Technical Report No. 1789

ORI

Construction Noise Control Technology Initiatives

Task Report

September 1980

Prepared For:

U.S. Environmental Protection Agency
Office of Noise Abatement and Control
Technology and Federal Programs Division

TECI PAGE

1. Report No.	2. Government Accession No.	3. F

4. Title and Subtitle
Construction Noise Control Technology Initiatives

5. Report Date
September 1980

6. Performing Organization Code

7. Author(s)
C. W. Patten, Dr. W. Benson, J. Kirkland, L. Ronk, B. Rudman, R. Samis and M. Staiano

8. Performing Organization Report No.
Technical Report No. 1789

9. Performing Organization Name and Address
ORI, Inc.
1400 Spring Street
Silver Spring, MD 20910

10. Work Unit No.
Task Order T-6

11. Contract or Grant No.
68-01-6154

12. Sponsoring Agency Name and Address
Technology and Federal Programs Division
Office of Noise Abatement and Control
U.S. Environmental Protection Agency
Washington, D.C. 20560

13. Type of Report and Period Covered
Task Report
July - September 1980

14. Sponsoring Agency Code
ANR-471

15. Supplementary Notes
A portion of this report is based on a survey conducted by Innovative Systems Research, Inc. under a subcontract agreement.

16. Abstract
The objective of this report is to develop construction noise technology initiatives which could be implemented by the Technology and Federal Programs Division, Office of Noise Abatement and Control, U.S. EPA during the period FY1981-FY1985. The report includes background information on the impact of construction noise, actions that have been carried out by Federal, State and local governments to control construction equipment and construction site noise, and a forecast of construction activity for the period 1980-1985.

Construction noise technology needs are developed by: (1) analyzing the noise problems and needs of State and local governments reported in several EPA sponsored surveys; (2) interviews with knowledgeable persons in the Federal government, and (3) a telephone survey of equipment manufacturers, construction contractors and trade organizations.

Technology initiatives are identified based on the analysis of needs. Project descriptions for each initiative are included in the Appendix. The relative priority for implementing each project is determined using a priority ranking scheme.

Finding and conclusions based on the expressed needs, the technology initiatives, and the priority for implementing the technology projects are presented.

17. Key Words
Construction equipment noise control
Construction site noise control
Noise abatement
Construction noise technology initiatives

18. Distribution Statement
Document is available through the National Technical Information Service Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	217	

Form DOT F 1700.7 (8-69)

N-96-01
II-A-118

ORI
Silver Spring, Maryland 20910

CONSTRUCTION NOISE CONTROL TECHNOLOGY INITIATIVES

TASK REPORT

SEPTEMBER 1980

PREPARED UNDER
CONTRACT NO. 68-01-6154, TASK ORDER T-6

FOR THE U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF NOISE ABATEMENT AND CONTROL
TECHNOLOGICAL AND FEDERAL PROGRAMS DIVISION

PREFACE

This report has been prepared by ORI, Inc. in response to Task Order 40 (T-6), Contract No. 68-01-6154. This Task Order requires that ORI identify construction noise technology initiatives which could be implemented by the Technology and Federal Programs Division, Office of Noise Abatement and Control, during the period FY 1981-FY 1985. Under this Task Order an ORI Project Team has developed background information on construction equipment and construction site noise control; identified technology needs from surveys of state and local governments' experiences in construction noise abatement and control, and interviews with knowledgeable persons in the Federal departments and agencies concerned with noise control. In addition, a survey was conducted to determine technology needs as seen by equipment manufacturers, construction contractors, trade organizations, and consultants. This survey was carried out by Innovative Systems Research, Inc. under a subcontract agreement with ORI.

The authors wish to acknowledge the contribution and cooperation of those individuals who provided much of the information on technology needs included in this report. These individuals, too numerous to mention here, are listed in Appendix B and Appendix C.

The ORI project team that prepared this report included C. W. Patten, Project Leader, Dr. William Benson, John Kirkland, Larry Ronk, Beverly Rudman, Robert Samis, and Michael Staiano.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

PURPOSE

The purpose of this report, undertaken in response to EPA/Office of Noise Abatement and Control Task Order 40, is to develop construction noise technology initiatives which could be implemented by the Technology and Federal Programs Division, Office of Noise Abatement and Control during the period FY 1981-FY 1985.

METHODOLOGY

This report was developed in three steps. The first step was to develop background information on the impact of construction noise, what had been done to date by the Federal, State and local governments to control construction equipment and construction site noise, and to examine the forecasts of construction activity for the next five years.

