications for Audiometers."

The audiometer shall have a certificate of calibration before it is placed in use, and shall be recalibrated each year thereafter. This calibration shall check both frequency and intensity at each setting, rise time and overshoot, and electrical and mechanical integrity. A current certificate attesting to such calibration shall be readily available for inspection by the Department of Labor.

On the audiometer shall be a statement indicating whether it is calibrated to ASA 1951 values or to the current American National Standard, which is identical to the ISO 1964 standard.

The audiometer shall be subjected to a biological check, preferably once a week but at least once a month, or before each use of the instrument if it is used less than once a month. The check shall be made by testing a person with a known and stable audiometric curve. The monthly check should include movement and bending of cord, wire, and lead, knob turning, switch actuating, and button pushing to ensure that there are no sounds other than the test tones. A log of these checks shall be maintained and be available for inspection.

3. Records

In addition to the certificates and logs referred to in 2 above, a record of each audiogram made on each individual tested shall be available for inspection. Records of audiometric tests shall indicate whether readings are based on ASA 1951 or on American National Standard (ISO 1964). The complete records on each employee required to be tested shall be retained for 1 year following termination of employment or transfer to an area in which noise levels above 90 dBA do not exist.

The records will be examined for evidence of any deterioration of hearing acuity and of action taken to prevent further deterioration in those employees found to suffer some loss of acuity. Conclusions as to effectiveness of control measures taken will be based on examination of a significant number of audiograms and not upon the basis of one or two cases.

4. Audiometric Tests Outside of Plant

If audiometric tests are done outside the plant, the Department of Labor representative will also inspect the facilities and test records, as noted above, and the same standards will apply.

Plant management will make arrangements for such inspection with the person conducting the audiometric tests and may accompany the representative in his inspection and review of records.

Noise Surveys

A noise survey of each area in the plant in which sound levels exceed 90 dBA shall be made at least once each year to ensure that sound levels have not increased above those originally existing. The survey may also establish that noise levels in some areas have been reduced to levels below 90 dBA and thereby justify discontinuing application of requirements for administrative controls, ear protection, and audiometric tests of individuals in such areas.

A noise survey of an area is recommended whenever a change is made in either equipment or type of operations so that significant changes in noise level will be acted upon immediately.

Tests of noise levels will be made with a sound level meter on the A-scale, slow response. The use of octave band analyzers or impact meters for control or other purposes shall be in addition to, not in place of, tests made with the sound level meter.

The sound level meter used will be one meeting specifications in ANSI standard S1.4-1961, "General Purpose Sound Level Meters."

Records will be made of such surveys showing: the instrument used; date, time, and location of such tests; machinery or equipment generating the noise; and name of person making the test.

Test records shall be kept readily available for inspection for 1 year or until a subsequent survey is made, if done more frequently.

The noise survey will be made by an insurance carrier, a consultant, a representative of a State health or labor department, or by a qualified individual designated by the company.

Compliance Plan

Whenever a noise survey shows noise levels in excess of those listed in Table I, necessary steps to reduce the noise exposure to or below those levels shall be ascertained and a detailed plan, with completion dates for individual steps, shall be prepared.

Following the original survey which shows existence of overexposures, the steps in a typical compliance plan might include the following, not necessarily in this order and some usually going on simultaneously:

1. A detailed survey of sound levels and sound spectra to determine the sources of excessive sound levels.

2. Initiation of engineering studies to determine methods for reducing sound levels at their sources.

3. Planning and initiation of feasible administrative controls, such as modifying production schedules to divide noisy jobs among enough people to bring each below the permissible limit or spreading part-time noisy operations.

4. Initial audiograms for personnel excessively exposed.

5. Installation of a personal protective equipment program.

6. Followup audiograms at appropriate intervals to assess effectiveness of the personal protective equipment program and administrative controls.

7. Installation of engineering controls, or process changes to reduce noises at their source.

8. Repeated noise surveys to measure effectiveness of the engineering changes.

When the compliance plan involves long term engineering projects (for example, 1 or 2 years) it may be revised from time to time as conditions change. The orderly completion, on schedule, of the various phases of the compliance plan, together with other components of the hearing conservation program, will be considered compliance with the regulation.

Applicable ANSI standards are available from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018

S1.4-1961 -- Specification for General Purpose Sound Level Meters--$2.75
S1.6-1967 -- Preferred Frequencies and Band Numbers for Acoustical Measurements--$2.75
S3.1-1960 -- Criteria for Background Noise in Audiometer Rooms--$2.75
S3.6-1969 -- Specification for Audiometers--$4.50

June 8, 1971

* U. S. GOVERNMENT PRINTING OFFICE : 1971 O - 444-788 (8)

DEPARTMENT OF TRANSPORTATION

AUG [illegible]

Dr. Alvin F. Meyer, Jr.
Director, Office of Noise Abatement
and Control
Environmental Protection Agency
1835 K Street, N.W.
Washington, D.C. 20460

Dear Dr. Meyer:

This is in response to your letter of July 29, 1971, requesting information dealing with Federal activities in noise effects, abatement and control.

In your meeting of August 6 questions were asked concerning the specific format of information required for the preparation of a report pursuant to Title IV of the Clean Air Act of 1970. At that time you stated that your office would format information provided we could furnish it to permit an evaluation that you need.

The Department of Transportation's functions with respect to noise abatement programs stem from the Department of Transportation Act of 1966 (P.L. 89-670), Section 4, which states that the Department will promote and undertake research and development relating to transportation, including noise abatement, with particular attention to aircraft noise. In addition, P.L. 90-411 provides for noise certification of aircraft. Funding is supported by the Transportation Planning, Research and Development (TPR&D) Appropriation of the Department.

Copies of the Department's First and Second Federal Aircraft Noise Abatement Plan have been furnished Mr. [illegible]. These documents outline our overall program objectives and list specific research efforts concerning aircraft noise reduction.

Pursuant to its transportation noise abatement research and development objectives, the Department employs the in-house technical capabilities of the Transportation Systems Center (TSC) at Cambridge, Massachusetts, as well as the services of outside contractors. Attached is a listing of the contractual projects of this office, with copies of write-ups for each. (See Attachment #1) Also attached are copies of our FY-1971 and FY-1972 Transportation Noise Abatement Project Plan Agreement with the Transportation Systems Center, together with a copy of their June 1971 technical progress report. (See Attachment #2)

With respect [illegible] procedures used for coordination, we use the Interagency Airc[illegible] se Abatement Program (IANAP) structure with which you are familia[illegible] addition, the Department and NASA have an agreement wherein all p[illegible]ed projects are reviewed prior to finalization. Within the Department we have a formal DOT Noise Abatement Committee which coordinates transportation noise abatement research and development activities across the board.

Extracts from the Department's FY-1972 Congressional Submission relating to transportation noise abatement are attached for your information. (See Attach[illegible]) The fiscal information has been corrected to reflect our latest plan[illegible] level to support these efforts.

An additional attachment (#4) is furnished to provide information pertaining to the personnel assigned within our Department to discharge transportation noise abatement responsibilities.

Regulation and certification authority is reposed within the Department under the auspices of the FAA pursuant to Public Law 90-411. This provides for noise certification of aircraft pursuant to Federal Air Regulation Part 36.

We hope this information will prove useful to you in preparing your report. If you need further assistance, please advise.

Sincerely,

Original Signed by
Charles R. Foster

Charles R. Foster
Director
Office of Noise Abatement

Enclosures - 4

TST-52 MRankin:ekk 8-27-71 x. 64558
TST-50 reading
TST-50 subject
TST-1
M.Rankin

~~29 April 1970~~
Updated 11/3/70

DOT-OS-00002

Start Date: 19 12 69

Estimated Completion Date: 12 72 (3-yr. effort)

Kind of Report: New

Performing Organization, Name: Department of Aerospace Engineering
University of Southern California
University Park
Los Angeles, California 90007

Principal Investigator, Name: John Laufer, Professor and Chairman
Department of Aerospace Engineering

Responsible Government Organization, Name: Department of Transportation
Assistant Secretary
for Systems Development and Technology
Office of Noise Abatement
800 Independence Avenue, SW
Washington, D.C. 20590

Responsible Government Individual, Name: W. Harry Close
Research Division
Office of Noise Abatement

Key Words: Basic research on jet engine noise and its abatement

Title: Modeling for Jet Noise

Summary: Develop engineering guidelines for the noise abatement of subsonic and supersonic jets. The program of basic research will be conducted over a period of three years. The first year's activity will include: a) the overall design and construction of the research facility: the anechoic chamber, the air supply system for the jet, the jet nozzle, the traversing mechanisms used for detailed measurements; b) development of special narrow angle microphones of electronic system for data processing; and c) preliminary measurements in a high subsonic "clean jet". In the second year plans are laid out to conclude the "clean jet" experiments to initiate the theoretical study on a source model, as well as to start an experimental and analytical work on the effects of initial conditions. Depending on the progress of this program, it is hoped that in the third year research on the supersonic jet noise problem could be initiated.

Resources Estimate, Funds: $529,000 for 3-yr. effort. First year - $236,166.
Second year - $126,863

Security of Report: Unclassified

Procurement Method: Grant Agreement.

~~29 April 1970~~
~~Updated September 1970~~
Updated May 15, 1971

DOT-OS-00035, Task Order #3

Start Date: 28 01 70

Estimated Completion Date: 01 71

Kind of Report: New

Performing Organization, Name: National Academy of Sciences
National Research Council
Division of Engineering
Highway Research Board

Principal Investigator, Name: W. N. Carey, Jr.
Executive Director, Highway Research Board

Responsible Government Organization, Name: Department of Transportation
Assistant Secretary
for Systems Development & Technology
Office of Noise Abatement
800 Independence Avenue SW
Washington, D.C. 20590

Responsible Government Individual, Name: ~~John G. Gourlas~~ W. Harry Close
Research Division
Office of Noise Abatement

Key Words: Advisory and information services for transportation noise

Title: NAS Services Trans Noise Abate

Summary: Provide four interrelated information services: 1) Advisory Services -- Information Storage, Retrieval and Synthesis: an Advisory Committee within the Highway Research Board of the National Research Council, National Academy of Sciences of approximately 8 experts in the various aspects of transportation noise will be appointed to advise on the scope, sources and input/output requirements of a storage and retrieval system for noise information and to advise on topics and procedures to be used in the synthesis of stored information and that which is available from other resources. Initial priority for committee concerns is in the area of surface transportation noise; 2) Storage and Retrieval System for Transportation Noise Research Information: develop a specialized file for transportation noise research information service (TNRIS). The service will provide for up to 2500 references in the first year operation to cover ongoing research activities, reports on completed research and publications or other documents within the scope of the service. Output from the system will include response to direct queries, monthly lists and indexes of stored material and, at the end of the contract year, an experimental publication to represent the year's accomplishments; 3) Synthesis of Information

for Selected Topics on Transportation Noise Abatement: after an adequate information base has been acquired, a small number of relatively narrow topics within the field of transportation noise abatement will be selected as high-priority topics for information synthesis. One topic will then be selected for producing a corresponding information synthesis document; 4) Advisory Services - Research Programs: examine and make recommendations for research and development activities that may lead to the implementation, within the transportation community, of policies, standards and procedures for alleviating transportation noise.

Resources Estimate, Funds: $116,000

Security of Report: Unclassified

Procurement Method: Contract - Task Order

Amendment #2 to above provided $50,000 to continue the advisory and information services for transportation noise abatement through August 21, 1971.

8 October 1970

DOT-AS-10094

S[illegible]rt Date: 27 08 70

Estimated Completion Date: 31 12 71

Kind of Report: New

Performing Organization, Name: U.S. Department of Commerce
National Bureau of Standards
Office of Vehicle Systems Research
Washington, D.C. 20234

Principal Investigator, Name:

Responsible Government Organization, Name: Department of Transportation
Asst. Secretary for Systems Development & Technology
Office of Noise Abatement, TST-50
Rm. 10409, 400 - 7th St., S.W.
Washington, D.C. 20591

Responsible Government Individual, Name: Close, W. Harry
Chief, Research Division
Office of Noise Abatement

Key Words: Identify and quantify the physical parameters which affect the noise generation characteristics of truck tires; develop an information base that may lead to standardized tire-noise testing procedures and to highway noise reduction criteria, standards, and regulations.

Title: Truck Tire Noise Investigation

Summary: This study will provide a scientific basis for designing quieter tires. Hopefully the information produced will prompt additional action by vehicle and tire manufacturers, truckers, highway designers and local law enforcement agencies to achieve a full measure of environmental quality improvement. A literature search will be performed for existing information as well as ongoing related work to determine the scope of the overall truck tire noise problem; visits and contacts will be made to trucking industry and tire and vehicle manufacturers to identify and define the truck tire population, practices of the fleet and individual users of trucks, and the basic differenc[illegible] that exist among different users. An attempt will be made to identify the parameters that affect noise generation. Reassessment of the status of laboratory and roadside noise measurement development will be conducted. As a result of these efforts, certain tire types will be selected and tested on the road and in the laboratory. Upon completion of testing and the collection and reduction of data, an analysis will be conducted to determine significant findings of the truck tire noise investigation.

[illegible]ource Estimate, Funds: Total funding estimate - $327,000. Initial funding of $60,[illegible] for FY-70 was provided by FHWA in April 1970. Interagency Agreement DOT-AS-10[illegible] addresses the first increment of FY-71 required to continue work without interruption. Total FY-71 requirements are estimated at $200,000.

Security of Report: Unclassified

Procurement Method: Interagency Agreement

Other Funding Agencies: FHWA.

19 February 1971

DOT-OS-10025

Start Date: 17 02 71

Estimated Completion Date: 01 06 71

Kind of Report: New

Performing Organization Name: Society of Automotive Engineers, Inc.
Two Pennsylvania Plaza
New York, N.Y. 10001

Principal Investigator, Name: Favata, Fred

Responsible Government Organization, Name: Department of Transportation
Asst. Secretary for Systems Development and Technology
Office of Noise Abatement
400 Seventh Street, S.W.
Washington, D.C. 20590

Responsible Government Individual, Name: Paullin, Robert L.
Chief, Regulatory Policy & Standards Div.
Office of Noise Abatement

Key Words: Analysis and report of the Plenary Session of the SAE Conference on Aircraft and the Environment

Title: Aircraft and the Environment

Summary: Analyze and report on the results of the Plenary Session of the SAE Conference on Aircraft and the Environment. The review and evaluation shall cover the following:

1) A delineation of the conclusions and recommendations of the nine workshop sessions, as modified (if any) by the Plenary Session.
2) A delineation of the pertinent discussions at the Plenary Session, with identification of appropriate groups or representatives of those groups.
3) A technical/engineering review of the conclusions and recommendations arising from the Plenary Session, with a ranking of such results as to viability, reasonableness and scheduling.
4) An evaluation of the feasibility of implementing the results of the Plenary Session, with particular emphasis on the following:
   a. The technical interation of air, noise, solid waste and fluid pollutants.
   b. The economic implications of the results.
   c. Suggested priorities from a materials and manpower standpoint.
   d. The effect on the air transportation system.

Resources Estimate, Funds: $8,855 (fixed price)

Security of report: Unclassified

Procurement method: Contract - fixed price.

28 May 1971

DOT-OS-10183

Start Date: 14 5 71

Estimated Completion Date: 14 7 71

Performing Organization, Name: B&K Instruments, Inc.
5111 West 164th Street
Cleveland, Ohio 44142

Principal Investigator, Name: E. John Wootten, Vice President
Systems and Engineering

Responsible Government Organization, Name: Dept. of Transportation
Asst. Secretary for Systems
Development and Technology
400 7th Street, S. W.
Washington, D.C. 20590

Responsible Government Individual, Name: Close, W. H.
Chief, Research Division
Office of Noise Abatement

Key Words: Sound level detection system; noise monitoring system.

Title: Field Noise Monitor System

Summary: Obtain sound level detection system for unattended monitoring of aircraft and ambient noise levels in airport environs.

Resources Estimate, Funds: $18,000. ($17,099 Actual)

Security of Report: Unclassified.

Procurement Method: Contract - fixed price

Other Funding Agencies: N/A

Final Product Due: July 14, 1971

14 May 1969

DOT-OS-A9-026

Start Date: 18 10 68

Estimated Completion Date: 07 69

Kind of Report: New

Performing Organization, Name: Southwest Research Institute (under contract to Society of Automotive Engineers, Inc.)

Principal Investigator, Name: Walters, F. C., Chairman
SAE Research Project Committee

Responsible Government Organization, Name: Department of Transportation
Asst. Secretary for Research & Technolog
Office of Noise Abatement
800 Independence Avenue, S.W.
Washington, D.C. 20590

Responsible Government Individual, Name: Foster, Charles R.
Director, Office of Noise Abatement

Key Words: Urban noise levels; noise generating machines; operator tolerance.

Title: Support of Society of Automotive Engineers, Inc. Noise Research Study.

Summary: Obtain data which is correlatable to urban noise levels for use in transportation noise abatement research.

This program is to gather, catalog, analyze and summarize available noise data in 3 areas relative to noise associated with the operation of tractors and related equipment. Specifically, the 3 areas are:

(1) Definition of the physical characteristics of typical noises to which operators of such equipment might be exposed.
(2) The tolerance levels of such opefators, both with and without protection.
(3) Degree of possible hearing damage and operator disorientation from exposure to variable noise.

Resources Estimate, Funds: $5,000. ($4,290 Actual)

Security of Report: Unclassified.

Procurement Method: Contract - fixed price.

Other Funding Agencies: Industry - Farm & Industrial Equipment Institute;
Construction Industry Manufacturers Assn.;
Power Saw Manufacturers Association.

Final Report received December 1969.

~~14 May 1969~~
Updated 17 April 1970

DOT-OS-A9-009

Start Date: 23 08 68

Estimated Completion Date: 06 69

Kind of Report: New

Performing Organization, Name: Bolt Beranek & Newman
50 Moulton Street
Cambridge, Massachusetts 02138

Principal Investigator, Name: Franken, Peter A., Vice President
Physical Sciences Division

Responsible Government Organization, Name: Department of Transportation
Assistant Secretary for Research & Technology
Office of Noise Abatement
800 Independence Ave., S.W.
Washington, D.C. 20590

Responsible Government Individual, Name: Paullin, Robert L.
Chief, Regulatory Policy & Standards Div.
Office of Noise Abatement

Key Words: Metropolitan airports near-term noise abatement alternatives; operational and non-operational procedures; composite noise rating; aircraft noise exposure forecasts.

Title: Metropolitan Aircraft Noise Abatement Study (Logan International Airport)

Summary: Develop useful alternatives for achieving both preventive and remedial relief from aircraft noise exposure in the vicinity of a large metropolitan airport - Logan International Airport, Boston, Massachusetts. Included are considerations of: basic causes, growth trends, and social-economic impact of aircraft noise exposure on individuals and communities near airports. The project will include preparation of alternative approaches for use by local, state, and Federal governments to guide them in land use development, airport development and related aircraft operational procedures.

Develop a methodology for use by other airport and metropolitan planning officials.

Progress: ~~Revised draft report in review by Government~~. Final report rec'd 3/70.

