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**FEDERAL RESEARCH,  
DEVELOPMENT AND DEMONSTRATION  
PROGRAMS**

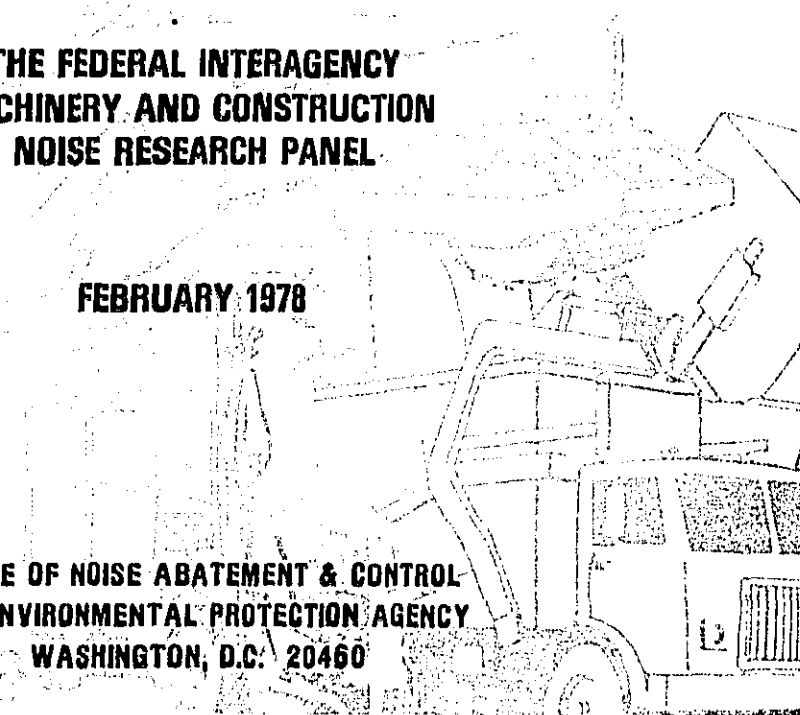
**IN**  
**MACHINERY AND CONSTRUCTION  
NOISE**

**PREPARED BY**

**THE FEDERAL INTERAGENCY  
MACHINERY AND CONSTRUCTION  
NOISE RESEARCH PANEL**

**FEBRUARY 1978**

**OFFICE OF NOISE ABATEMENT & CONTROL  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460**



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FEDERAL RESEARCH, DEVELOPMENT, AND DEMONSTRATION  
PROGRAMS IN MACHINERY AND CONSTRUCTION NOISE

Prepared by the  
Federal Interagency Machinery and  
Construction Noise Research Panel

February 1978

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

## PREFACE

One of the purposes of the Noise Control Act of 1972 was to establish a means for effective coordination of Federal research, development, and demonstration (RD&D) activities in noise control. As part of this coordination role, the Act directs the Administrator of EPA to compile and publish a report on the status and progress of Federal noise research and noise control programs and to assess the contributions of these programs to the Federal government's overall efforts to control noise.

In partial fulfillment of its responsibility, EPA established four interagency ad hoc research panels in early 1974 in the areas of aviation, surface transportation, machinery and construction equipment, and noise effects. Reports were issued by the panels during March-June 1975. The reports summarized the ongoing or planned noise research, development, and demonstration programs within the various agencies of the Federal government through FY 75.

During 1976, the four panels were reestablished for the purpose of updating and extending the program and fiscal data base through FY 78. The primary objectives of the panels were broadened to include assessment of the RD&D programs in light of each agency's mandates, goals, and objectives as well as the overall goals of the Federal government to control noise.

The current Federal Interagency Machinery and Construction Noise Research Panel included representatives from the Department of Interior (DOI); Department of Health, Education, and Welfare (HEW); Department of Defense (DOD); Environmental Protection Agency (EPA); Department of Transportation (DOT); and Department of Commerce, National Bureau of Standards (DOC/NBS). The panel was chaired by Mr. Joseph A. Lamonica of the Mining Enforcement and Safety Administration (MESA), a component agency within DOI. DOI was selected for the chairmanship since it was the lead department within the Federal government involved in machinery and construction noise RD&D. EPA served as secretariat to the panel.

This report has been prepared by the members of the Federal Interagency Machinery and Construction Noise Research Panel. The information, assessments, conclusions, and recommendations are the consensus of the panel members and are not necessarily the official views of each of the Federal agencies.

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\* MESA was transferred from DOI to the Department of Labor (DOL),  
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## 1.0 INTRODUCTION

The United States Government is involved in research, development and demonstration (RD&D) activities related to machinery and construction noise abatement and control through a number of its agencies and departments. These agency programs have varying goals and objectives according to their individual agency charters, statutory authorities and other priorities.

Section 4 of the Noise Control Act of 1972 (PL 92-574, October 1972) states that the Congress:

"...authorizes and directs that Federal agencies shall, to the fullest extent consistent with their authority under Federal laws administered by them, carry out the programs within their control in such a manner as to further the policy ... to promote an environment for all Americans free from noise that jeopardizes their health or welfare..."

Section 4 further requires the Administrator of EPA to:

"...coordinate the programs of all Federal agencies relating to noise research and noise control..." and "On the basis of regular consultation with appropriate Federal agencies ... shall compile and publish, from time to time, a report on the status and progress of Federal activities relating to noise research and noise control. This report shall describe the noise control programs of each Federal agency and assess the contributions of those programs to the Federal Government's overall efforts to control noise."

## 1.1 BACKGROUND

In partial fulfillment of its responsibility for coordinating Federal noise research, the Environmental Protection Agency has reconvened the Federal Interagency Machinery and Construction Noise Research Panel. After its original establishment in 1974, that panel produced the first report summarizing ongoing and planned Machinery and Construction noise research, development and demonstration programs within the various agencies and departments of the Federal

government through FY 75. In addition to brief descriptions and fiscal data for the agencies' programs, references of reports and publications resulting from the Federal RD&D activities were also included. The data through FY 73 were firm. FY 74 resource allocations were best estimates in many cases and FY 75 funds were estimates with incomplete project descriptions. This report is a continuation of the first report. FY 75 programs are reexamined. FY 74 funding is identified only for those projects underway in FY 74 and continuing into the time frame of this report (FY 75 to FY 78).

## 1.2 PURPOSE AND SCOPE

When the reestablished panel met to charter its course of action as a consultative body, they significantly broadened the panel's objectives to include—in addition to an update of the status and progress of ongoing Federal machinery and construction noise research activities—(1) identification of each agency's statutory mandates, goals, and objectives; (2) assessment of each agency's noise program in light of these mandates; (3) assessment of the contributions of each agency's noise program to the Federal government's overall effort to control noise; and (4) recommendation of future Federal government research programs in the area of machinery and construction noise abatement and control.

By involving many agencies and departments in the preparation of this report, a means is provided to increase the dialogue among officials concerning the relationships of Federal noise research programs. In this way this report contributes to the coordination of Federal research activities.

This panel report is a digest and analysis of information provided by the Federal agencies involved in machinery and construction noise RD&D. Individual program descriptions and funding levels have been included to identify the Federal activities. The panel has concluded that the programs should principally be judged in terms of benefits to the public and the advancement of the state-of-the-art in noise abatement technology. Tables detailing current and planned project descriptions and fundings, by area of research and by agency and department, are identified in the Appendices.

The research programs undertaken by each agency during the FY 75-78 period are at the end of this report in appendices B through H. Appendix A contains a summary of funds expended by the agencies and an Index of Machinery and Construction Noise Projects.

This report is directed toward noise research, development and demonstration programs; however, a significant portion of the EPA effort is for regulatory noise control programs. Appendix I provides brief descriptions of EPA regulatory programs.

## 2.0 SUMMARY

This report is a compilation of the research, development, and demonstration (RD&D) activities of Federal agencies and departments from FY 75 through FY 78 in the area of machinery and construction equipment noise. This report also contains assessments of these activities as well as recommendations for future areas of work.

Federal agencies and departments with machinery and construction noise RD&D programs during this time period are as follows:

- . Department of Interior (DOI)
- . Environmental Protection Agency (EPA)
- . Department of Defense (DOD)
- . Department of Health, Education, and Welfare (HEW)
- . Department of Commerce (DOC)
- . Department of Transportation (DOT)
- . Department of Agriculture (USDA)\*.

The various RD&D activities undertaken by these agencies and departments are implemented under their various mandates as well as in accordance with the intent of the Congress as expressed in Section 2(b) of the Noise Control Act of 1972: "... it is the policy of the United States to promote an environment for all Americans free from noise that jeopardizes their health or welfare ... "

Machinery and construction noise RD&D activities undertaken are grouped into six categories to facilitate review, discussion, and comments. These categories are:

- . Construction and mining
- . Manufacturing
- . Engine technology and machine parts
- . Consumer products
- . Agricultural machinery
- . Acoustic properties.

Construction and mining noise abatement activities include programs in quieting earth-movers and similar types of construction vehicles, military sites and equipment, compressors, generators, breakers and drills, mining equipment

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\* USDA was not represented by panel membership but USDA programs in machinery and construction noise RD&D are reported.

and facilities, and general construction sites and equipment.

The manufacturing category encompasses for the most part all industrial machinery. Manufacturing subcategories include textile, woodworking, metal working, other industrial equipment not specifically cited here, and military ship-board equipment.

The engine technology and machine parts category is composed of major machinery and construction equipment sub-components. Included are studies involving such areas as combustion noise, diesel engines, and specialty truck items such as truck mounted solid waste compactors and refrigeration units.

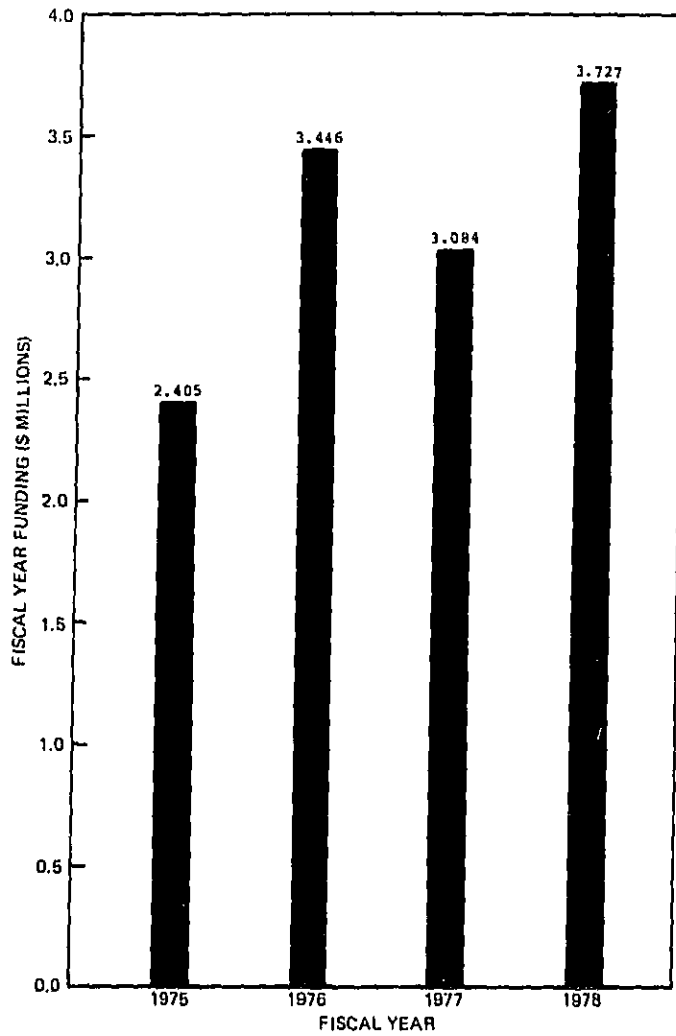
Consumer products deal with appliances, tools, equipment, and toys common to the household (e.g., blenders, dishwashers, garbage disposal units, and vacuum cleaners).

Agricultural machinery noise reduction studies include all equipment related to agriculture. The only specific agricultural machinery for which noise reduction work was performed was the cotton gin.

Activities in acoustic properties consist of studies on basic sound field behavior. Studies involve such areas as: noise measurement methodology, sound propagation, and sound field characteristics. Also included are all activities relating to building acoustics.

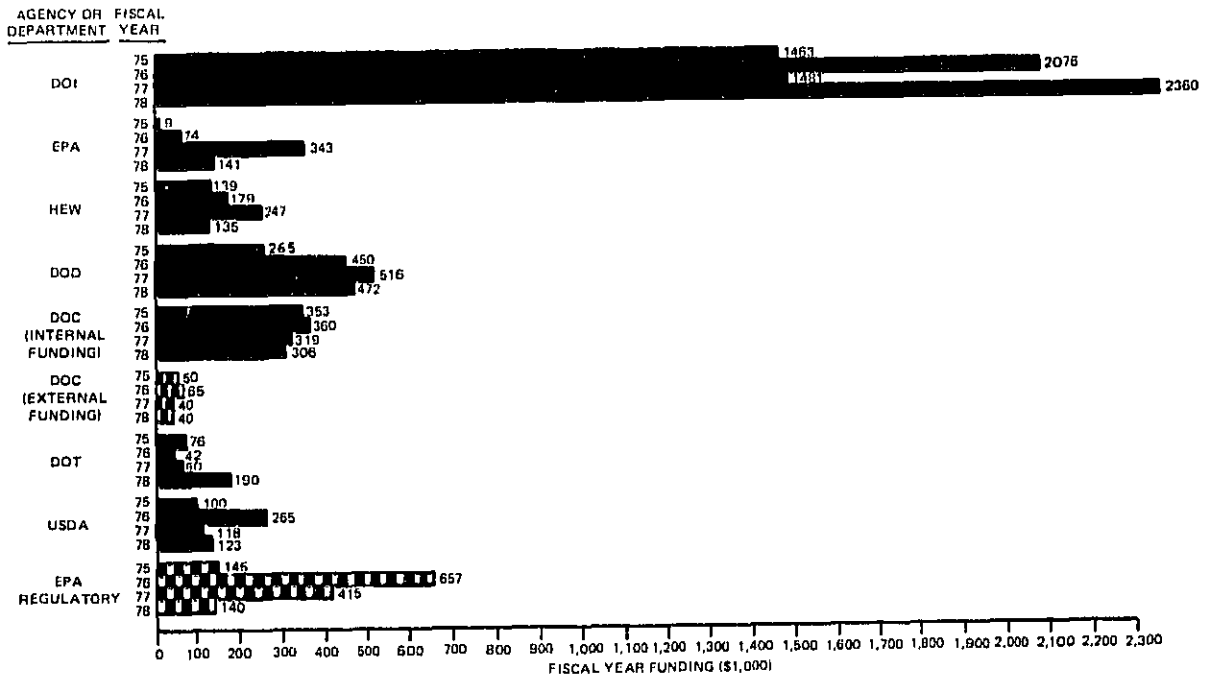
The extent of Federal activity on machinery and construction noise RD&D as indicated by the levels of funding is shown in Figures 2-1 and 2-2. Figure 2-1 shows the total combined levels of funding of all Federal agencies and departments from FY 75 through FY 78. Figure 2-2 shows the level of funding for each individual Federal agency and department during this time period.

The most active participants in terms of funding and number of projects in machinery and construction RD&D are DOI and DOD. Due to research activities at the Bureau of Mines, DOI is the most active participant on the basis of the information supplied in this report. Within DOD, the Department of Navy has a large number of classified RD&D machinery noise programs. The lead of DOI and DOD in terms of funding is followed to a lesser degree by the other participating Federal organizations.



- NOTE: 1. FY 76 FUNDING SPANNED 15 MONTHS DUE TO THE ADDITION OF THE TRANSITION QUARTER.  
 2. FY 78 FUNDING TOTALS INCLUDE FUNDS NOT IDENTIFIED FOR SPECIFIC PROJECTS IN THE APPENDICES BECAUSE OF CONTRACT PROCUREMENT PROCEDURES.  
 3. FUNDING TOTALS DO NOT INCLUDE EPA REGULATORY PROGRAM FUNDS, AND TO AVOID DOUBLE COUNTING DO NOT INCLUDE DOC FUNDS SUPPLIED BY OTHER FEDERAL AGENCIES.

FIGURE 2-1  
 TOTAL FEDERAL FISCAL YEAR FUNDING  
 FOR MACHINERY AND CONSTRUCTION NOISE RD&D



- NOTE:
1. FY 76 FUNDING SPANNED 15 MONTHS DUE TO THE ADDITION OF THE TRANSITION QUARTER.
  2. FY 78 AGENCY FUNDING TOTALS INCLUDE FUNDS NOT IDENTIFIED FOR SPECIFIC PROJECTS IN THE APPENDICES BECAUSE OF CONTRACT PROCUREMENT PROCEDURES.
  3. INTERNAL AND EXTERNAL WITH RESPECT TO DOC, REFERS TO FUNDS SUPPLIED BY DOC AND TO FUNDS SUPPLIED BY OTHER FEDERAL AGENCIES TO DOC, RESPECTIVELY.

FIGURE 2-2  
 FISCAL YEAR FUNDING BY FEDERAL AGENCY OR DEPARTMENT FOR  
 MACHINERY AND CONSTRUCTION NOISE RD&D



DOI's noise RD&D program is conducted by the Bureau of Mines (BOM) and the Mining Enforcement and Safety Administration (MESA). The major RD&D effort is conducted by BOM. MESA's principal effort is enforcement and inspection pertaining to safety and health regulations. MESA does however provide technical support to its enforcement staff and conducts RD&D activities to define noise problems or develop noise control techniques using existing technology. DOI's noise RD&D activities are conducted to reduce hazardous noise associated with hearing loss in underground and surface coal and mineral mining operations. Noise control projects involve the development of noise control techniques using both new and existing technology and incorporation of new designs or modifications into existing equipment. DOI's noise RD&D effort in construction and mining equipment is clearly larger than that of any other Federal organization.

In the past EPA's principal technology efforts in the machinery and construction arena have involved technology assessment in support of the regulatory process. There has been a recent increase in the level of EPA noise RD&D activity with the undertaking of a source control program to reduce internal combustion engine noise and a noise control demonstration project involving both construction and industrial activities.

DOD's machinery and construction noise RD&D activities are conducted by the Army and the Navy. DOD's activities in this area principally support their tactical mission requirements but also support their domestic environmental needs. The tactical mission efforts are undertaken to protect the hearing of personnel, to maintain effective communication, and to avoid detection in combat. Environmental programs are undertaken to reduce the noise impact of DOD activities on military and civilian communities. Army RD&D activities are directed to developing facility-wide noise impact prediction methodologies and noise reduction techniques and strategies. The Army's RD&D efforts are also directed toward reducing noise associated with construction equipment and construction sites and to a lesser degree electrical generators. The Navy's RD&D efforts, though classified for most areas of activity, focus principally on surface ship and submarine noise problems. Some newly initiated demonstration effort is directed toward shipyard noise.

The Department of Commerce (DOC), through the National Bureau of Standards (NBS), undertakes RD&D noise activities through in-house funding as well as funding from other

Federal organizations. In-house funding has been directed toward relevant activities in support of noise emission measurements rather than toward specific machinery and construction noise RD&D programs. These research activities are aimed at improving noise measurement procedures. NBS has received funds from EPA for supportive services in the development of machinery, construction and consumer product noise regulations.

The Department of Transportation has undertaken RD&D noise programs involving construction equipment utilized in building transportation systems. These programs were principally sponsored by the Federal Highway Administration and were initiated to provide guidance for construction noise measurement, prediction and abatement to highway officials who have to meet the requirements of the Federal Highway Planning Manual (FHPM). Approximately one-half of the DOT funding was appropriated under the Highway Planning and Research (HP&R) program. These programs, for the most part, dealt with one or more of the following factors: noise levels, noise sources, noise mitigation, and prediction methodologies.

The Department of Health, Education and Welfare, through the National Institute for Occupational Safety and Health (NIOSH), conducts RD&D noise activities in support of other Federal organizations. Specifically NIOSH has the responsibility to provide the Occupational Safety and Health Administration with information on which to develop and promulgate standards. In addition, NIOSH research is aimed at developing control technology which will guarantee each worker a safe and healthful workplace. The research has led to the development of several general noise control publications and specific reports dealing with punch press and woodworking noise control.