The second step, which was carried out concurrently with the first, was to develop a list of construction noise technology needs from which the technology initiatives could be derived. This step was accomplished by (1) analyzing the surveys of the noise problems and needs of State and local governments; (2) interviews with knowledgeable persons in the Federal government who are or have been in the recent past involved in some aspect of construction noise abatement; and (3) a telephone survey of seven equipment manufacturers, eight construction contractors, three trade organizations and two noise control consultants who work closely with the construction industry. The views of those individuals surveyed, plus the findings of the machinery and construction workshop convened as part of the EPA/ONAC sponsored Noise Technology Research Symposium in January 1979, were consolidated and analyzed to determine the construction noise technology needs.

The third step consisted of the identification of technology initiatives to respond to the previously identified needs; preparation of detailed project descriptions for each identified initiative; and ranking each project to determine its relative priority for implementation by the Technology and Federal Programs Division.

CONCLUSIONS

The findings and major conclusions of this investigation into construction noise technology initiatives are listed below:

- Construction noise is a major source of public irritation with excessive noise (Section II)
- ONAC surveys of state and local officials show that construction noise ranks third as a noise problem at both the state and local levels (behind transportation and industrial noise) (Section V)
- Of those States which indicated they have a construction noise problem, only eight percent felt they had achieved significant noise reduction with their current programs indicating a need for information on in-use controls (Section V)
- Exposure to construction site noise is expected to increase over the next five years because of the anticipated increase in construction activity of all types (Section III)
- EPA/ONAC long-term goals indicate that EPA must take action to reduce the number of people exposed to construction site noise greater than L_{dn} 65 by 20 percent

by the year 2000. This goal can probably be achieved by the currently planned regulation of new construction equipment (Section VI)

- Extending noise emissions regulations to new medium and heavy trucks used in construction industry, such as concrete mixers would reduce noise from the most ubiquitous source of noise in construction activities of all types (Section VI)
- The "Buy Quiet" and Urban Initiatives programs offer opportunities for reducing construction site noise but require guidelines and specifications (Section VII)
- Federal funds obligated for construction noise control RD&D have decreased significantly since FY 1978 (Section VII)
- Analysis of State and local laws and ordinances indicate that many of the known construction noise control techniques are not being used (Section VIII and Appendix F)
- Equipment manufacturers indicate that they have the "know how" to reduce equipment source noise but that the equipment users are not willing to pay for the added cost and weight. (Section VIII and Appendix C)
- Much of the technology to quiet construction equipment and site noise (except impulse noise) is known but needs to be demonstrated and disseminated to State and local governments, and the construction industry. (Section VIII)
- Pile drivers have the highest estimated total sound energy of all construction equipment (Table 2.5) and are second in total population impacted (Table 2.6). EPA/ONAC should continue its efforts with CERL to demonstrate cost-effective noise reduction techniques.

- The Technology and Federal Programs Division should undertake the priority projects listed in Table S.1 as soon as available funds permit
- EPA/ONAC should develop and fund a Five-Year Construction Noise Technology Program to supplement "EPA's Quiet Communities Five-Year Plan, FY 1981-FY 1985".

TABLE S.1
PRIORITY LISTING OF TECHNOLOGY PROJECTS
(Priorities A, B and C)

Priority	Project Title	Est. Cost $(000)	Ref 1/
A-7	Coordinate and Assess Federal Construction Noise RD&D and Noise Control Programs	30	D-60
B-8	Conduct Demonstration on Pile Driver Noise Control	120	D-4
B-8	Develop and Publish Guidelines for Construction Site Noise Control	50	D-38
B-7	Demonstrate Cooling System Noise Reduction in Construction Equipment	65	D-26
B-7	Investigate Maintenance Requirements and Procedures	65	D-24
B-6	Develop and publish Engineering Noise Control Handbook(s) for Construction Industry	200	D-34
C-6	Conduct Feasibility Studies and Demonstration Using Quiet Truck Technology on Concrete Mixers and Other Construction Over-the-Road Vehicles	135	D-28
C-5	Develop Site Specific Construction Noise Impact Model	50	D-54
C-5	Demonstrate Construction Site Noise Control Techniques	50	D-40
E-2	Develop Low Annoyance Back-Up Alarms 2/	65	D-12

1/ Page Number in Appendix D.

2/ It is the opinion of the ORI project team that this project should be included in top 10 projects because of high degree of annoyance caused by these devices.

I. INTRODUCTION

THE PROBLEM OF CONSTRUCTION NOISE

On any list of noise sources to which the general public is particularly sensitive, construction activities rank near the top. In fact, construction noise sources follow immediately after surface transportation noise sources (trucks, motorcycles, etc.) as a source of public irritation with excessive noise. Congress, being aware of these feelings, specifically identified construction equipment in the Noise Control Act of 1972 as a source of noise to be brought under control.