Resources Estimate, Funds: $31,027 (Jointly funded: Department of Transportation/ Department of Housing and Urban Development)

Security of Report: Unclassified.

Procurement Method: Contract - fixed price.

Other Funding Agencies: Department of Housing and Urban Development.

30 May 1969
Updated 31 Dec 1970

DOT-OS-A9-018

Start Date: 21 05 69

Estimated Completion Date: ~~01 71~~ 02 71

Kind of Report: New

Performing Organization Name: Serendipity, Inc.
Special Studies Division
2001 Jefferson-Davis Highway
Arlington, Virginia 22202

Principal Investigator, Name: Safeer, Harvey
Program Manager, Special Studies Division

Responsible Government Organization, Name: Department of Transportation
Asst. Secretary for Research & Technology
Office of Noise Abatement
800 Independence Ave., S.W.
Washington, D.C. 20590

Responsible Government Individual, Name: Paullin, Robert L.
Chief, Regulatory Policy & Standards Div.
Office of Noise Abatement

Key Words: Assessment of transportation noise abatement problems; potential solutions; all modes of transportation - airplanes, buses, trucks, autos, trains, and boats.

Title: A Study of the Magnitude of Transportation Noise Generation and Potential Abatement.

Summary: Determine the magnitude of the transportation noise abatement problem in the U.S. and develop a set of analytical tools which can be used to determine the extent of the problem in the future and to evaluate alternative proposals for noise abatement; provide a comprehensive analysis of the current technical, economic and legal limits of noise reduction, and estimates of what they may be in the future; determine the level of responsibility (public and private) for noise abatement, and the ability at each level to provide the necessary resources to implement noise abatement programs; determine the need for government standards and regulations for transportation noise abatement, to establish specific recommendations for standards and regulations and their means of enforcement; determine the scientific research needed to understand noise abatement and develop a research program which will maximize the expected return from all related resource allocations; determine how to provide transportation services that produce acceptable noise exposure in populated areas, given the operation, economic, social and political constraints.

Resources Estimate, Funds: $492,683

Research & Development Contracts

Title	Contractor/Contract No./ Date Signed	Amount	FY Funds	Report Due	Report Received	State
[illegible] Urban Noise Study (Machine noise/Operator Tolerance)	Society of Automotive Engineers (Southwest Research Institute) DOT-OS-A9-035 signed 10/13/68	$8,290	1969	7/69	12/69	N.Y.
Metropolitan A/C Noise Assessment Study (Logan) (Joint with HUD)*	Bolt Beranek & Newman/DOT-OS-A9-009 signed 8/23/68	22,860 8,167 Mod. 31,027*	1969	6/69	3/70	Mass.
Transportation Noise Study	Serendipity, Inc. DOT-OS-A9-018 signed 5/21/69	492,683 16,270 Mod. 80,000 Mod. 588,953	1969 1971 1971	1/71 8/71		Va.
Noise Criteria Evaluation	University of Washington DOT-OS-A9-036 signed 12/2/68	24,402	1969	9/69	3/70	Wash.
Acoustical Measurements (Subway)	Bolt Beranek & Newman DOT-OS-A9-040 signed 4/1/69	16,778	1969	9/69	2/70	Mass.
Transfer to FAA (Wyle Lab ext.) V/STOL Noise Characteristics	DOT-OS-A9-059 signed 1/17/69	40,000	1969	12/69		Calif.
Transfer to HUD (MANAPS)	DOT-OS-A9-072 signed 2/25/69	100,000	1969	6/70		Fla. N.Y. Ill. Conn.
Transfer to FAA (ADS) for Glide Slope Computers	DOT-OS-A9-086 signed 5/21/69	50,000	1969	12/70		N.J.

OFFICE OF NOISE ABATEMENT

Research and Development Contracts

Title	Contract/Contract No./ Date Signed	Amount	FY Funds	Report Due	Report Received	State
Impacts & Alleviation of Transportation Noise	Univ. of California DOT-OS-A9-118 signed 6/30/69	$125,466	1969	Phase I-10/70 Phase II-~~10/71~~ 12/72		Calif.
Formulation of Noise Stds. (Support of Acoustical Soc. of America Stds Activities)	National Science Foundation DOT-OS-00006 signed 10/8/69	21,400	1970	6/70	10/70	D.C.
Tire Acoustics Program	National Bureau of Standards DOT-AS-00014 signed 10/15/69	50,000	1970	7/70	Rewrite	D.C.
Modeling for Jet Noise	U. of Southern California DOT-OS-00002 signed 12/19/69 Second Yr. Grant signed 1/18/71	236,166 126,883 363,049	1970 1971	Qrtrly		Calif.
Advisory & Info Services for Trans. Noise Abatement	National Academy of Sciences Highway Research Board, Task #3 DOT-OS-00035 signed 1/23/70 Amendment #2 (Continue thru 8/71)	116,000 50,000 166,000	1970 1971	1/71		D.C.
Truck Tire Noise Investigation	National Bureau of Standards DOT-AS-10004 signed 8/27/70 Amdmt #1 (2nd half FY-71)	100,000 100,000 200,000	1971 1971			D.C.
Clean Air Car Race	Bolt Beranek & Newman, Cambridge, Mass. Purchase Order PS-10123 dated 8/4/70	2,500	1971			Mass.

OFFICE OF NOISE ABATEMENT

Research and Development Contracts

Title	Contract/Contract No./ Date Signed	Amount	FY Funds	Report Due	Report Received	State
Aircraft & the Environment	Society of Automotive Engineers, Inc., N.Y., N.Y. DOT-OS-10025 dated 2/17/71	8,855	1971	6/71	6/14/71	N.Y.
Field Noise Monitor	B&K Instruments, Inc., Cleveland, Ohio DOT-OS-10183 dated 5/14/71	17,099	1971	N/A		Ohio

DEPARTMENT OF TRANSPORTATION

TRANSPORTATION SYSTEMS CENTER

CAMBRIDGE, MASS.

PROJECT PLAN AGREEMENT

GWA NO.	2. PPA NO.	REV. NO.	AFFECTS PAGES	3. DATE:
72-OS	OS207	0	1-9	August 23, 1971

4. TITLE: Transportation Noise Abatement

5. SPONSOR:
Mr. Charles R. Foster, TST-50
Office of Noise Abatement
DOT/400 Seventh Street, S.W.
Washington, D.C. 20591
(202) 426-4553

7. TASK MANAGER:
John E. Wesler, TME
DOT/Transportation Systems Center
55 Broadway
Cambridge, Massachusetts 02142
(617) 494-2258

6. SPONSOR NO.:

8. RELATED PPAS:

9. BRIEF TECHNICAL SUMMARY: In continued cooperation with the OST Office of Noise Abatement, TSC will work in two broad areas of transportation noise abatement: (1) continue measurement and simulation modeling of community noise levels created by transportation-related sources; and (2) conduct research into the mechanisms of noise generation by jet engine exhausts, V/STOL aircraft, and internal combustion engines. In addition, TSC will provide technical support in all aspects of transportation noise abatement, providing suitable expertise on call, monitoring research contracts negotiated by the Office of Noise Abatement, and directing demonstration projects as appropriate. Further, the TSC Task Manager will serve as the focal point for all noise abatement activities involved in other programs underway at TSC for coordination purposes.

10. RESOURCE REQUIREMENTS:

	FY 71	FY 72	FY
DIRECT MANYEARS	6.6	10.5	
SALARIES & BENEFITS $K	140.0	210.0	
MAJOR EQUIPMENT	44.0	125.0	
RESEARCH CONTRACTS	142.0	275.0	
IN-HOUSE SERVICES & OTHER	104.0	134.0	
INDIRECT	160.0	231.0	
TOTAL	590.0	975.0	

11. APPROVALS:

	TSC	SPONSOR
BY:		
TITLE:	Director of Technology	
DATE:		

PRELIMINARY COPY

DRAFT

12. DESCRIPTION OF WORK:

Transportation noise abatement constitutes an important program within the Department of Transportation, with high priority and emphasis. This importance is clearly evident in the Departmental budget submitted to the Congress. The Transportation Noise Abatement program will receive correspondingly high priority and attention at TSC.

1. Noise Abatement

A. Surface Transportation Vehicle Noise Reduction:

No specific work at TSC is planned under this portion of the Departmental noise abatement program. As noted in the Brief Technical Summary above, however, TSC will provide technical support and suitable expertise on call to assist the Sponsor in monitoring or directing projects in this grouping.

B. Right-of-Way (Guideway) Noise Reduction:

Begin research and field measurements to assess the effectiveness of various types of noise barriers, highway depressions, and elevations, in reducing the transmission of highway noises to wayside areas. This work will encompass the refinement and expansion of noise prediction procedures along surface transportation guideways, including the effects of various types and configurations of barriers in reducing noise levels in adjacent areas. Actual field measurements of the effectiveness of existing barriers will also be made, for comparison and validation of the prediction procedures. The ultimate goal of this work is the development of meaningful information to guide highway and guideway designers in reducing noise exposure impact on neighboring land areas.

C. Research on Noise Generation Mechanisms:

(1) Jet Exhaust Noise Basic Research. Continue basic research into the noise generation mechanisms of jet engine exhausts, begun during Fiscal Year 1971. Initial contracted research began a systematic analysis of laboratory-scale jet flows, using a shock tunnel and cold gas jets to generate flow patterns. Shadowgraphic and holographic techniques are in use to visualize the shockwaves present in the jet exhausts, for correlation with simultaneous acoustic measurements. These experimental results are being used to validate theoretical analyses of the noise generation mechanisms, in order to permit an improved understanding of these phenomena, leading to development of effective noise suppression techniques. The Fiscal Year 1972 work will continue the analyses begun in Fiscal Year 1971, extending the experimental work to additional nozzle shapes and designs, and operating parameters. It is anticipated that the second year of this research effort will provide definitive guidelines and potential approaches for suppressing

jet exhaust noise. This work will extend through the summer of 1972 to take advantage of summer academic research at MIT.

(2) V/STOL Noise Basic Research. Continue research into the generation and propagation of noise into urban areas by V/STOL aircraft, begun in Fiscal Year 1971. The previous work investigated two areas of importance in assessing the potential impact of V/STOL operation into city-center areas: (a) trade-off studies to relate noise characteristics of possible V/STOL designs to their operating conditions, and the probable effect on operating cost of imposed noise constraints; and (b) theoretical and experimental studies of sound propagation into typical city-center environments. The goal of this work is an improved understanding of V/STOL noise levels in urban areas in order to provide better technical bases for future standards and certification criteria. The Fiscal Year 1972 work will extend the studies begun in Fiscal Year 1971. Specifically, work will continue using laboratory scale models to predict noise levels in a typical urban environment. Theoretical studies of this problem will also continue, to include the effects of non-specular reflections from building faces, and the limits imposed by diffraction on the shielding of buildings. It is also planned to simulate an urban area surrounding a vertiport or stolport, such as that proposed for a floating Manhattan stolport, and measure noise levels associated with STOL aircraft operations. A second area of effort will include actual field measurements of VTOL and STOL aircraft flying over open terrain for calibration, and over city streets to validate laboratory simulations. These measurements will made by the TSC mobile van and crew. The third area of effort will involve laboratory studies of rotor and STOL propeller noise, for inclusion in further noise-design trade-off studies of potential VTOL and STOL aircraft, including a tilt-rotor VTOL concept and STOL configurations including fan jet noise and lift-augmentation devices. As the result of this second year of study, it is felt that substantial information will be available to guide future designs of V/STOL aircraft for urban transportation. This work will extend through the summer of 1972 to take advantage of summer academic work at MIT.

(3) Internal Combustion Engine Noise Research. Begin a study of the most promising approaches to the reduction of noise radiated from typical internal combustion engines used to power ground transportation vehicles. Initial emphasis will be placed on diesel engines, commonly installed in heavy trucks and buses, since these vehicles constitute the loudest types commonly found on urban streets and interstate highways. If feasible, this work will also be extended to other troublesome vehicles. It is planned that the ICE noise research will proceed concurrently with other work at TSC in reducing exhaust emissions of diesel engines and similar power plants appropriate to ground transportation. If the emission program fails to materialize at TSC, the Fiscal Year 1972 work will develop a meaningful longer-term ICE noise reduction

program, and begin an appropriate demonstration project, within the funds available.

D. Noise Measurement, Analysis and Information:

(1) Continue a program of measurement of community noise characteristics caused by transportation-related sources. During Fiscal Year 1971, a mobile noise measurement van was procured and outfitted at TSC to permit field noise level analysis, and a crew of engineers and technicians was trained in its use. The van and crew conducted a three-month survey of the noise levels present in the town of Medford, a suburb of Boston. That project provided an in-depth analysis of community noise levels. During Fiscal Year 1972, the van's equipment capabilities will be expanded through the addition of a multi-channel tape recorder, additional microphones, and other improved apparatus. In addition, portable equipment will be acquired for use in remote measurement of transportation noise levels at sites such as Pueblo, in subway stations, and at similar locations where use of the van is inappropriate or inconvenient. Additional TSC personnel will be trained in the recording, measurement, and analysis of transportation noises, to expand the ability to perform field measurements, and to man an additional mobile van which may be assigned to TSC, following completion of a research program at the National Bureau of Standards, under the sponsorship of the Office of Noise Abatement. The van(s) will continue the program of field noise measurements begun in Fiscal Year 1971, to provide measurements of air and ground vehicle noises to compare with simulation model results, to measure the abatement characteristics of barriers, roadway depressions, and similar design characteristics for highway planning, to measure the noise characteristics of new types of transportation vehicles (such as the tracked air cushion type) for determination of their potential environmental impact, and to survey further the noise levels existing in American communities.

(2) Continue the refinement and expansion of the airport noise exposure simulation, begun in Fiscal Year 1971, in order to assess and compare alternative approaches to the reduction of the noise impact on airport neighbors. This developmental effort will concentrate on improved interactive input and display techniques, in order to permit simpler use of the simulation model by airport planners and similar groups. In cooperation with the program sponsor, the simulation model will be used in various analyses, such as the cost-effectiveness comparison of airliner engine retrofit begun during Fiscal Year 1971 and continuing into Fiscal Year 1972. In addition, physical elements included in the simulation program will be refined and expanded to assure accurate representation of the acoustical aspects involved.

3. INTERFACES:

The performance of this work will require the close coordination and cooperation of the Office of Noise Abatement, Office of the Secretary, to insure that the actual work performed is meaningful and related to the overall program of the Office. Close contact and supervision will also be required with those contractors which will perform selected portions of the work program. Finally, continued close liaison with other government agencies, such as the Department of Housing and Urban Development regarding noise standards for land use, will be maintained, to insure the widest possible benefit to the public from work accomplished at TSC.

14. SCHEDULES:

The following milestones are appropriate to each of the task areas described above:

Task 1 A	No specific work planned initially.
Task 1 B	Traffic Noise Guidelines and Standards drafted - 1 Jan 1972 Summary report drafted - 30 June 1972
Task 1 C (1)	First year's research completed - 1 October 1971 Second year's research completed- 1 October 1972
Task 1 C (2)	First year's research completed - 1 October 1971 Second year's research completed- 1 October 1972
Task 1 C (3)	Summary report drafted - 30 June 1972
Task 1 D (1)	Technical reports of each field measurement project as it is completed
Task 1 D (2)	Aircraft/Airport System Noise model ready for simple interactive use and graphic display of results - 1 January 1972

15. PROCUREMENTS:

Research and development contracts are anticipated in three of the five task areas, as outlined in the attached program summary. Equipment procurements are planned to augment the mobile van's measurement capabilities, and to expand the graphic display and interactive use of the noise simulation models.

16. MANAGEMENT:

The Transportation Noise Abatement program will be managed within the Electromechanical Branch, Mechanical Engineering Division of the

Technology Directorate, Transportation Systems Center

17. REVIEW AND REPORTS:

The TSC Task Manager will furnish the Director, Office of Noise Abatement:

a. Monthly technical progress reports
b. Annual summary report
c. Individual technical reports covering results of important projects
d. Oral program reviews as required.

18. CONTROLS:

All work will be conducted with the close coordination of the Director, Office of Noise Abatement, Office of the Secretary.

FINANCIAL SUMMARY

TASK	LABOR	R&D CONTRACTS	EQUIPMENT	ADP IN-HOUSE SERVICES	OTHER	TOTAL
1A						0
1B	2½/$105K	$ 50K			$ 20K	$175K
1C (1)	½/ 21K	75K			4K	100K
1C (2)	½/ 21K	150K			4K	175K
1C (3)	1/ 42K				8K	50K
1D	6/ 252K		$ 125K	$ 60K	38K	475K
1E						0
	10½/$441K	$275K	$125K	$ 60K	$ 74K	$975K

Direct Labor @ $20K/MY
Overhead @ $22K/MY
$42K/MY

TRANSPORTATION SYSTEMS CENTER

PPA: OS207	TITLE: Transportation Noise Abatement	FUNDING: [illegible]

BRIEF PROJECT DESCRIPTION:

Perform work in two broad areas of transportation noise abatement: (1) continue measurement and simulation modeling of community noise levels created by transportation-related sources; and (2) conduct research into the mechanisms of noise generation by jet engine exhausts, V/STOL aircraft, and internal combustion engines.

TASK	FY'71 1Q	FY'71 2Q	FY'71 3Q	FY'71 4Q	FY'72 J	FY'72 A	FY'72 S	FY'72 O	FY'72 N	FY'72 D	FY'72 J	FY'72 F	FY'72 M	FY'72 A	FY'72 M	FY'72 J	FY'73 1Q	FY'73 2Q	FY'73 3Q	FY'73 4Q
1B Right-of-Way Noise Reduction: Adapt highway noise model					Begin Refinement			Refinement Complete			Ready For Use	Continued Refinement and Use								
Study effectiveness of highway noise barriers						Begin Field Analysis				Complete Analysis										
Prepare highway noise standards					Begin Analysis					Standards Drafted										
1C(1) Jet Exhaust Noise Basic Research: Continue MIT contracted work			FY71 Contracts Awarded				FY72 Contracts Awarded										Final Report			
1C(2) V/STOL Noise Basic Research: Continue MIT contracted work		FY71 Contracts Awarded					FY72 Contracts Awarded										Final Report			

LEGEND:
- △ SCHEDULED
- ▲ ACCOMPLISHED

REMARKS:

AMR MAY 7, 1971

TRANSPORTATION YSTEMS CENTER

PPA: OS207	TITLE: Transportation Noise Abatement	FUNDING: $975K

BRIEF PROJECT DESCRIPTION:

TASK	FY'71				FY'72												FY'73			
	1Q	2Q	3Q	4Q	J	A	S	O	N	D	J	F	M	A	M	J	1Q	2Q	3Q	4Q
1C(3) ICE Noise Basic Research: Prepare diesel engine noise reduction program																Final Report				
1D Noise Measurement: Expand mobile van capability Perform field measurements				Procurement Package				Receive Equipment		Install Equipment										
Interactive use and graphics for airport noise model	Model Received									Ready For Use		Continue	Refinement				and	Use		
Hire new personnel for Program			PDS				Hire													
o3																				

LEGEND:
- △ SCHEDULED
- ▲ ACCOMPLISHED

REMARKS: New Personnel: Hire two Acoustic Engineers 10-1-71.