Within the Department of Agriculture (USDA), the Agricultural Research Service and the Forest Service engage in machinery and construction noise RD&D efforts. The Agricultural Research Service, concerned with the hearing hazards associated with agricultural machinery, undertakes agricultural equipment noise reduction research. There are two laboratories within the Forest Service undertaking acoustics research. The Equipment Development Center, in an effort to reduce hearing hazards associated with specialized equipment such as fire fighting, has a small equipment noise reduction program. The Forest Products Laboratory undertakes research in building acoustics.

Many interagency efforts were undertaken during the FY 75 through FY 78 time period. DOC/NBS, for example, provided technical assistance and/or measurement data to EPA for truck mounted solid waste compactors, paving breakers and rock drills, dozers and loaders, truck refrigeration units and household appliances. NBS also provided measurement data and technical support to EPA (prior to FY 75) for the EPA noise emission regulations for portable compressors promulgated in 1976. Within DOD, the departments of the Army and Navy cooperated with EPA. The Army provided test data and methodology studies for dozers and loaders, and paving breakers and rock drills. The Army also performed non-highway construction site noise studies. The Navy is undertaking a joint demonstration program with EPA to study noise control in shipyards. DOT and EPA will jointly fund a highway construction noise demonstration study in FY 78.

### 3.0 ASSESSMENT

#### 3.1 INTRODUCTION

Prior to the passage of the Noise Control Act of 1972, Federal agency and department noise programs had to be undertaken for the principal purpose of meeting their mandates, operational authorities, and goals. The Noise Control Act expanded the agency and department responsibilities with respect to noise by directing them to go beyond their immediate charges and contribute to the total national effort of improving the environment.

Congress was cognizant of these responsibilities and authorities of the agency mandates as evidenced by the explicit wording in Section 4 (a) of the Act.

"...The Congress authorizes and directs that Federal agencies shall, to the fullest extent consistent with their authority under Federal laws administered by them, carry out the programs within their control in such a manner as to further the policy ... to promote an environment for all Americans free from noise that jeopardizes their health or welfare..."

In this regard, any assessment of Federal programs must be carried out on two levels, namely,

- . Assessment of RD&D programs in light of each agency's mandates and goals
- . Assessment of the contributions of each agency's noise programs to the Federal Government's overall effort to control noise.

In general, the Federal agencies have utilized their RD&D funds to carry out those programs necessary to meet the mandates of their individual agencies. The programs in the past have resulted in significant advances in the development and demonstration of noise control technology applicable to machinery and construction noise.

### 3.1.1 Scope of the Noise Problem

There are principally two types of noise problems associated with machinery and construction activities. These are occupational noise, which is usually related to safety and hearing loss, and environmental noise, which involves community impacts resulting from noise intrusions. These problems are to varying degrees associated with most machinery and construction areas of activity.

According to a survey of 15 industrial insurance companies, hearing loss is the largest single compensable health problem today; greater, for instance, than black lung disease and exposure to vinyl chloride. EPA estimates that some 14.7 million American workers<sup>1\*</sup> have occupational noise exposures above the hazardous level<sup>2</sup> ( $L_{eq}(8)^\dagger \geq 75$  decibels). These workers are spread throughout many industries.

In the mining industry, for example, 450,000 workers are directly involved in underground, surface mining, and associated preparation plant operations for coal, metal, and non-metal mines.<sup>3</sup> Approximately 25 percent of these workers have noise exposures considered hazardous to hearing and virtually all are regularly exposed to noise levels above 90 dB<sup>††</sup>. The number of workers in the mining industry will increase 28 percent by 1983 according to projections; mostly due to the increased emphasis on coal as an energy source. Safety and environmental problems associated with noise are also matters of concern. Mining is by nature a relatively hazardous operation. High noise adds to the safety problems by interfering with speech communication, with the detection of sounds that can alert a miner to an impending danger, or with the recognition of alarms.

In the fabricated metal products industry, virtually all of the 440,000 machine operators are exposed to sound levels above 85 dB; and 87 percent are exposed to levels

\* A list of numbered references may be found at the end of this chapter.

†  $L_{eq}$ , equivalent sound level, is the average A-weighted energy level of sound over a given period of time. The period of time is shown in parentheses, in this case, 8 hours.

†† A-weighted sound levels are used throughout this report.

above 90 dB.<sup>4</sup> This does not include the additional 440,000 production workers such as machine setup men, materials handlers, inspectors and foremen whose occupations in this industry lead to intermittent exposures. Overall, approximately 8.8 million,<sup>5</sup> or 68 percent, of all production workers for all industries have noise exposures considered hazardous to hearing.

In addition, over 4.5 million operators of farm tractors are exposed to noise levels above those considered safe.<sup>5</sup> It is not known how many of the 4 million plus construction workers have exposures to noise which are hazardous to hearing but the numbers are believed to be significant.<sup>5</sup> Construction machinery noise levels, at the operator position, can be in the 90 to 100 dB range.

EPA estimates that close to half of the nation's population, 103 million Americans,<sup>1</sup> experience environmental or community noise from innumerable sources, including machinery and construction equipment. This noise interferes with normal daily activities such as speech communication, sleep, relaxation, and privacy. Construction site noise alone interferes with the activities of some 30 million people.<sup>6</sup>

Not all agencies are concerned with both occupational and environmental problems. The Department of Interior, for example, through the Bureau of Mines (BOM) and the Mining Enforcement and Safety Administration (MESA); and the Department of Health, Education and Welfare, through the National Institute for Occupational Safety and Health (NIOSH), have for the most part been concerned with occupational noise exposure. Abatement of noise in the community is usually incidental to the fulfillment of their main objective. In the area of construction equipment, the Department of Transportation, on the other hand, is primarily concerned with abating environmental noise which occurs during construction of highways and mass transit systems. The Department of Defense; Environmental Protection Agency, through the Office of Noise Abatement and Control (ONAC); Department of Agriculture, through the U.S. Forest Service (USFS), and the Agricultural Research Service (ARS); and Department of Commerce, through the National Bureau of Standards (NBS) work toward the abatement of both occupational and environmental noise.

### 3.1.2 Technological Change and the Purpose of RD&D

The noise RD&D efforts of the Federal Government provide technological answers which can and do solve noise problems. However, many times the findings of research are not always fully implemented. To understand why problems still exist in spite of technological solutions, it is necessary to understand the steps in effecting technological change. The process of technological change is comprised of three stages:

- . RD&D which provides the knowledge basis for technological change.
- . Production in which new knowledge and resources are incorporated in goods, productive processes, or services.
- . Market use whereby the fruits of production enter the marketplace and provide social and economic benefits.

This report deals with the initial stage, RD&D.

Any break within these three stages stops the process of technological change. If the technology to solve a noise problem does not exist, then there is no first stage and no basis for technological change to take place. But, having the noise technology available does not, in itself, ensure technological change. There are many problems which can arise to forestall efforts to implement known noise technology. A principal problem is economics where the ratio of cost versus benefit is a vital trade-off parameter.

### 3.2 AGENCY ASSESSMENTS

The following assessments have been prepared collectively by members of the Federal Interagency Machinery and Construction Noise Research Panel.\* These assessments are the consensus of the panel members and are not necessarily the official views of the Federal agencies.

#### 3.2.1 Department of the Interior

##### Mandates with Respect to Research

The Bureau of Mines (BOM) is authorized to conduct noise research to develop the technology necessary to reduce the occupational health, safety, and environmental problems associated with coal, metal, and non-metal mining operations.

The Mining Enforcement and Safety Administration (MESA) has a mandate to protect the mine worker through inspection of mines and enforcement of health and safety requirements.

##### Scope of Current Efforts

The BOM Machinery Noise Research effort is the largest reported among all Federal organizations. MESA has a comprehensive occupational noise program which includes engineering investigations. These investigations complement the efforts of BOM and are usually undertaken when applied or immediate solutions are required. Without BOM involvement in mining equipment noise research there would be a void in the development of mining equipment noise control technology because the mining industry for the most part conducts little research. Construction machinery noise research can be applied to some surface mining equipment.

The BOM research and investigative effort includes the following areas:

- . Underground mining equipment
- . Surface mining equipment
- . Surface processing operations
- . Measurement of worker noise exposure
- . Technology transfer to private industry.

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\* Since the USDA is not represented by panel membership, no assessment is made of their machinery and construction noise RD&D programs.



Research is directed primarily at reducing noise at its source. Although the most desirable approach to the problem of excessive noise in mining operations is through development and use of quieter equipment, accomplishing this in a reasonable length of time would require excessive funding levels and would ignore the problem of noise from existing equipment. Thus research efforts are primarily concentrated on identifying existing problems and developing retrofit techniques to control the noise. The cooperation of both manufacturers and coal companies is usually sought because of the high cost and limited availability of mining machinery. The noise controls developed must be cost effective, readily implemented on a retrofit basis, and cause no interference with normal operation of the machine. Current technology development efforts are principally directed at retrofit measures.

#### Accomplishments of the Noise RD&D Efforts

BOM and MESA have made notable progress in assessing the noise problems associated with various types of mining operations, identifying noise sources, and developing noise control measures. Retrofit methods that can be used by industry have been developed to substantially reduce the noise of some types of machines.

The BOM research program on mining noise was undertaken in FY 71 at a minimum level and was directed at underground coal mines. As the program developed, the scope was expanded to include surface operations of coal mines and a complementary program on noise problems in metal and non-metal mine operations. Progress has been relatively slow but commensurate with the magnitude of the problem. Particularly for underground operations, the hostile environment, space limitations, and requirements for materials acceptability greatly complicate the application of noise control measures. Noise control techniques must be evaluated on a test machine under in situ production conditions. Consequently the cooperation of mine operators is required.

In spite of these constraints, notable progress in the development of noise control technology has been made in certain areas. However, the reduction of the number of people exposed to hazardous noise (the principal goal of the research program) has been less than it could have been because of the slowness of mining industry in adopting the noise control technology that has been developed.

Examples of a few of the noise control technology research accomplishments are:

- . The stoper drill (a tool somewhat similar to the jackhammer) is found at many mines. BOM has developed measures, suitable for field use, to reduce noise levels from approximately 120 dB\* to as low as 107 dB. MESA working with BOM undertook an effort to transfer this technology to the mining industry and to the mining equipment manufacturers. Partly as a result of these efforts, this technology has been adopted commercially in an available noise control retrofit package.
- . In addition to the stoper retrofit efforts, a BOM effort is underway to reduce stoper noise through machine redesign. The feasibility of building a stoper drill with noise levels reduced to 95 to 100 dB has been proven through the building and testing of a prototype. Six production type models are being built for field testing.
- . Notable progress in identifying and assessing mining related noise problems has been made. This involved factors such as identification of the severity of noise problems, number of people impacted, and noise sources. Examples of some mining activities investigated are: surface and underground mining operations, taconite plants, diesel powered underground mining equipment, and surface coal mining equipment.
- . The auger miner used in low seam height coal mines has been identified by MESA to be a major source of hazardous noise. The Jeffrey 100-L and the Wilcox Mark 20 auger miners are the two principal types in use. BOM has developed a retrofit kit to reduce noise from the Jeffrey auger miner. This kit now needs to be field tested. BOM and MESA developed noise reduction retrofit kits for the Wilcox Mark 20 that were shown to be suitable for field use through 1-½ years of field testing. MESA undertook an effort for field adoption of this technology. Private industry, utilizing the results of this research,

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\* All sound levels identified for DOI are at the operator's ear in the underground environment.

has now commercially marketed a noise retrofit kit for the Mark 20. Further work is still required on the auger miner.

- . BOM has developed measures to reduce noise of a Wagner Mining Company load-haul dump machine from 99 to 93 dB. Wagner makes 80 percent of the approximately 700 diesel powered mining vehicles in operation. After more than a year of use under production conditions, the noise control system is still intact and performing as expected. As a result of this demonstration project, Wagner is marketing a noise quieting package for new equipment.
- . There are about 400 coal preparation plants in operation. The feasibility of reducing exposure to hazardous noise in coal preparation plants to comply with noise regulations has been demonstrated. Both the effectiveness of the noise abatement measures and compatibility with production requirements was proven. MESA through its inspection and technical assistance is helping to implement this technology.

BOM and MESA have worked closely in coordinating their noise research and investigative activities to establish priorities. At least 60 percent of the BOM research has been performed after concurrent agreement was reached between BOM and MESA. The information MESA gained through its field inspection has been invaluable in guiding BOM research programs. There are serious concerns about the effects of the transfer of MESA from DOI to DOL. With MESA and BOM in separate departments a greater effort will be required to ensure that they collaborate as closely as in the past. Most notably MESA has been directly involved in transferring BOM-developed technology to industry.

#### Adequacy of Funding

Noise research funding at BOM became adequate in FY 78 to support all planned research programs. Priorities given to noise research have increased to where noise research funding levels are now 5 percent of the total BOM Safety and Health budget. Though current funding levels are adequate for the noise research activities planned, a continued high level of funding is necessary because of the

magnitude of the mining noise problem. Several factors could dramatically alter current research requirements. Mining operations are growing and needs for noise source control are increasing. BOM research programs are new and continually changing to meet rising needs.

#### Areas for Future Research

Future research efforts by BOM will need to address just about all mining machinery since most equipment has noise levels above 90 dB. The program needs to look at both equipment retrofit and redesign. Future noise research efforts will, however, require some shifting of the current RD&D priorities from retrofit to equipment or process redesign.

Almost all of the acoustical technology required to develop mining machinery to meet the current 90 dB standard is available today. It is now necessary to determine methods of applying this technology in a manner that will satisfy the unique problems of the mining industry.

#### 3.2.2 Environmental Protection Agency

##### Mandates with Respect to Research

The Noise Control Act gives EPA the authority to identify major noise sources, issue labeling requirements, and issue noise emission standards.

In addition, the Noise Control Act authorizes EPA to complement the noise research programs of other Federal agencies by conducting and financing research on the effects, measurement, and control of noise, including determining the most effective and practicable means of controlling noise emission.

##### Scope of Current RD&D Efforts

There has been little RD&D activity by EPA in the machinery and construction equipment area. The few programs undertaken prior to FY 77 dealt primarily with noise measurement methodologies. FY 77 was marked by an increase in the level of RD&D effort and funding. EPA has recently initiated demonstration programs for construction site and

industrial machinery noise reduction. It has also initiated a research program that will lead to a demonstration project for internal combustion engines. The industrial machinery program will identify products for source regulations and identify areas where technological advances are needed and demonstrate the feasibility of current noise control methodology. The internal combustion engine program will advance the state-of-the-art of noise control for internal combustion engines. Since internal combustion engines are common to a class of products, accomplishments will result in benefits to a number of areas.

EPA/ONAC has construction equipment pre-regulatory action underway (technology assessments, health and welfare impacts, and economic impacts) on earthmoving equipment such as backhoes, scrapers, excavators, and trenchers. In addition, final regulatory development activities are to continue on pavement breakers and rock drills.

#### Accomplishments of RD&D Efforts

EPA's regulatory actions with respect to machinery and construction equipment are:

- . A noise emission regulation effective January 1, 1978 limits noise emissions of new portable air compressors to 76 dB.
- . A Notice of Proposed Rulemaking was issued for wheel and crawler tractors in July 1977.
- . A Notice of Proposed Rulemaking was issued for truck-mounted solid waste compactors in August 1977.

EPA's demonstration programs for noise mitigation from construction sites and industrial machinery, and the research program on internal combustion engine noise control are in their initial stages. Thus it is too early to report accomplishments.

#### Adequacy of Funding

EPA's Office of Research and Development has discontinued its support of noise control RD&D. In the past ONAC has elected not to request research funds but to depend on existing resources and research commitments in other agencies.

With the de-emphasis that is taking place in other agencies there is a greater need for EPA to support research through actual funding. EPA has found it difficult to influence the research programs in advancing the state-of-the-art without a research budget. Increased RD&D funding would enable EPA to support a broad noise control technology development effort.

#### Areas for Future Research

Noise technology RD&D efforts are needed for a wide range of products in the machinery and construction area to reduce excessive noise levels. EPA's responsibilities resulting from their charge as set forth in the Noise Control Act are broad.

EPA's program plan for FY 78 and FY 79 currently includes regulatory standards and preregulatory study activities for the following product or class of products:

- . Earthmoving equipment (backhoes, scrapers, excavators, trenchers, and similar performing machines)
- . Road building equipment (graders, pavers, rollers, compactors, and other equipment)
- . Small engine powered equipment (motor generator sets, pumps, commercial lawn and garden care equipment, commercial snow removal equipment, etc.)
- . Electrical and electronic equipment (power transformers, welding equipment, home heating and ventilating equipment, and lighting systems)

EPA's regulatory plans defined above identify areas where future research is required. Standards are limited by and based upon best available technology. To meet national goals, more stringent standards may be needed. Thus, research is needed to develop the technology to meet these lower noise emission standards.

Some very specific areas regarded by EPA as requiring noise RD&D are:

- . New designs of pneumatic and hydraulic pavement breakers and rock drills which address the fundamental problem of noise produced by the interaction of the tool and workpiece
- . Investigations of new combustion processes of internal combustion engines that result in a decrease in the noise generating mechanisms rather than the noise radiating mechanisms
- . Research activities toward the design of quiet fans
- . A broadening of the technical information base concerning typical work cycle noise levels or representative samples of road building and construction activities
- . A development of data base relating to the noise degradation of construction equipments and machinery as a function of time, use cycle, use environments, maintenance, and productivity

Workplace noise is a major occupational safety and health problem. There is currently a void in the Federal government with respect to noise RD&D technology development for industrial equipment of all types, EPA should take a lead in filling this void.

### 3.2.3 Department of Health, Education, and Welfare

#### Mandates with Respect to Research

The HEW noise effort with Machinery and Construction activities is carried out by the National Institute for Occupational Safety and Health (NIOSH). NIOSH is charged with undertaking activities related to insuring safe and healthful workplace conditions. Results of the National Occupational Hazard Survey,<sup>7</sup> conducted by NIOSH, reveal that over four million Americans are exposed to noise levels in excess of 85 dB in some 110,000 plants throughout the United States. There is ample evidence that these noise levels cause hearing loss and safety problems.

### Scope of Current Efforts

The emphasis of NIOSH research before FY 76 was on noise effects rather than noise control. However, since FY 76 several noise control research projects have been undertaken. Utilizing the NIOSH research grant program, funds were made available to North Carolina State University (NCSU) to conduct research in several areas: punch press noise, wood working noise, and noise generated during textile manufacturing.

In 1976 NIOSH reorganized, and a group was formed to study the control of physical agents in the occupational environment. This group has initiated several noise control projects.

During FY 78 NIOSH will complete revisions to the Industrial Noise Control Manual and the Compendium of Materials for Noise Control which will remain useful to a large segment of industry.

### Accomplishments

The NIOSH program in noise control, although small, has managed several major accomplishments:

- Publication of two reference works, the Industrial Noise Control Manual and the Compendium of Materials for Noise Control, both of which have been widely utilized. Both publications are currently being updated
- Development of noise control techniques for one punch press by North Carolina State University under a NIOSH grant
- Development of methods for reducing wood planer noise by approximately 6 dB at operator locations by North Carolina State University under a NIOSH grant
- Development of techniques to reduce noise levels in textile mills by 4.5 dB, as well as dissemination of information on these techniques to industry



### Adequacy of Funding

Recently there has been a de-emphasis in the NIOSH noise program partly as a result of other occupation health areas receiving higher priority. Funds and manpower required to support an adequate level of effort in noise have been unavailable.

### Areas for Future Research

There is no comprehensive Federal involvement in industrial machinery noise research despite the fact that millions of workers are exposed to hazardous levels of noise. The technology to quiet many industrial machines has not yet been demonstrated.