Requirements of the Act

There are a number of specific requirements in the Act that relate to a construction noise control program:

- Section 4(c)(1) of the Act directs EPA to coordinate the programs of all Federal agencies relating to noise research and noise control
- Section 4(c)(3) directs the agency to publish from "time to time," a report on the status and progress of Federal activities relating to noise research and noise control. This section further requires that the report "describe the noise control programs of each Federal agency and assess the contribution of those programs to the Federal Government's overall efforts to control noise."

- Sections 6(a) and (c) directs the Agency to publish regulations for allowable noise emission levels for construction equipment if such standards are necessary to protect the public health and welfare and a desired feasible.
- Section 14(a) directs the Agency to disseminate information on noise effects and noise control methods to promote the development of effective State and local noise control programs.
- Section 14(b) directs the Agency to conduct research, development, on demonstration on noise effects, measurements, or control. In particular, such activities shall be directed toward products that are candidates for regulation, toward investigating the economic impact of noise on property and human activity, and investigation of the use of economic incentives to control noise.
- Section 15 authorizes the agency to certify a set of "Low-Noise-Emission Products". These products shall be acquired for use by the Federal government in lieu of other products.

Past and Current Activities in Construction Noise

Under the mandated requirements of the Act, as paraphrased above, EPA/ONAC has undertaken some activities in construction noise control. For example, acting under the requirements of Section 4(c), in 1978 EPA published a report, "Federal Research, Development and Demonstration Programs in Machinery and Construction Noise." This report was prepared by a Federal Interagency Machinery and Construction Noise Research Panel. This panel summarized the RD&D on machinery and construction noise from the period FY1975 through FY1978 and prepared an 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. Recently, the Technology and Federal Programs Division of ONAC prepared a report, "Federal Noise Control Technology - Research, Development, and Demonstration Projects on Industrial Manufacturing, Mining and Construction Equipment During the Fiscal Year 1980." This report consists of descriptions of projects of Federal agencies and did not attempt to access the contributions of these programs to the Federal government's overall effort to control noise.

Under the requirements of Section 6, EPA/ONAC has identified several products adjudged to be a major source of noise and has undertaken studies into technology, costs and alternative methods of noise control for these products. As a result, EPA has promulgated regulations for new portable air compressors and heavy and medium trucks.* Regulations have been proposed on wheel and tracked loaders and bull dozers.

A program of State and local assistance has been undertaken under Section 14(a), and a "Buy Quiet" program initiated to satisfy the requirement of Section 15. The requirements of Section 14(b) are being met by RD&D conducted by several Federal agencies in addition to EPA.

Objective and Scope of this Report

In order to approach the control of construction noise in a more systematic fashion, EPA/ONAC now wishes to plan its activities in this field for the next five years. The first step in developing such a plan is to list a set of construction noise technology initiatives that could be implemented by EPA/ONAC in cooperation with other Federal agencies during the period FY 1981-85. Since resources are limited, the list of possible initiatives must be analyzed to determine their priority based on such criteria as effectiveness, cost, and time. Finally, a set of high priority initiatives can be used to develop a five year plan of construction noise activities.

The objective of this report is to develop the set of required technology initiatives and to assign priorities to them. The initiatives are directed toward both occupational and environmental concerns. However, a five year plan in this area is not given in this report. Therefore, this report covers the development of background information on construction equipment and site noise control; the development of evaluation criteria and

*Although the greatest use of trucks is in surface transportation, they are also an important source of noise associated with construction activity.

the identification, description, and prioritization of construction noise technology initiatives.

Summary of the Report

Sections II and III that follow define the principal types of construction noise problems and, based on economic trends, show the expected trend in the magnitude of these problems in the future. Sections IV thru VII are devoted to background information. Included are Federal, foreign, State, and local noise regulations and the types of programs conducted by these governments. Thus, Sections II through VII provide the information that is necessary for developing the technology needs that are presented in Sections VIII and IX. Section X is devoted to deriving specific technology initiatives and to assigning priorities to them.

Appendices are devoted to:

- Sketches of construction equipment
- A list of contacts in government agencies from whom further information was obtained on construction noise technology research needs
- A survey of a set of typical contractors and users
- Descriptions of proposed construction noise control research projects.

II. CONSTRUCTION NOISE

CONSTRUCTION NOISE PROBLEM

Congress, through the Noise Control Act of 1972 (Section 6(a)(1)(c)) specifically identified construction equipment noise as one of the major items degrading the country's environment.

Within the continental limits of the United States there are typically more than 2.4 million active construction sites including residential, mixed residential/commercial, industrial, and public works projects. EPA estimates on the basis of national surveys of construction site types, site locations, and the average population densities around cities that more than 100 million people are exposed on any one day to construction noise. More than 37 million of these people are exposed to noise levels greater than L_{dn} 55 dB on an annual basis, the level EPA has identified as adequate to protect the public health and welfare. Table 2.1 lists the number of construction projects as of September 1978 on a site type basis, the attendant estimated population exposed on any one day and on an annual basis.