AMR MAY 7, 1971

TRANSPORTATION SYSTEMS CENTER

TECHNICAL PROGRESS REPORT

for June 1971

GENERAL WORK AGREEMENT NO.: 71-OS-2

PROJECT PLAN AGREEMENT NO.: OS-07-1

TITLE: Transportation Noise Abatement

TASK MANAGER (TSC): J. E. Wesler

APPROVED:

TASK MANAGER: J. E. Wesler

DIVISION CHIEF: A. J. R. Schneider

OPERATING DIRECTOR: Gene G. Mannella

TRANSPORTATION SYSTEMS CENTER

TECHNICAL PROGRESS REPORT

GENERAL WORK AGREEMENT NO.: 71-OS-2

PROJECT PLAN AGREEMENT NO.: OS-07-1

TITLE: Transportation Noise Abatement

TASK MANAGER (TSC): J. E. Wesler

1.0 SUMMARY

During Fiscal Year 1971, the following significant accomplishments were derived from the Transportation Noise Abatement program at TSC:

a. A mobile noise measurement laboratory was purchased and outfitted, and a crew of engineers and technicians was trained to provide field measurements of community noise levels.

b. An extensive survey of community noise levels existing in a typical metropolitan suburb was completed, by measuring noise levels at 50 selected sites in Medford Massachusetts.

c. A brief, informal survey of noise levels present in the Everglades of Florida was performed to document noise conditions in that relatively uninhabited environment.

d. A computer program, initially developed by Serendipity, Inc., under contract to the OST Office of Noise Abatement, was adapted to the computers at TSC, and the program's capability was expanded significantly to allow automatic calculation and plotting of noise exposure contours around airports.

e. The expanded airport noise exposure computer program was applied to an analysis of the cost-effectiveness of engine retrofits for commercial airliners on a world-wide basis, in support of the OST Office of Noise Abatement work within the ICAO Committee on Aircraft Noise.

f. Three research contracts were negotiated with MIT for laboratory studies of the mechanisms of jet exhaust and V/STOL vehicle noise, with the goal of better understanding of these noise-generation factors and of the most promising means for noise reduction.

g. The feasibility of adapting a split-beam laser velocimeter as a remote sound and vibration detector was demonstrated in the laboratory, and a patent application for this technique was submitted for legal processing.

h. The Task Manager for the Transportation Noise Abatement program began to serve as the focal point at TSC for noise abatement efforts, by participating in review procedures and limited contracted research on tracked air cushion vehicle noise sources and predicted performance.

2.0 TECHNICAL DISCUSSION

The work underway at TSC in the Transportation Noise Abatement program during Fiscal Year 1971 was initially divided into three general categories. As the work progressed during the year, however, a fourth or miscellaneous category was created to encompass a number of smaller informal efforts performed in cooperation with the OST Office of Noise Abatement. The technical discussion which follows is organized along these four categories of work.

2.1 Modeling and Field Measurement of Community Noise Levels

As a part of its extensive contract with the OST Office of Noise Abatement, Serendipity, Inc., developed three simulation models to calculate noise exposure conditions caused by aircraft operations near airports, ground transportation vehicles along guideways, and the composite community noise levels generated by all modes of transportation. The original Serendipity computer listing for the airport noise simulation model was delivered to TSC in late September 1970, for adaptation to the computers at TSC. The adaptation and expansion efforts culminated in the Airport Noise Exposure Model MOD 4, which was 'frozen' at TSC in May 1971. The details of this model were reported in the TSC Technical Progress Report for May 1971, and need not be repeated here. A formal TSC report, describing this model and serving as a user's manual, has been drafted and will be issued in early August 1971.

The second Serendipity model, for ground transportation noise exposure simulation, was delivered to TSC early in calendar year 1971. Because of the higher priority for the airport noise model, only limited efforts were devoted to the so-called highway noise model. The only work accomplished has been a brief review of the computer listing, in order to understand the procedures involved and the probable efforts necessary to adapt the model to TSC computers and streamline its operation. The third model, simulating composite community noise levels, was still under development by Serendipity at the end of the fiscal year. Receipt and adaptation of this model at TSC is expected during Fiscal Year 1972.

In the adaptation and expansion of the airport noise exposure model, the specific application of the procedures to Logan International Airport, Boston, was used for learning purposes. During the spring and summer of 1971, TSC personnel worked closely with FAA regional personnel, and representatives of the Massachusetts Port Authority (the operators of Logan Airport) to obtain meaningful airport information and to develop relevant analyses. The results of all these analyses have been retained at TSC and are considered entirely developmental in nature. Nevertheless, these preliminary results have provided valuable insight into noise problems at a U. S. Airport. A further adaptation of the Airport Noise Exposure Model MOD 4 was also applied to an analysis of noise exposure levels at seven international airports, for 1975 and 1980, and for several alternative levels of engine retrofit, in support of the OST Office of Noise Abatement committment to the ICAO Committee on Aircraft Noise. This ICAO work began to produce usable results only during June 1971, and will continue into Fiscal Year 1972.

The second major area of work during Fiscal Year 1971 under the general category of community noise modeling and field measurement involved the procurement and outfitting of a mobile noise measurement laboratory, and the training of a crew of engineers and technicians to man that laboratory. Details of the van and its included equipment were included in several monthly Technical Progress Reports, and need not be repeated here. As soon as it was available, and the crew familiar with its operation, the van was used to survey noise levels existing in Medford, Mass., a nearby suburb of Boston. Medford was selected for this analysis because of its proximity to TSC, its variety of environments (from busy industrial sites to a serene park and reservior area), its ready availability of traffic flow and demographic information, and (primarily) its inclusion of major highways, railways, and Logan Airport overflights within its boundaries. Noise level recordings and analyses were made at 50 sites within Medford, with the sites selected randomly throughout the town area. At five of these sites, analyses were made throughout a 24-hour weekday period, and were analyzed in hourly segments. At 45 additional sites, measurements were made from 0730 to 0830 and from 1130 to 1230 on a weekday between 1 March and 15 May 1971. The format and method of presentation of the measurements were included in the Technical Progress Report for March 1971, and need not be repeated here. Pertinent preliminary results have been relayed to the Serendipity, Inc., for inclusion in its continuing development of a composite community noise level model. A formal report is nearly complete, and should be published early in August 1971.

2.2 Research into Mechanisms of Jet Engine Exhaust Noise

This phase of the Fiscal Year 1971 program at TSC initiated two research contracts at MIT, intended to provide a better understanding of the physical phenomena governing noise generation by jet exhausts. The ultimate goal of such work is improved approaches to the reduction of such noise. The first contract, formally begun on 15 November 1970, involves the use of shadowgraphic and acoustic analyses of jet flows produced in the MIT laboratory by a shock tunnel technique. This device provides repeatable brief-duration, high-velocity jets without elaborate requirements for high temperature materials and anechoic surroundings. The results of a systematic study of two jet nozzle configurations, under the direction of Dr. Jean Louis, is due 30 September 1970.

The second research contract at MIT, formally begun on 15 February 1971, involves the use of optical holographic visualization techniques, in correlation with acoustic measurements to analyze jet flow shock wave generation. Here, cold gas jets are generated in the laboratory to provide the sound source. These analyses, under the direction of Dr. Richard Salant, are due for completion in draft report form on 14 March 1972.

As a portion of this program phase, preliminary development of a laser sound probe was conducted at TSC to demonstrate, at least in the laboratory, the feasibility of this approach to the remote detection of sound and/or vibrations in a jet flow, for example. An informal report describing the results of this developmental effort will be issued during July 1971. Briefly, through the use of laboratory equipment on hand at TSC, a split-beam laser velocimeter was fabricated and demonstrated capable of detecting sound fields and surface vibration from a remote point. TSC personnel participating in this developmental work have prepared a patent disclosure covering the general concept. The final report will assess the potential capabilities and limitations of the approach, and will recommend further action, if any, for future use.

2.3 Research into Noise Generation and Propagation by V/STOL Vehicles

This phase of the Fiscal Year 1971 program at TSC initiated one research contract at MIT to study, both experimentally and theoretically, noise propagation into a typical city-center environment from V/STOL vehicles, and to assess the design and operating limitations which may be imposed on commercial V/STOL operation by possible noise abatement restraints. This work, formally begun on 15 October 1970 under the direction of Drs. Richard Lyon and Sheila Widnall, is scheduled for completion on 30 September 1971. Dr. Lyon's portion of the study involves the theoretical and experimental analyses of noise propagation into urban area comprised of typical downtown buildings and streets. 32:1 scale model of a city intersection, plus an alley way, was fabricated in the laboratory at MIT, and sound level measurements using both steady-state and spark (impulse) sound sources are being performed. To date, street-level sound levels produced by typical VTOL flyovers have been measured for a variety of situations, and the results related to a comparable open-field situation. The impulse sound source will be used in attempts to ray-trace the sound paths among the scale-model "buildings."

Dr. Widnall's area of work responsibility includes simulations of noise characteristics of VTOL aircraft elements, for inclusion in simulation models of urban noise propagation, and V/STOL vehicle design factor tradeoffs relative to operating constraints possibly imposed by noise abatement procedures or limitations. The results of the entire contract efforts are reported bi-monthly by the two Principal Investigators.

In-house at TSC, to augment the contracted work underway at MIT, a brief analysis examined the possibility of applying optical diffraction theory to the calculation of sound levels among buildings at street level in an urban environment. Within funding limitations available for this small effort, a computer program was prepared to calculate the sound field inside a two-dimensional "channel", representing the canyon between two tall 'uildings. Preliminary calculations demonstrated the increase .. sound level from an elevated source, due to multiple reflections from the building faces. Brief details of this analysis are appended as Attachment 1 to this report.

2.4 Miscellaneous Activities at TSC in Noise Abatement

Following informal discussions with the Director, OST Office of Noise Abatement, a very brief analysis was performed to determine the feasibility of using a microwave link to transmit acoustical measurements from a number of remote locations to a central recording and analyzing van. Three basic systems were examined for such use:

a. microwave relays
b. high-quality telephone lines
c. optical transmission links

A brief report of this study is appended as Attachment 2 to this report. In summary, it appears that all three of the concepts are feasible, and could be implemented in a resonably short time.

Reflecting the coordinating role of the Director, OST Office of Noise Abatement, in consolidating the noise abatement activities for the entire department, the Task Manager for the ansportation Noise program at TSC has effectively begun to act as a focal point for noise control and abatement activities at TSC. As an example of this role, the Task Manager has actively participated in work sponsored at TSC by the Urban Mass Transportation Administration in the development of tracked air cushion vehicles. This participation included cooperation in the drafting of noise level specifications for the TACV originally intended for use at the Dulles Airport Access and later used as the basis for two developmental contracts for TACV's for undetermined sites, participation in two proposal evaluation teams, and management of a study contract (under UMTA funding) for the analysis of TACV noise sources and characteristics. The details of this contract were included in the Technical Progress Report for April 1971, and need not be repeated here. The final report of that work is due 15 July 1971.

3.0 SIGNIFICANT DOCUMENTATION

No significant documentation has been published to date as the result of the Transportation Noise Abatement program at TSC. Formal reports are in draft describing the results of noise measurements in the Everglades, the Airport Noise Exposure Model MOD 4, and the results of the noise level survey of Medford, Massachusetts, and these will be published early in Fiscal Year 1972.

..0 MILESTONES

All scheduled milestones for the Transportation Noise Abatement program were met, as indicated on the attached Milestone Schedule. In general, it is felt that the entire program progressed well during this first year of its activity at TSC. The only major schedule deficiency was the failure to achieve all the required ICAO airport noise exposure analyses by the end of the fiscal year. All other schedules were met as planned.

5.0 FINANCIAL MANAGEMENT

See attached Financial Progress Report.

Attachments:

1 - Brief description of acoustic reflection program
2 - Brief report of remote data collection systems
3 - Milestone Schedule
4 - Financial Progress Report

Attachment 1

Brief description of acoustic reflection program to calculate noise levels between buildings:

The geometry of the problem is shown in Fig. 1. A plane acoustic wave is incident upon the channel so that the rays make an angle θ with the x-axis. The sides and bottom of the channel (simulating the sides of buildings and a city street) are assumed to be perfectly hard so that they impose upon the acoustic pressure field, P, the boundary condition, $\partial P/\partial n = 0$, where $\partial/\partial n$ denotes the normal derivative at each surface. This condition determines the phase change experienced by the wave at the surface and could be relaxed to take into account mixed boundary conditions with losses if necessary.

To determine the sound pressure field at an arbitrary point in the channel, it is noted first that there are at most four non-zero contributions at each point. Denote the wave vector of the incident wave by $k = (k_x, k_y)$. With the coordinate axes of Fig. 1, $k_x > 0$ and $k_y < 0$. The four possible contributions to the pressure will therefore come from rays with the following wave vectors:

Type	1	2	3	4
Vector	(k_x, k_y)	$(-k_x, k_y)$	$(k_x, -k_y)$	$(-k_x, -k_y)$

Diagram

In the above set, wave types 1 and 2 characterize descending rays, while types 3 and 4 characterize ascending rays that have been reflected from the bottom of the channel. The logic of the computer program is designed to determine which, if any, of the four ray types actually contribute to the sound pressure at any point in the channel for any direction of incidence. For descending rays a point in OBC is in shadow for types 1 and 2. If a line with slope $m = \tan\theta$ is drawn through any point inside this triangle, its x-intercept will be negative (to the left of the origin) which corresponds to the fact that no point in OBC receives a direct ray. If a line of slope $m = -\tan\theta$ is drawn, it intersects the line $x = w$ in $y > 0$, which corresponds to the fact that no ray reflected from the surface at $x = w$ enters the triangular region. Similar rules can be found to show that OAC receives rays of type 1 but not 2, while ACD receives both types 1 and 2. The ascending ray diagram shows similar but displaced regions for ray types 3 and 4. Note that the incident ray bundle ab is split into two diverging bundles when it leaves the channel. Having determined which ray types are able to reach a particular point, the computer can then calculate complex amplitudes of the resultant sound pressure.

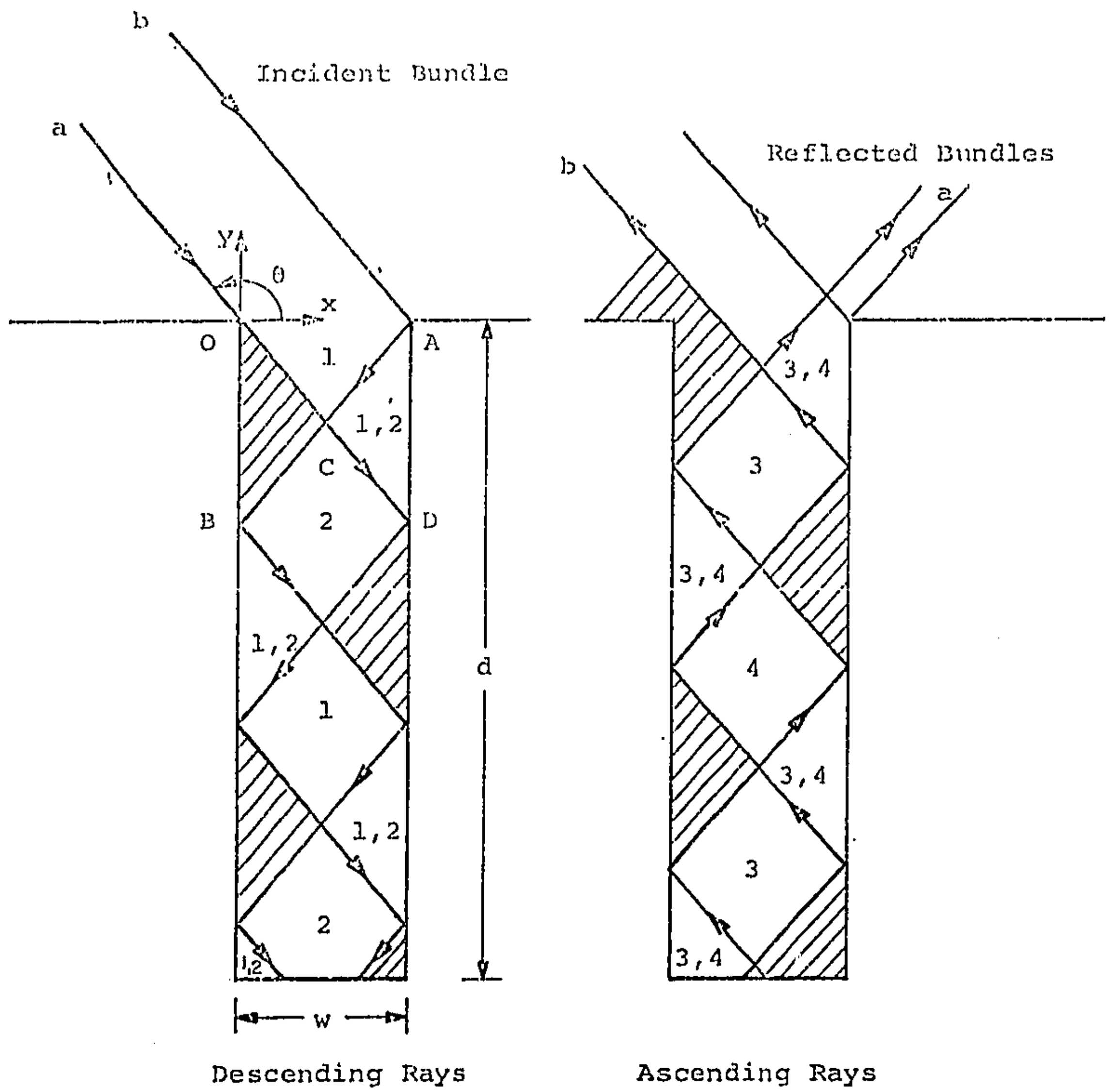


Figure 1.- Reflection from a Channel

Attachment 2

Brief report on remote data collection systems:

Three basic systems were investigated:

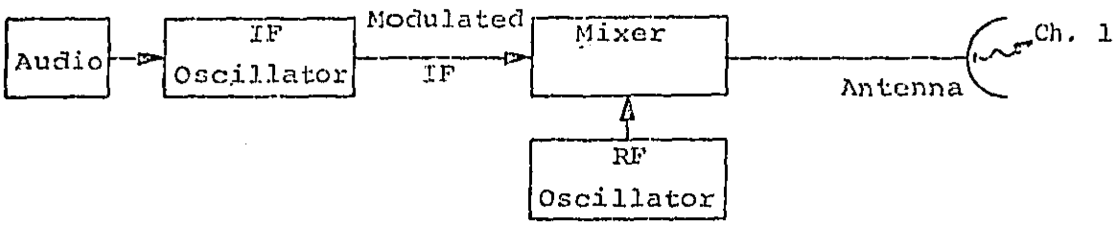
1) Microwave relays
2) High-quality telephone lines
3) Optical transmission

Microwave Relays

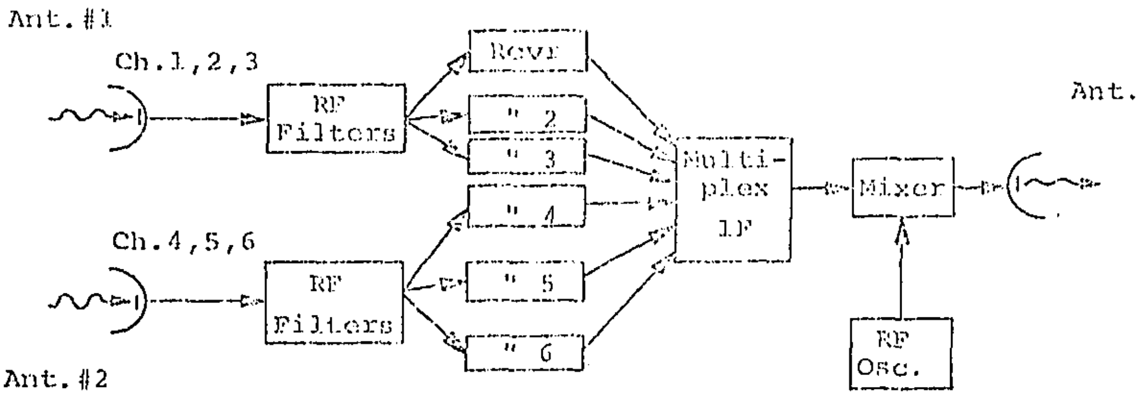
a) As anticipated, a large number of companies are in a position to supply microwave links with widely varying capacity and cost. These range from companies like GE and Raytheon that manufacture complex and expensive equipment for long distance communications systems, to those like AIL and Microwave Associates that specialize in smaller and less costly special purpose equipment.