### 3.2.4 Department of Defense

#### Mandates with Respect to Research

The DOD mission requires a noise RD&D program to minimize detection in combat, reduce the incidence of hearing loss to military personnel, improve communication, and minimize the impact of peacetime military base operations on surrounding communities. Principal machinery and construction noise problems associated with military operations are: weapons (armor, artillery, demolition, bombs, and small arms), equipment onboard boats and ships, machinery (dozers, engines, generators, etc.), weapons manufacturing equipment, military base and facility operations, and military construction and civil works activities, (hydroelectric dams, dredges, levee repairs equipment).

#### Scope of Current Efforts

The Navy has a large machinery noise RD&D effort for the submarine and surface fleet directed principally at fleet detection avoidance. Also of concern are the reduction of the incidence of hearing loss and improvement of speech intelligibility among Naval personnel. Research as indicated by the projects identified, is directed at shipboard machinery such as pumps, compressors, ventilation systems, electrical and mechanical systems. Because much of the Navy work has been identified as classified, little information has been made available to the panel.

The Army's machinery and construction equipment noise RD&D effort has two principal components. The first addresses specific noise sources involving mostly construction related equipment such as dozers and diesel generators. The second involves efforts to reduce noise associated with military base operations arising from the amalgamation of the many base activities. This second effort involves the development and improvement of methodologies for predicting and mitigating noise levels associated with base operations. This research effort will help the military to operate bases that are compatible with surrounding community life. Building acoustics, which might be considered a third component, is also addressed.

No noise research activities have been identified by the Air Force for this area.

#### Accomplishments

The following are some of the accomplishments of the Army program:

- . A preliminary methodology for identifying the composite noise signature from all noise sources on military bases has been developed for land use planning. Primary noise sources of consideration in this methodology are aircraft and weapons. The composite noise signatures (contours) provide base planners with a tool to locate buildings and operations to minimize noise intrusions and to work with neighboring communities. Validation and refinement of this methodology is underway.
- . Noise levels of rough terrain Army forklifts have been reduced at operator positions to 90 dB. Field deployed forklifts are currently being retrofitted under a \$6.5 million program. Retrofit kits have also been developed for wheeled dozers, with about \$10.2 million being spent on implementation. This work contributes to the Army's effort to reduce the incidence of hearing loss.
- . A method of reducing the background noise levels of air conditioning units in Army field deployed shelters was developed and implemented. Noise levels were reduced to improve communication.

- . Reduction of noise associated with military construction site activity is closer to reality because of initial RD&D efforts to control noise through specification requirements, management of site noise, and studies of costs associated with noise control strategies. Cost variables are to be a part of all noise control evaluations of DOD construction site activities.
- . A true integrating noise monitor to measure the impulse sources unique to military operations has been developed. Currently available commercial designs, with their analog circuitry, are unable to accurately measure the impulsive noise. These monitors coupled with Army-developed temporal sampling criteria, enable assessments of military weapon noise intrusions to be readily made.

#### Adequacy of Funding

Considering the vast areas of land currently or potentially impacted by noise emanating from military facilities, current funding can only address the "tip of the iceberg" in applied research and is all but non-existent in the more fundamental areas.

Funding to develop noise exposure prediction methodologies for specialized military operations will lead to the development of validated methodologies by 1985 if current funding levels are maintained.

Fundamental research required to refine and improve methodologies and to assess the worth of various strategies is virtually non-existent. This research should as a minimum be funded at 50 percent of current applied research funding levels.

#### Areas for Future Research

To support the goal of making the noise from military base operations compatible with surrounding civilian community activities, further research is required in the development of noise impact prediction methodologies as well as abatement measures. Related factors such as sound propagation, noise source characteristics, community response to noise intrusions common to military operations, and costs/benefits associated with reducing noise also need to be addressed.

Research is required to continue development of the noise abatement measures applicable to DOD civilian construction works such as hydroelectric dams, construction dredging, and levee repairs.

The DOD mission imposes needs for protecting the hearing of military personnel, avoiding detection in combat, and providing acceptable communication.

Methods to mitigate industrial machinery noise such as in Navy shipyards or on Corps of Engineers dredges are required to reduce the incidence of hearing loss.

Environmental needs unique to DOD can only be achieved by direct DOD sponsored research. DOD's hearing conservation needs can be achieved by direct DOD research, by technology transfer from other Federal agency programs, or by encouraging private industry to conduct research through imposition of noise requirements in purchase specifications.

### 3.2.5 Department of Commerce

#### Mandates with Respect to Research

The Department of Commerce conducts the noise RD&D effort through the National Bureau of Standards (NBS). NBS activities in environmental noise measurement are undertaken to support the NBS mandate for developing and maintaining standards of measurement used in scientific investigations, engineering, manufacturing and commerce, as well as in support of Section 14 of the Noise Control Act of 1972. The Noise Control Act authorizes and encourages a cooperative relationship between NBS and the EPA in regard to developing methodologies and standards.

The NBS role is unique in that its mission is primarily restricted to addressing questions about the validity and adequacy of measurement procedures. NBS's efforts are directed at ensuring that the many regulations and administrative actions directed towards the control and abatement of noise are guided by scientifically valid measurement methodology.

Regulatory and other Federal agencies are each vitally affected by existing and proposed noise emission regulations. Leadership in the development of consistent and adequate physical measurement for these purposes is a required role of NBS.

These needs for measurement methodologies are all-pervasive in the implementation of noise control engineering or of regulations, for the vast majority of engineering data have been shown to be explicitly or implicitly reliant upon measurement at some point. Measurement error as a consequence of reliance upon imperfect noise measurement methodologies can give rise to significant and substantial economic and social impacts. NBS estimates of the annual costs to consumers associated with systematic measurement errors of 1 dB are more than \$300 million.<sup>8</sup>

#### Scope of Current Efforts

The NBS program in acoustics is directed toward meeting the country's need for noise measurement methodology and providing services that require reference to national standards. The principal effort has been to quantify the uncertainties associated with existing test methods, to conduct research to enable improved measurement technology, and to work closely with regulatory agencies and standards organizations to promote the incorporation of reliable measurement procedures in noise emission regulations.

#### Accomplishments

Recent work has been directed at determining the adequacy of present noise measurement standards. This determination has consisted primarily of critical reviews of the sources of measurement error and experimental measurement using existing NBS facilities and present procedures. These studies indicate the magnitude of measurement imprecision and systematically address the requirements for improvements in the existing standards and provide the scientific and technical basis for improvements to those standards.

A continuing study is addressing the adequacy of a current air conditioning industry measurement practice for determining the sound power of small sources in reverberation rooms. This is a critical study because EPA is considering regulation or labeling of noise emissions of air conditioning equipment. A revision to the current sound power measurement standard<sup>9</sup> of the American National Standards Institute (ANSI) has been proposed by NBS and is under study by ANSI authorities.

Low frequency panel absorbers have been designed and installed on the walls of NBS's large reverberation room to increase the precision of the acoustic power measurements conducted therein. This improvement will facilitate a series of comparisons of acoustic power measurements. These measurements address the continuing concern over variations in the acoustic power emitted and measured in differing acoustic environments by reference sound sources.

The measurement of source noise emission outdoors in a free field above an acoustically hard reflecting plane is of great interest because of its proposed use in noise enforcement programs. Measurement of the signal propagation over, and of the acoustic characteristics of the surface has been refined by the use of cross-correlation techniques in the analysis of broad-band signal propagation. Improved accuracy in determining the impedance of a hard asphalt surface as well as the separation of effects due to propagation from effects due to variations in source emission are expected to result from this work.

#### Adequacy of Funding

Deficiencies in funding and manpower have restricted the scope of the NBS program and prevented necessary work from being undertaken. With respect to facilities, for example, NBS was unable to accommodate EPA, Office of Noise Abatement and Control's need for evaluation and development of a noise measurement methodology for window air conditioners because of the absence, at NBS, of appropriately coupled reverberation room facilities with environmental control systems. NBS has a mandate to support the measurement needs of engineering and commerce; however, the absence of adequate representative test facilities of this nature imposes a severe constraint on the NBS program.

In general, increased funding and manpower would enable program expansions in areas not identified with facility constraints; however, allocation of funding for test facilities, instrumentation and test sites will also enable expansion in void areas.

#### Areas for Future Research

Dependence on voluntary standards may increase in the future due to the proposed Office of Management and Budget (OMB) policy that the Federal government is to rely on

commercial standards whenever feasible. It is essential that NBS maintain extensive involvement in the development of voluntary standards. This involvement is particularly important since there are no non-governmental organizations to support acoustics research in standards. This is also important because of the involvement of NBS in providing a centralized effort for research in measurement accuracy to support the several Federal agencies involved in acoustics. NBS technical support to other agencies will be required in the development of acoustical measurement instrumentation and standards. NBS provides a centralized effort for research on measurement accuracy for the Federal Government.

Specific topics which future research must address include:

- . Development of means for specifying limitations on atmospheric conditions (wind and temperature gradients, barometric pressure, relative humidity), and procedures for accounting for influence of these factors on measurements of the actual noise emitted by a source.
- . Development of means for specifying physical characteristics of test sites, including such factors as site flatness, acoustical impedance of test pads, and maximum size of reflecting objects.
- . Development of procedures for adjusting data for the influence of test site and atmospheric properties to correspond to what would have been obtained under standard conditions.
- . Development of experimental procedures to enable noise measurements under less than favorable wind conditions.
- . Development of in situ procedures for highly accurate and precise measurements of industrial machinery noise. The correction factors used to account for the acoustic conditions of a machinery space are not technically well based at present. These factors are principal variables affecting comparisons of data obtained in differing, non-ideal test environments. Similarly, procedures for the estimation of noise emission when machinery is closely spaced or clustered need to

be developed and studied for their adequacy in implementing noise control engineering.

### 3.2.6 Department of Transportation

#### Mandates with Respect to Research

The Department of Transportation (DOT) has a mandate to undertake research and development relating to transportation, including noise abatement. The Department of Transportation administers large trust funds which finance the construction of highways and urban mass transit systems. Construction of these systems impact surrounding communities; for example, EPA has estimated that approximately seven million people are exposed to construction noise from Federal and State highway projects. While this represents only a small percentage of the population (approximately three percent), DOT considers it to be a potentially serious problem due to the magnitude of the noise levels.

#### Scope of Current Efforts

The noise from highway construction is transient in that it moves as the construction activity proceeds forward and ends when the facility has been completed. For this reason, Federal, State, and local attention is primarily directed toward traffic noise impacts resulting from highway operations rather than on highway construction noise. In fact, it is difficult if not impossible, to determine whether complaints received during construction of such facilities are in fact directed toward the construction activity itself or toward the future highway—and its resultant traffic noise—which will remain a part of the neighborhood long after the construction is completed.

The Departmental program in this area—carried out by the Office of Noise Abatement and the Federal Highway Administration—is directed toward two distinct goals: (1) transfer of demonstrated truck noise abatement technology to construction equipment typically utilized in the construction of transportation facilities, especially highways, and (2) development and dissemination of guidelines for the measurement, prediction, and mitigation of highway construction noise for use by community planners and interested groups and individuals who must deal with such problems.



### Accomplishments

Because of funding limitations the initiation of construction noise control demonstration programs has been delayed and has not been able to fully address the entire range of source and/or site mitigation techniques. Even so, past DOT efforts in this area have produced some noteworthy accomplishments. Examples include:

- . Demonstration that truck exhaust noise reduction technology could be transferred to selected pieces of construction equipment. For reasonably well-muffled machines, it was found that improved muffling would lower noise levels an additional 1 to 3 dB\* while for equipment which either did not have a muffler or had a very poor one, application of a good muffler would reduce noise levels 6 to 12 dB.
- . Development and dissemination of interim guidelines for the measurement, prediction and mitigation of highway construction noise based on the current state-of-the-art.
- . Demonstration to indicate that ground vibrations associated with pile driving and trucks operating on haul roads are not of sufficient magnitude to cause physical damage to surrounding structures.

### Adequacy of Funding

The DOT program is a relatively small effort. Due to other priorities available funding has been, and continues to remain, limited.

### Areas for Future Research

It is anticipated that DOT will maintain a low level effort in the near future to develop the necessary data to revise the interim guidelines.

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\* All sound level reductions identified for DOT are determined from measurements at 50 feet from the source.

### 3.3 OVERALL ASSESSMENT

The noise RD&D efforts by both industry and the Federal government can provide technological answers to solve present and future problems. There currently appears to be an insufficient number of noise abatement technology demonstration programs. Federal efforts to develop and demonstrate noise control technology for future noise abatement actions should be increased significantly.

There are many reasons why the Federal government needs to be involved in noise research and development. While the major responsibility for developing the needed technology should rest with industry, investment by the Federal government is necessary in some cases to help bring new technology into the marketplace or to stimulate industry developments. This Federal initiative is appropriate when:

- . The market is not responsive to the demands (needs) of society
- . A directed effort is needed to meet a national objective
- . Development costs exceed the financial capability of any one manufacturer
- . Feasible noise-reducing technology must exist for enforcement of regulations.

In the case of DOD, there are unique noise problems which only they can address.

Specific benefits from Federal sponsorship of research are:

- . Results are equally available to all manufacturers. The results of industry RD&D are usually closely held, and even if they were implemented, would not provide a broad base of application potential
- . Spin-offs and technology transfer help to mitigate noise problems in other areas
- . The Federal government is provided with a basis for regulatory and enforcement actions.

### 3.3.1 Interagency Cooperation

Many interagency cooperative efforts were undertaken during the FY 75 through FY 78 time period. DOC/NBS for example, provided technical assistance and/or measurement data for EPA for truck-mounted solid waste compactors, paving breakers and rock drills, dozers and loaders, truck refrigeration units and household appliances. NBS also provided measurement data and technical support to EPA (prior to FY 75) for the EPA noise emission regulations for portable compressors promulgated in 1976.

Within DOD, the Departments of the Army and Navy collaborated with EPA. The Army provided test data and methodology studies for dozers and loaders and paving breakers and rock drills. The Army also performed non-highway construction site noise studies. The Navy is undertaking a joint program with EPA to demonstrate noise control in shipyards.

In FY 78 EPA will jointly fund a highway construction noise study with DOT and a building construction study with the Corps of Engineers. EPA is planning cooperative demonstration programs in FY 78 with other Federal agencies on industrial noise control.

In order for the Federal agencies involved in machinery and construction equipment noise RD&D to effectively meet national objectives for noise abatement, continued cooperation is essential. EPA will continue to take a lead role in coordinating Federal machinery and construction noise RD&D activities primarily because of its role in the promulgation of regulations. The technological accomplishments of the other Federal agencies are most important in forming the bases for regulatory legislation. EPA must collaborate with all agencies: (1) to gain knowledge on noise control techniques as well as measurement methodologies and (2) to disseminate information to other agencies for their use in either setting priorities for research, setting policy for land use planning, or enforcement of regulations.

Close collaboration needs to be maintained between the Federal organizations involved in occupational noise control, BOM and NIOSH, and the Federal organizations involved in occupational noise enforcement, MESA and the Occupational Safety and Health Administration (OSHA). It is hoped that the effective coordination of activities between BOM and MESA will continue in spite of MESA's transfer from DOI to the Department of Labor.

### 3.3.2 Adequacy of Funding

In 1974 the requirements of the Noise Control Act of 1972 began to have an impact on the budgetary cycle of Federal agencies. The charge to EPA by the Act was interpreted by the other agencies as a lessening of their charges with respect to noise. The end result has been a change in priorities within some Federal agencies away from noise RD&D at a time when there has been increasing concern to solve noise problems which affect both industrial workers and the community.

In addition, other actions have occurred which have resulted in reduced emphasis on noise RD&D:

- . The National Science Foundation, which was one of the earliest proponents of noise RD&D, has significantly reduced its emphasis in this area
- . The Department of Housing and Urban Development has significantly reduced its efforts in the area of noise control research
- . The recent reorganization of the Secretary's office in the Department of Transportation disestablished the Office of Noise Abatement which provided effective centralized coordinating functions for all of the operating administrations of DOT
- . NIOSH has structured a very limited and inadequate role for itself in the machinery noise RD&D technology area. Program plans for FY 78 and beyond have been directed at little beyond textile machinery.

### 3.3.3 Research Needs

There must be a balance between fundamental research, technology development, and demonstration. Fundamental research and demonstration programs are currently underfunded and need greater emphasis. Demonstration programs need to go beyond the laboratory demonstration stage to prove practicability in an operating environment.

Reducing machinery noise is important because it involves a large portion of the working population exposed to hazardous noise levels. Virtually all areas of the mining and manufacturing industries need noise RD&D to solve existing and future problems. Manufacturing equipment must be quieted to improve worker health. Programs must be initiated and should concentrate on equipment and processes which create the most severe exposures and/or which may be common to many industries.

Impulsive noise RD&D efforts to develop predictive methods, mitigation techniques, and reduction strategies need to be expanded. Large amplitude impulse noise is a particularly severe noise problem, especially to DOD (armor, artillery, small arms, etc.).

It is necessary that "corrective factors" be developed to allow comparisons of industrial machinery noise data obtained in differing environments or sites. Significant experimental investigation is needed on the effects of ground surface (topography) and meteorological conditions on sound propagation, especially in relation to construction sites, certification measurements, and large amplitude impulses.

There is currently no significant sustained noise RD&D technology effort underway in the Federal government (with the exception of that of BOM) to support the development of low noise industrial machinery and to create an environment that is adequate to protect the hearing of the American work force.

Demonstration programs are needed to establish the practicability of noise control technology for construction equipment. Some of the noise control technology developed in the surface transportation area can possibly have spin-offs to the construction equipment area.

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#### 4.0 AGENCY PROGRAMS

Noise research programs conducted or sponsored by each agency, while contributing to the national objectives of noise reduction in general, are primarily focused on the specific agency's needs for complying with its legislative mandates. The noise RD&D activities are directly related to their civilian or military constituency needs.

This section of the report discusses the overall noise program objectives of each Agency with respect to their noise control mandates.

#### 4.1 DEPARTMENT OF THE INTERIOR

The Department of the Interior (DOI) was created by the act of March 3, 1849 (9 Stat. 395; 43 U.S.C. 1451). Over the years, as functions have been added and removed, its role has changed from that of general housekeeper for the Federal government to that of custodian of the nation's natural resources.

The organizations within the Department reporting machinery and construction equipment noise programs include the Bureau of Mines and the Mining Enforcement and Safety Administration (MESA).\* These two organizations report to the Secretary of the Interior through the Assistant Secretary for Energy and Minerals.

##### 4.1.1 Bureau of Mines

The Bureau of Mines was established July 1, 1910, in the DOI by the Organic Act of May 16, 1910 (36 Stat. 369; 30 U.S.C. Secs. 1, 3, 5-7), as amended. This Act has been supplemented by several statutes, including those that authorize the conduct of research on environmental problems associated with minerals. The Bureau's overall objective with respect to noise is to develop the necessary technology to reduce noise exposure of mining personnel to within the limits set by the mandatory standards promulgated under the Federal Coal Mine Health and Safety Act of 1969 and the Federal Metal and Nonmetallic Mine Safety Act (PL 91-173 and PL 89-577). The Federal Coal Mine Health and Safety Act also authorized appropriation of funds for a balanced program of research and technical support to build a mining technology amenable with long-lasting health and safety improvements.

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\* The Federal Mine Safety and Health Amendments Act of 1977 transferred MESA from the Department of Interior to the Department of Labor. The transfer becomes effective March 9, 1978. There will be no loss of organizational integrity in MESA, and MESA will be renamed the Mine Safety and Health Administration (MSHA). Mandatory standards issued under PL 91-173 and PL 89-577 remain in effect under the 1977 act.



The Bureau of Mines' objectives with respect to noise are accomplished through development and implementation of engineering noise control techniques and measuring instrumentation. The following goals have been defined:

- . Abatement of noise in underground mining equipment, surface mining equipment, and surface processing operations associated with mining
- . Improvements in worker noise exposure measurement techniques
- . Transfer of technology to industry.

Underground and surface mining equipments are being assessed with the objective of reducing operator daily noise exposure levels to 90 dB or lower.

The thrust of the noise abatement effort is directed toward identifying the sources of noise and reducing the noise at these sources. The noise reduction techniques developed must be cost effective, suitable for retrofit, and cause minimum interference with machine operations.