According to a survey of 15 industrial insurance companies, hearing loss is the largest single compensable health problem today. The survey estimated that out of 14.7 million workers exposed to $L_{eq}(8)$ 75 dB and above, a level high enough in commulative doses to result in damage to hearing, over 4 million work at construction sites.

TABLE 2.1

CONSTRUCTION SITE NOISE IMPACT

SITE TYPE	NUMBER OF SITES	POPULATION EXPOSED TO LEVELS ABOVE Ldn 55 dB FROM CONSTRUCTION ACTIVITIES	
		On any one Day	Annually
Residential	1,159,100	35,730,000	N/A
Mixed Residential/Office	108,764	7,280,000	N/A
Industrial/Commercial	148,135	9,820,000	N/A
Public Works	1,013,582	48,330,000	N/A
TOTAL	2,429,581	101,160,000	37,000,000

N/A - Not Available.

Source: EPA's Quiet Communities Five-Year Plan, FY 1981 - FY 1985 - Draft, February 1980

The construction site noise problem is comprised of over 20 different categories of contributing noise sources. To further complicate the problem, construction site noise is dependent upon an equipment mix which, in turn is generally dictated by the type (Table 2.1) and stage of (clearing, excavation, etc.) of construction activity. Moreover, as will be indicated in the next section, there is evidence that construction activity will continue to grow in terms of the number of sites and that the population density near construction sites will also increase. Furthermore there is a continuing transition from small size equipment to larger, more powerful units in an effort to increase productivity and decrease overall construction costs. These trends bring with them, high noise levels and increases in the severity and extensiveness of construction site noise impacts.

The remainder of this section provides a brief description of the construction site activities, noise levels of typical construction equipment and the health and welfare impact of construction activity.

CONSTRUCTION SITE ACTIVITY

Construction sites may be categorized into the following major types:

- Domestic housing
- Non residential housing including office and public buildings, hospitals, schools
- Industrial - including industrial buildings, religious and recreational centers, stores, service and repair facilities
- Public works - including roads, streets, water mains, sewers.

The type of activity at any given site varies considerably as construction progresses. Since the noise produced at the site depends on the equipment being used, it exhibits a great deal of variability. For the purposes of characterizing noise, one may consider construction at a given site in terms of the following five consecutive phases:

- Ground clearing including demolition, rough ground clearing, utility installation

- Excavation
- Placing foundation
- Execution - including framing, placing of walls, floors, windows, pipe installation
- Finishing - including filling, paving, landscaping and cleanup.

Construction Site Noise

To totally describe construction site noise, the five described phases of four different types of sites must be considered. The energy equivalent noise levels (L_{eq}) for each construction phase at each site is shown in Table 2.2. For each phase/construction type element, a range of levels is given, reflecting different mixes of construction equipment that might be used for the same kind of process. The range encompasses maximum (I) and minimum (II) concentrations of equipment. The table shows that the initial ground clearing and excavation phases generally are the noisest, that intermediate foundation placement and execution phases are some what quieter, and that the final finishing phase tends to produce considerable noise annoyance.

CONSTRUCTION EQUIPMENT NOISE

Although there is a great variety in types and sizes of available construction equipment, similarities in the dominant noise sources and operational characteristics of commonly used equipment items permit noise characterization of all equipment in terms of only a few categories as will be discussed below. Drawings of some of the major equipment types are included in Appendix A.

Equipment Powered by Internal Combustion Engines

Engine-powered equipment may be characterized according to its mobility and operating characteristics as:

- Earth moving, including excavating machinery (e.g., bulldozers, shovels) and highway building equipment (e.g. scrapers, graders, compactors)

TABLE 2.2

TYPICAL RANGES OF ENERGY EQUIVALENT NOISE LEVELS, L_{eq} IN dBA, AT CONSTRUCTION SITES

Construction Phase	Domestic Housing		Office Building, Hotel, Hospital School, Public Works		Industrial Parking Garage, Religious Amusement & Recreations, Store, Service Station		Public Works Roads & Highways, Sewers, and Trenches	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Ground Clearing	83	83	84	84	84	83	84	84
Excavation	88	75	80	79	89	71	88	78
Foundations	81	81	78	78	77	77	88	88
Erection	81	65	87	75	84	72	79	78
Finishing	88	72	89	75	89	74	84	84

Max. - All pertinent equipment present at site.

Min. - Minimum required equipment present at site.

Source: Report to the President and Congress on Noise, Senate Document No. 92-63, February 1972.

- Materials handling equipment, such as cranes and mixers.
- Stationary equipment, such as generators, compressors and batching plants.