The two most interesting proposals were made by these latter organizations, both of which have considerable experience with short range microwave relay links. AIL has marketed a Portable Wireless Microphone which was originally designed for use at the 1968 presidential conventions in order to transmit mobile voice to the fixed-camera audio channel. They quote six one-way links at $70,000.

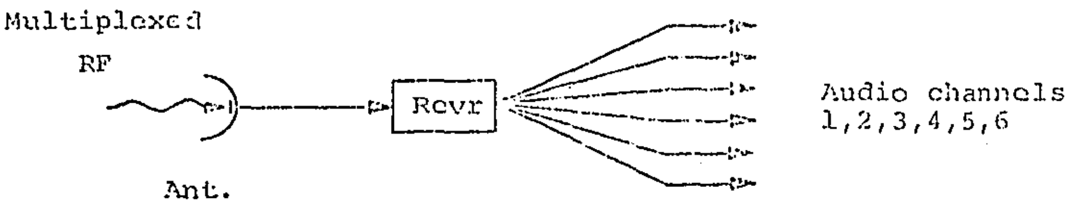
Microwave Associates has no commercial system available. However, they have proposed to assemble a system consisting of six links to a central terminal which would relay one multiplexed signal to the recording van. Their estimated price in February was $66,000, remarkably close to AIL's. The μ Wave Assoc. system would be organized as follows:



N channels similar to the above would transmit to a central collecting point on a convenient high building. This central repeater would have two receiving antennas, one for each 180° sector, and one transmitting antenna. They would be connected as shown on the following page:



From the repeater the signal would be propagated down to the suitably located mobile van where a single antenna would receive the multiplexed RF and feed it to a receiver which would provide six separate audio outputs corresponding to the inputs.



Once the above system has been aligned it should give very reliable, high quality service.

<u>High-Quality Telephone Lines</u>

An inquiry with the New England Telephone Company revealed that it would not be very difficult to rent telephone lines to do the job at hand - in effect this would substitute existing cables for the ad hoc connections that might otherwise be required. Telephone lines are available in all urban areas. They have the following characteristics:

Response: $\pm$ 1 db, 50-15,000 Hz

Normal use: High quality FM stereo transmission

Noise Level: -55 dbm

Circuit Loss: 20-25 db

Maximum Level: 8 vu (volume units)

(i.e. 8 db above zero vu, where zero vu = 1 mw in 600 ohms at 1,000 Hz)

The telephone company representative is Mr. Bob Pierce (743-3463). He indicated that it would take two weeks initially to lay out the circuits. Subsequently, each hook-up would require 2-3 weeks for installation, equalization, test and measurement. The rates quoted are:

Installation		$10.00
Equalization, test and measurement		$15.00
Use charge	$4.10/mo. for 1st 1/4 mile $1.85/mo. for each additional 1/4 mile	

If this service were to be used on a continuing basis, Mr. Pierce thought that it would probably be advisable to equip the van with a special patch panel.

From the point of view of cost, this system is clearly competitive with any other.

Optical Transmission

One possibility for line-of-sight transmission that should not be overlooked is the use of modulated laser beams. A number of suitable commercial equipments are available, the most practical of which seems to be that manufactured by Meteorological Instruments, Inc. of Bellmaur, N. J. Their modulated laser, ML-382, costs $275 and is designed for voice and data transmission. The laser is intensity modulated with a 0-5 volt signal, and capable of achieving 100% modulation up to frequencies exceeding 100 KHz. The frequency response is flat from D.C. to 100 KHz so that audio FM modulation can be used for low distortion and noise. The receiving system for such a laser, not including the receiving optics, is around $100. The ML-382 is a helium-neon laser which radiates in the red at a wavelength of 633 nm. The maximum power output is one milliwatt.

Summary

Each of the three possible data communications systems discussed above has advantages and disadvantages. The microwave system is expensive. However, once operational it would be quick to align, reliable, almost impervious to interference, and would present no environmental hazard. The laser system is cheap and easy to use, but only in clear weather. The hazard, though minimal, is present and must be considered. Telephone lines obviously offer a cheap solution with no compromise in quality. The disadvantages are primarily the long lead time required to set up the system in each location and secondarily the restrictions on location imposed by the possible lack of appropriate telephone connections.

It seems certain that one or more systems for simultaneous data collection from multiple sites is feasible and could be implemented in a reasonably short time.

MILESTONE SCHEDULE

SPONSOR DOT/OST

PPA NO. OS-07-0

STATUS AS OF June 30, 1971

ORIGINAL SCHEDULE July 1, 1970

LAST SCHEDULE CHANGE July 1, 1970

MILESTONE

Task I:

- Airport Noise Model Usable
- CALCOMP Plotter Usable
- ICAO Analysis Begins
- Mobile Van Operational
- Small Urban Area Study Report

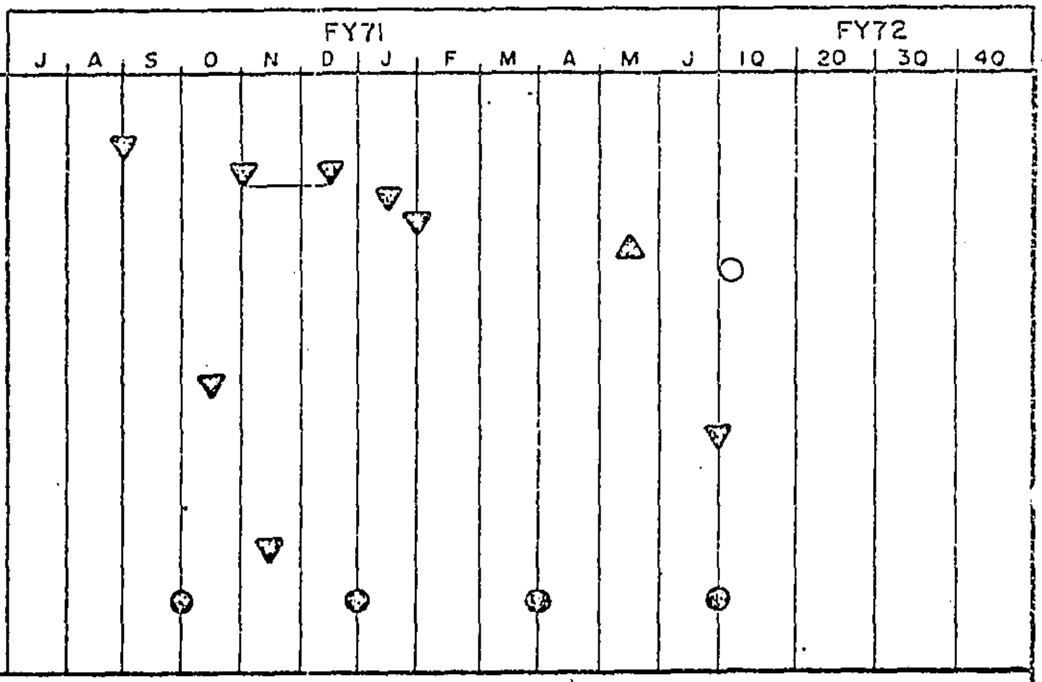
Task II:

- Begin Jet Noise Research at MIT
- Demonstrate Laser Sound Probe Feasibility

Task III:

- Begin V/STOL Noise Research at MIT

TSC Quarterly Reports



LEGEND:

- ▽ SCHEDULED INITIATION
- △ SCHEDULED COMPLETION
- ○ SCHEDULED REPORT SUBMISSION
- ACTUAL INITIATION
- ACTUAL COMPLETION
- ACTUAL REPORT SUBMISSION

TSC F 5100.1

FINANCIAL PROGRESS REPORT

SPONSOR OST/TST

REPORT FOR MONTH ENDING: 6/30/71
(PRELIMINARY)

PPA NO. OS-07

Dollar Items Below Are In Thousands

	P.P.A Planned Amount	Salaries & Benef	Indirect Expense	R&D Contr	Equip	Other Expense	TOTAL	Uncom-mitted P.P.A Plan	Total Accrued Cost	Man Years Effort
OBLIGATED	580	138.3	159.1	142.2	43.4	106.5	589.5	(9.5)	507.0	7.2
COMMITTED	580	138.3	159.1	142.2	43.4	106.5	589.5			

DEPARTMENT OF TRANSPORTATION
TRANSPORTATION SYSTEMS CENTER
CAMBRIDGE, MASS.

PROJECT PLAN AGREEMENT

1. GWA NO.	2. PPA NO.	REV. NO.	AFFECTS PAGES	3. DATE:
71-08	0807	1	1-4	March 30, 1971

4. TITLE:
Transportation Noise Abatement

5. SPONSOR:	7. TASK MANAGER:
Mr. Charles Foster, TST-50 Office of the Secretary of Transportation 400 Seventh Street, S.W. Washington, D.C. 20590 (202) 426-4553	John E. Wesler, TRE DOT/Transportation Systems Center 55 Broadway Cambridge, Massachusetts 02142 (617) 494-2258
6. SPONSOR NO.:	8. RELATED PPAS:

9. BRIEF TECHNICAL SUMMARY: In cooperation with the Office of Noise Abatement (TST-50), the Transportation Systems Center will undertake a modeling and field measurement program to produce quantitative description of community noise resulting from transportation systems taking into account the phenomena of noise generation and propagation; and assessing possible means of supressing or reducing transportation generated noise. In addition to a variety of special analyses conducted for TST-50, TSC will undertake the computer model study of a selected city and sample field measurements to validate these results. Research will also be undertaken to develop needed additions to our understanding of jet turbulence and sheer boundary parameters associated with high velocity jet noise. Finally, TSC will undertake both in-house and with contract support, a study of V/STOL noise to delineate the area of most promising pay-off through noise abatement research.

10. RESOURCE REQUIREMENTS:

	FY 71	FY	FY
DIRECT MANYEARS	7.3		
SALARIES & BENEFITS $K	148.0		
MAJOR EQUIPMENT	51.0		
RESEARCH CONTRACTS	142.0		
IN-HOUSE SERVICES & OTHER	68.0		
INDIRECT	171.0		
TOTAL	580.0		

11. APPROVALS:

	TSC	SPONSOR	TST
BY:	[signature]	[signature]	/S/ Findley
TITLE:	Director of Technology	Director, Office of Noise Abatement	
DATE:	4-5-71	4-12-71	28 May 71

12. Description of Work:

Task 1 - Undertake a modeling and field measurment program to assimilate and assess community noise caused by transportation systems -

a. Program and exercise TSC digital computers to quantify the micro and macro noise environment of an urban center (prescribed by TST-50) and compute projected noise environments as influenced by postulated noise abatement alternatives. (Basic computer programs in Fortran IV are now becoming available under contract DOT OS-A9-018.)

b Expand upon and refine existing theories of sound propagation under conditions of complex urban activity and mitigating structures, terrain and vegetation.

c. Acquire and equip (with TST-50 concurrence) a high quality mobile noise laboratory with portable equipment that will be set up at numerous sites within an urban center approved by TST-50 for the measurement and monitoring of noise including acquisition of visual data and pertinent traffic flow, geographic and demographic data.

d. Acquire noise data as prescribed by TST-50 to quantify such relationships as highway traffic flow parameters effecting roadside and community noise levels, highway terrain and vegetation parameters modifying nominal highway generated noise levels; airport operational factors effecting nearby community noise levels; overall city traffic flow parameters effecting ambient urban noise levels.

Task 2 -

a. Initiate basic research contract with MIT (Prof. Lewis approx. $35K) for the investigation of fluid dynamic/turbulence/mixing parameters effecting noise generation at high jet velocities.

b. As a supporting effort, utilize TSC optical instrumentation in conjunction with the ongoing research on jet noise. TSC optical assistance is to aid in the mapping of jet turbulence and sheer boundary parameters for correlation with MIT acoustics and fluid dynamics experimentation.

c. Based upon the experience and tr[illegible]ning per above and as qualified fluid dynamics personnel can be acquired, develop independent program proposals (for TST-50 approval) aimed at basic jet and aerodynamic noise abatement.

Task 3 - Undertake contract studies ($75K) and in-house analysis of V/STOL noise to ascertain areas of maximum payoff through noise abatement research.

Each of the previously discussed tasks will start as soon as this document is approved.

13. INTERFACES:

The interface problem in this program is substantial and will require close direction by the Office of the Secretary, Office of Noise Abatement.

14. SCHEDULES and DELIVERABLES:

Task 1.a. - Begin dialog with DOT contractor, 1 September, 1970.
- Airport Noise Model usable at TSC, 1 October, 1970.
- Highway Noise Model usable at TSC, 1 July, 1971.
- Begin ICAO airport analyses, 1 February, 1971.
- Report results of ICAO airport analyses, 1 July, 1971.
- Perform airport analyses, as directed by TST-50.

Task 1.b. - Begin study of expanded model needs, 1 October, 1970.
- Report results of study, 1 July, 1971.

Task 1.c. - Begin procurement of mobile van, 1 September, 1970.
- Van operational, 1 February, 1971.

Task 1.d. - Select suburban area for noise survey, 1 February, 1971.
- Begin suburban area noise survey, 1 March, 1971.
- Report results of suburban area noise survey, 1 July, 1971.

Task 2.a. - Begin discussions with MIT,
1 [illegible]ptember, 1970.
- Award research contracts,
1 February, 1971.
- Report results of research bi-monthly.

Task 2.b. - Begin feasibility study of sound probe,
1 August, 1970.
- Report results of feasibility study,
1 July, 1971.

Task 2.c. - Begin recruitment,
1 September, 1970.

Task 3 - Begin discussions with MIT,
1 September, 1970.
- Award research contract,
1 December, 1970.
- Report results of research bi-monthly.
- Begin in-house study,
1 January, 1971.
- Report results of in-house study,
1 July, 1971.

15. PROCUREMENT:

Principal items discussed in Item 14 above.

MANAGEMENT:

This program will be managed by the Mechanical Engineering Division of the Technology Directorate with assistance from the Computer Division and Electromagnetic Division in response to technical direction from the Office of Noise Abatement, DOT (TST-50).

17. REPORTING METHODS:

Quarterly reports with reviews and presentations as required

First report - draft copy - June 1, 1971
- final copy - July 1, 1971

Security of Report: Unclassified.

Procurement Method: Contract - Cost Plus Fixed Fee

*Modification to contract signed 11/19/70 increased the cost by $16,270 and covered escalation of Overhead and General and Administrative rates during FY-1970.)

Modification to contract signed 12/31/70 increased the cost by an additional $80,000 and covered an expansion of the scope of Task 1. Using the Aircraft/Airport model developed for the Baltimore Washington Metropolitan Area, the contractor, in cooperation with the Transportation Systems Center, will develop and implement a research and demonstration program to measure and evaluate an urban area in the Boston Metropolitan Area, and thereby validate and provide more confidence in the methodology used for evaluating noise exposure in urban areas.

~~15 May 1969~~
Updated March 1970

DOT-OS-A9-036

Start Date: 02 12 68

Estimated Completion Date: 08 69

Kind of Report: New

Performing Organization: University of Washington
Seattle, Washington 98105

Principal Investigator, Name: Dr. James D. Chalupnik, Associate Professor
Department of Mechanical Engineering

Responsible Government Organization, Name: Department of Transportation
Asst. Secretary for Research & Technology
Office of Noise Abatement
800 Independence Avenue, S.W
Washington, D.C. 20590

Responsible Government Individual, Name: Paullin, Robert L.
Chief, Regulatory Policy & Standards Div.
Office of Noise Abatement

Key Words: Criteria for measuring and evaluating transportation noise; sound level scales; subjective response scales; laboratory testing methods; field testing methods; unified noise rating system.

Title: Evaluating the Noises of Transportation - A Symposium on Acceptability of Criteria for Transportation Noise

Summary: Define and evaluate the noises of transportation with an overall goal of defining the requirements for uniform criteria and objectives for transportation noise abatement. Identify and quantify the parameters which characterize differences in the annoyance levels of different sources of transportation. A thorough understanding as to the application of differences in noise rating systems shall be developed such that an ultimate solution of the noise rating problems, i.e., the unified noise rating system, will result.

Resources Estimate, Funds: $24,402

Security of Report: Unclassified.

Procurement Method: Contract.

Other Funding Agencies: N/A

Final report received March 1970.

15 May 1969

<u>DOT-OS-A9-040</u>

<u>Start Date:</u> 01 04 69

<u>Estimated Completion Date:</u> 09 69

<u>Kind of Report:</u> New

<u>Performing Organization, Name:</u> Bolt Beranek & Newman
50 Moulton Street
Cambridge, Massachusetts

<u>Principal Investigator, Name:</u> Franken, Peter A., Vice President
Physical Sciences Division

<u>Responsible Government Organization, Name:</u> Department of Transportation
Asst. Secretary for Research & Technology
Office of Noise Abatement
800 Independence Avenue, S.W.
Washington, D.C. 20590

<u>Responsible Government Individual, Name:</u> Paullin, Robert L.
Chief, Regulatory Policy & Standards Div.
Office of Noise Abatement

<u>Key Words:</u> Mass transit rail systems (subways); acoustical measurements and studies; matrix of the acoustical environment.

<u>Title:</u> A Study for Research and Reporting on Mass Transportation Systems (Subways) Acoustical Environment.

<u>Summary:</u> Perform a study by reviewing available technical reports on the mass transit rail systems now in existence in foreign cities such as Toronto, Hamburg, London, Berlin, Paris, and Rotterdam. Select seven systems that appear to have the lowest noise levels. Make acoustical measurements and studies of these systems so as to complement existing data and provide additional data necessary to present a complete matrix of the acoustical environment. Analyze the results of the studies and tests and identify the parameters that define the systems acoustical environment. Rank the systems studied.