Bureau of Mines noise research programs deal primarily with existing mine operations and are usually conducted in close cooperation with mining equipment manufacturers and mine operators. Project selection is based in large part on problems identified by MESA's inspection and engineering noise control activities. Noise abatement and control projects have been undertaken for various mining equipments such as roof bolters, loaders, continuous miners, conveyors, pneumatic drills, mantrip vehicles, and crushers. These projects involve the development of new noise control techniques, incorporation of new designs or modifications into existing equipment, and demonstration of utility, survivability, repairability, and noise reduction under field conditions. A comprehensive noise control handbook is being prepared to provide guidelines for the selection, design, and implementation of effective abatement methods for mine machinery noise. Language that is clearly understandable by the mining community will present essential acoustical information and describe details and techniques developed and demonstrated by BOM and others.

Projects planned but not yet funded include development of quiet resilient decks for coal screening, identification of noise sources in longwall mining systems, definition of acoustic radiation characteristics of underground

coal cutting augers, and development of noise controls for surface coal cutting augers.

#### 4.1.2 Mining Enforcement and Safety Administration

The Mining Enforcement and Safety Administration (MESA) was established May 7, 1973, by Secretarial Order No. 2953. The functions of the Administration are carried out under the authority of the Federal Metal and Nonmetallic Mine Safety Act of 1966 and the Federal Coal Mine Health and Safety Act of 1969. In addition to establishing occupational noise limits for mining personnel, these Acts provide for the inspection of domestic mines and enforcement of all health and safety requirements.

MESA's programs are directed toward controlling health hazards and reducing fatalities and injuries in the mineral industries. These objectives are accomplished by MESA through mine inspections, field investigations, engineering studies, safety education, training and motivation, health studies, and the development and enforcement of appropriate health and safety standards.

MESA does not have a research mission similar to that of the Bureau of Mines. However, MESA's Pittsburgh Technical Support Center, Noise Branch, which provides technical support to MESA's enforcement activity, conducts noise development and control projects aimed toward defining a noise problem and providing early solutions using existing technology. Close liaison is maintained with the noise research group at the Pittsburgh Mining and Safety Research Center of the Bureau of Mines. When a need for extensive research and development is determined, referrals are made to the Bureau of Mines.

In addition to the noise control activities, MESA performs noise studies related to noise instrumentation, exploratory studies, and standards development. Instrumentation work is devoted to development of more precise, easier to use noise instruments to facilitate monitoring of the miner's noise environment. Exploratory studies are valuable for forecasting potential noise problem areas. The objective of standards and specifications development is to ensure reliable, accurate noise instrumentation for MESA as well as for the mining industry.

The activities of the Pittsburgh Technical Support Center's Noise Branch since 1975 included noise control

work relative to such products as underground auger miners, pneumatic stoper drills, coal preparation plants, strip mine equipment, and underground fans. A few results of these projects are: noise emissions were reduced from 102 to 97 dB for underground auger miners and from 117 to as low as 105 dB for pneumatic stoper drills.

Other efforts included planning for an acoustical calibration laboratory, evaluation and checkout of commercially available noise dosimeters, acoustical characterization of the underground environment, development of noise regulation standards, and presentation of training courses to MESA inspectors.

In the area of noise instrumentation, a new calibration program was initiated, which is expected to ensure the accuracy of the inspectors' noise measurements. A second effort resulted in the development of a dosimeter calibrator, which will permit the use of the noise dosimeter for noise surveys.

Activities in communications and standards development are anticipated to enable the publication of new techniques in noise control and more reliable and accurate noise instruments for the MESA inspection force as well as for industry. Exploratory studies are expected to yield results valuable for forecasting potential noise problem areas.

Appendix B identifies funding and provides brief descriptions of projects conducted by DOI.

#### 4.2 ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) was established in the executive branch of the Federal government as an independent agency pursuant to Reorganization Plan No. 3 of 1970. It was created to facilitate coordinated and effective governmental action relative to protection of the environment. Therefore, EPA endeavors to abate and control pollution systematically by integration of a variety of research, monitoring, standard-setting, and enforcement activities.

EPA derives specific noise control authority from the Noise Control Act of 1972 (PL 92-574, October 1972). The purpose of the Act is:

"...to establish a means for effective coordination of Federal research and activities in noise control, to authorize the establishment of Federal noise emission standards for products distributed in commerce, and to provide information to the public respecting the noise emission and noise reduction characteristics of such products..."

EPA's responsibilities relative to noise emission regulatory authority include:

- . Identification of major noise sources; noise criteria and control technology (Section 5)
- . Noise emission standards for products distributed in commerce (Section 6)
- . Noise emission labeling (Section 8)
- . Interstate rail carrier noise emission standards (Section 17)
- . Interstate motor carrier noise emission standards (Section 18).

Regulatory activities include evaluation of the state-of-the-art of product noise abatement technology, assessment of attendant health and welfare benefits, consideration of costs, and the development of noise compliance methodologies. In each of the above regulatory areas, the Congress directed EPA to consult with appropriate Federal agencies. These activities do not advance technology but instead provide an assessment. Since these activities are essential

to EPA in the promulgation of regulations, both in the setting of noise emission levels and the determination of noise measurement procedures, they are tabulated separately in this report (Appendix I). They are also not included in the noise RD&D funding totals of Appendix A.

Section 14 of the Noise Control Act defines EPA's primary responsibilities relative to noise abatement and control research programs and authorizes the Administrator of EPA to complement as necessary the noise research efforts of other Federal agencies by conducting and financing research on the effects, measurement, and control of noise. All noise technology related RD&D activities conducted by EPA are currently being carried out by its Office of Noise Abatement and Control (ONAC).

#### 4.2.1 Technology Assessment Programs

Machinery and construction equipment and related products identified as major noise sources by EPA for which technology assessments have been completed, include the following:

- . Portable air compressors
- . Wheel and crawler tractors
- . Truck refrigeration units
- . Truck-mounted solid waste compactors
- . Lawn mowers
- . Pavement breakers and rock drills.

Studies in support of regulatory actions for these products are in progress.

Technology assessment projects were conducted by EPA through contracts with outside contractors or through cooperative agreements with other agencies.

#### 4.2.2 Research Programs

Noise-related RD&D activities in which ONAC participates involve advancement of the state-of-the-art of noise control technology and demonstration of the practicality and technical adequacy of newly developed noise control concepts. EPA's involvement with research, however, has principally been directed toward surface transportation problems. In terms of funding, the FY 75 and FY 76 effort

in machinery and construction noise is relatively small. This effort dealt with impact noise and vibration evaluation and measurement methodology. One study examined noise sampling techniques for a number of different stationary and non-stationary noise sources for both surface transportation and machinery and construction equipment. A second study was directed at microsampling techniques of noise measurement. A third study investigated the noise and vibration problems associated with quarry operations.

In the FY 77 to FY 78 time period, EPA started programs in the areas of engine technology and machine parts and manufacturing equipment. A project was initiated to advance the state-of-the-art and to demonstrate noise control techniques applicable to internal combustion engines. The diesel engine is one of the principal noise sources at construction sites. This project supports both the surface transportation and the machinery and construction equipment areas. Two other programs, Occupational Noise in Industrial Plants and Shipyard Noise Control, were initiated to demonstrate noise control in industrial applications. Both programs involving joint efforts with other Federal agencies will identify potential and existing noise problems; identify economic, production, and administrative impacts associated with noise control; demonstrate the feasibility of noise exposure reduction methods; and identify areas where additional noise control research is required.

Funding and brief project descriptions for EPA RD&D and regulatory projects are identified in Appendices C and I, respectively.

#### 4.3 DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

The Department of Health, Education, and Welfare (HEW) is a cabinet-level department of the Federal executive branch created by Congressional legislation in 1953.

The Center for Disease Control, a subdivision of the Public Health Service, provides policy guidance and administrative management to the National Institute for Occupational Safety and Health (NIOSH), the arm of HEW which is responsible for noise technology related RD&D.

By the Occupational Safety and Health Act of 1970 (Section 20(9)(1) of PL 91-596) and the Federal Coal Mine Health and Safety Act of 1969 (PL 91-173), NIOSH is charged with undertaking research and related activities to ensure safe and healthful workplace conditions. With respect to noise, the NIOSH effort is directed toward protecting the hearing of industrial workers. NIOSH conducts programs to develop and demonstrate techniques that will enable industry to reduce noise in the occupational environment to levels that meet existing hearing conservation criteria. These industrial noise programs are conducted through contracts, grants, and in-house research.

The NIOSH industrial noise programs are aimed toward developing methods of modifying machinery, as well as investigating alternative manufacturing processes. NIOSH also provides industry with technical information relating to noise.

The noise reduction efforts from FY 75 through FY 77 were for the most part directed at four industrial noise sources: pneumatic tools, wood planers, textile-loom, and welding and brazing operations. These studies identified noise sources, mechanisms of noise generation, and methods of noise control. Of these, the principal effort was directed toward textile noise problems.

Although NIOSH's textile noise reduction efforts have achieved a number of accomplishments, the noise problem has not been solved, and further research efforts are required. NIOSH's efforts so far have been directed at source control, rather than path control with enclosures. For example, noise reductions were obtained from design modifications made on bobbins, from removal of vibrating panels, and from the addition of mufflers. NIOSH has also sponsored a symposium at which textile industry representatives met to exchange information on noise

problems and is publishing a noise control manual identifying case histories of textile noise control. Two technical information manuals providing explicit data in the general area of industrial noise control were also published by NIOSH. The two publications, Compendium of Materials for Noise Control and Industrial Noise Control Manual, were widely distributed and have been well received by industry noise control personnel. An update of the compendium is planned and completion is scheduled in FY 78.

In FY 78, NIOSH is concentrating their noise control technology RD&D efforts to the textile industry. The textile effort will be undertaken through their university research grant program.

Appendix D identifies funding and provides brief descriptions of projects conducted by HEW.



#### 4.4 DEPARTMENT OF DEFENSE

The Department of Defense (DOD) is the successor agency to the National Military Establishment created by the National Security Act of 1947 (61 Stat. 495). DOD was established as an executive department of the Federal Government by the National Security Act Amendments of 1949, with the Secretary of Defense as its chief administrator (63 Stat. 578; 5 U.S.C. 101). The Act identified the Army, Navy, and Air Force organizations as military departments within DOD.

Environmental quality matters are coordinated through the Office of the Secretary of Defense. Each of the military departments is responsible to the Secretary for individual environmental programs, including noise abatement and control.

Machinery and construction noise RD&D efforts are conducted to support mission needs such as protecting the hearing of military personnel, avoiding detection in combat, and reducing the noise impact of peacetime military operations on the surrounding communities.

The Departments of the Army and the Navy identified machinery and construction noise research programs underway or planned within DOD. (Air Force programs lie primarily within the noise effects and aviation areas, and are identified in the appropriate Federal Interagency Research Panel reports).

##### 4.4.1 Department of the Army

Within the Department of the Army, the organizations mainly involved in machinery and construction noise RD&D are the Army Materiel Development and Readiness Command (DARCOM) and the Army Corps of Engineers. Within DARCOM the Mobility Equipment Research and Development Command (MERADCOM) has the principal responsibility for DARCOM's machinery and construction equipment noise RD&D work. The Human Engineering Laboratory (HEL) also is engaged in machinery and construction research. Within the Corps of Engineers, the responsibility for machinery and construction noise lies with the Construction Engineering Research Laboratory (CERL) where activities center on community noise.

MERADCOM's tasks are being conducted to reduce machinery operator exposure levels to comply with the sound emission level requirements of Federal, State, local, and foreign laws. The mission of HEL is to conduct basic and applied research in human factors engineering, and to provide direct design support to all materiel development programs sponsored by DARCOM.

The CERL authority for machinery and construction RD&D activity was established by the Office of the Chief of Engineers in response to Corps requirements in the areas of master planning, environmental quality, and architecture. Methods and criteria to determine and control the impacts of noise from Army activities on military installations are needed to comply with Army noise emission criteria (DOD Instruction 4165.57 and TAG letter of 5 August 1974).

CERL is filling this need by a coordinated program for solving problems in noise pollution and abatement unique to Army installations (artillery, armor, helicopters, and construction). The program will develop tools for predicting and reducing noise levels in and adjacent to military facilities. The tools will be used in master planning, design, and assessment to locate and construct facilities which emit minimum noise pollution to inhabitants and the surrounding environment.

#### 4.4.2 Department of the Navy

The Department of the Navy is extensively involved in machinery RD&D noise control with their surface ship and submarine fleet. This effort supports tactical mission requirements, protects the hearing of personnel, and provides an acceptable living and work environment.

The Navy has a number of tactical mission needs with respect to noise. Surface ships and submarines must radiate a minimum amount of noise to avoid detection. In addition, noise radiated from sources such as the ship's structure, mechanical equipment, and propellers must not interfere with sonar operations to detect an enemy presence. Tactical mission needs also require that noise levels in critical mission stations permit direct person to person speech communication. For personnel living onboard ships, noise levels must be low enough to safeguard hearing during both work and non-work hours as well as to minimize annoyance.

Technical information and funding levels for the Navy noise programs are for the most part classified.

An innumerable variety of noise sources and control measures are embraced in the Navy's noise programs (e.g., structural vibration such as that from ship hulls, piping systems, and propellers; electric motors; diesel engines; pumps; ventilation systems; fans; gear drives; and electronic equipment. Methods of noise abatement use structural damping material, vibration and shock isolation systems, enclosures, silencers, as well as source control through design modifications.

The few Navy noise projects for which information has been released are identified in Appendix E. These programs are being carried out by the Naval Sea Systems Command (NAVSEA), the Naval Ship Engineering Command (NAVSEC), and the David Taylor Naval Ship Research and Development Center (DTNSRDC).

Appendix E identifies funding and provides brief descriptions of projects conducted by DOD.

#### 4.5 DEPARTMENT OF COMMERCE

The Department of Commerce was designated by the act of March 4, 1913 (37 Stat. 736; 15 U.S.C. 1501), which reorganized the Department created February 14, 1903 (32 Stat. 825; 15 U.S.C. 1501). The mission of the Department of Commerce is to foster, serve, and promote the nation's economic development and technological advancement. This is carried out through activities that encourage and assist States, local organizations, and private industry.

The Department of Commerce is composed of the Office of the Secretary, several Offices of Assistant Secretary, and numerous operating units. Of these, only the National Bureau of Standards (NBS) administered through the Office of the Assistant Secretary for Science and Technology, reported machinery and construction equipment noise RD&D activities. NBS was established by PL 56-177, Organic Act of 1901, March 3, 1901, and as amended by PL 81-619, July 22, 1950. NBS was originally part of the Treasury Department and was subsequently transferred to the Department of Commerce. The 1950 amendment authorized the Secretary of Commerce to undertake the following functions:

- . The custody, maintenance, and development of the national standards of measurement, and the provision of means and methods for making measurements consistent with those standards, including the comparison of standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the government
- . The determination of physical constants and properties of materials when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere
- . The development of methods for testing materials, mechanisms, and structures and the testing of materials, supplies, and equipment including items purchased for use by government departments and independent establishments
- . Cooperation with other governmental agencies and with private organizations in the establishment of standard practices incorporated in codes and specifications

- . Advisory service to government agencies on scientific and technical problems
- . Invention and development of devices to serve special needs of the government.

NBS also has responsibilities mandated by and specifically mentioned in two other Acts: the Noise Control Act of 1972 (PL 92-574) and the Consumer Product Safety Act (PL 92-573).

Under the Noise Control Act, the EPA Administrator is authorized to:

"Conduct research and finance research by contract with any person on the effects, measurement, and control of noise, including but not limited to... development of improved methods and standards for measurement and monitoring of noise, in cooperation with the National Bureau of Standards, Department of Commerce...."

The Consumer Product Safety Act (PL 92-573) directs that:

"The (Consumer Product Safety) Commission shall, to the maximum extent practicable, utilize the resources and facilities of the National Bureau of Standards, on a reimbursable basis, to perform research and analyses related to risk of injury associated with consumer products (including fire and flammability risks), to develop test methods to conduct studies and investigations and to provide technical advice and assistance in connection with the functions of the Commission."

At the present time, NBS does not conduct any machinery and construction noise reduction programs. However, they do conduct research on measurement procedures in this area, including projects conducted under and supportive of inter-agency agreements with other Federal agencies as well as nongovernment organizations.

The objective of NBS's work on measurements of noise emission from machinery and construction equipment is to quantify the measurement uncertainties associated with existing test methods and to conduct research to enable improved measurement technology.

NBS machinery and construction noise research performed under reimbursable interagency agreements emphasizes the determination of the adequacy of present standards for the measurement of noise emissions. This determination consists primarily of critical reviews of the sources of measurement error and the conduct of experimental measurements using existing NBS facilities and present measurement procedures. These studies are intended to (1) indicate the magnitude of measurement imprecision and systematically address the requirements for improvements in the existing standards, and (2) provide the scientific and technical basis for improvements to those standards.

An element common to many areas in acoustic measurements is the extensive role of voluntary standards, such as those developed by the American Society of Testing and Materials (ASTM), American National Standards Institute (ANSI), and the American Society of Mechanical Engineers (ASME). The extensive use of voluntary standards and their incorporation into regulations and mandatory standards highlights the significance of NBS's position in carrying out a coordinated program in support of both voluntary and mandatory standards.

A recurrent theme of present-day concern relative to enforcement of noise emission standards is the adequacy of techniques for specifying test site acoustical properties. As the use of regulations becomes more widespread, accuracy and precision of noise emission measurements become more critical. Uncertainty in measurement requires a corresponding increase in the margin manufacturers must allow between the regulated limit and design levels and consequently an increase in the cost of compliance. Significant variations have been noted between measurements made at different sites or at the same sites at different times. These concerns indicate the increasing relevance of evaluating present standards for the measurement of noise emissions and of improved understanding of the associated measurement uncertainties.

NBS has provided technical assistance to the Environmental Protection Agency's Office of Noise Abatement and Control in support of the development of regulations for specific noise sources, including contributions to the portable air compressor regulation. Additional efforts have included evaluation of existing data bases and measurement procedures for wheel and crawler tractors, truck refrigeration units, and compactors. NBS is also

continuing its support to EPA in the technical evaluation of contractors' reports. In recognition of the need for support of the technical basis for Federal, State, and local regulations on noise emissions from a variety of sources, NBS has supported research toward improvements in procedures for the measurement of noise emissions.

Appendix F identifies funding and provides brief descriptions of projects conducted by DOC.

#### 4.6 DEPARTMENT OF TRANSPORTATION

The Department of Transportation (DOT) was created by the authority of the Department of Transportation Act of 1966 (PL 89-670, October 15, 1966), in the interest of the general welfare, economic growth, and national stability to develop

"...national transportation policies and programs conducive to the provision of fast, safe, efficient, and convenient transportation at the lowest cost consistent therewith and with other national objectives including efficient utilization and conservation of the nation's resources."

To accomplish these basic mission goals and other specific Congressional mandates, each element of the Department is expected to integrate noise control into its policy, program criteria, and project requirements.

The machinery and construction noise RD&D programs of the Department of Transportation are consistent with Section 4(a) of the Noise Control Act (PL 92-574, October 27, 1972) which

"...authorizes and directs that Federal agencies shall, to the fullest extent consistent with their authority under Federal laws administered by them, carry out the programs within their control in such a manner as to further the policy ... to promote an environment for all Americans free from noise that jeopardizes their health or welfare..."

With respect to machinery and construction noise, research is presently being carried out at the Secretarial level by the Office of Noise Abatement and within the Federal Highway Administration.

##### 4.6.1 Office of Noise Abatement\*

The Office of Noise Abatement (ONA) was established to fulfill a mandate of the Department of Transportation Act of 1966, which authorized the Secretary to:

\* Office of Noise Abatement was disestablished in 1970.



"...undertake research and development relating to transportation, including noise abatement..."