Earthmoving equipment employs internal combustion engines (primarily diesel) rated from 50 hp to above 600 hp; both for propulsion and power for working mechanisms. Materials handling equipment, for which locomotion does not constitute a part of the major work cycle, employs internal combustion engines for powering working parts. In stationary equipment, engines are used for the desired power generation.

Noise levels observed 7 meters (50 feet) from the construction equipment are shown in Figure 2.1 by equipment type. The specific equipment included in each equipment type is listed in Table 2.3. The number of each equipment type measured is shown in parenthesis. The range of these measurements and the arithematic mean sound level is shown in Figure 2.1. These sound level data were derived from a survey of the literature.*

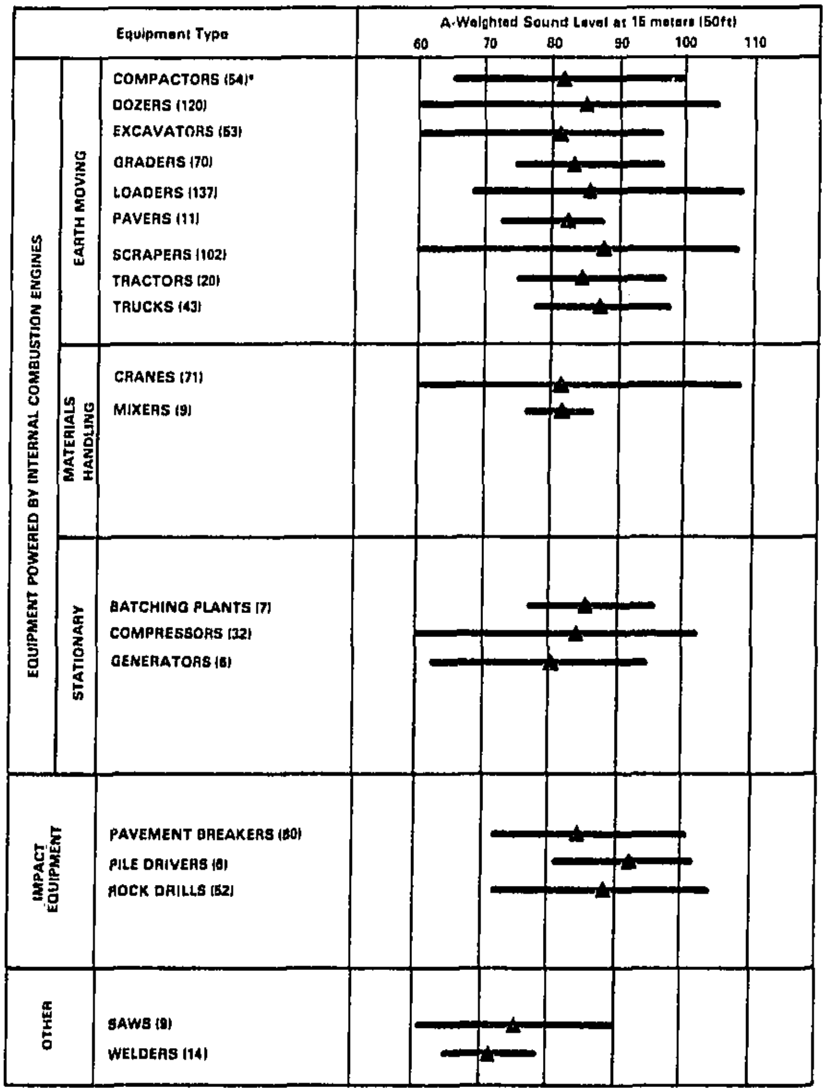
Noise Sources. In virtually all engine-powered equipment, the engine constitutes the primary noise source. Usually, exhaust noise predominates, but intake noise also tends to be significant. Noise from fans used for cooling the engine and hydraulic system often constitutes an important component, with noise from mechanical or hydraulic power transmission or actuation systems generally of secondary importance. In earthmoving equipment, the crawler tracks often contribute noticeable noise, and in both earth moving and materials handling equipment, the working process - interaction of the machine and the material on which it acts - often contributes much noise.

Impact Equipment and Tools

Pile drivers and penumatic tools accomplish their functions by causing a "hammer" to strike against a work piece. The resulting impact constitutes one of the major noise sources associated with such equipment. Representatives noise levels are given in Figure 2.1.

---

*Fuller, W. R., et al., Summary Report: Task A Literature Review: Highway Construction Noise, Wyle Research Report, WR 79-3, Contract No. DOT-FH-11-9455, June 15, 1979.



▲ Mean Noise Level

*Numbers in parenthesis are numbers of each equipment type measured

Figure 2.1. Ranges and Means of A-Weighted Sound Levels of Construction Equipment Operating or Stationary at 15m (50 ft.)