<u>Resources Estimate, Funds:</u> $16,778

<u>Security of Report:</u> Unclassified

<u>Procurement Method:</u> Contract - fixed price.

<u>Other Funding Agencies:</u> N/A

Final Report received February 1970.

OFFICE OF NOISE ABATEMENT, TRT-50

INTERDEPARTMENTAL AGREEMENTS - FY-1969:

DOT-OS-A9-086:-

Name of other agency: FAA
Date of agreement: 21 May 1969
Term for which agreement is effective: Complete December 1970
Purpose of agreement: Support the engineering development of selectable glide slope computers for operational evaluation using FAA aircraft.
Financial details: $50,000 for the procurement of 25 computers at a rate of approximately 2 units per month.
Officer maintaining cognizance: Mr. Charles H. Williams.

DOT-OS-A9-072:-

Name of other agency: HUD
Date of agreement: 25 February 1969
Term for which agreement is effective: Complete June 30, 1970.
Purpose of agreement: Provide funds to facilitate and extend HUD's research in conducting a series of Metropolitan Aircraft Noise Abatement Policy Studies (MANAPS)
Financial details: Joint funded effort - $100,000 DOT/$100,000 HUD.
Officer maintaining cognizance: Mr. Charles H. Williams.

DOT-OS-A9-059:-

Name of other agency: FAA
Date of agreement: 17 January 1969
Term for which agreement is effective: Complete December 31, 1969.
Purpose of agreement: Provide financial support for a research and development effort to examine the problems associated with VSTOL noise characteristics. This effort is an extension to an existing contract between FAA and Wyle Laboratories.
Financial details: $40,000
Officer maintaining cognizance: Mr. Charles H. Williams

9 July 1969

DOT-OS-A9-118

Start Date: 30 06 69

Estimated Completion Date: ~~06 71~~ 12 72

Kind of Report: New

Performing Organization, Name: University of California, College of Engineering, Office of Research Services, Berkeley, California

Principal Investigator: Professor Robert Horonjeff
Office of Research Services

Alternate Investigator: Professor W. W. Soroka
Office of Research Services

Responsible Government Organization, Name: Department of Transportation
Asst. Secretary for Research & Technology
Office of Noise Abatement
800 Independence Ave. S.W.
Washington, D.C. 20590

Responsible Government Individual, Name: Paullin, Robert L.
Chief, Regulatory Policy & Standards Div.
Office of Noise Abatement

Key Words: Alleviation of environmental noise caused by transportation systems; development of criteria for evaluating the acceptability of transportation noise.

Title: Impacts and Alleviation of Transportation Noise

Summary: Make specific contributions to existing knowledge about the impact of transportation noise on community, physical, social, and economic environment; further explore methods for reducting transportation noise by analyzing their effectiveness, impact on system performance, cost, feasibility, and economic desirability; provide urban planners, transportation system planners and operators, acousticians, governmental agencies and others with better measures of the community cost of transportation noise, and with better techniques for noise alleviation.

Resources Estimate, Funds: $125,466

Security of Report: Unclassified.

Procurement Method: Contract.

30 April 1970

DOT-OS-00006

Start Date: 8 10 69

Estimated Completion Date: ~~30-06-70~~ 31 12 70

Kind of Report: New

Performing Organization, Name: National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550

Principal Investigator, Name: Wallace Waterfall, Treasurer
Acoustical Society of America

Responsible Government Organization, Name: Department of Transportation
Assistant Secretary
for Systems Development and Technology
Office of Noise Abatement
800 Independence Avenue, SW
Washington, D.C. 20590

Responsible Government Individual, Name: Robert L. Paullin
Regulatory Policy and Standards Div.
Office of Noise Abatement

Key Words: Research in noise standards

Title: Formulation of Noise Standards

Summary: Support the continuation of work by the Acoustical Society of America dealing with the formulation of acoustical standards. The three standards committees of the Acoustical Society (S-1 - Acoustics, S-2 - Shock and Vibration, and S-3 - Bioacoustics) will report upon current engineering and scientific research designed to provide technical bases for specifying standard methods for the measurement of noise and vibration and defining acceptable limits for noise and vibration by transportation equipment.

Resources Estimate, Funds: $21,400

Security of Report: Unclassified

Procurement Method: Interagency Agreement

17 April 1970
Updated September 1970

DOT-AS-00014

Start Date: 15 10 69

Estimated Completion Date: 07 70

Kind of Report: New

Performing Organization, Name: U.S. Department of Commerce
National Bureau of Standards
Washington, D.C.

Principal Investigator, Name: Paul J. Brown
Chief, Office of Vehicle Systems Research
Institute for Applied Technology, NBS

Responsible Government Organization, Name: Department of Transportation
Assistant Secretary
for Systems Development and Technology
Office of Noise Abatement
800 Independence Ave., S.W.
Washington, D.C. 20590

Responsible Government Individual, Name: ~~John G. Courlas~~ W. Harry Close
Research Division
Office of Noise Abatement

Key Words: Study of tire sound generation

Title: Tire Acoustics Program

Summary: Determine through a study of tire sound generation whether the variations between tires can lead to an effective acoustical grading of tires. The two distinct areas of investigation are: a) the physical distribution and characteristics of the sound generated by a representative range of commercial tires under various conditions; and b) a comparative assessment of the auditory responses to typical noises generated by tires. -- The use of NBS facilities and expertise may provide an inhouse capability for measuring tire noise that could lead to a federal rating system or a regulatory procedure for limiting tire noise generation.

Resources Estimate, Funds: $50,000

Security of Report: Unclassified.

Procurement Method: Reimbursable Agreement.

Draft report received.

[illegible]

[illegible] ... and [illegible] pollution control.

The efforts [illegible] are broad in scope and include [illegible] on the major sources of [illegible] surface and air transportation. [illegible] directed toward such areas as trucks and truck tires, rail, and construction equipment. [illegible] research [illegible] on aircraft, including the SST and V/STOL types. [illegible] of these types of aircraft will depend greatly on their compatibility with the environment.

Pollution has been amply demonstrated to possess serious ecological consequences unless it is controlled. The research planned in pollution control is designed to provide stimulation of U. S. industry and to produce effective controls for their products. The area of aviation exhaust emissions continues to require basic inquiry. This is particularly true in the case of the effects of worldwide SST operations on the upper atmosphere. In addition, the effect of pollution controls imposed on the transportation industry will be examined.

I. NOISE ABATEMENT .... ~~$9,715~~ 5,745
(Transportation Systems Center)............................ ($1,500) (900)

This program provides for [illegible] research into the causes, effects, and properties of transportation noise (surface as well as air); selective experimentation with and demonstrations of noise reduction techniques; and research in support of the Interagency Aircraft Noise Abatement Program (IANAP). Major emphasis is directed toward the demonstration of practical applications of noise reduction techniques to existing transportation vehicles and the development of research capabilities to provide the basis for solution of problems into the future.

a. Surface Transportation Vehicle Noise Reduction $450

This program is composed of projects intended to demonstrate economic methods of abating noise generated by existing transportation vehicles. Contracts will be entered into with acoustic research firms and/or manufacturers and operators of transportation vehicles to develop and demonstrate modifications to vehicles which incorporate recent state-of-the-art noise reduction techniques. These projects will demonstrate noise reduction in truck engines, truck tires, construction equipment, and mass transit rail vehicles.

b. Right-of-Way (Guideway) Noise Reduction $100

This program is intended to demonstrate [illegible] and technologically feasible methods of attenuating noise transmissions generated by vehicles operating on highways and/or other guideways. Noise

($ in 000)

enforcement problems encountered by state and local authorities will also be examined to determine areas of possible refinement and innovative methods of noise measurement. The proposed work will demonstrate improved noise barrier design and noise enforcement measurement techniques.

c. Research on Noise Generation Mechanisms $450

This program will enhance the basic knowledge needed for further understanding of fundamental noise generation and propagation associated with jet noise, V/STOL noise sources, and internal combustion engine noise. The program will be supported both by grants to appropriate universities and the development of an in-house capability at the Transportation Systems Center.

d. Noise Measurement, Analysis, and Information $500

This program will provide further refinement of techniques used to measure transportation systems noise in metropolitan areas. It will further provide additional in-depth analyses and refinement to mathematical models previously developed to assist transportation system planners and operators. It will also provide incremental support of a sophisticated noise information retrieval and storage system.

e. Airport Noise Reduction Program $8,245 4245

In the absence of additional advanced noise reduction devices and techniques, current and future aircraft will produce excessive airport noise. In order to enhance compatability between the airplane and its airport

($ in 000)

neighbors, the research and technology program for reducing airport noise must be moved forward with all deliberate urgency. Several promising methods of abating noise will be pursued vigorously. If possible, innovative methods will be developed and tested to complement or replace known technology. This work will be entirely complementary to Federal Aircraft Noise Abatement programs.

(1) Exhaust Noise Suppressor ~~$5,745~~ 3,000

In order to provide significant noise suppression for current and future aircraft, suppression devices must be developed that have the potential of substantial jet noise reduction. To achieve this degree of engine exhaust noise suppression, the feasibility of developing efficient multi-tube nozzle/lined ejector noise suppressors must be investigated. This program will include development of theory and empirical data for this type of noise control through analyses and tests of: tube size, shape, spacing, number and length, cooling methods, and material development. Variables of ejector design, such as area ratio, length, and acoustic lining properties, will also be analyzed. This work will be initiated with scale model suppressor development, but will lead to full-scale demonstrations.

(2) Structure and Turbulence Investigations and Related Demonstrations ~~$2,500~~ 1,245

Theoretical and experimental studies will be initiated to determine the overall structure, turbulence levels, and noise source distribution in jet flows to gain a more complete understanding of the mechanisms by which noise is generated. Without such understanding, noise reduction must be pursued using purely empirical approaches to suppression and engine cycle changes. This effort will involve laboratory and scale model research.

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
FY 1972 - Congressional Submission

b. Environmental Quality Program (Noise Suppression, Sonic Boom, and Aircraft Emission)................. $3,500,000

The objectives of these programs are to: (1) alleviate the aircraft noise problem; (2) reduce the intensity and adverse effects of the sonic boom phenomena; and (3) mitigate the effect of aircraft emissions on the environment. Efforts to be accomplished are:

(1) Noise Suppression, $1,850,000

(a) Source, $900,000

The work will involve investigations into the parameters that cause or influence the actual generation of noise emanating from aircraft, plus development of guidelines for changes to the engine hardware to minimize this noise. In addition, the effort will include development of equipment or devices necessary to be installed, attached, or actually built into engines of various designs to suppress that noise which is generated. Included are studies to improve techniques of noise measurement, data reduction and analysis, plus refinement of yardsticks for evaluation and rating of various levels of aircraft noise.

(b) Transmission Paths, $150,000

This program concerns itself with efforts to minimize the noise by proper consideration of the paths the noise takes to travel from its source to the receivers. The work will involve development of optimum safe operational procedures designed to minimize noise. The studies will cover the aircraft performance characteristics, the safety aspects of noise abatement procedures, as well as the noise exposure that results from various flight profiles and ground operations. Included are studies to improve techniques of noise measurement data reduction and analysis, plus refinements of the yardsticks used for evaluation and rating of various levels of aircraft noise.

(c) <u>Receiver (Human Response), $250,000</u>

This effort provides for the reduction, control, and evaluation of noise at the receiving end. The work will involve developing and refining acceptable yardsticks for evaluation and rating of various levels of aircraft noise, and the development of guidelines for planning for and control of the residual noise inherent in airplane operations.

(d) <u>System Analysis, $550,000</u>

This program involves a systematic study of all facets of the aircraft noise abatement program. Technical, economic, social, operational, and psychological aspects of the problem are quantified and/or qualified to be used as aids in making decisions. Costs and benefits of alternative solutions, certification standards, land use guidelines, operational standards, and abatement programs are defined and reduced according to a rationale established by analysis.

(2) <u>Sonic Boom, $1,200,000</u>

A sonic boom certification research program is needed both to develop technical and social criterion for sonic boom limits that must be established in accord with Public Law 90-411, and to form definitive guidelines upon which to base government and industry policies for the regulation of future supersonic or transonic commercial aircraft.

(a) <u>Generation and Propagation, $600,000</u>

This subprogram is concerned with the reduction and control of sonic boom by aerodynamic design and the investigation of parameters that influence shock wave generation and propagation.

(b) <u>Human Response, $400,000</u>

This work involves investigation into the psychological, physiological and sociological factors and the interaction between these as related to the effects of sonic boom upon people and communities.

(c) <u>Animal Response, $75,000</u>

The objective of this program is to determine short and long-range effects of sonic boom on wild and domestic birds and animals and aquatic life forms.

(d) <u>Structural Response, $125,000</u>

The effects of isolated and repeated sonic booms on structures including glass breakage will be investigated. Included in the program is the development of the special instrumentation and analysis methods required to properly evaluate response to sonic booms and superbooms.

(3) Aircraft Emissions, $450,000

(a) Transmission Paths, $300,000

This work includes investigation of the effect of engine emissions at altitude, engine emission dissipation rates under various meteorological conditions, and analysis of ground operations to determine possible procedural modifications to reduce pollution ascribable to aircraft and aircraft related activities.

(b) Receiver (Human, Animal, Ecological), $150,000

Investigations will be made under this subprogram on the effects of exposure of people to concentrations of aircraft engine emissions. Studies also will include the effect of various concentrations of such emissions and fall-out of particulate matter on property as well as on the ecology.

DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

Active Studies '72

Study Title	Type	Current Funding
Field Evaluation of Traffic Noise Reduction Measurements	NCHRP	50K
Relating Highway Design and Environment to Abatement of Traffic Noise	HPR (Maryland)	42K*
Pollution of Michigan Urban Atmospheres by Highway Generated Noise	HPR (Michigan)	28K*
Community Noise Survey and Evaluation	Administrative	17K*
Traffic Noise Near Highways and the Effect of Design and Environmental Variables	HPR (California)	12K*

*Federal funding = 70%
State funding = 30%

DEPARTMENT OF TRANSPORTATION

Office of the Secretary
(Office of Noise Abatement)

Position Title	Series	Grade
Director	1301	17
Secretary	318	9
Chief, Plans & Programs Div.	2101	16
Program Analyst	345	14
Program Analyst	345	9
Chief, Regulatory Policy & Stds. Div.	1301	16
Operations Research Analyst	1515	15
Secretary	318	7
Chief, Research Division	801	16
Mechanical Engineer	830	15
General Engineer	801	15
Secretary	318	7

Federal Aviation Administration
Systems Research and Development Service
(Noise Abatement Division)

Position Title	Series	Grade
Chief	861	16
Secretary	318	7
Program Analyst	345	14
Chief, Aircraft Noise Branch	861	16
Aerospace Engineer	861	15
Aerospace Engineer	861	15
Aerospace Enginer	861	14
Chief, Sonic Boom Branch	861	16
Psychologist	180	15

Transportation Systems Center
Mechanical Engineering Div.
(Electromechanical Branch)

Position Title	Series	Grade
Chief (detail from Coast Guard)		
Special Projects Officer	301	14
Mechanical Engineer	830	14
Mechanical Engineer	830	13
Electronics Engineer	855	13
Electronics Technician	856	11
Engineering Technician	802	11
Clerk-Steno	301	5

Federal Aviation Administration
Office of Environmental Quality

The authorized staffing for the FAA, Office of Environmental Quality includes 11 professionals and 1 military (Colonel) detail from the Department of Defense, responsibile for environmental research (noise and pollution). There are 3 - GS-16s; 7 - GS-15s; and 1 - GS-14. Disciplines represented in these positions are: systems analysis, technical environmental planning, environmental science, operations systems analysis, measurement and research planning.

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

7 SEP 1971

Dr. Alvin F. Meyer
Director, Office of Noise Abatement
and Control
Environmental Protection Agency
Washington, D. C. 20460

Dear Dr. Meyer:

The Office of Environmental Quality, within the Federal Aviation Administration, has just completed the execution of a noise reduction flight (operational) evaluation project. This project was performed at our National Aviation Facilities Experimental Center near Atlantic City, New Jersey, and constitutes but one of many projects this office has programmed and directed toward the control and abatement of aircraft noise.

The subject program objectives include the quantification of measured and recorded reduction in aircraft noise through the use of various operating procedures/techniques by the same aircraft. For a cross-reference on the impact of noise reduction by aircraft type design the same procedures were also evaluated for four different turbojet powered airplanes.

Enclosed for your review and consideration are the program's past and current progress reports (1-5). We intend to forward a copy of the final report when such is complete. If there is additional program information desired, please contact Mr. R. D. Shreve, EQ-20, Program Director.

We endorse and are looking forward to continued Federal coordination in the process of resolution to the nation's environmental problems.

Sincerely,

R. P. SKULLY
Director
Office of Environmental Quality

Enclosures

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

DATE: 19 August 1970

IN REPLY REFER TO: NO-1'

SUBJECT: Operational/Procedural Noise Reduction Flight Program - Progress Report No. 1

TO: Deputy Administrator
Through: PL-1

A program has been developed for the flight evaluation and data analysis of potential noise reduction, specifically during the approach to landing flight phase, associated with:

1. Configuration change (airframe/thrust)
2. Variable glide slope intercept altitude
3. Two-segment approach
4. Uniform (3°) vs variable glide slope angle

The flight program will be executed in such a manner so as to develop noise data which can be related to a base procedure/configuration, thus enabling an incremental or delta noise level to be identified with each of the profiles flown.

This flight program, by necessity, requires the cooperative and coordinated efforts of several Offices and Services within the agency. A task force made up of representatives from each of the Offices and Services involved has been formed to ensure effective coordination and expeditious completion of the program.

Under Secretary Beggs requested the program's schedule as soon as possible. It is anticipated that such a schedule will be available within two to three weeks. Virtually, all of the programs' variables have to be defined prior to establishing a schedule. The task force is currently working on this program phase.

While final results rather than progress reports are the program's objectives, it is suggested that such reports on the program's status can be helpful in identifying the program's achievements, program delays and, in many cases, resolve situations before they become program problems. With your concurrence, such reports will periodically be sent forth.

The Office of Noise Abatement's contact in regard to this program development is Mr. R.D. Shreve, NO-20.

for JOHN O. POWERS
Acting Director, Office of Noise Abatement, NO-1

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

DATE: 7 October 1970

REPLY TO ATTN OF: NO-1

SUBJECT: Operational/Procedural Noise Reduction Flight Program - Progress Report No. 2

TO: Deputy Administrator
Through: PL-1

The development of the program's' scope, coordination requirements and functional execution has been completed. In association with completing the developmental task, certain key program elements have been defined. Included are:

1. The flight phase will be executed on or about 5 April 1971. All contributing program components; i.e., site preparation, outside contractual support, rescheduling of FAA airplanes, etc., will be effected to ensure meeting the 5 April date.

2. NAFEC, Atlantic City, New Jersey, is the test site of prime consideration.

3. Takeoff profiles will be flight evaluated as well as and supplementary to the prime objectives of approach profiles relative to potential noise reduction.

4. The necessary funding for the program's execution, including all support components, will be allocated through reapportionment of the R&D budget in the FAA Office of Noise Abatement.