The mission of DOT/ONA is:

- . To provide Department-level leadership and direction in the development of DOT programs for the abatement of environmental noise caused by transportation systems
- . To provide policy guidance to, and coordination among, the various DOT administrations and their individual programs to assure the timely development of effective Department policies and programs for the abatement of noise generated by all modes of transportation
- . To provide liaison and coordination between DOT and other Federal agencies

In addition to these responsibilities, ONA undertakes a variety of noise RD&D programs in such areas as development of analytical techniques, measurement and instrumentation technology, noise control technology (including development and demonstration testing support), and systems analysis.

During the period covered by this report, ONA activities in machinery and construction noise RD&D were directed toward reducing exhaust noise emissions from diesel engine powered construction equipment. This project was an extension of achievements made in the various DOT surface vehicle diesel engine noise reduction programs. The diesel engine is one of the principal sources of noise at transportation system construction sites. The study evaluated the various technologies identified and developed for reducing exhaust noise of truck diesels by applying the technologies to construction equipment diesels.

#### 4.6.2 Federal Highway Administration

Research programs for developing construction noise and vibration criteria, impact prediction methodologies, and abatement measures are currently underway within the Federal Highway Administration (FHWA). Projects are funded from either of two programs: (1) the Federally Coordinated Program (FCP), which addresses problems of national interest, or (2) the Highway Planning and Research (HP&R) Program, which funds projects initiated by the States.

Federally Coordinated Program (FCP). Based on specific guidelines, the FCP appropriates funds for highway construction and associated research efforts. The legislative mandates for the FCP derive initially from the Federal-Aid Highway Act of 1954 (PL 83-350, May 6, 1954), Section 10(a), which authorizes and directs the Secretary:

"...in his discretion to engage in research on all phases of highway construction, reconstruction, modernization, development, design, maintenance, safety...."

Subsequent legislation provided specific mandates in the noise area. For example, the Federal-Aid Highway Act of 1970 (PL 91-605, December 31, 1970), Section 136(c) authorizes and directs the Secretary to:

"...include in the highway research program... studies to identify and measure, quantitatively and qualitatively, those factors which relate to economic, social, environmental, and other impacts of highway projects."

Section 136(b) of this Act further authorizes and directs the Secretary to:

"Not later than July 1, 1972...promulgate guidelines designed to assure that possible adverse economic, social, and environmental effects relating to any proposed project on any Federal-aid system have been fully considered in developing such project, and that the final decisions on the project are made in the best overall public interest, taking into consideration the need for fast, safe, and efficient transportation...and the costs of eliminating such adverse effects and the following: (1) air, noise and water pollution... Such guidelines shall apply to all proposed projects...approved by the Secretary after the issuance of such guidelines."

The Federal-Aid Highway Act of 1973 (PL 93-87, August 13, 1973), Section 114 authorizes and directs the Secretary to:

"...not approve plans and specifications for any Federal-aid system for which location approval has not yet been secured unless he determines that such plans and specifications include adequate measures to implement the appropriate noise level standards."

These broad legislative mandates require the FHWA to identify adverse effects relating to highway projects and to make reasonable efforts to mitigate the adverse effects. Recognizing that noise from highway construction activities can impact surrounding communities adversely and that measures are available to abate construction activity noise, FHWA incorporated into Federal Highway Planning Manual 7-7-3, Procedures for Abatement of Highway Noise and Construction Noise, three general requirements on construction noise:

"The following general steps are to be performed for all Type IA, IB, and II projects after the effective date of this directive.\*

- a. Identify land use or activities which may be affected by noise from construction of the highway. The identification is to be performed during the project development studies.
- b. Determine the measures which are needed in the contract plans and specifications to minimize or eliminate adverse construction noise impacts to the community. This determination shall include a weighing of the benefits achieved and the overall adverse social, economic, and environmental effects of the abatement measures.
- c. Incorporate the needed abatement measures in the contract plans and specifications."

In order to provide guidance in the area of construction noise measurement, prediction and abatement to highway officials, interested groups, and individuals who must deal with construction noise during the various stages of highway construction, FHWA initiated an in-house project in 1976 to prepare a manual which would summarize the state-of-the-art in construction noise measurement, prediction, and abatement. In addition, FHWA sponsored a workshop to develop long-range strategies for controlling construction activity noise.

In the past, most Federal, State, and local efforts have been directed toward highway traffic rather than highway construction noise. FHWA plans to initiate a

\* Effective May 24, 1976.

two-year joint research effort with EPA (starting in FY 78) to define the noise environment at highway construction sites and evaluate the effectiveness of various measures for mitigating construction activity noise.

Highway Planning and Research (HP&R) Program. Section 151 of the Federal-Aid Highway Act of 1972 (PL 93-87, August 13, 1973) authorizes HP&R funds

"Not to exceed 1½ percentum of the sums apportioned for each fiscal year beginning with fiscal year 1974 ...shall be available for expenditure upon request of the State Highway Department, with the approval of the Secretary...for research and development, necessary in connection with the planning, design, construction, and maintenance of highways..."

These funds are available for solution of specific State and local problems. FHWA assists in coordination of this research, but does not use the control of Federal-aid funds to control or unduly influence State or local research programs.

HP&R funds have been utilized by the States of California and Louisiana for RD&D programs associated with construction activity noise, including the following:

- . Investigation of ground vibration at construction sites
- . Establishment of feasible noise limits for highway construction and maintenance equipment

Appendix G identifies funding and provides brief descriptions of projects conducted by DOT.

#### 4.7 DEPARTMENT OF AGRICULTURE

The U.S. Department of Agriculture (USDA) was created by act of Congress approved May 15, 1862 (12 Stat. 387; 5 U.S.C. 511, 514, 516). The Department was made the eighth executive department in the Federal government in 1889.

The USDA is directed by law to acquire and disseminate information on agricultural subjects. To accomplish this purpose, the Department functions in the areas of research, conservation, and regulatory work. Machinery and construction noise programs are conducted within the USDA by the Agricultural Research Service and the U.S. Forest Service (USFS).

##### 4.7.1 Agricultural Research Service

ARS was established by Secretary's Memorandum 1320, Supplement 4, dated November 2, 1953. Its basic mission is to provide the necessary knowledge and technology so that farmers can produce efficiently, conserve the environment, and meet the food and fiber needs of the American people. Research efforts are conducted in very close cooperation with the States, as well as other agencies in USDA, other Federal agencies, industry, foundations, and private groups.

Noise RD&D programs conducted under the ARS are aimed at protecting the health and welfare of agricultural workers. The research efforts are directed toward identifying noise sources and developing feasible methods of reducing levels associated with agricultural operations. Areas of investigation include materials handling systems for cotton gins, sawmill operations, dust collection systems, and agricultural packing equipment.

##### 4.7.2 U.S. Forest Service

USFS was created by the act of February 1, 1905 (33 Stat. 628; 16 U.S.C. 472), which transferred the Federal forest reserves and the responsibility for their management from the Department of the Interior to the Department of Agriculture. USFS has the Federal responsibility for national leadership in forestry. Toward this purpose, it has adopted, among its objectives and policies, those of protection and improvement of the quality of air, water,

soil, natural beauty, and quality of the open space and urban and community areas. Research programs are conducted under the authority of the McSweeney-McNary Act of May 22, 1928 (45 Stat. 699; U.S.C. 581-581i), as amended and supplemented.

Within the USFS, there are two laboratories undertaking acoustics research. These are the Equipment Development Center located in San Dimas, California and the Forest Products Laboratory, located in Madison, Wisconsin.

The Equipment Development Center machinery and construction noise RD&D efforts have been directed at developing noise control measures for specialized forest utilized equipment having hearing hazards, such as fire fighting equipment.

The Forest Products Laboratory is the Forest Service's national center for wood utilization research. Its staff of over 100 scientists works to develop new and improved techniques for efficient use of the nation's timber resources.

Construction and upkeep of wood buildings consume nearly  $\frac{1}{2}$  of the annual output of U.S. lumber, plywood, and wood base building board industries. Research in light-frame construction seeks new design methods for more effective coordination between performance goals and construction practice. In the light-frame construction program a scientific effort of 7.5 man-years provides emphasis on structural integrity, fire safety, acoustical control, thermal efficiency, and durability. Acoustics is an important part of the light-frame construction program since, for example, acoustical theory emphasizes high weight, low stiffness, and decoupled construction which is opposed to efficient mechanical design.

Noise control is a major problem in multi-family dwellings. During FY 75-78, one senior scientist has been working full time on noise transmission between dwelling units. The total cost of a man-year for one scientist, which includes technical, administrative, and other support is currently about \$100,000. All research work is done in-house.

Appendix B identifies funding and provides brief descriptions of projects conducted by USFS.

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APPENDIX A  
SUMMARY OF MACHINERY AND CONSTRUCTION NOISE  
FUNDING BY AGENCY AND INDEX TO  
NOISE PROJECTS

SUMMARY OF MACHINERY AND CONSTRUCTION NOISE RD&D FUNDING BY AGENCY

AGENCY	FISCAL YEAR FUNDING (\$1000)			
	1975	1976 <sup>1</sup>	1977 <sup>2</sup>	1978 <sup>2</sup>
• DEPARTMENT OF THE INTERIOR	1463	2076	1481	2360
• ENVIRONMENTAL PROTECTION AGENCY				
- RD&D PROGRAMS	9	74	343	141
- REGULATORY PROGRAMS	145 <sup>3</sup>	657 <sup>3</sup>	415 <sup>3</sup>	140 <sup>3</sup>
• DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE	139	179	247	135
• DEPARTMENT OF DEFENSE	265	450	516	472 <sup>5</sup>
• DEPARTMENT OF COMMERCE				
- DOC SPONSORED	353	360	319	306
- OTHER AGENCY SPONSORED	50 <sup>4</sup>	65 <sup>4</sup>	40 <sup>4</sup>	40 <sup>4</sup>
• DEPARTMENT OF TRANSPORTATION	76	42	60	190
• DEPARTMENT OF AGRICULTURE	100 <sup>5</sup>	265 <sup>5</sup>	118 <sup>5</sup>	123 <sup>5</sup>
<b>TOTAL FEDERAL RD&amp;D FUNDING FOR MACHINERY AND CONSTRUCTION NOISE</b>	<b>2405</b>	<b>3446</b>	<b>3084</b>	<b>3727</b>

<sup>1</sup> INCLUDED TRANSITION QUARTER, JULY 1 THROUGH SEPTEMBER 30.

<sup>2</sup> INCLUDES ESTIMATES OR INCOMPLETE DATA FOR FY 77 AND 78.

<sup>3</sup> REGULATORY PROGRAM FUNDING NOT INCLUDED IN TOTALS.

<sup>4</sup> FUNDING SUPPLIED BY OTHER FEDERAL AGENCIES NOT INCLUDED IN TOTALS.

<sup>5</sup> FUNDING IS INCOMPLETE BECAUSE SOME PROJECT BUDGETARY INFORMATION WAS NOT AVAILABLE.

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NOISE PROJECTS

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MANUFACTURING EQUIPMENT

Woodworking Machinery

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ENVIRONMENTAL PROTECTION AGENCY (Continued)

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Not specified

Fiscal Year Funding\* (\$1000): 1975 1976 1977 1978  
106 81

ACOUSTIC PROPERTIES

Impact and Vibration

Quarry Blast Noise and Vibration

An experimental program was conducted to determine the mathematical transfer functions relating quarry blast noise and vibration with building structural response. Four distinct noise and vibration signals were produced inside nearby dwellings from outdoor dynamite blasts. Results indicated that, due to resonances excited within the dwellings, the noise and vibration excitation was greater inside the dwellings than outside. A report was issued in February 1977.

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Kamperman Associates

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
50

Measurement and Methodology

Temporal Sampling

Studies are underway to determine the most accurate temporal sampling techniques for the measurement of over

\* The internal combustion engine project contributes to both the surface transportation and the machinery and construction areas. The project is identified both in this report and the surface transportation noise report with proportionate funding. Total FY 77 and 78 funding levels are \$425K and \$325K respectively. Total estimated funding for the program is 2.25 million dollars.

ENVIRONMENTAL PROTECTION AGENCY (Continued)

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
50

Noise Control in Shipyards

This study, conducted under an interagency agreement with the Naval Sea Systems Command (NAVSEA), will identify occupational noise hazards in shipyards, design noise control measures where the technology is sufficiently developed, demonstrate these noise control measures, and identify areas where additional noise control research is required. Funding levels reported represent EPA portion of funding only.

Sponsor: EPA/Office of Noise Abatement and Control and Navy/  
NAVSEA

Investigator: Not cited

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
75

ENGINE TECHNOLOGY AND MACHINE PARTS

Engine

Internal Combustion Engine

This program will advance noise control state-of-the-art and demonstrate noise reduction techniques applicable to internal combustion engines (gas turbines are excluded). Included are diesel, gasoline, and rotary engines. Engines powering such products as small industrial compressors, automobiles, trucks, marine vessels, locomotives, lawn mowers, chain saws, and tractors are to be considered. Only existing engine concepts will be utilized. The work will focus on methods of adjusting or modifying structure, combustion process, and mechanical design of power producing parts.

ENVIRONMENTAL PROTECTION AGENCY (Continued)

- . Demonstrate no less than three highway construction noise abatement measures
- . Estimate national exposure to highway construction on present and planned Federal aid highway construction projects

Funding shown represents EPA portion only.

Sponsor: EPA/Office of Noise Abatement and Control and  
DOT/FHWA

Investigator: Not selected

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
100

MANUFACTURING EQUIPMENT

Other Industrial Equipment

Occupational Noise Reduction in Industrial Plants

Under this proposed program two occupational noise reduction demonstration programs will be funded under inter-agency agreement with two other government facilities. The agencies being considered are HEW/NIOSH, DOC/NBS, and the Government Printing Office.

Two programs are being initiated in recognition of the need to reduce occupational noise to protect industrial workers from hearing loss. These two programs will:

- . Support OSHA's regulatory actions by demonstrating the feasibility of noise exposure reduction methods
- . Provide detailed actual economic and other impact information associated with noise control
- . Identify areas where technological advances are needed
- . Provide leadership for private industry.

ENVIRONMENTAL PROTECTION AGENCY

Funding for FY 76 includes the transition quarter (July 1, 1976 to September 30, 1976). Funding cited for FY 77 and FY 78 includes estimates. Projects for FY 78 have not been finalized.

CONSTRUCTION AND MINING EQUIPMENT

General Construction Equipment

Non-Highway Construction Site Noise Control

This program, conducted under an interagency agreement with the Construction Engineering Research Laboratory (CERL) of the Army Corps of Engineers will demonstrate the cost effectiveness and practicability of applying construction noise reduction techniques. Under this program a DOD construction site will be selected as the demonstration site for this program, a test plan will be developed, the most promising and applicable noise reduction techniques will be identified, and the demonstration program will be carried out. Funding shown represents EPA portion only.

Sponsor: EPA/Office of Noise Abatement and Control and Army/  
CERL

Investigator: CERL

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
50

Highway Construction Site Noise Study

This three-part program is to be conducted under an interagency agreement with DOT/Federal Highway Administration (FHWA) to support ongoing FHWA programs related to abatement of highway construction noise. The three program parts are:

Use field data to develop and validate a highway noise prediction model

ENVIRONMENTAL PROTECTION AGENCY  
RD&D FUNDING FOR MACHINERY AND CONSTRUCTION NOISE

	<u>Fiscal Year Funding (\$1000)</u>			
	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
CONSTRUCTION AND MINING EQUIPMENT FUNDING BY SUB-CATEGORY				
. GENERAL CONSTRUCTION EQUIPMENT			150	
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. MEASUREMENT AND METHODOLOGY	9	24	12	10
TOTAL: ENVIRONMENTAL PROTECTION AGENCY	9	74	343	141

C-3

APPENDIX C  
ENVIRONMENTAL PROTECTION AGENCY  
RD&D PROGRAMS

DEPARTMENT OF THE INTERIOR (Continued)

demonstrate the performance of selected techniques. The design goal is to reduce noise levels to achieve a noise exposure index of less than one over the course of an 8-hour shift for the drill operator and nearby personnel. The scheduled completion date is June 1978.

Sponsor: Bureau of Mines  
Investigator: Bolt Beranek & Newman, Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
92 5



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**CORRECTION!**

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APPENDIX B  
DEPARTMENT OF  
THE INTERIOR  
RD&D PROGRAMS

DEPARTMENT OF THE INTERIOR  
RD&D FUNDING FOR MACHINERY AND CONSTRUCTION NOISE

Fiscal Year Funding (\$1000)

CONSTRUCTION AND MINING EQUIPMENT FUNDING BY SUB-CATEGORY	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
. EARTHMOVERS AND RELATED EQUIPMENT		9	10	164	
. SPECIALIZED MINING EQUIPMENT	639*	1,331	1,878	1,161	444†
. BREAKERS AND DRILLS		123	188	156	†
TOTAL: DEPARTMENT OF INTERIOR	639*	1,463	2,076	1,481	2,360††

8-13

\* FY 74 funding is only for projects listed. It is not the total FY 74 funding for DOI.

† Sub-category funding totals are not complete because of contract procurement procedures for some projects.

†† Total FY 78 funding includes funds not identified for specific projects because of contract procurement procedures.



DEPARTMENT OF THE INTERIOR (Continued)

Demonstration of Bulldozer Noise Control

This project will demonstrate the feasibility of reducing bulldozer noise levels to less than 90 dB. Two tracked dozers with engine ratings of 150 hp or greater will be selected and tested. Scheduled completion date is November 1978.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
142

Specialized Mining Equipment

Alternate Conveyor Designs for Mine Machinery

The purpose of this development and testing project was to develop new concepts in quiet conveyors suitable for continuous miners or loading machines, incorporate new designs into a prototype conveyor system, and evaluate its performance. Completed November 1976.

Sponsor: DOI/Bureau of Mines  
Investigator: Foster-Miller Assoc. Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
167 20 52

Abatement of Noise of Continuous Mining Machines

After the major noise sources of a continuous miner had been defined, a development and testing project was undertaken to develop corrective measures to reduce operating noise levels to 90 dB or less. The corrective measures are to be implemented on a continuous miner for field evaluation of their effectiveness. The scheduled completion date is October 1978; additional work on quieting continuous miners is projected through FY 81.



DEPARTMENT OF THE INTERIOR (Continued)

Sponsor: DOI/Bureau of Mines  
Investigator: Bolt Beranek & Newman, Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
162 71 91

Auger Miner Noise Control

A project was undertaken to develop noise abatement methods that can be applied in-mine to the auger-type mining machine. Implementation of noise control features should result in a field noise level of 90 dB or less for the auger miner. The scheduled completion date for the applied research effort is February 1978. Additional work on quieting augers is projected to continue through FY 80.

Sponsor: DOI/Bureau of Mines  
Investigator: Donaldson Co., Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
168 18

Mantrip Noise Control

A project was undertaken to develop noise control techniques for reduction of noise in mantrip vehicles consistent with state-of-the-art technology. The goal for noise emission level is 85 dB. The scheduled completion date is July 1978.

Sponsor: DOI/Bureau of Mines  
Investigator: Bolt Beranek & Newman, Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
105 28

Noise Control of Underground Load-Haul-Dump Machines

A project was undertaken to develop a noise control package for an underground load-haul-dump machine. Completed December 1977. Additional work, including field demonstrations, is projected to continue through FY 80.

DEPARTMENT OF THE INTERIOR (Continued)

Sponsor: DOI/Bureau of Mines  
Investigator: Bolt Beranek & Newman, Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
78 24

Development of Quiet Conveyor System for Mining Machinery

In conjunction with the Jeffrey Mining Machinery Company, the contractor undertook a development project to determine the noise sources of the conveyor system used on a Model 120 Heliminer. Noise control techniques were developed and applied and the results measured. The goal was a conveyor system with noise emission levels of 90 dB or less that is practical from a manufacturer's and user's standpoint. The completion date was November 1976.

Sponsor: DOI/Bureau of Mines  
Investigator: Bolt Beranek & Newman, Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
78 38

Noise Control for Secondary Crushers

Two applied research contracts were let to develop noise control techniques for secondary crushers in taconite plants. Enclosures were designed under both contracts. The effectiveness of one of the enclosures is to be demonstrated by installation in an operating plant (done under separate contract).