TABLE 2.3

EQUIPMENT TYPE CATEGORIZATION

Equipment Category	Equipment Types
Batching Plant	Asphalt and Concrete Plants
Compactors	Rollers (Sheepsfoot, Steel Drum, Steel Wheel, Pneumatic Tired, Vibrating)
Compressors	Stationary and Portable Compressors, Air Compressors
Cranes	All Types (Derrick, Mobile, etc.)
Dozers	Bulldozer, Crawler Dozer, Crawler Tractor, Track Type Tractor, Pusher, Ripper, Ripper Scarifier
Excavators	Backhoe, Clamshell, Shovel, Front Shovel, Dragline, Trenchers
Generators	All Types
Graders	Motor Grader, Gradall
Loaders	Wheel Loader, Track Type Loader, Front End Loader, Skid Steer Loader
Mixers	Portable, Truck Mounted, Stationary
Pavement Breakers	Portable and Mounted, Chipping Hammer, Jackhammer
Pavers	Concrete Paver, Bituminous Paver
Pile Drivers	All Types
Rock Drills	Portable and Mounted
Saws	Chain Saw
Scrapers	Wheel Tractor Scraper, Hauler, Elevating Scraper
Tractors	Wheel Tractor, Utility Tractor
Trucks	Rear Dump
Welders	All Types

Other Equipment and Tools

The high-pitched wine of power saws (Figure 2.1) is a significant factor in several construction phases; e.g., woodcutting occurs in the construction of concrete forms, in assembly of frames, and in finishing operations. Welders of all types are probably the least noisy of the equipment measured.

Contribution of Individual Equipment to Construction Noise

Estimates made by EPA of the sound energy contribution to construction noise by individual items of construction equipment are presecuted in Table 2.4. Changes in usage factors assigned to the various construction equipment since these data first appeared in 1970, have resulted in computed values of sound energy cummulative which changes the relative positions of different items of equipment. Table 2.5 presents data prepared by Danes and Moore using updated usage factors and equipment sound level data. This table indicates that the pile drivers are the largest single contributor to construction site noise with the dump trucks and concrete mixers ranking second and third respectively.

CONSTRUCTION NOISE IMPACTS

Efforts to assess the impact of construction site noise have stemmed from the need to assess the health and welfare impacts associated with specific construction equipment noise regulations. To provide a quantitative assessment of the noise impact, EPA developed a construction site noise model to compute on a national average, the number of people exposed to levels higher than the thresholds required to protection of public health and welfare.* This section summarizes the primary conclusions derived regarding the impact of construction noise as shown by the model. Note that attention here is directed towards construction noise as it impacts sourrounding communities and not equipment operator exposure.

Construction Site Noise Impact Model

The EPA construction site noise impact model provides a means for estimating the exposure of "stationary" populations, as well as drivers and pedestrians, to construction site noise as a function of the construction

*Bolt, Beranek and Newman, Inc., Noise from Construction Equipment and Operations, Building Equipment, and House Appliances, Report No. NTID 300.1, prepared for U.S. Environment Protection Agency, December 1971.

TABLE 2.4

CONTRIBUTION TO CONSTRUCTION SITE NOISE BY INDIVIDUAL PIECES OF CONSTRUCTION EQUIPMENT

Construction Equipment	Percent Contribution* to Construction Site Noise			
	Residential	Public Works	Industrial	Non-residential
Backhoe	5.6	2.2	7.1	3.5
Dozer	10.0	6.8	8.9	4.8
Grader	2.0	1.9	0.3	0.2
Loader	6.3	3.0	4.4	2.5
Paver	2.5	10.8	1.7	0.8
Roller	0.5	1.7	0.2	-
Scraper	3.1	4.8	1.7	1.5
Shovel	2.2	1.0	2.5	1.2
Truck	6.3	21.5	11.3	7.7
Concrete mixer	28.1	10.0	8.9	6.1
Concrete pump	**	-	2.1	2.2
Crane, derrick	-	1.9	1.6	3.1
Crane, mobile	5.6	0.7	1.0	1.9
Air compressor	4.6	6.1	10.0	16.9
Generator	1.8	2.5	1.1	2.5
Pump	1.3	2.7	-	3.5
Paving hammer	0.8	8.5	5.1	2.5
Pile driver	-	-	20.6	24.6
Pneumatic tool	11.3	1.4	6.3	3.1
Rock drill	2.2	13.8	5.1	4.8
Concrete vibrator	4.4	-	0.6	0.4
Saw	-	0.2	0.9	3.1

* On an energy basis.

** - indicates the equipment is not primarily used at the type of site cited or the percent contribution is less than 0.1 percent.

Source: The National Environmental Policy Act of 1969 Public Law 91-190, 91st Congress, January 1, 1970.