The decision to execute the flight phase during April 1971 was made in lieu of attempts to establish an earlier program execution (Fall of 1970) only after due consideration had been given to the practical analysis of the factors required for program implementation. Such factors included; (a) the possibility of inclement flight test weather anticipated for the late Fall or early Winter season; (b) minimum time required for site preparation and scheduling of on-site facilities; (c) sole source versus competitive bidding on required contractual support; and (d) conflicts created through the rescheduling of FAA airplanes, both for flight training and specified ground down time required.

Of the various test site locations given consideration, NAFEC with its in-house facilities, competent manpower and ground support equipment was selected as the most desired and advantageous site offering support to and compatibility with the objective requirements of this program.

The flight evaluation of various takeoff profiles has been included within the program's scope. While it is recognized that takeoff profiles have been evaluated in previous programs, the need for additional data acquisition exists. Industry has either proposed or is executing various takeoff profiles which tend to effect relief at a given point in the profile or are being adopted simply as company noise abatement procedures. Industry is to be commended for the initiative shown; however, this program will execute in summary these various profiles to a much expanded data base. The noise levels generated by these various profiles will be measured and analyzed out to a 10 mile point. Such evaluation will then include not only potential noise reduction close-in, but also downstream of the highly impacted area. As an example - such data would reveal the actual impact of the thrust cut versus no thrust cut as identified with the cross-over or tradeoff in the various profiles relative to the total noise exposure experience.

The program's task force is now in a position, relative to the key element decisions, to structure the required details of program implementation. In this regard, a task force meeting is called for Monday, October 12, 1970 at 9:30 a.m. in room 9C. The agenda for this meeting includes:

1. Final concurrence in the definition of the approach and takeoff flight profiles.

2. Initiation of airplane leasing arrangements.

3. Scheduling of installation for required operational flight equipment and rescheduling, where necessary, of flight training.

4. Scheduling of NAFEC facilities and site preparation.

5. Preparation of specific airplane flight performance values for both approach and takeoff operation.

6. Review of acoustic contractual support.

7. Open review of progress or problems, if any, associated with the April 1971 program execution.

3.

Enclosed for the task force member's consideration and guidance are the program's scope, profiles, and scheduling. A concerned review of these enclosures will contribute to the resolution of the agenda items for the 12 October meeting.

Thank you for your continued cooperation.

John O Powers

JOHN O. POWERS
Acting Director, Office of Noise Abatement, NO-1

Enclosures

Enclosure #1

OPERATIONAL-PROCEDURAL NOISE REDUCTION FLIGHT PROGRAM

OBJECTIVES

TO IDENTIFY THE LEVELS OF NOISE REDUCTION OBTAINABLE THROUGH VARYING AIRCRAFT FLIGHT PATHS AND OPERATIONAL PROCEDURES IN THE TERMINAL AREAS.

SCOPE

VARIATIONS IN FLIGHT PATHS AND OPERATIONAL PROCEDURES FOR:

APPROACH-TO-LAND

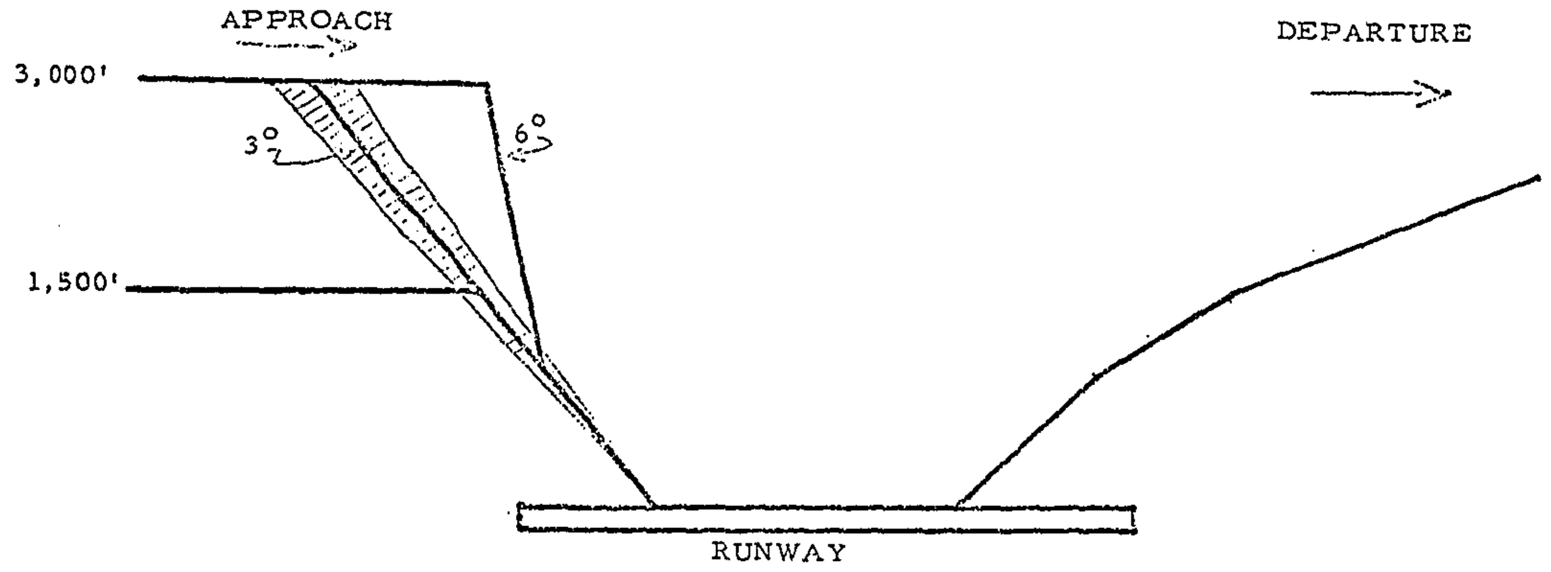
1. CONFIGURATION CHANGES (AIRFRAME/THRUST)
2. DIFFERENT GLIDE SLOPE INTERCEPT ALTITUDES
3. TWO-SEGMENT APPROACH, AND -
4. UNIFORM (3^{o}) VS OTHER GLIDE SLOPE ANGLES

DEPARTURE

1. CLIMB OUT SPEEDS
2. CLIMB OUT CONFIGURATIONS (AIRFRAME)
3. THRUST REDUCTION, AND -
4. ALTITUDES FOR THRUST REDUCTION

Enclosure #2

PROGRAM PROFILES



KEY VARIABLES - SPEED, THRUST/THRUST CUT, CONFIGURATION

Enclosure #3

ELEMENTS OF PROGRAM DEVELOPMENT

1. SITE SELECTION
2. "OUTSIDE" CONTRACTUAL SUPPORT
3. COORDINATION OF AGENCY OFFICE AND SERVICE FUNCTIONS
4. FLIGHT SCHEDULING,

Enclo. .re #

PROGRAM FLIGHT SCHEDULE

AIRPLANES TO BE USED:

1. B-727 (FAA)
2. DC-9 (FAA)
3. B-720 (FAA)
4. B-707-320B (LEASED)

FLIGHT TIME PER AIRCRAFT

APPROXIMATELY 20 HOURS (ONE WEEK

TOTAL EXECUTION PERIOD

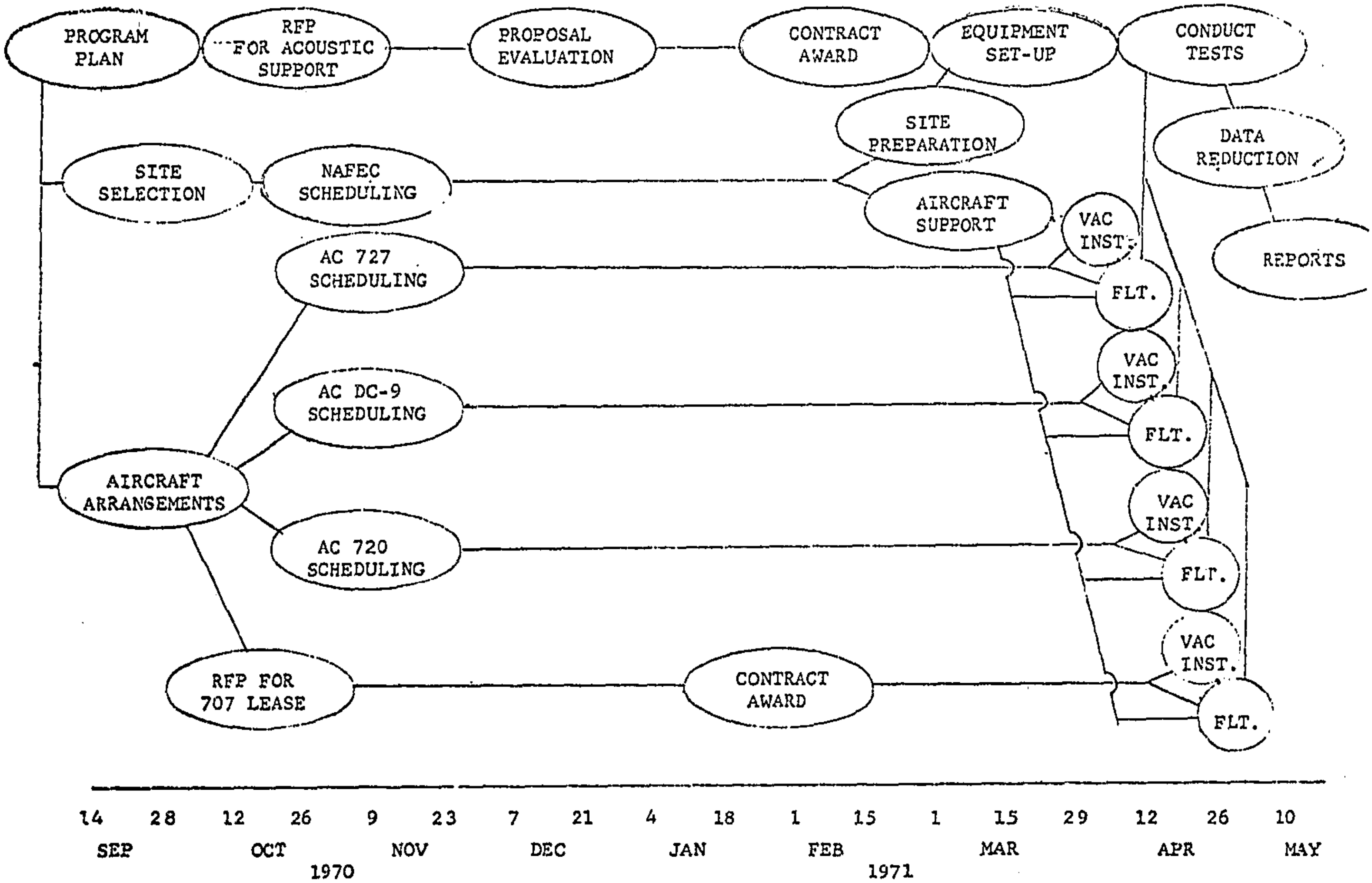
FOUR WEEKS

PROPOSED INITIATION AND EXECUTION DATES

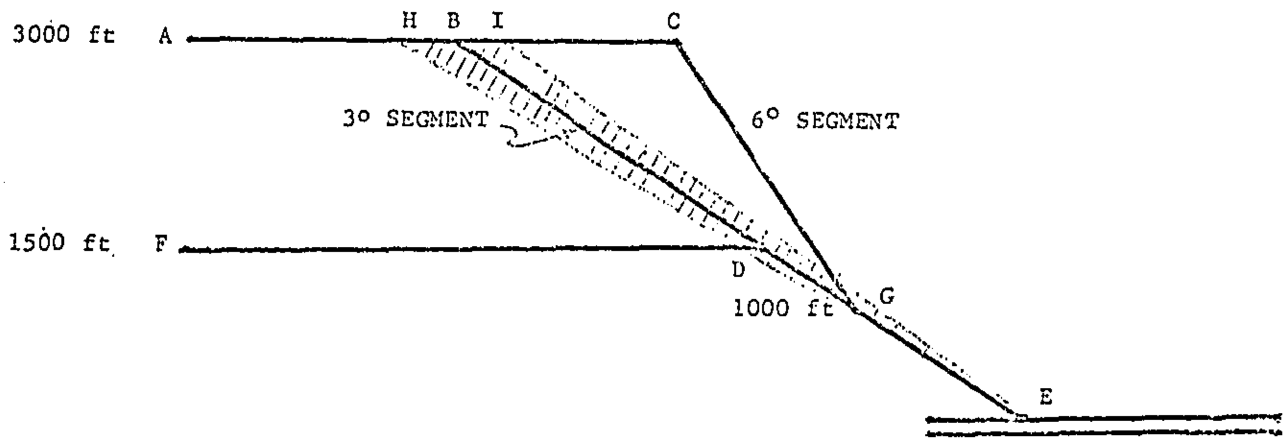
APRIL 5, 1971 THROUGH APRIL 30, 1971

Enclosure #5

OPERATIONAL-PROCEDURAL NOISE REDUCTION FLIGHT PROGRAM



APPROACH TO LANDING PROCEDURES
(MAXIMUM LANDING WEIGHT)



NOTE:

1. GEAR UP UNTIL REACHING B, C, OR D

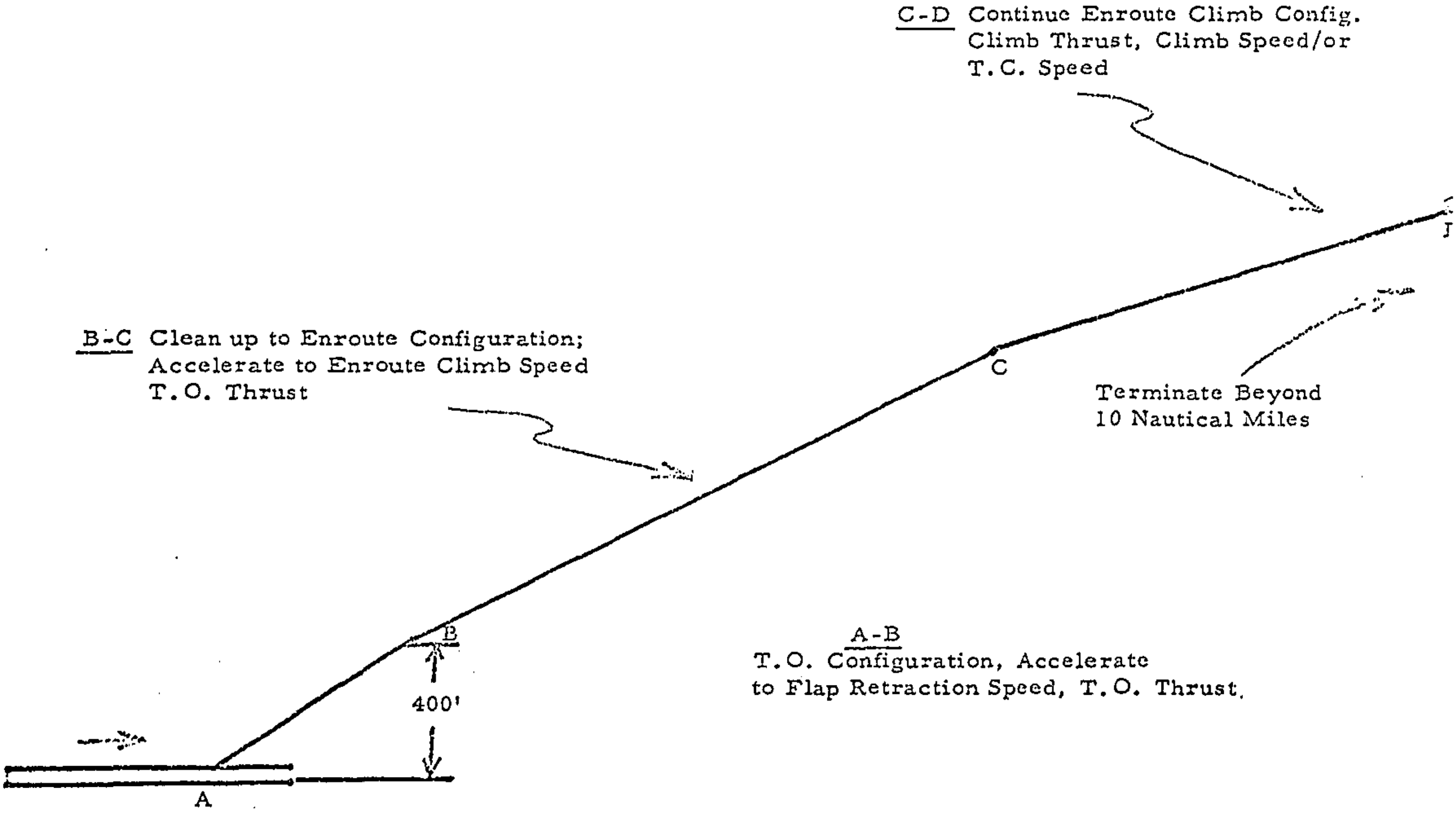
2. APPROACH CONFIGURATION UNTIL REACHING B, C, OR D EXCEPT FOR CLEAN CONFIGURATION

PROFILE	CONFIGURATION			
	LAND. #2	LAND. #1	APPROACH	CLEAN
CONVENTIONAL (1500'-F-D-E)	X	X	X	
CONVENTIONAL (3000'-A-B-E)	X	X	X	X
TWO SEGMENT (A-C-G-E)	X			
HIGH GLIDE SLOPE (3000'-A-I-E)	X			
LOW GLIDE SLOPE (3000'-A-H-E)	X			