Sponsor: DOI/Bureau of Mines  
Investigator: Industrial Acoustics Co.; Aerophysics Co.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
65

Noise Abatement in Mining Machinery

A development and testing project was undertaken to define the noise sources from bolters, loaders, and continuous miners and assess in-mine corrective measures to reduce operating exposure to noise levels of 90 dB. The proposed

DEPARTMENT OF THE INTERIOR (Continued)

measures were experimentally evaluated for effectiveness on a loader, a continuous miner, and a rotary roof bolter. The output of the project was a report describing in detail the three machines selected, the noise sources, the corrective measures applied, and the results from testing the modified machines in a mine for one month. Completion date was July 1975.

Sponsor: DOI/Bureau of Mines  
Investigator: Apt, Bramer, Conrad, & Assoc., Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
27 5

Noise Control in Surface Mining Facilities: Chutes and Screens

An applied research project was undertaken to develop economical retrofit methods for control of noise generated by chutes and screens and to demonstrate their wearability, utility, and noise reduction under field conditions. Completion date was March 1977.

Sponsor: DOI/Bureau of Mines  
Investigator: Bolt Beranek & Newman, Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
126 25

Demonstrating Noise Control of a Coal Preparation Plant

A demonstration project was undertaken, the objective of which was to apply all available noise control technology to completely treat a coal preparation plant with the goal of reducing noise levels to 90 dB or less. Plant has been brought into compliance. Contract has been extended to evaluate reliability, maintenance, and cost factors of the noise abatement techniques.

Sponsor: DOI/Bureau of Mines  
Investigator: Bolt Beranek & Newman, Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
129 17 86

DEPARTMENT OF THE INTERIOR (Continued)

Noise of Surface Coal Mining Equipment

A project was undertaken to determine the number of machines utilized in surface coal mines, their noise levels, and the extent of workers' exposures to these machines; to identify the noise generating mechanisms associated with surface machines and to recommend cost-effective noise control techniques. Survey and census work were completed June 1977. Work on developing abatement measures is continuing.

Sponsor: DOI/Bureau of Mines  
Investigator: Bolt Beranek & Newman, Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
156 8

Retrofitting Noise Controls for Load-Haul-Dump Machines

The objective is to determine the major sources of noise of a typical LHD (load-haul-dump) machine and to apply noise control techniques to quiet these sources. Results will be verified by conducting underground tests. The investigation is to be conducted in cooperation with a major LHD manufacturing company with a design control of 90 dB.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
\*

Noise Control of Underground Diesel-Powered Mining Equipment

An applied research project was undertaken to determine the nature and extent of noise exposure caused by underground diesel-powered equipment and to identify specific sources and possible controls. The completion date was June 1976.

\* Funding is not disclosable because of contract procurement procedures.

DEPARTMENT OF THE INTERIOR (Continued)

Sponsor: DOI/Bureau of Mines  
Investigator: Bolt Beranek & Newman, Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
69 41

Effect of Underground Environment and Loading Conditions on  
Noise Levels of Coal Mining Equipment

An applied research project was undertaken to determine correction factors for the effect of load conditions on mine machinery noise levels and to assess the method developed under BOM contract, Noise of Diesel-Powered Underground Mining Equipment, for predicting the increase in noise level for machines located in the underground coal mining environment. The scheduled completion date is June 1978.

Sponsor: DOI/Bureau of Mines  
Investigator: Donaldson Co., Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
103 20

Study of Noise Sources in a Cross-Section of Taconite Plants

The objective of this applied research project was to conduct plant investigations of a representative cross-section of taconite mills to determine the magnitude and nature of the noise sources of the various processes. Completed in December 1977.

Sponsor: DOI/Bureau of Mines  
Investigator: Donley, Miller, & Nowikas

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
66 15

Source Diagnosis and Abatement Techniques in Taconite Plants

An applied research project was initiated to diagnose noise sources in taconite plants, develop noise control measures, assess the impact of these measures from a technical and economic standpoint, and analyze the arc-air gouger

DEPARTMENT OF THE INTERIOR (Continued)

noise problem. This study is an amplification of the previous study (Donley, Miller & Nowikas).

Sponsor: DOI/Bureau of Mines  
Investigator: Bolt Beranek & Newman, Inc.

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
93

Definition and Correction of Noise in Coal Mines

The objective of this applied research project was to define the noise problems of various types of mining operations, correct or abate such problems, devise instrumentation to measure their nature, and develop interim personal protection. The completion date was September 1976.

Sponsor: DOI/Bureau of Mines  
Investigator: In-house

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
140 154 147

Assessment of Noise Control Techniques for Coal Mining Machinery

The objective of this in-house reasearch project is to assess noise problems associated with mining equipment, apply available technology, and evaluate instrumentation for the accurate measurement of worker noise exposure. The work is continuing.

Sponsor: DOI/Bureau of Mines  
Investigator: In-house

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
93 105



DEPARTMENT OF THE INTERIOR (Continued)

Noise Abatement of Preparation Plant Equipment

A program was undertaken to reduce the noise emitted by preparation plant equipment, including screens, crushers, dryers, and car shakers. The following techniques were included in the study:

- . Installation of worker enclosures
- . Utilizing materials for vibration isolation, vibration damping, and sound absorption
- . Introducing new, quieter machine designs in cooperation with manufacturers.

Where retrofit design and installation are feasible, these will be implemented.

Sponsor: DOI/Mining Enforcement and Safety Administration  
Investigator: In-house

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
7 10 21 26

Noise Abatement of Pneumatic Equipment

Noise surveys in underground coal mines showed the pneumatic stoper (drill) to be the worst noise offender. The objective of this project was to reduce the noise emitted by drills by application of acoustical materials and mufflers. Jumbo mounted drills in metal and nonmetal mines and shaft and slope sinking operations also result in excessive levels of exposure. Noise control activity included evaluation of materials that can be used to fabricate muffling systems. Field evaluations included monitoring of effectiveness of hardware developed by various companies.

Sponsor: DOI/Mining Enforcement and Safety Administration  
Investigator: In-house

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
16 19 20 16



DEPARTMENT OF THE INTERIOR (Continued)

Noise Study of Longwall Mining Systems

Definition of the noise sources associated with Longwall mining systems and assessment of the feasibility of abating the sources identified. The study will involve a survey of at least 10 longwall mining systems using shears or plows.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
\*

Noise Control of Rod and Ball Mills

Demonstrate noise abatement techniques for rod and ball mills. The effectiveness and practicality of noise abatement techniques proposed under previous contracts will be evaluated.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
\*

Noise Control of Portable Crushing and Screening Plants

Demonstrate noise control techniques for portable crushing and screening plants. Design developed under previous contracts will be implemented and tested.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
\*

\* Project funding is not disclosable because of contract procurement procedures.

DEPARTMENT OF THE INTERIOR (Continued)

Noise Control of Channel Burners

Investigate the noise generating mechanisms of channel burners to determine if feasible engineering noise control techniques exist or can be developed.

Sponsor: DOI/Bureau of Mines  
Investigator: not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
\*

Noise Control of Mechanical Coal Cutting/Extraction Systems

This project will characterize the noise generating mechanisms and parameters associated with cutting of coal at the coal/machine interface, and will develop techniques to reduce or eliminate the sources identified through machine redesign. This base information is needed before new extraction techniques can be developed to minimize noise presently inherent in coal extraction.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
\*

Development of Quiet Resilient Screens for Use in Coal Preparation

Develop quiet resilient deck for coal screening and demonstrate durability and acoustical effectiveness under production conditions. The performance of the screens chosen will be demonstrated for a one year period to determine their acceptability.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
\*

\* Project funding is not disclosable because of contract procurement procedures.

DEPARTMENT OF THE INTERIOR (Continued)

Noise Control of Surface Coal Augers

Develop feasible engineering controls that will reduce the noise emanating from surface coal augering equipment. Noise source diagnosis will be conducted, cost-effective durable noise control techniques will be investigated, and a field manual describing the abatement principles and implementation techniques will be prepared.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978

\*

Acoustic Radiation from Underground Auger Cutting Heads

Define the acoustic radiation characteristics of coal cutting augers used underground. A combined field test and laboratory effort will be conducted. The study is confined to assessing techniques that can be implemented on a retrofit basis.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978

\*

Implementation and Evaluation of Crusher Noise Control

This task will demonstrate noise control techniques for secondary crushers. The effectiveness and practicality of noise abatement techniques developed under a previous contract will be evaluated.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978

\*

\* Project funding is not disclosable because of contract procurement procedures.

DEPARTMENT OF THE INTERIOR (Continued)

Design Concept for Crusher Noise Control

Investigation of the mechanisms of noise generation in secondary crushers will be accomplished to determine if noise control techniques can be applied to the basic machine design.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978

\*

Evaluation and Selection of Materials for Noise Control

Determine the extent of application and acoustical effectiveness of commercially available acoustic materials. Materials will be tested under difficult environmental conditions to assess their utility and acceptability for noise control applications in the coal mining industry.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978

\*

Flammability Evaluation of Noise Control Products for Use in Underground Mines

The purpose of this study is to identify those noise and vibration reduction materials that have potential use in the noise control of underground mining equipment. One hundred materials are to be selected and tested against flammability standards and toxicity criteria. Scheduled completion date is July 1978.

Sponsor: DOI/Bureau of Mines  
Investigator: IIT Research Institute

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978

55

\* Project funding is not disclosable because of contract procurement procedures.

DEPARTMENT OF THE INTERIOR (Continued)

Investigation of Direct Airborne Noise Generated During Coal Cutting

This project will conduct a preliminary investigation of noise generation associated with coal breakage for the purpose of defining a comprehensive RD&D program to minimize such noise. The investigation will better define and characterize the physical/acoustical phenomenon associated with coal breakage and identify the principal cutting parameters affecting the noise. Scheduled completion date is September 1978.

Sponsor: DOI/Bureau of Mines  
Investigator: Wyle Laboratories

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
124 \*

Engineering Noise Control Guidelines for the Coal Mining Industry—Handbook

A noise control handbook will be developed for the coal mining industry that provides guidelines for the selection, design and implementation of effective abatement methods for mine machinery noise.

Sponsor: DOI/Bureau of Mines  
Investigator: Booz, Allen Applied Research

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
91 30 \*

Airblast Assessment and Control

Determine the effect on humans and structures of airblast overpressures from surface mine blasting. Field test data will be used to examine the relative effects of airblast and ground vibrations as well as various airblast characteristics.

Sponsor: DOI/Bureau of Mines  
Investigator: In-house

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
149 149 146 159

\* Project funding is not disclosable because of contract procurement procedures.

DEPARTMENT OF THE INTERIOR (Continued)

Evaluation of Existing Methodologies of Ground Vibration Measurement

Determine which parameters of ground motion from blasting relate to structural damages and how best to measure these parameters. Existing instrumentation, methods, and measurement criteria will be evaluated to produce a standardized measurement system. Completed September 1977.

Sponsor: DOI/Bureau of Mines  
Investigator: In-house

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
43

Evaluation of Noise Measuring Devices of Airblast Transients

Examine the techniques for the measurement of blast noise overpressures and evaluate the performance of commercially available instrumentation for measuring impulsive sound levels from production blasting. Completed September 1977.

Sponsor: DOI/Bureau of Mines  
Investigator: In-house

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
43

Control of Vibration and Blast Noise from Surface Coal Mining

Determine the extent of adverse environmental effects and ground vibration from blasting in large scale surface coal mines. Develop blasting techniques to minimize these effects.

Sponsor: DOI/Bureau of Mines  
Investigator: Wiss, Janney and Associates

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
366 196

DEPARTMENT OF THE INTERIOR (Continued)

Noise Control for Metallurgical Processing

Reduce the noise generated by equipment used in metal forming, mining, or construction operations through utilization or development of damping alloys and metallic composites.

Sponsor: DOI/Bureau of Mines  
Investigator: In-house

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
110 194 341 158

Noise Control of Ventilation Systems

Mine ventilation systems can produce noise levels that affect people in nearby areas. The objective of this project is to develop and apply noise control techniques for surface and underground ventilation systems. Commercially available silencing systems have been applied to underground and surface ventilating fans, and their effectiveness has been evaluated.

Sponsor: DOI/Mining Enforcement and Safety Administration  
Investigator: Not cited

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
4 5 15

Breakers and Drills

Development of Other Pneumatic Drills

The object of this project is to develop new drill designs and/or modifications to existing drill designs that will result in an overall drill noise level of 90 dB or less without degrading performance of the original stoper drill. Development research completed in April 1977.

Sponsor: DOI/Bureau of Mines  
Investigator: Ivor Hawkes Associates

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
90 32 16

DEPARTMENT OF THE INTERIOR (Continued)

Development of Six Prototype Production Stoper Drills

The objective is to fabricate six production prototype drills using the quiet drill techniques developed earlier under Contract J0155099 including the drills steel abatement systems. Delivery of the six drills is scheduled for October 1978. These drills are to be deployed in various coal mines and evaluated for a period of six months.

Sponsor: DOI/Bureau of Mines  
Investigator: Ivor Hawkes Associates

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
134

Evaluation of Wet-Head Drilling Techniques

The use of a wet-head drilling system was tested and evaluated on both percussive and rotary type roof bolting drills. System parameters to be studied included noise level, efficiency, cost, and safety. The results of this initial investigation will provide a basis for continuing research into alternative drilling techniques for noise control. Project was completed.

Sponsor: Bureau of Mines  
Investigator: FMC Corporation

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
33

Noise Abatement Systems for Stoper Drills

The objective of this demonstration and testing project was to fabricate and install on Government-furnished drills two noise abatement systems developed under a previous contract. Project has been completed.

Sponsor: Bureau of Mines  
Investigator: USS Engineers and Consultants

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
7



DEPARTMENT OF THE INTERIOR (Continued)

demonstrate the performance of selected techniques. The design goal is to reduce noise levels to achieve a noise exposure index of less than one over the course of an 8-hour shift for the drill operator and nearby personnel. The scheduled completion date is June 1978.

Sponsor: Bureau of Mines  
Investigator: Bolt Beranek & Newman, Inc.

Fiscal Year Funding (\$1000):	1974	1975	1976	1977	1978
			92	5	

DEPARTMENT OF THE INTERIOR (Continued)

Design of Quiet Rock Drill Using Principles of the Leavell Model D Pavement Breaker

A project was undertaken to conduct an engineering study to assess the feasibility of using the principles embodied in the Leavell Model D breaker to design a quiet drill unit with the drilling performance of a stoper/sinker drill used in underground mining. The applied research was completed in August 1977. Continuing work on construction and testing of prototype and application of principles to larger drills is projected to extend into Fiscal Year 1982.

Sponsor: Bureau of Mines  
Investigator: VAST Corporation

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
57 1

Application of Quiet Stoper Drill Technology to the Redesign of Jumbo Drills

Develop a quiet jumbo-mounted drill through redesign by using the noise abatement concepts incorporated in the design of the quiet stoper from a previous contract. All available noise control technology is to be integrated into the redesign of a typical jumbo drill. Redesign and fabrication of a prototype will be followed by field assessment of its long-term noise level, drilling efficiency, and other operating parameters.

Sponsor: DOI/Bureau of Mines  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
\*

Noise Control of Jumbo Mounted Drills

A development and testing project was conducted to investigate a cross-section of jumbo mounted drills to develop and assess corrective measures for noise control, and to

\* Project funding is not disclosable because of contract procurement procedures.

APPENDIX C  
ENVIRONMENTAL PROTECTION AGENCY  
RD&D PROGRAMS

ENVIRONMENTAL PROTECTION AGENCY  
RD&D FUNDING FOR MACHINERY AND CONSTRUCTION NOISE

Fiscal Year Funding (\$1000)

1975      1976      1977      1978

CONSTRUCTION AND MINING EQUIPMENT FUNDING BY SUB-CATEGORY

.    GENERAL CONSTRUCTION EQUIPMENT 150

MANUFACTURING EQUIPMENT FUNDING BY SUB-CATEGORY

.    OTHER INDUSTRIAL EQUIPMENT 75      50

ENGINE TECHNOLOGY AND MACHINE PARTS FUNDING BY SUB-CATEGORY

.    ENGINES 106      81

ACOUSTIC PROPERTIES FUNDING BY SUB-CATEGORY

.    IMPACT AND VIBRATION 50

.    MEASUREMENT AND METHODOLOGY 9      24      12      10

TOTAL: ENVIRONMENTAL PROTECTION AGENCY 9      74      343      141

ENVIRONMENTAL PROTECTION AGENCY

Funding for FY 76 includes the transition quarter (July 1, 1976 to September 30, 1976). Funding cited for FY 77 and FY 78 includes estimates. Projects for FY 78 have not been finalized.

CONSTRUCTION AND MINING EQUIPMENT

General Construction Equipment

Non-Highway Construction Site Noise Control

This program, conducted under an interagency agreement with the Construction Engineering Research Laboratory (CERL) of the Army Corps of Engineers will demonstrate the cost effectiveness and practicability of applying construction noise reduction techniques. Under this program a DOD construction site will be selected as the demonstration site for this program, a test plan will be developed, the most promising and applicable noise reduction techniques will be identified, and the demonstration program will be carried out. Funding shown represents EPA portion only.

Sponsor: EPA/Office of Noise Abatement and Control and Army/  
CERL

Investigator: CERL

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
50

Highway Construction Site Noise Study

This three-part program is to be conducted under an interagency agreement with DOT/Federal Highway Administration (FHWA) to support ongoing FHWA programs related to abatement of highway construction noise. The three program parts are:

Use field data to develop and validate a highway noise prediction model

ENVIRONMENTAL PROTECTION AGENCY (Continued)

- . Demonstrate no less than three highway construction noise abatement measures
- . Estimate national exposure to highway construction on present and planned Federal aid highway construction projects

Funding shown represents EPA portion only.

Sponsor: EPA/Office of Noise Abatement and Control and  
DOT/FHWA

Investigator: Not selected

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
100

MANUFACTURING EQUIPMENT

Other Industrial Equipment

Occupational Noise Reduction in Industrial Plants

Under this proposed program two occupational noise reduction demonstration programs will be funded under inter-agency agreement with two other government facilities. The agencies being considered are HEW/NIOSH, DOC/NBS, and the Government Printing Office.

Two programs are being initiated in recognition of the need to reduce occupational noise to protect industrial workers from hearing loss. These two programs will:

- . Support OSHA's regulatory actions by demonstrating the feasibility of noise exposure reduction methods
- . Provide detailed actual economic and other impact information associated with noise control
- . Identify areas where technological advances are needed
- . Provide leadership for private industry.

ENVIRONMENTAL PROTECTION AGENCY (Continued)

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
50

Noise Control in Shipyards

This study, conducted under an interagency agreement with the Naval Sea Systems Command (NAVSEA), will identify occupational noise hazards in shipyards, design noise control measures where the technology is sufficiently developed, demonstrate these noise control measures, and identify areas where additional noise control research is required. Funding levels reported represent EPA portion of funding only.

Sponsor: EPA/Office of Noise Abatement and Control and Navy/  
NAVSEA  
Investigator: Not cited

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
75

ENGINE TECHNOLOGY AND MACHINE PARTS

Engine

Internal Combustion Engine

This program will advance noise control state-of-the-art and demonstrate noise reduction techniques applicable to internal combustion engines (gas turbines are excluded). Included are diesel, gasoline, and rotary engines. Engines powering such products as small industrial compressors, automobiles, trucks, marine vessels, locomotives, lawn mowers, chain saws, and tractors are to be considered. Only existing engine concepts will be utilized. The work will focus on methods of adjusting or modifying structure, combustion process, and mechanical design of power producing parts.

ENVIRONMENTAL PROTECTION AGENCY (Continued)

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Not specified

Fiscal Year Funding\* (\$1000): 1975 1976 1977 1978  
106 81

ACOUSTIC PROPERTIES

Impact and Vibration

Quarry Blast Noise and Vibration

An experimental program was conducted to determine the mathematical transfer functions relating quarry blast noise and vibration with building structural response. Four distinct noise and vibration signals were produced inside nearby dwellings from outdoor dynamite blasts. Results indicated that, due to resonances excited within the dwellings, the noise and vibration excitation was greater inside the dwellings than outside. A report was issued in February 1977.