TABLE 2.5

TYPICAL CONSTRUCTION SITE EQUIPMENT SOUND LEVELS (in dBA) AND ASSOCIATED SOUND ENERGY (in kw - hrs/day) (RECOMPUTED JUNE 1976)

Construction Equipment	Typical Sound Level at 50 feet	Estimated Total Sound Energy
1) Pile Driver	101	211.6
2) Truck	88	188.8
3) Concrete Mixer	85	109.1
4) Air Compressor	81	88.3
5) Dozer	87	78.7
6) Paver	89	69.6
7) Scraper	88	40.0
8) Backhoe	85	39.9
9) Loader	84	39.4
10) Pneumatic Tool	85	38.0
11) Pump	76	33.2
12) Portable Paving Breaker	85	33.2
13) Generator	78	21.9
14) Crane, Derrick	88	18.6
15) Shovel	82	15.9
16) Crane, Mobile	83	14.9
17) Saw	78	14.3
18) Grader	85	14.3
19) Roller	80	10.9
20) Mounted Rock Drill	96	8.8
21) Concrete Pump	82	7.6
22) Mounted Paving Breaker	87	5.8
23) Concrete Vibrator	76	1.9
24) Portable Rock Drill	86	1.6

Source: Dames and More, Technology Analysis - Noise Paving Breakers and Rock Drills, June 30, 1976.

type and phase. Here, stationary population means observers in nearby residences or buildings.

The number of people exposed to various levels of noise from construction sites is calculated by the model combining information on population density and construction activity levels, with a sound propagation model. Noise exposures estimates on a national basis are calculated for stationary populations as well as for drivers and pedestrians. These estimates are presented in terms of average A-weighted sound level, L_A.

Table 2.6 lists the equipment in The Construction Site Noise Impact Assessment Model and the level-weighted population associated with each type. Note that six types of equipment account for more than half the level-weighted population.

The construction noise impact calculations of the model may be summarized as follows:

- Speech interference is the single most obvious effect. In all phases of construction, the potential exists for degradation of speech communication. It is estimated that about 34 million people suffer a total of several hundred hours of speech interference annually due to construction noise.
- For the most part, construction noise does not interfere with sleep at night. However, construction noise does impact approximately 5.5 million people who sleep during daytime hours
- The risk of hearing damage for those not directly concerned with construction activity appears to be minimal
- Annoyance is a major consequence of exposure to construction noise for many people. However, annoyance from construction noise is probably less of a problem than annoyance produced by aircraft or traffic noise (verified by Large and Ludlow in 1976)*.

---

*Large, J. B. and Ludlow, J.E., "Community Reaction to Noise from a Construction Site", Noise Control Engineering, 59-65, March-April 1978.

TABLE 2.6

TYPES OF EQUIPMENT USED IN CONSTRUCTION SITE NOISE IMPACT ASSESSMENT MODEL AND THE LEVEL-WEIGHTED POPULATION (LWP) ASSOCIATED WITH EACH TYPE*

Equipment Type	% of Total LWP
W&C Tractors	16.15
Pile Drivers	10.95
Trucks	8.16
Paving Breakers	6.40
Forklift Trucks	6.11
Graders	5.03
**	
Excavators	4.89
Pavers	4.71
Integral Backhoe/Loaders	3.91
Rollers	3.90
Pneumatic Tools	3.87
Concrete Mixers	3.82
Saws	3.45
Pumps	3.28
Rock Drills	3.18
Cranes, Mobile	2.57
Air Compressors	1.95
Manually-Guided Compactors	1.94
Generators	1.76
Concrete Pumps	1.57
Scrapers	0.64
Cranes, Derrick	0.60
Concrete Vibrators	0.47
Trenchers	0.43
Skid Steer Loaders	0.27

*Documentation of the Construction Site Noise Impact (Health and Welfare) Assessment Model. Larry A. Ronk and Daniel F. Lam, Science Applications, Inc., EPA Contract No. 68-01-4608, January 1980.

**The equipment listed above this line accounts for more than half of the total LWP.

III. TRENDS IN CONSTRUCTION 1975-1985

BACKGROUND AND SCOPE

Construction activity is a prime contributor to the problems of a noisy environment. It is important to know the types of construction which expose the population to the highest noise levels in order for regulation to be effective. It is also important to note the amount of activity in different types of construction (i.e., residential, highway, commercial). Only with this information will it be possible to determine the most effective course to prevent high population exposure to noise.

Therefore, this chapter will examine the actual trends in construction activity which took place from 1975 to 1979. It will also present projections of construction activity for the period 1980-1985.

Construction Activity, 1975-1979

The second half of the seventies was a period of growth in the value of construction put in place. Although a slight downturn occurred in 1979 (3% in constant dollars), the value of a year's construction increased 17% between 1975 and 1979. The industry's record for the years 1975 to 1979 is shown in Table 3.1.