Enclosure #7

DEPARTURE PROCEDURE

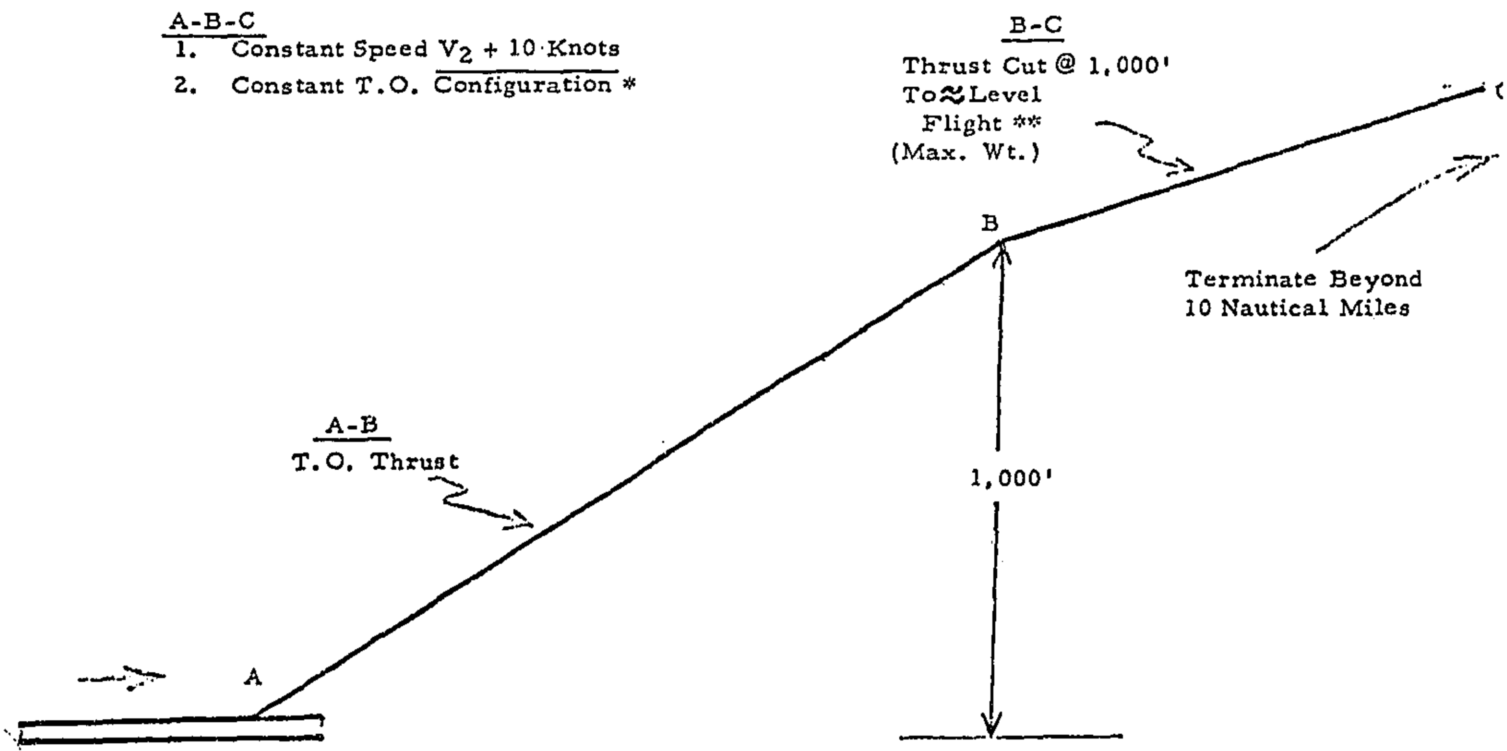
NUMBER 1



Enclosu: #8

DEPARTURE PROCEDURE

NUMBER 2



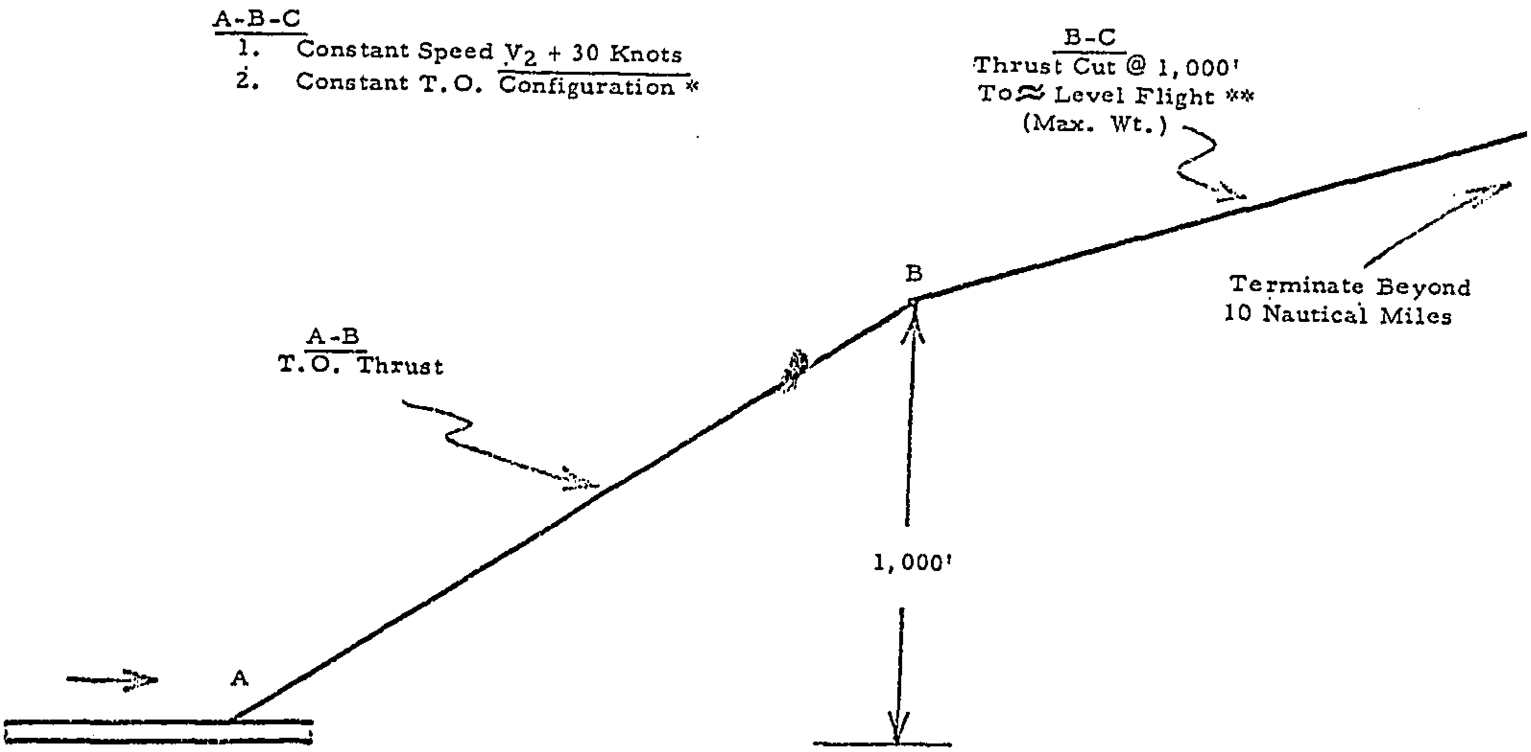
* Less Gear Retraction

** Engine Out Performance

Enclosure

DEPARTURE PROCEDURE

NUMBER 3

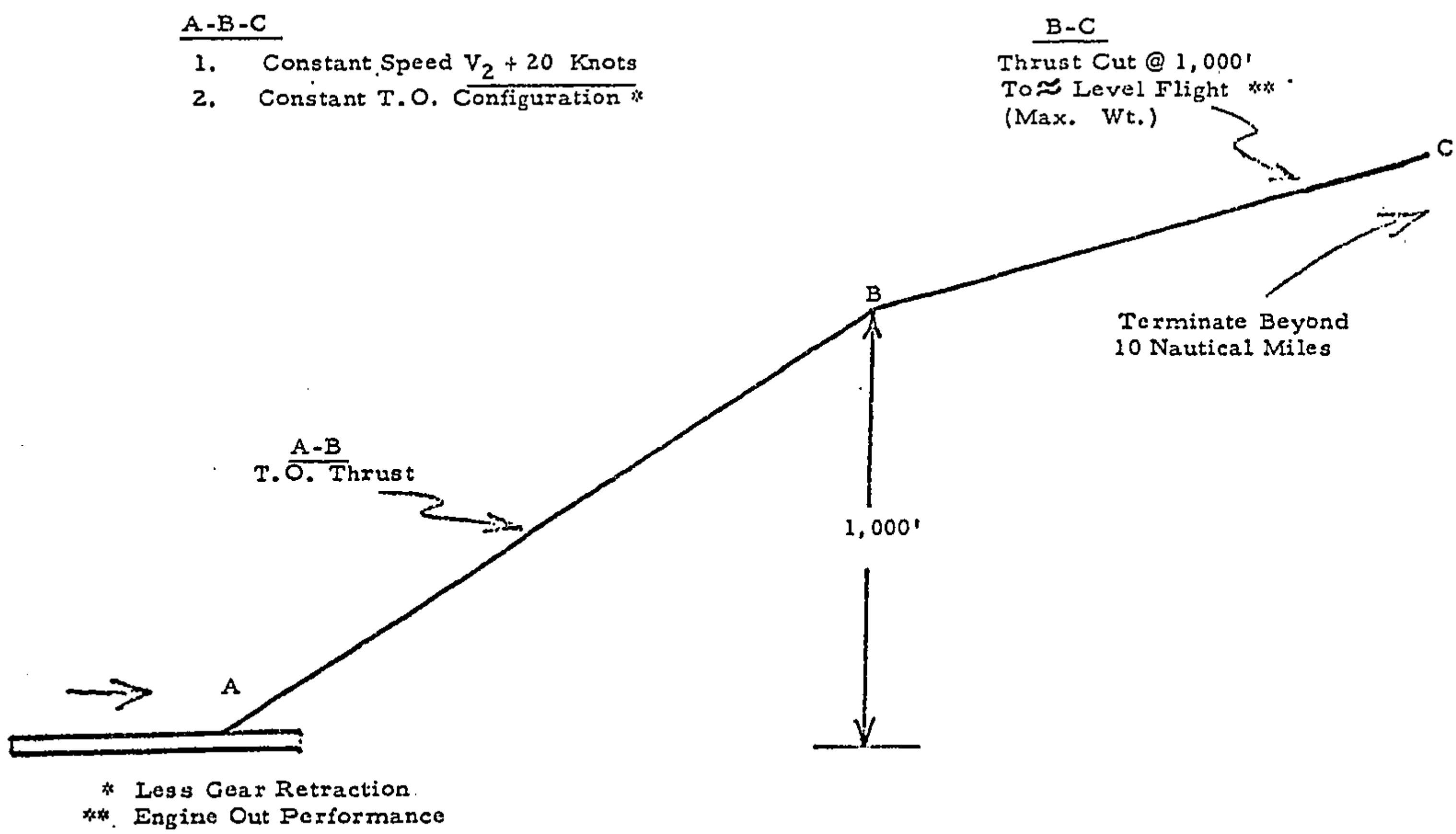


* Less Gear Retraction
** Engine Out Performance

Enclosure #10

DEPARTURE PROCEDURE

NUMBER 4



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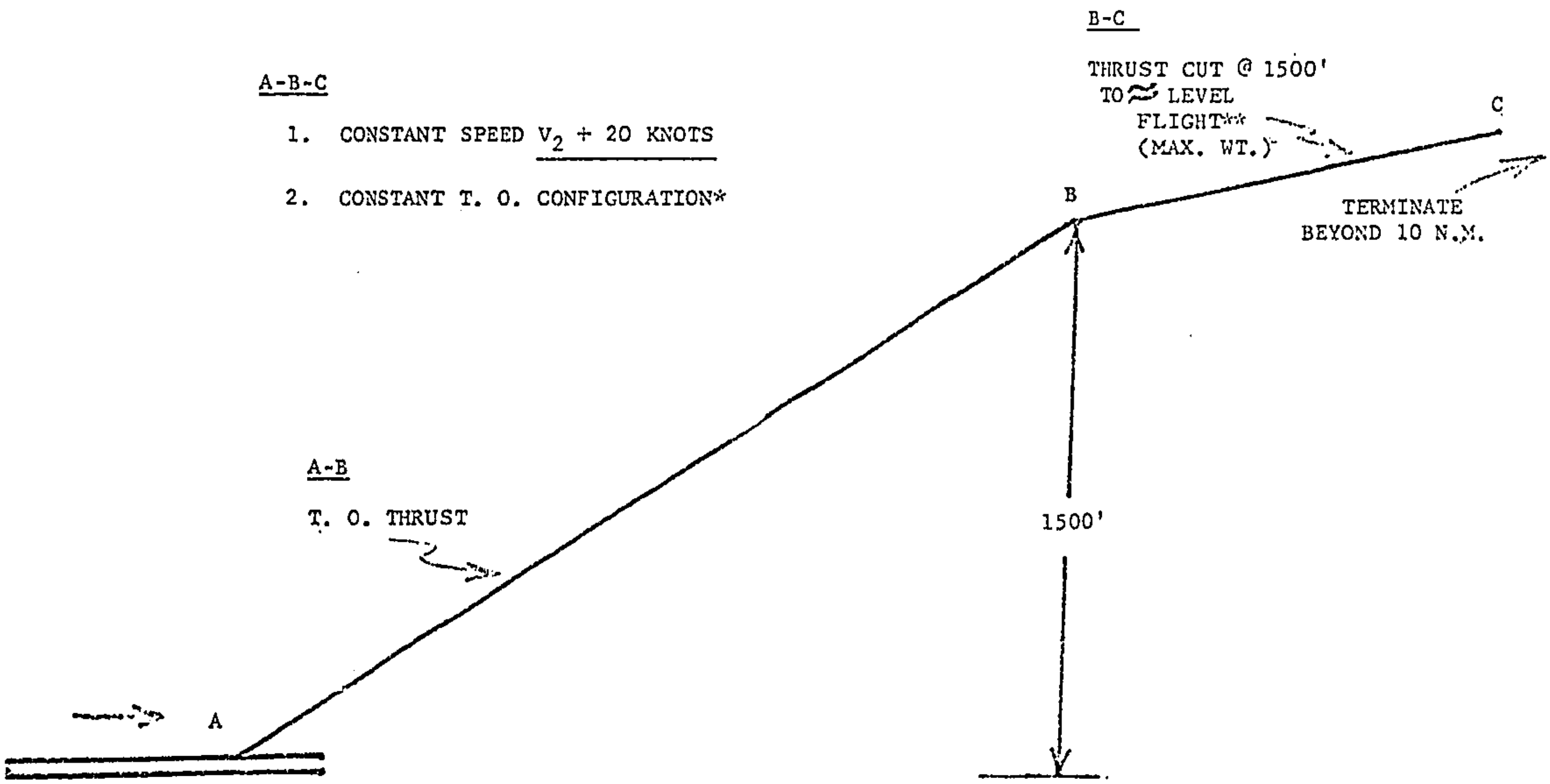
DEPARTURE PROCEDURE