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Kamperman Associates

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
50

Measurement and Methodology

Temporal Sampling

Studies are underway to determine the most accurate temporal sampling techniques for the measurement of over

---

\* The internal combustion engine project contributes to both the surface transportation and the machinery and construction areas. The project is identified both in this report and the surface transportation noise report with proportionate funding. Total FY 77 and 78 funding levels are \$425K and \$325K respectively. Total estimated funding for the program is 2.25 million dollars.



ENVIRONMENTAL PROTECTION AGENCY (Continued)

twenty stationary and non-stationary noise sources with fluctuating levels and varying time histories. These studies will determine the degree of error that will be incurred in the use of different sampling techniques. The noise sources studied included construction equipment, trains, buses, car crushers, car washes, foundries, refrigeration units, batching plants, and cement mixers. The results of these studies will be incorporated in a manual on community noise monitoring.

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Not cited

Fiscal Year Funding (\$1000):	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
	9	12	12	10

Noise Monitoring by Analog Microsampling Techniques

This project investigated the feasibility of using analog microsampling techniques to identify noise source. Analog microsampling refers to the intermittent recording of an analog acoustic signal as a technique for sampling the environment. Analog tape recordings of various noise environments were used to investigate various microsampling rates and times to evaluate the accuracy associated with noise source recognition by humans for several types of noise, types of microsampling, and kinds of noise descriptors.

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Southern Methodist University

Fiscal Year Funding (\$1000):	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
		12		

APPENDIX D  
DEPARTMENT OF HEALTH, EDUCATION AND WELFARE  
RD&D PROGRAMS

DEPARTMENT OF HEALTH EDUCATION AND WELFARE  
RD&D FUNDING FOR MACHINERY AND CONSTRUCTION NOISE

	<u>Fiscal Year Funding (\$1000)</u>			
	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
CONSTRUCTION AND MINING EQUIPMENT FUNDING BY SUB-CATEGORY				
. GENERAL CONSTRUCTION EQUIPMENT			50	
MANUFACTURING EQUIPMENT FUNDING BY SUB-CATEGORY				
. WOODWORKING MACHINERY	39			
. TEXTILE MACHINERY	100	144	125	125
. METALWORKING MACHINERY			7	10
. OTHER INDUSTRIAL EQUIPMENT		35	65	
TOTAL: DEPARTMENT OF HEALTH EDUCATION AND WELFARE	139	179	247	135

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Funding for FY 76 includes the transition quarter (July 1, 1976 to September 30, 1976). Funding cited for FY 77 and FY 78 includes estimates. Projects for FY 78 have not been finalized.

CONSTRUCTION AND MINING EQUIPMENT

General Construction Equipment

Pneumatic Tool Noise

Research is being conducted on pneumatic tools to obtain data on noise emissions and state-of-the-art of noise controls. This task was completed in October 1977. A report is scheduled for April 1978.

Sponsor: HEW/NIOSH  
Investigator: In-house

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
50

MANUFACTURING EQUIPMENT

Woodworking Machinery

Wood Planer Noise Control

An experimental rig that included a compact wood plane enclosure to suppress board vibration in both the "in-feed" and "out-feed" operation was developed. Investigator of aerodynamic planer noise was approached by analytical studies of the parameters connected with rotating cutterheads isolated from the machine. Such factors as blade geometry, speed, air flow, and air flow pathway were investigated. The results of this study were applied to noise suppression devices and methodology utilized in woodworking machinery throughout the furniture industry.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE (Continued)

Sponsor: HEW/NIOSH  
Investigator: University of North Carolina

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
39

Textile Machinery

Coordinated Textile Industry Noise Reduction Program

The general objective of the program is to ascertain, and develop where necessary, information needed by the textile industry to facilitate maximum possible workplace noise reductions, thus aiding the industry in achieving compliance with noise standards of the Occupational Safety and Health Act. Specifically, the program includes the collection of noise control case histories from the textile industry, the evaluation of effective noise control measures, the conduct of a noise control research program, the publishing of bulletins and papers, and the compilation of a textile industry noise control manual.

Sponsor: HEW/NIOSH  
Investigator: University of North Carolina

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
100 144 125 125

Metalworking Machinery

Control of Ultraviolet and Infrared Radiation, and Noise for Physical Agents Associated with Welding and Brazing

This project will incorporate in-house research to provide engineering control data for physical agents associated with welding and brazing operations and delineate gaps in current control technology. This research will concentrate on controls for ultraviolet and infrared radiation, and noise. The report is scheduled for completion by September 1978.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE (Continued)

Sponsor: HEW/NIOSH  
Investigator: In-house

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
7

Metal Fabrication Noise Control

This project will determine the direction of future NIOSH noise control research in the metal forming industry.

Sponsor: HEW/NIOSH  
Investigator: In-house

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
10

Other Industrial Equipment

Update of Compendium of Noise Control Materials

A contract will be developed and awarded to update the recently published NIOSH publication, Compendium of Materials for Noise Control. This research is required because the increase in concern for noise control has greatly increased the materials available for noise control. This updated report will provide noise control engineers with the latest available information on noise control materials. Final report is due by the fourth quarter of FY 78.

Sponsor: HEW/NIOSH  
Investigator: In-house

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
50

Industrial Noise Control Case Histories

A contract was developed and awarded in July 1976 for the collection of industrial noise control case histories. Approximately twenty unique case histories are being obtained. Completion is scheduled for June 1978.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE (Continued)

Sponsor: NIOSH  
Investigator: Not cited

Fiscal Year Funding (\$1000):	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
		35	15	

APPENDIX E  
DEPARTMENT OF DEFENSE  
RD&D PROGRAMS



DEPARTMENT OF DEFENSE  
RD&D FUNDING FOR MACHINERY AND CONSTRUCTION NOISE

	<u>Fiscal Year Funding (\$1000)</u>			
	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
<b>CONSTRUCTION AND MINING EQUIPMENT FUNDING BY SUB-CATEGORY</b>				
. EARTHMOVERS AND RELATED EQUIPMENT	40		19	16
. MILITARY CONSTRUCTION EQUIPMENT	115	190	190	189
. GENERATORS	25	25	25	25
. GENERAL CONSTRUCTION EQUIPMENT	45	55	20	*
. BREAKERS AND DRILLS		5	10	
<b>MANUFACTURING EQUIPMENT FUNDING BY SUB-CATEGORY</b>				
. OTHER INDUSTRIAL EQUIPMENT	1		30	135
. MILITARY SHIPBOARD EQUIPMENT		65	97	
<b>ACOUSTIC PROPERTIES FUNDING BY SUB-CATEGORY</b>				
. BUILDING ACOUSTICS			40	60
. MEASUREMENT METHODOLOGY	39	110	85	47
<b>TOTAL: DEPARTMENT OF DEFENSE</b>	<b>265</b>	<b>450</b>	<b>516</b>	<b>472*</b>

\* Funding is incomplete because some project budgetary information was not available.

DEPARTMENT OF DEFENSE

Funding for FY 76 includes the transition quarter (July 1, 1976 to September 30, 1976). Funding cited for FY 77 and FY 78 includes estimates. Projects for FY 78 have not been finalized.

CONSTRUCTION AND MINING EQUIPMENT

Earthmovers and Related Equipment

830 MB Wheel Tractor

The objective of this project is to reduce operator noise exposure levels to safe limits of 85 dB and to show the feasibility of fielding noise-reduced machines with and without cabs. Approximately \$1.2 million will be spent on retrofitting for existing equipment through FY 78. The estimated completion date for retrofit is October 1979.

Sponsor: MERADCOM  
Investigator: Not Cited

Fiscal Year Funding (\$1000):	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
	40		19	16

Testing and Methodology of Tractors (Dozers) and Loaders

This study is being conducted under an interagency agreement with EPA. It was initiated as a prerequisite to the promulgation of noise emission regulations on dozers and loaders, which have been identified as major noise sources. The objective of this project is to find a representative test methodology for regulation of environmental noise emitted by loaders and tractors (dozers) during steady-state and duty-cycle operation. Other objectives include the identification of major noise sources and the estimation of possible noise emission reduction.



DEPARTMENT OF DEFENSE (Continued)

Sponsor: CERL  
Investigator: In-house

Fiscal Year Funding (\$1000): 

1975	1976	1977	1978
115	170	135	115

Retrofit to Reduce Noise of 6K Rough Terrain Forklift

The objective of this project is to reduce operator noise exposure levels to safe limits of 85 dB and to show the feasibility of fielding noise-reduced machines with and without cabs. Approximately \$4.7 million will be spent on retrofitting existing equipment through FY 78. The estimated completion date is October 1979.

Sponsor: MERADCOM  
Investigator: Not cited

Fiscal Year Funding (\$1000): 

1975	1976	1977	1978
	15	6	11

Retrofit to Reduce Noise of 10K Rough Terrain Forklift

The objective of this project is to reduce operator noise exposure levels to safe limits of 85 dB and to show the feasibility of fielding noise-reduced machines with and without cabs. Approximately \$1.8 million will be spent on retrofitting existing equipment through FY 78. The estimated completion date is October 1979.

Sponsor: MERADCOM  
Investigator: Not cited

Fiscal Year Funding (\$1000): 

1975	1976	1977	1978
	5	5	5

Generators

Portable Electric Generator Noise Control

The primary objective of this study is to reduce the noise levels of a new family of 1.5 through 6K kW portable

DEPARTMENT OF DEFENSE (Continued)

electric generator sets used by DOD to meet tactical needs, to eliminate annoyance and hearing damage risk to operating personnel, and to comply with sound level requirements of local, State, Federal, and foreign communities. This study is also intended to develop an ultraquiet 1.5 kW portable electric generator for Army tactical needs. A prototype thermal/acoustic enclosure kit has been developed for each of the generator sizes except a 3 kW generator and are being evaluated. The enclosures, in addition to suppressing noise, must provide adequate cooling air to prevent overheating of the units. The 3-kW generator has a cooling system that is not compatible with any type of enclosure. There is no effort to develop kits for the existing inventory of older Army design diesel sets. The estimated completion date is October 1981.

Sponsor: MERADCOM  
Investigator: Not cited

Fiscal Year Funding (\$1000): 

1975	1976	1977	1978
25	25	25	25

General Construction Equipment

Non-Highway Construction Site Noise Control

Conducted under an interagency agreement with EPA, this program will demonstrate the cost, effectiveness, and practicality of applying construction noise reduction techniques. Under this program a DOD construction site will be selected for demonstrating noise mitigation measures, the most promising and applicable noise reduction techniques will be identified, a test plan will be developed, and the demonstration program will be carried out.

Sponsor: CERL and EPA/Office of Noise Abatement and Control  
Investigator: In-house

Fiscal Year Funding (\$1000): 

1975	1976	1977	1978
			*

\* CERL funding has not been finalized

DEPARTMENT OF DEFENSE (Continued)

Construction Site Noise Specifications and Control

This program is to develop a cost/benefit relationship for alternative equipment usage, operational methods, or physical means to attenuate the noise of construction sites to acceptable levels. A report has been published that gives specifications for construction site noise, measurement means, and mitigation methods. A final report on the cost/benefit relationship for the mitigation techniques and an analysis of noise-producing situations was planned for September 1977.

Sponsor: CERL  
Investigator: In-house

Fiscal Year Funding (\$1000):	1975	1976	1977	1978
	45	55	20	

Breakers and Drills

Testing and Methodology of Paving Breakers

This study is being conducted under an interagency agreement with EPA. It was initiated as a prerequisite to the promulgation of noise emission regulations on paving breakers, which have been identified as a major noise source. The objectives of this project are to provide and to compare representative samples of noise emissions from current air (muffled and unmuffled), hydraulic, electric, and gas breakers under steady-state and working-cycle conditions. The funding levels represent the DOD portion of funding only.

Sponsor: MERADCOM with EPA/Office of Noise Abatement and Control  
Investigator: In-house

Fiscal Year Funding (\$1000):	1975	1976	1977	1978
		5	10	

DEPARTMENT OF DEFENSE (Continued)

MANUFACTURING EQUIPMENT

Other Industrial Equipment

Noise Control in Hydroelectric Power Houses

This project will determine noise sources and develop noise control techniques for hydroelectric power house environments.

Sponsor: CERL  
Investigator: In-house

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
30 60

Noise Control in Shipyards

This study, conducted under interagency agreement with EPA, will investigate and demonstrate noise abatement measures for occupational noise hazards in shipyards. Funding levels reported represent NAVSEA portion only.

Sponsor: NAVSEA and EPA/Office of Noise Abatement and Control  
Investigator: Not cited

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
75

Development of Universal Ducting Envelopes for S-280 Shelter

The objective of this noise study was to reduce the noise levels within the S-280 Shelter to an NC-55, using eight combinations of duct configurations with single and double environmental conditioning unit combinations operating in the high cooling mode. The second purpose of this noise study was to provide the project office with a series of alternate duct configurations to meet the requirements for different types of shelter arrangements. Noise levels within the shelter for the eight combinations with all noise and vibration control treatment installed meet the original design objective (NC-55) in all but the 125 Hz and the 500 Hz octave bands.

DEPARTMENT OF DEFENSE (Continued)

Sponsor: HEL  
Investigator: Bolt Beranek and Newman, Inc.

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
1\*

Military Shipboard Equipment

Surface Ship Equipment Silencing

A project was undertaken to review existing in-house airborne noise source level data of surface ship machinery and equipment to analyze noise levels of electronic equipment cooling cabinets. Existing documentation was used to determine acoustical characteristics of machinery items, and the airborne noise levels of selected electronic equipment were measured. The estimated completion date was July 1977.

Sponsor: Naval Ship Engineering Center  
Investigator: David W. Taylor Naval Ship R&D Center

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
39

Aircraft Carrier CORD Development Program

A study was undertaken to develop a Cascade Orificial Resistive Device (CORD) for aircraft carriers of the Kitty Hawk, Nimitz, and Enterprise classes. This device will provide quiet throttling for the regulation of seawater flow through the flight deck cooling panels and the jet blast deflector. This project will involve (a) development of CORD initial design parameters from system requirements, (b) finalization of design parameters, (c) preparation of an unclassified initial CORD booklet and CORD construction guidance, and (d) the shipboard installation and evaluation of the CORDs.

\* Contract-out portion of funding for this project prior to FY 75 was \$28K.



DEPARTMENT OF DEFENSE (Continued)

Sponsor: Naval Ship Engineering Center  
Investigator: David W. Taylor Naval Ship R&D Center

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
6 6

Development of Document: Ship Noise Control Devices—Their Use, Maintenance, Inspection, and Replacement

A document was developed to acquaint the ship forces and those responsible for ship implementation with various noise reduction hardware and techniques. The objective is to reduce the transmission of machinery noise and thereby minimize sonar self-noise and radiated noise. The document will also describe care, maintenance, inspection, and criteria for replacement of these items. Completion was scheduled for April 1977.

Sponsor: Naval Sea Systems Command  
Investigator: David W. Taylor Naval Ship R&D Center

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
10

Hydrofoil Auxiliary Machinery Development

The objective of this project was to establish auxiliary machinery requirements of hydrofoils. Auxiliary machinery selection alternatives and design criteria for future-generation U.S. Navy hydrofoils are also to be developed. New concepts were to be developed or existing systems adapted for naval use. Laboratory tests of components and systems will be conducted in terms of functions, effectiveness, reliability, operational requirements, weight, and cost. All auxiliary systems on existing hydrofoils were to be studied. Technical assistance was to be provided for solution of problems on existing craft, and design reviews were to be conducted.

Sponsor: Naval Sea Systems Command  
Investigator: Naval Ship R&D Center Systems Development

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
43 22

DEPARTMENT OF DEFENSE (Continued)

Silencing of Combatant Craft and Standard Boats

The objective of this project was to reduce the airborne noise levels of combatant craft and standard boats. Improved methods of silencing combatant craft are being developed, and acoustical evaluations of silencing treatments are being performed. In addition, procedures were to be developed for designing improved vibration isolation mountings for diesel engines.

Sponsor: Naval Sea Systems Command  
Investigator: Naval Ship R&D Center, Propulsion and Auxiliary Department

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
16 20

ACOUSTIC PROPERTIES

Building Acoustics

Acoustical Specifications for Building Noise Control

The objective of this program is to provide design procedures and performance requirements based on existing manuals; to adopt the procedures for implementation with conventional and turn-key construction processes; to develop and issue specific noise reduction guidance for Army - unique sources; and to develop guidance for open-plan office acoustical design. A technical manual will be developed giving methods of controlling and mitigating noise within buildings.

Sponsor: CERL  
Investigator: In-house

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
40 60

DEPARTMENT OF DEFENSE (Continued)

Measurement and Methodology

Hydraulic (Fluid Power) System Noise Studies

A basic and applied research and development project is underway to develop a procedure to test and compare the air-borne, fluidborne, and structureborne noise of hydraulic components; to develop procedures to evaluate fluidborne noise attenuators; and to develop some new designs and demonstrate their effectiveness.

Sponsor: MERADCOM  
Investigator: Not cited

Fiscal Year Funding (\$1000):	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
	39	15	10	12

Noise Monitoring

The purpose of this project is to develop true integrating environmental noise monitors capable of accurately measuring impulse noises (armor, artillery) in accordance with EPA and National Academy of Sciences recommendations. Specifications will be prepared such that devices can be procured for DOD and general governmental use. Initially, nine monitors plus spare parts and a data reduction system are to be manufactured. This program is based in part upon work conducted by CERL for EPA to design prototype equipment on an assessment of currently available commercial monitors.

Sponsor: CERL  
Investigator: In-house

Fiscal Year Funding (\$1000):	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
		95	65	25

Sampling Strategies

Under this project, mathematical criteria will be developed for assessing the accuracy of environment noise monitoring with respect to temporal consideration.

Sponsor: CERL  
Investigator: In-house

Fiscal Year Funding (\$1000):	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
			10	10

APPENDIX F  
DEPARTMENT OF COMMERCE  
RD&D PROGRAMS

DEPARTMENT OF COMMERCE  
INTERNAL\* RD&D FUNDING FOR MACHINERY AND CONSTRUCTION NOISE

	<u>Fiscal Year Funding (\$1000)</u>			
	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
ACOUSTIC PROPERTIES FUNDING BY SUB-CATEGORY				
. BUILDING ACOUSTICS	253	235	99	100
. MEASUREMENT AND METHODOLOGY	100	125	220	206
TOTAL INTERNAL FUNDING: DEPARTMENT OF COMMERCE	353	360	319	306

EXTERNAL\* RD&D FUNDING FOR MACHINERY AND CONSTRUCTION NOISE

	<u>Fiscal Year Funding (\$1000)</u>			
	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
ACOUSTIC PROPERTIES FUNDING BY SUB-CATEGORY				
. MEASUREMENT METHODOLOGY	50	65	40	40
TOTAL EXTERNAL FUNDING: DEPARTMENT OF COMMERCE	50	65	40	40

\* Internal and external funds refers to funds supplied by DOC and funds supplied by other Federal agencies to DOC, respectively.

## DEPARTMENT OF COMMERCE

Funding for FY 76 includes the transition quarter (July 1, 1976 to September 30, 1976). Funding cited for FY 77 and FY 78 includes estimates. Projects for FY 78 have not been finalized.

### ACOUSTIC PROPERTIES

#### Building Acoustics

##### Noise Measurements in Buildings

Improved procedures are being developed for measurement of the acoustical properties of building materials and elements and of noise isolation within and into buildings. Current emphasis has been on a review of vibration isolation procedures and on reverberation room determinations of the sound absorption of acoustical materials. Work will shortly begin on the assessment of uncertainties in noise isolation measurements. Specific accomplishments during recent years include the following:

- . Literature review on the use and characterization of the performance of antivibration mountings for the control of noise and vibration.
- . Review of building noise criteria for rating the noise environment in dwellings, noise isolation between dwellings and noise isolation from outside to inside a dwelling.
- . Studies of the transmission loss, thermal transmittance and air leakage of exterior walls, doors and windows.
- . Investigation of the measurement uncertainties associated with reverberation room determinations of sound absorption coefficients.

DEPARTMENT OF COMMERCE (Continued)

Sponsor: National Bureau of Standards  
Investigator: In-house

Fiscal Year Funding (\$1000):	1975	1976	1977	1978
	253	235	99	100

Measurement and Methodology

Noise Emission Measurements

The National Bureau of Standards has supported research toward improvements in procedures for the measurement of noise emissions. This project is supported through DOC funds in consistency with the NBS mission of providing for the physical and engineering services necessary for equity in trade and the advancement of science and technology. Specific accomplishments during recent years include the following:

- . Completion of a joint EPA/NBS report on air compressor noise measurements and on the estimation of sound power from sound pressure measurements.
- . Evaluation and improvements to the large reverberation room.
- . Evaluation of the precision of reference sound source emission measurements.
- . Several publications on the use of reverberation room procedures.
- . Studies of the effectiveness of rotating diffusers.
- . Research on absolutely determinable sound sources.
- . Characterization of the properties of outdoor test sites.
- . Completion of special purpose acoustical and environmental parameter recording systems.

DEPARTMENT OF COMMERCE (Continued)

Sponsor: National Bureau of Standards

Investigator: In-house

Fiscal Year Funding (\$1000):	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
	100	125	220	206

Environmental Noise Measurements

Technical assistance was provided to EPA to support the development of regulations for specific noise sources. Specifically NBS has provided:

- . Measurement methodology for portable air compressor noise and procedures for estimating sound power from measurements of sound pressure.
- . Docket analysis for the new truck regulation.
- . Evaluation of existing data bases and measurement procedures for six major noise sources: tires, buses, motorcycles, dozers and loaders, truck refrigeration units, and compactors.
- . Measurements of the impulsive noise emission of garbage compactors, motorcycles, pavement breakers, and rock drills.
- . Identification of difficulties or ambiguities in measurement by using different methodologies.
- . Evaluation of alternative measurement techniques for characterization of asphalt surface acoustic properties.
- . Development of procedures for measurement of noise impact from household and consumer products.



DEPARTMENT OF COMMERCE (Continued)

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: National Bureau of Standards

Fiscal Year Funding* (\$1000):	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
	50	65	40	40

\* Funding levels are shown for information only. Funding is reported under sponsoring agency. The Environmental Noise Measurements project contributes to both the surface transportation and the machinery and construction areas. The project is identified both in this report and in the surface transportation noise report with proportionate funding. Total FY 75 through FY 78 funding levels are \$50K, \$120K, \$75K, and \$75K, respectively.

APPENDIX G  
DEPARTMENT OF TRANSPORTATION  
RD&D PROGRAMS

DEPARTMENT OF TRANSPORTATION  
RD&D FUNDING FOR MACHINERY AND CONSTRUCTION NOISE

	<u>Fiscal Year Funding (\$1000)</u>				
	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
<b>CONSTRUCTION AND MINING EQUIPMENT BY CATEGORY</b>					
. EARTHMOVERS AND RELATED EQUIPMENT	50	66	42	40	40
. GENERAL CONSTRUCTION EQUIPMENT				20	150
<b>ACOUSTIC PROPERTIES FUNDING BY CATEGORY</b>					
. IMPACT AND VIBRATION	10	10			
<b>TOTAL: DEPARTMENT OF TRANSPORTATION</b>	<b>60</b>	<b>76</b>	<b>42</b>	<b>60</b>	<b>190</b>

DEPARTMENT OF TRANSPORTATION

Funding for FY 76 includes the transition quarter (July 1, 1976 to September 30, 1976). Funding cited for FY 77 and FY 78 includes estimates. Projects for FY 78 have not been finalized.

CONSTRUCTION AND MINING EQUIPMENT

Earthmovers and Related Equipment

Off-Highway and Stationary Equipment Noise Abatement

Previous DOT noise abatement programs concerning diesel-powered trucks demonstrated that significant noise reduction could be achieved through optimization of exhaust silencing. This project (initiated in FY 74) applied the knowledge gained from the surface vehicle efforts to construction equipment powered by diesel engines (excavator, front end loader, crawler dozer, and industrial tractor). Factors associated with reducing diesel engine noise by means of mufflers were identified and developed into a form suitable for dissemination to manufacturers, owners, users, and regulatory and enforcement agencies. The most frequently used construction equipments were selected for proof-testing and demonstrating noise reductions achievable from exhaust silencers. A technical report summarizing study results will be available during the second quarter of FY 78.

Sponsor: Office of Noise Abatement  
Investigator: Society of Automotive Engineers  
Vehicle Research Institute,  
Donaldson Company

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
50 5\*

\* Total DOT funding was \$55K.

DEPARTMENT OF TRANSPORTATION (Continued)

Construction and Maintenance Equipment Noise Limits

This multiyear program, conducted by the State of California, deals with a number of facets of construction site activity noise. Noise levels are being monitored at a number of construction sites, and noise emission levels of specific construction equipment are being identified. Methods of reducing noise and highway construction equipment are being developed. Equipment with diesel engine power plants was found to be the principal noise source, and, as a result, noise control efforts will be directed primarily at such equipment. A dump truck has been retrofitted with noise control devices.

Sponsor: Federal Highway Administration  
Investigator: State of California/Department of  
Transportation

Fiscal Year Funding (\$1000):	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
	61	42	40	40

General Construction Equipment

Highway Construction Noise: Measurement, Prediction, and Mitigation

This project was initiated in 1976 to provide guidance to State highway agencies relative to measurement, prediction, and abatement of highway construction noise.

Two of the three parts of the study have been completed. A manual, Special Report—Highway Construction Noise: Measurement, Prediction, and Mitigation, has been completed, using state-of-the-art information to detail the measurement, prediction, and abatement of highway construction noise. Subsequently a workshop was sponsored to identify short and long-range construction noise abatement strategies. This workshop resulted in the publication FHWA-TST-77-211, Report of 1977 Symposium on Highway Construction Noise. The third part of the project will include sponsorship of research necessary to verify and, if needed, to improve the FHWA highway construction noise manual (see "Highway Construction Site Noise Study" below).



DEPARTMENT OF TRANSPORTATION (Continued)

ACOUSTIC PROPERTIES

Impact and Vibration

Ground Vibration at Highway Construction Site

The State of Louisiana has completed an investigation of the ground vibrations associated with construction site activities, specifically pile driving and hauling, to determine whether the vibrations generated by these activities could damage surrounding property and precipitate damage suits. The study found that vibrations from pile driving operations are not severe enough to physically damage surrounding structures. Similarly, ground vibrations at locations near haul roads were determined to be insufficient to damage adjacent structures.

Sponsor: Federal Highway Administration  
Investigator: State of Louisiana

Fiscal Year Funding (\$1000): 1974 1975 1976 1977 1978  
10 10

APPENDIX H  
DEPARTMENT OF AGRICULTURE  
RD&D PROGRAMS



DEPARTMENT OF AGRICULTURE  
RD&D FUNDING FOR MACHINERY AND CONSTRUCTION NOISE

	<u>Fiscal Year Funding (\$1000)</u>			
	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
MANUFACTURING EQUIPMENT FUNDING BY CATEGORY				
. WOODWORKING MACHINERY	*	*	*	*
AGRICULTURAL MACHINERY	15	175	23	23
ACOUSTIC PROPERTIES				
. BUILDING ACOUSTICS	85	90	95	100
TOTAL: DEPARTMENT OF AGRICULTURE	100*	265*	118*	123*

H-3

\* Funding is incomplete because some project budgetary information was not available.

DEPARTMENT OF AGRICULTURE

Funding for FY 76 includes the transition quarter (July 1, 1976 to September 30, 1976). Funding cited for FY 77 and FY 78 includes estimates. Projects for FY 78 have not been finalized.

MANUFACTURING EQUIPMENT

Woodworking Machinery

Sawmill Noise Reduction

This is a basic research program for noise reduction in sawmills. Of particular concern are circular saws. The study will identify instability mechanisms, analyze self-excited blade oscillation, measure and model sound radiation, and design a quiet saw tooth.

Sponsor: Agricultural Research Services  
Investigator: University of California/Berkley

Fiscal Year Funding (\$1000):\* 1975 1976 1977 1978

AGRICULTURAL MACHINERY

Cotton Ginning Machinery Noise Reduction

This project is a continuation of a larger program to develop material handling and foreign matter collection systems for gin processing of stripped cotton. This work will enable the equipment to meet environmental standards for air quality and noise emission. Conventional pneumatic ventilation systems will be compared with experimental belt, auger, and air-jet conveyors to evaluate noise emission, dust levels and costs. The funding shown represents the noise portion only.

\* ARS Funding has not been identified.

DEPARTMENT OF AGRICULTURE (Continued)

Sponsor: Agricultural Research Service  
Investigator: In-house

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
10 20 20 20

Abatement and Control of Noise Associated with Agricultural Processes

This project is to identify sources of noise that are detrimental to the health of agricultural workers. Methods for noise reduction are to be developed with the expectation that detailed design data and guidelines will be published for industry use.

Sponsor: Agricultural Research Service  
Investigator: Agricultural Research Station/Athens, Georgia

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
133

Materials Handling and Pollution Control at Gins

This project was to develop materials handling and foreign matter collection systems for gins processing stripped cotton that meet new environmental standards for air quality and noise, and that are more efficient from an energy utilization standpoint. Funding shown represents the noise portion only.

Sponsor: Agricultural Research Service  
Investigator: Agricultural Experiment Station/Lubbock, Texas

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
20

Forest Service Equipment Noise Reduction

This ongoing program examines the noise generating mechanisms and means of silencing portable Forest Service fire equipment such as portable generators, portable pumps, etc. Inexpensive, portable partial noise enclosures for these types of equipment have been developed. Noise levels

DEPARTMENT OF AGRICULTURE (Continued)

were reduced by approximately 12 dB by using these partial enclosures.

Sponsors: Forest Service  
Investigator: In-house

Fiscal Year Funding (\$1000): 

1975	1976	1977	1978
5	2	3	3

ACOUSTIC PROPERTIES

Building Acoustics

Noise Control and Privacy in Multi-Family Dwellings

There is one long-term project underway addressing noise control and privacy in multi-family dwellings. This project has been underway since 1970. The work emphasizes the acoustical properties of wood structures suitable for low rise dwelling units. Studies have addressed the design of specific partitions and the techniques necessary for their applications in real structures. This includes evaluation and correlation of laboratory data and field data. Studies also address test methodology and test equipment. A current effort is underway to develop an acoustical applications manual for light frame housing construction. The manual is intended for architects and builders, with appendices for acoustical engineers. The manual will integrate FPL accomplishments with other technologies and structures, and will include the outer shell of a building as well as party-wall partitions.

Major technical accomplishments are:

1. A lab/field measurement correlation technology was completed which provided new knowledge about partition performance, flanking, and room environment effects.
2. Further improvement in the prediction of laboratory, field, and laboratory/field performance as achieved by combining the FPL laboratory loss (TL) theories.

DEPARTMENT OF AGRICULTURE (Continued)

3. A current compilation of TL data from seven National American laboratories has revealed some inter-laboratory data correlation and accuracy problems.

Major accomplishments with respect to specific structural designs:

1. Evaluation of several constructions for single rows of wood studs showed the sound insulation performance for some constructions to be lower than expected from previously published data.
2. Higher laboratory sound insulation performance than previously reported was shown for double rows of studs on separate floor plates with gypsum board faces.
3. A field measurement flanking study, in progress, is expected to show that a very high field sound insulation performance can be obtained in practical wood frame construction when adequate framing precautions are taken against flanking paths. Partitions tested are in the sound transmission class (STC) 60 range.

Sponsor: Forest Products Laboratory  
Investigator: In-house

Fiscal Year Funding\* (\$1000): 

1975	1976	1977	1978
85	90	95	100

Physical Acoustics

Acoustic Properties of Wood

This basic research program will determine the velocity of sound in radial, tangential, and longitudinal directions of commercial woods at different moisture contents. This information is necessary for the calculation of sound radiation from board vibration in woodworking machinery.

\* Funding levels are estimated, based on one man-year of effort for each fiscal year.

DEPARTMENT OF AGRICULTURE (Continued)

Sponsor: Agricultural Research Service  
Investigator: University of Kentucky

Fiscal Year Funding (\$1000):\* 1975 1976 1977 1978

Noise Transmission Through Wooded Areas

Noise measurements are being made to determine the attenuation across areas forested by white pine. These measurements are being compared to those made across an open field. Air pollution studies are included in this task.

Sponsor: Agricultural Research Service  
Investigator: Delaware State College

Fiscal Year Funding\* (\$1000): 1975 1976 1977 1978

\* ARS Funding has not been identified

APPENDIX I  
ENVIRONMENTAL PROTECTION AGENCY  
NOISE REGULATORY PROGRAMS

ENVIRONMENTAL PROTECTION AGENCY  
REGULATORY FUNDING FOR MACHINERY AND CONSTRUCTION NOISE

	<u>Fiscal Year Funding (\$1000)</u>			
	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
<b>CONSTRUCTION AND MINING EQUIPMENT FUNDING BY SUB-CATEGORY</b>				
. EARTHMOVERS AND RELATED EQUIPMENT	55	270	30	10
. COMPRESSORS			83	
. GENERAL CONSTRUCTION EQUIPMENT		28	115	70
. BREAKERS AND DRILLS	40	92	77	10
<b>ENGINE TECHNOLOGY AND MACHINE PARTS FUNDING BY SUB-CATEGORY</b>				
. SPECIALTY TRUCK COMPONENTS		108		
<b>CONSUMER PRODUCTS FUNDING BY SUB-CATEGORY</b>				
. TOOLS		49	70	10
. APPLIANCES		45		
<b>ACOUSTICAL PROPERTIES</b>				
. MEASUREMENT AND METHODOLOGY	50	65	40	40
<b>TOTAL: ENVIRONMENTAL PROTECTION AGENCY REGULATORY NOISE REDUCTION PROGRAMS</b>	<b>145</b>	<b>657</b>	<b>415</b>	<b>140</b>



ENVIRONMENTAL PROTECTION AGENCY  
NOISE REGULATORY PROGRAMS

These technology programs are undertaken to directly support regulatory actions.

Funding for FY 76 includes the transition quarter (July 1, 1976 to September 30, 1976). Funding cited for FY 77 and FY 78 includes estimates. Projects for FY 78 have not been finalized.

CONSTRUCTION AND MINING EQUIPMENT

Earthmovers and Related Equipment

Testing and Methodology of Tractors (Dozers) and Loaders

The study, funded by EPA and conducted under inter-agency agreement with MERADCOM of the Army, was undertaken to develop a representative test methodology for regulation of environmental noise emitted by loaders and tractors (dozers) during steady-state and duty-cycle operation. Sources amenable to noise abatement were identified as well as the extent of noise reduction attainable and a representative sample of present equipment was identified.

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Army/MERADCOM

Fiscal Year Funding (\$1000):	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
		5	10	10

Earthmoving Equipment

This preregulatory study is part of a continuing effort to evaluate the noise emission from construction activities. Equipment evaluated includes scrapers, backhoes, excavators, and other operationally similar equipment except wheel and crawler tractors, and loaders. The noise studies encompass current and best-available noise control technology, cost and economic impact analysis, and health and welfare benefits



ENVIRONMENTAL PROTECTION AGENCY (Continued)

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Science Applications, Inc.

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
83

General Construction Equipment

Other Road Building Equipment

This preregulatory project will be directed toward developing noise emission standards for road building equipment such as rollers, graders, pavers, and other similar types of construction equipment.

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Not selected

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
80 70

Construction Site Noise Model

This project will update, evaluate, and expand existing construction activity noise prediction models. The areas of concern are on site equipment distribution and usage.

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Not cited

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
28 35

Breakers and Drills

Testing and Methodology of Paving Breakers

This project was initiated as a prerequisite to the promulgation of noise emission regulations on paving breakers. Paving breakers have been identified as a major noise source.

ENVIRONMENTAL PROTECTION AGENCY (Continued)

This study is being conducted through an interagency agreement with MERADCOM of the Army. Funding level represents the EPA portion only.

Sponsor: EPA/Office of Noise Abatement and Control and  
ARMY/MERADCOM  
Investigator: MERADCOM

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
35

Pavement Breakers and Rock Drills

This project was initiated as a prerequisite to the promulgation of noise emission regulations on portable and mounted pavement breakers and rock drills. The multiphase study included product classification and development (modification) of a measurement methodology. The study identified present and feasible noise control technology and identified the sources of breaker and drill noise. It also discussed noise level variability among units of the same model and provided labeling information. Pneumatic, hydraulic, electric, and gas powered units were considered.

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Dames & Moore

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
40 92 42 10

ENGINE TECHNOLOGY AND MACHINE PARTS

Specialty Truck Components

Truck-Mounted Compactors and Refrigeration Units

The technology assessment phase of the specialty truck project included an identification of noise sources, classification of specialty trucks, development of a noise emissions data base, analysis of in-use degradation and noise level variability among units of the same model, and a discussion of currently available and potentially feasible noise control technology.

ENVIRONMENTAL PROTECTION AGENCY (Continued)

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Bolt Beranek and Newman, Inc.

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
108

CONSUMER PRODUCTS

Tools

Chain Saws

This multitask study includes a categorization of chain saws development of measurement methodology, and establishment of a chain saw noise emission data base. Other tasks are to identify currently available and potentially usable noise control technology; to identify noise emission deterioration or improvement over time; to analyze noise variability among units of the same model; and to identify the impact of post-purchase user noise modifications; and to develop possible labeling recommendations. Funding shown is for technology assessment portion of program only.

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Not cited

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
70 10

Lawn Mowers

This multitask study included a categorization of lawn mowers, comparison of outdoor and indoor measurement methodologies, identification of specific noise sources (e.g., blade, engine exhaust, engine intake, and engine casing), and establishment of a lawn mower noise emission data base. Other tasks include identification of currently available and potentially usable noise control technology; identification of noise emission deterioration or improvement over time; analysis of noise variability among units of the same model; identification of the impact of post-purchase user modifications and the development of possible labeling recommendations.

ENVIRONMENTAL PROTECTION AGENCY (Continued)

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Cambridge Collaborative

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
49

Appliances

Air Conditioners

This study of air conditioner technology develops an air conditioner classification scheme, compares measurement methodologies, and identified specific noise sources. It also establishes a noise emissions data base, identifies currently available and potentially usable noise control technology, and analyzes variability among units of the same model. It analyzes noise level improvement/deterioration over time and the impact of post-purchase user modifications, and makes possible labeling recommendations.

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: Cambridge Collaborative

Fiscal Year Funding (\$1000): 1975 1976 1977 1978  
45

ACOUSTIC PROPERTIES

Measurement and Methodology

Environmental Noise Measurements

Technical assistance was provided to EPA to support the development of regulations for specific noise sources. Specifically NBS has provided:

Measurement methodology for portable air compressor noise and procedures for estimating sound power from measurements of sound pressure.

ENVIRONMENTAL PROTECTION AGENCY (Continued)

- . Docket analysis for the new truck regulation.
- . Evaluation of existing data bases and measurement procedures for six major noise sources: tires, buses, motorcycles, dozers and loaders, truck refrigeration units, and compactors.
- . Measurements of the impulsive noise emission of garbage compactors, motorcycles, pavement breakers, and rock drills.
- . Identification of difficulties or ambiguities in measurement by using different methodologies.
- . Evaluation of alternative measurement techniques for characterization of asphalt surface acoustic properties.
- . Development of procedures for measurement of noise impact from household and consumer products.

Sponsor: EPA/Office of Noise Abatement and Control  
Investigator: National Bureau of Standards

Fiscal Year Funding* (\$1000):	1975	1976	1977	1978
	50	65	40	40

\* The Environmental Noise Measurements project contributes to both the surface transportation and the machinery and construction areas. The project is identified both in this report and in the surface transportation noise report with proportionate funding. Total FY 75 through FY 78 funding levels are \$50K, \$120K, \$75K, and \$75K, respectively.

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