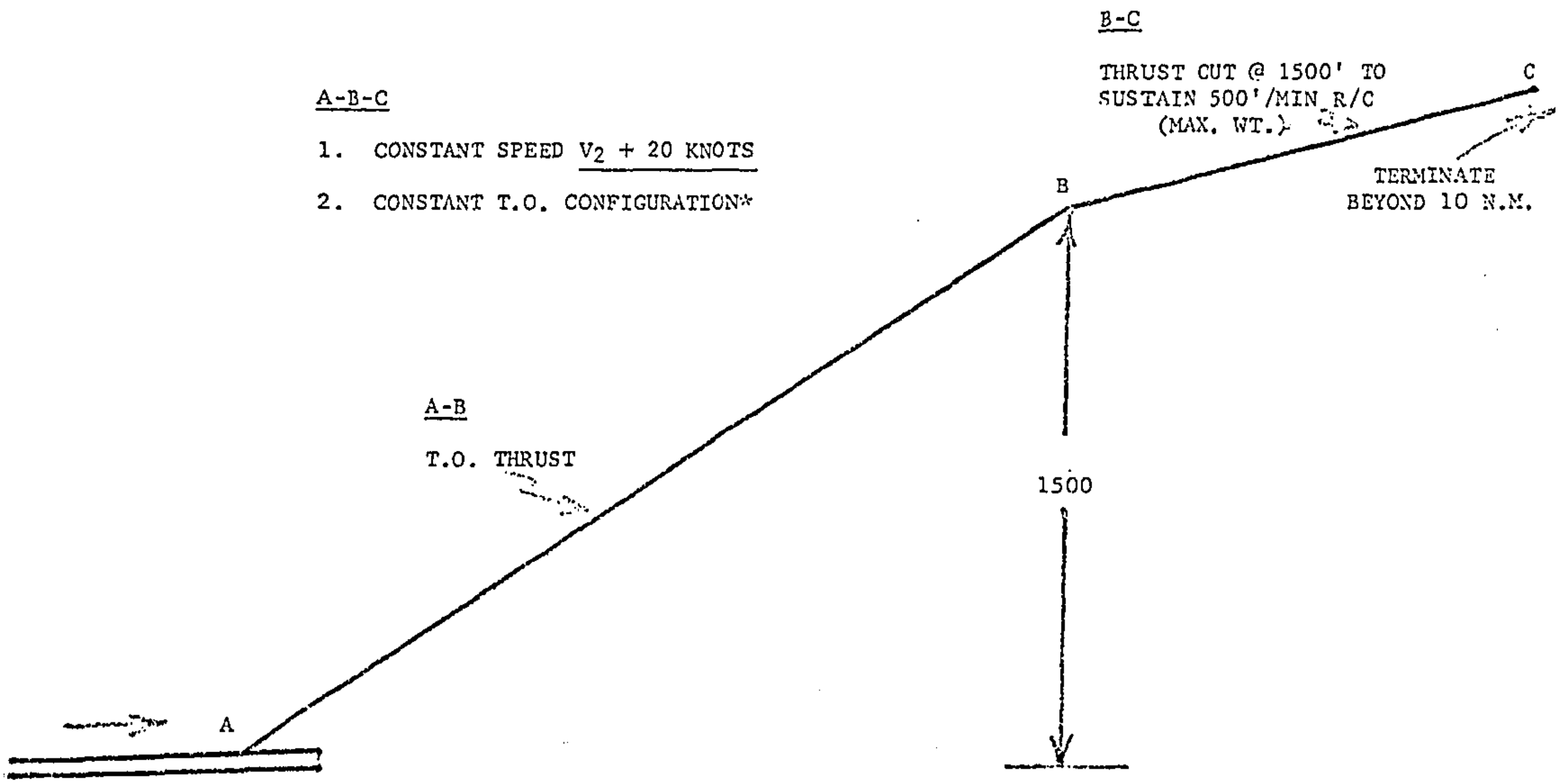
NUMBER 5



* LESS GEAR RETRACTION
** ENGINE OUT PERFORMANCE

D E P A R T U R E   P R O C E D U R E

N U M B E R   6

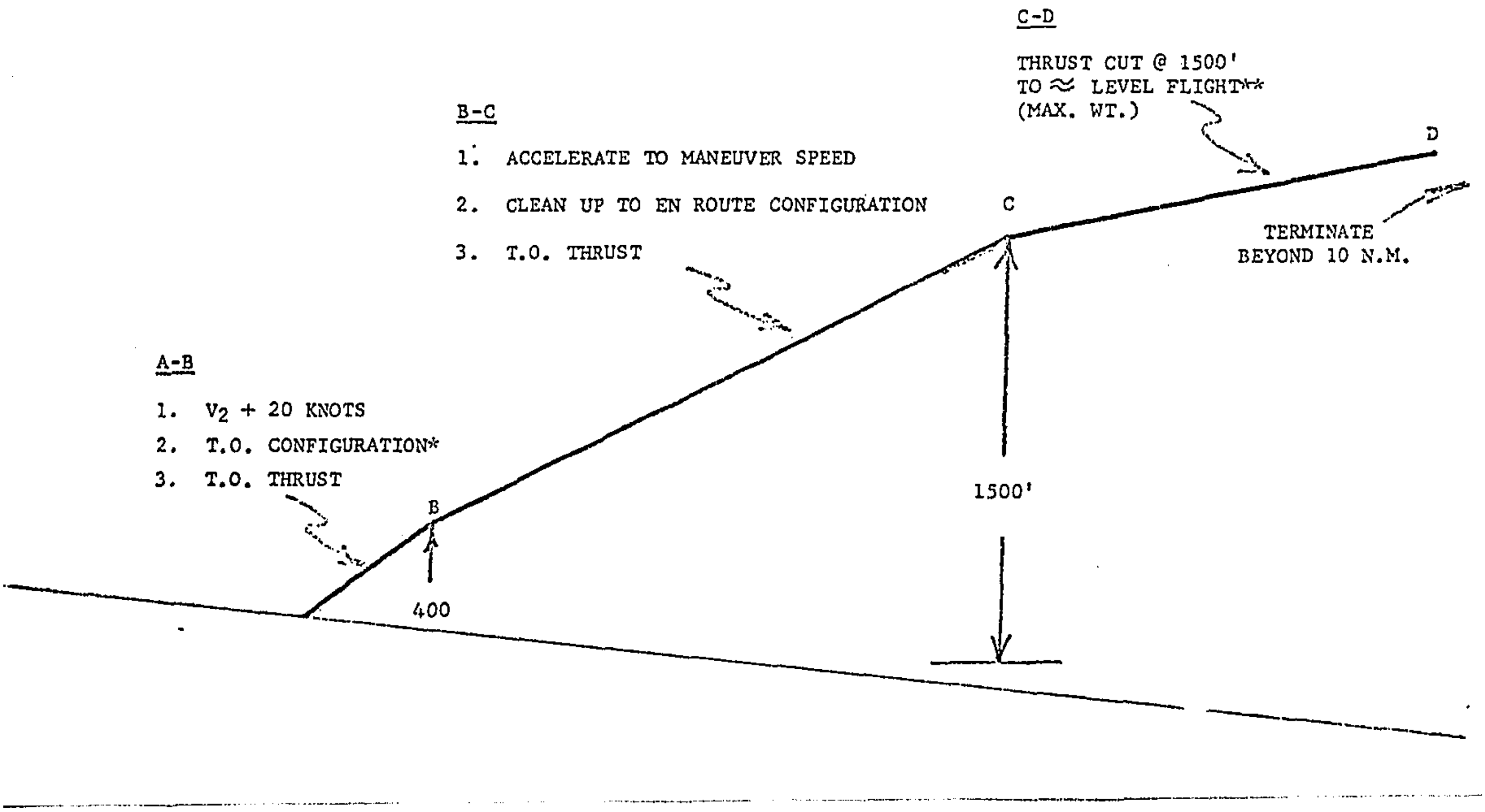


* LESS GEAR RETRACTION

Enclosure #.J

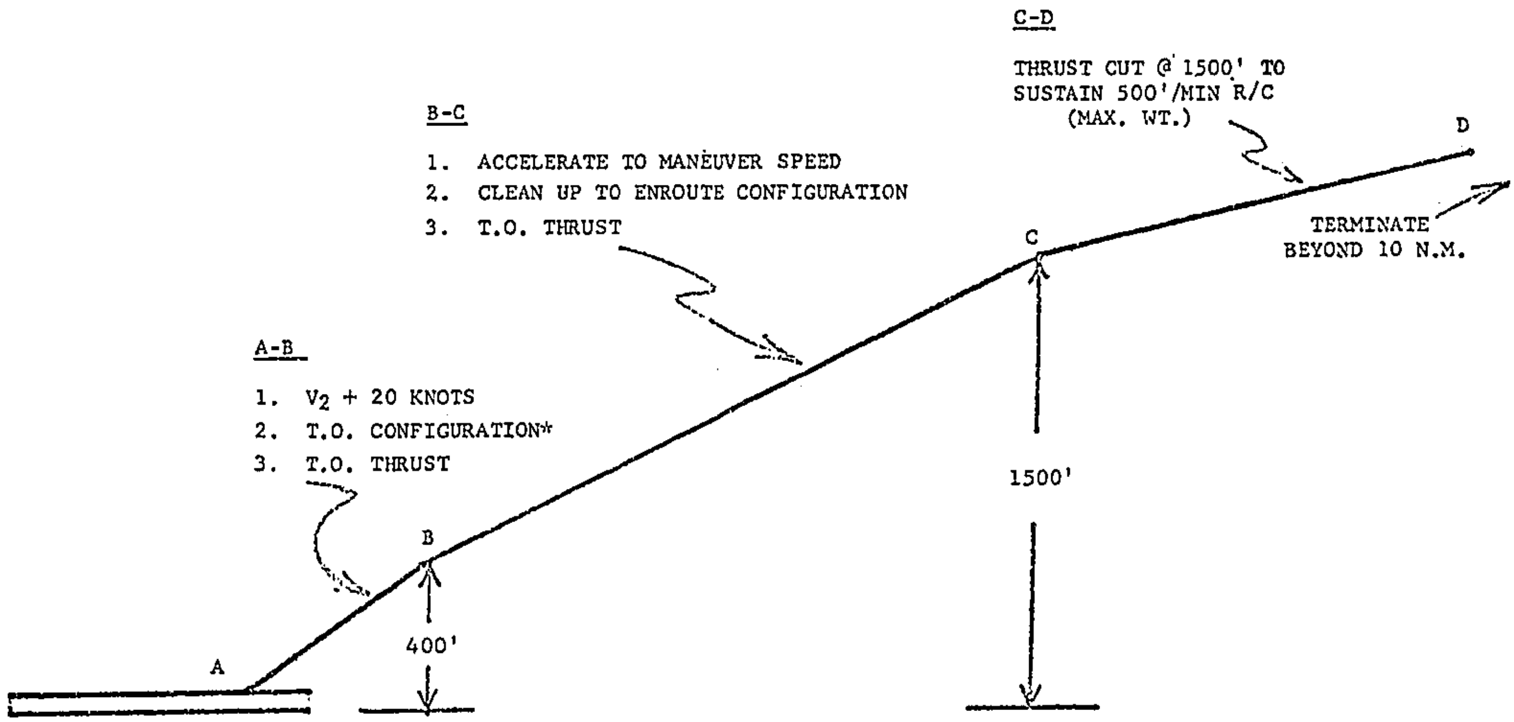
DEPARTURE PROCEDURE

NUMBER 7



DEPARTURE PROCEDURE

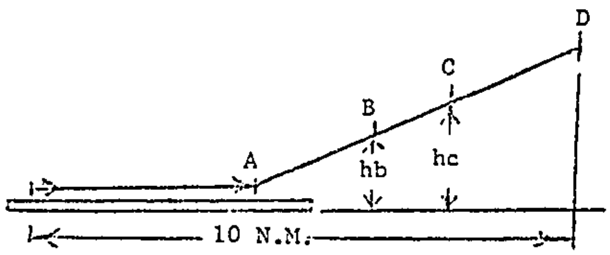
NUMBER 8



* LESS GEAR RETRACTION

Enclosure #15

TAKEOFF PROCEDURES



TAKEOFF		A-B	hb	B-C	hc	C-D
1	SPEED THRUST FLAP	→ FRS T.O. T.O.	400	→ ERCS (=) → ERCC	NA	ERCS → ERCT ERCC
2, 3, 4	SPEED THRUST FLAP	→ V_2+10, 20, 30 T.O. T.O.	1000	V_2+10, 20, 30 → TSL (=)	NA	(=) (=) (=)
5, 6	SPEED THRUST FLAP	→ V_2+20 T.O. T.O.	1500	V_2+20 → TSL, T500 (=)	NA	(=) (=) (=)
7, 8	SPEED THRUST FLAP	→ V_2+20 T.O. → ERCC	400	→ VA (=) ERCC	1500	VA → TSL, T500 (=)

DEFINITIONS:

NA = Not applicable
TSL = Thrust level need for straight and level flight at max. gross weight one eng. out
T500 = Thrust level need for 500 FPM climb at max. gross weight one eng. out
ERC = En route climb

T = Thrust
S = Speed
C = Configuration
(=) = Same as preceding value
VA = Design maneuvering speed
FRS = Flap retract speed

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

DATE: 5 FEB 1971

WASHINGTON, D.C. 20590

IN REPLY REFER TO: EQ-20

SUBJECT: Operational/Procedural Noise Reduction Flight Program - Progress Report No. 3

TO: Deputy Administrator
Through: PL-1

The cooperation and coordinated efforts of the various Offices, Services and Facilities in fulfilling their responsibilities (described in the enclosure) toward the execution of this program has, to date, been outstanding. While certain problems have arisen, the willingness displayed in their coordinated resolution is more than worthy of specific mention. Sincere appreciation is expressed to each task force member for their obvious motivation and unqualified desire to ensure a successful program.

At this point, the development of key program elements seems to be on or ahead of schedule. Specifically:

1. The RFP for acoustical contract support has been issued, responses have been evaluated and currently final negotiations are in process with the acceptable bidders,

2. The RFP for lease arrangements of a B-707-300 series airplane has been issued with respond and final contract anticipated soon,

3. Site leasing and preparation along with the scheduling of NAFEC support facilities has either been completed or is progressing with no apparent hitches,

4. The flight scheduling of the FAA and lease airplanes has been firmed up, and

5. Operational instrumentation required in the evaluation airplanes has either been scheduled or is installed.

The FAA Convair 880M will replace the heretofore scheduled Boeing B-720 airplane due to a conflict arising in the instrumentation and operational scheduling. This switch presents no problem to the program's objectives as they are both turbojet four-engined airplanes.

There have been some changes and additions to the program's task force membership, as follows:

1. Mr. Jack Burke replacing Mr. D. G. Cockran from Airports Service (AS-560),

2. Lt. Colonel R. Chubbay replacing Lt. Colonel T. R. Howell from Systems Research and Development Service (RD-740),

3. The addition of Mr. Hugh Riddle from the Bureau of National Capital Airports (CA-5),

4. The addition of Mr. Harry R. Jackson from the Measurement Branch, Technical Facilities Division of NAFEC (NA-141), and

5. From the Department's Office of Noise Abatement, in addition to Mr. Charles H. Williams, the program now has Dr. Gordan Banerian (TST-50).

The program's definition and development has and will continue to be enhanced by these new task force members and the functions they represent.

In support of the program's objectives, arrangements are in process to obtain stock footage film of the events and the methods and facilities used in their development. With such stock footage, it is anticipated that at a later date, subject to the Administrator's approval, an operational movie could be developed. The intent of such a movie would be to document both through "sight and sound" the potential reduction in airplane noise exposure through operational techniques. It is believed that the information contained in such a movie would be of great benefit to the local authorities (airport-communities) when reviewed in light of seeking operational noise reduction in their own local noise sensitive areas.

A meeting is planned for the latter part of February with interested industry and civic groups for the purpose of reviewing with them the scope and objectives of this program. Particularly, the flight profiles will be discussed. It is planned to invite comments on the proposed profiles and where reasonable and practical, if offered, adjust the departure profiles to those, by consensus of the task force members, most meaningful for evaluation. Participants of the meeting will be invited to send representatives to observe the flight evaluation itself, especially industry pilot representatives will be encouraged to observe. The task force members will be informed of the exact date, time and place soon.

John O Powers

JOHN O. POWERS, Acting Director
Office of Environmental Quality, EQ-1

Enclosure

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

DATE 16 DEC 1970

IN REPLY REFER TO: NO-20

SUBJECT: Office/Service Responsibilities, RE: Operational/Procedural Noise Reduction Program

TO: Program Task Force Members

Through the combined efforts of the task force with support from the Under Secretary and Administrator the subject program has been outlined and scheduled. Sincere appreciation is expressed for the unqualified support given in obtaining this phase of program development. With this phase accomplished, it is essential to the success of the program's execution that each Office and/or Service, by way of their task force representative, recognize and fulfill their program support responsibilities.

The purpose of this memorandum is to assemble in one document the responsibilities of each Office/Service as defined in previous task force coordination meetings. The fulfillment of these responsibilities, in many instances, will require close coordination with other Offices/Services. Thus, included with the listing of responsibilities are areas considered as those of prime coordination; accepting, that general coordination is required and anticipated within the working structure of the program's task force.

The following items are defined as Key, but not to be considered total, program support responsibilities for each of the contributing Office/Service functions:

FLIGHT STANDARDS SERVICE (Thru FS-403)

1. The leasing of out-of-agency airplane (B-707, 320 B/C). Such leasing arrangements should include -

   a. Consecutive calendar time of three (3) weeks

   b. Option in flight hours to be flown

   c. Lease crew and required airplane logistics

   d. Installation and post evaluation removal of required equipment and instrumentation

2. Scheduling of FAA airplanes (DC-9, B-720 and B-727)

   a. Pre-evaluation ground time for those airplanes requiring equipment and instrumentation installation, and -

   b. Airplane(s) at test site for not only program flight evaluation but also for pre-evaluation profile proficiency flights.

3. Arrange for required equipment and instrumentation for segmented approaches, including manpower required for such installation.

4. The assignment of FAA evaluation pilots for each of the airplanes in the program, with support crews for the FAA airplanes.

5. Establish for all of the evaluation airplanes for each of the approach-to-land and departure profiles to be executed -

   a. Thrust and performance values to be used, noting operational limitations, - if such exist.

   b. Airframe configurations, and

   c. Flight deck procedures

6. Develop and submit a summary report, following the flight evaluation, concerning the pilots analysis of each profile flown relative to normal procedures, as to;

   a. Pilot workload relative to operations in low and high density terminal areas,

   b. Additional flight training requirements

   c. Compatibility of procedure under all weather flight conditions (VFR, IFR, etc.), and

   d. Other reviews or comments

COORDINATION

NO-20, FS-700, FS-160, NAFEC, AND AERONAUTICAL CENTER

AIRPORTS SERVICE (Thru AS-560)

1. Advise in the development of the program profiles,

2. Assist and monitor the program's execution,

3. Develop and submit a summary report, following the flight evaluation, concerning the potential use of such flight procedures profiles within the airport system.

4. Act as the program's central information data release and retrieval source for regional coordination.

COORDINATION

NO-20, AT, FS, AND REGIONAL OFFICES

AIR TRAFFIC SERVICE (Thru AT-320)

1. Continue to advise and aid in the construction of the program's development,

2. Assist and monitor the program's execution,

3. Identify the known or potential impact of implementing operational procedural - flight profile modifications on the air traffic control system. Specific reference should be made regarding:

   a. Raising the glide slope intercept altitude to 3000 feet,

   b. establishing a uniform glide slope of 3 degrees.

Note: Such identification should include current and future facilities and equipment

4. Develop and submit a summary report, based on the flight evaluation, concerning ATS' analysis of implementing any such change in procedures or profiles (using specific airports as examples).

COORDINATION

NO-20, AS, AND FS

SYSTEMS RESEARCH AND DEVELOPMENT SERVICE (Thru RD-740)

1. Assist in procuring and making available, as per schedule, the agency developed equipment (selectable glide slope computer) for installation, as required, in the program's evaluation airplanes.

2. Prepare all necessary briefing material required to implement the functional operation of such equipment, and -

3. Assign qualified personnel(s) for:

   a. The flight deck and operational check out of the installed equipment

   b. Crew briefing on equipment, use and limitations, and

   c. Continuing surveillance of installed equipment during the flight evaluation execution, to ensure functional and reliable operation.

COORDINATION

NO-20, FS, AERONAUTICAL CENTER, AND NAFEC

NATIONAL AVIATION FACILITIES AND EXPERIMENTAL CENTER (Thru NA-141)

1. Acoustical measuring range site preparation, to include:

   a. off airport land leasing

   b. off airport land clearing

   c. surveying, and

   d. security surveillance at monitoring locations.

2. Availability and functional use of the Phototheodalite System to include, tracking plots, digitalized tapes of tracking, time synchronization, etc.

3. Supply and maintain communication network for central acoustic station, ground to air, ground to ground, control tower, etc.

4. Supply and maintain required ground support equipment to include vehicles, power units, etc.

5. Supply and operate land camera equipment, - minimum of two units.

6. Schedule and maintain control usage of the flight range and runway during the program's daily flight execution periods.

7. Logistics support for airplanes operational requirements, fuel etc.

8. Assignment and scheduling for manpower for the installation and maintenance of the evaluation airplane(s) operational equipment and instrumentation (SGSC).

9. The acquisition of the required meterological data

COORDINATION

NO-20, NO-10, FS, AND AERONAUTICAL CENTER

BUREAU OF NATIONAL CAPITAL AIRPORTS (Thru CA-5)

1. Participate and advise in the practical aspects and definition of the program's objectives, and

2. Evaluate and report on the program's execution as to the potential modification of existing procedural and flight profiles; wherein, such modifications would produce benefits/disbenefits to the airports operation and community relief.

COORDINATION

NO-20, AT, AND AS

OFFICE OF NOISE ABATEMENT (Thru NO-10)

1. Define the program's acoustical objectives and direct the

attainment of all acoustical data required to fulfill these objectives,

2. The procurement of required out-of-agency acoustical contracts; covering, —

    a. Acoustical measuring equipment

    b. Acoustical data acquisition

    c. Acoustical data reduction

    d. Preparation and submission of final data report

3. Assign an on-site acoustical project coordinator to direct and monitor all acoustical aspects of the program's requirement.

4. Develop, if required, additional use and presentation of the contractor's final data report,

5. Final approval in the selection and preparation of the acoustical range monitoring sites

6. Develop and outline the program's weather data acquisition requirements.

<u>COORDINATION</u>

NO-20, ACOUSTICAL CONTRACTOR(S), AND NAFEC

<u>OFFICE OF NOISE ABATEMENT</u> (Thru NO-20)

1. Direct and coordinate the over-all program development and execution

2. Develop and submit a final program report to the Administrator on the results of the program, to include,

    a. An analysis of the data obtained relative to the program's objective

    b. Identify the benefits - disbenefits regarding noise reduction through procedural/flight path modifications and their operational implementation, and

c. Recommendations as to agency action relative to over-all results of this program execution.

The above outline of Office/Service responsibilities to the program's development and execution is not suggested to be complete as to the definition and detail required for active fulfillment; this is properly left to the task force leadership in each function. However, to aid each task force representative in his respective action, a third task force meeting has been set for 10:00 a.m. on 12 January 1971 in FAA Conference Room 7A. During this 12 January meeting, using the above outline as guideline reference, each task force member is requested to present his plan of action including progress to date, future scheduling with anticipated workload completion dates, and identification to any conflicts or problems associated with the fulfillment of his program support.

Progress Report Number 2, dated 7 October 1970 contained, as an enclosure, tentative scheduling for the program's development and execution. While the over-all schedule had intentionally some flexibility the flight execution portion was considered relative firm. Since the issuance of this schedule FS has indicated that it would serve their support function better if the following changes were made in the airplane flight scheduling:

Week Of	Airplane
April 5, 1971	FAA B-727 or B-720
April 12, 1971	FAA B-727 or B-720
April 19, 1971	Leased B-707 -320B/C
April 26, 1971	FAA DC-9

The option of the FAA B-727 and/or B-720 during the first two weeks of flight evaluation is yet to be determined by FS as is not considered critical to the program's scheduling. However, for potential leasing or contractural reasons it is essential to establish a specific flight date for the B-707 -320B/C. The FAA DC-9 has earlier committments on the west coast, thus, should be and is scheduled last.

A revised flow chart of scheduling the program's development and execution will be developed and issued following the more specific dates presented for the various functions at the 12 January meeting.

Thank you for your past and anticipated continuing support to this program.

R. D. SHREVE
Program Manager, NO-20