TABLE 3.1

U.S. CONSTRUCTION
1975-1979

(Constant millions of (1972) dollars)

TYPE OF CONSTRUCTION	1975	1976	1977	1978	1979
Private Construction					
Residential Buildings	35,256	42,669	50,649	51,477	47,611
New housing units	26,096	33,312	41,099	41,759	37,645
Additions & Alterations	8,293	8,696	8,922	9,019	8,911
Non-housekeeping	866	611	628	699	1,055
Non-Residential Buildings	19,073	18,789	19,430	21,869	23,846
Industrial	5,791	5,174	5,222	6,606	7,493
Office	3,591	3,430	3,571	3,962	4,763
Other Commercial	5,658	5,756	6,436	7,228	7,776
Religious	627	688	708	751	794
Educational	409	475	447	440	415
Hospital and Institutional	2,318	2,445	2,232	2,029	1,822
Miscellaneous	678	821	814	852	783
Farm (Non-residential)	1,679	2,838	3,096	3,170	na
Public Utilities	11,888	13,064	12,437	13,948	na
Telephone	2,795	2,650	2,910	3,450	3,740
Electric light and power	6,635	7,474	7,386	8,355	na
Gas	870	784	936	1,265	na
Railroad	352	388	483	578	na
Petroleum pipeline	1,236	1,768	722	300	na
All other private	733	722	825	725	626
TOTAL PRIVATE CONSTRUCTION	68,628	78,082	86,438	91,189	89,634

na = Not available.

TABLE 3.1 (Continued)

TYPE OF CONSTRUCTION	1975	1976	1977	1978	1979
Public Construction					
Buildings	11,207	9,904	8,630	9,151	8,143
Housing and Redevelopment	572	509	571	578	586
Industrial	663	652	725	718	734
Educational	5,607	4,571	3,699	3,779	3,524
Hospital	1,261	1,347	1,177	1,106	859
Other public buildings	3,104	2,826	2,458	2,970	2,441
Highways and Streets	7,269	6,595	6,035	5,685	5,152
Military Facilities	992	1,145	948	862	803
Conservation and Development	2,286	2,485	2,415	2,589	2,508
Other public construction	6,847	6,784	6,711	7,883	7,593
Sewer systems	3,369	3,550	3,359	3,849	3,703
Water supply facilities	1,187	1,040	1,109	1,508	1,232
Miscellaneous*	2,292	2,194	2,243	2,526	2,659
TOTAL PUBLIC CONSTRUCTION	28,601	26,913	24,740	26,169	24,200
TOTAL NEW CONSTRUCTION	97,229	104,995	111,178	117,358	113,834

Source: Construction Review, U.S. Department of Commerce/Bureau of Industrial Economics, June 1980.

*Includes electric power facilities, recreation areas, airports, and mass transit systems.

Private residential construction accounted for more than 50% of all private construction each year. Industrial and commercial construction declined from 22% of total private construction in 1975 to 17% in 1979.

Public construction was down in constant dollars during the period, moving against the overall trend. "Highway and street" construction remained the largest single contributor to the public sector totals.

CONSTRUCTION FORECAST, 1980-1985

Several trends of the 1975-79 era are likely to change during the next five years. Overall, the construction slump of 1979 will probably last through 1980--led by the current decline in housing starts.

However, experts agree that the decade ahead will bring increases across the board in construction activity. Construction Equipment magazine (February 1980 issue) predicts $4.6 trillion (in current dollars) of construction activity in the next 10 years. Based on their predicted growth rates, the following table (Table 3.2) has been developed to indicate the 1985 position of the industry. The projections have been converted to constant 1972 dollars in order to delete the effects of inflation.

An analysis of the forecast growth indicates that residential building will continue its dominance of the private construction sector. Industrial and commercial construction will rise to 25% of private construction. The highway and streets category and sewer system and water supply facilities remain important.

While Construction Equipment magazine forecasts a tremendous boom in construction, the 1980 U.S. Industrial Outlook predicts a more moderate real growth rate of only 2% each year. Using 2% per year growth as a lower limit on construction activity through 1985, and with the 5.5% per year real growth rate shown in Table 2 as an upper limit, we can assume that actual construction activity will fall between these extremes. The difference between these forecasts is presented graphically in Figure 3.1. The growth shown is real growth--the effects of inflation have been factored out.

TABLE 3.2

U.S. CONSTRUCTION
1980 and 1985

(In millions of constant (1972) dollars)*

TYPE OF CONSTRUCTION	1980	1985
Private Construction		
Residential Buildings	40,867	53,491
New housing units	30,822	38,964
Additions and alterations	9,132	13,356
Non-housekeeping	913	1,171
Non-Residential Buildings	22,785	29,009
Industrial	7,991	10,247
Office	4,383	6,147
Other commercial	6,849	7,562
Religious	708	1,135
Educational	434	712
Hospital and Institutional	1,758	2,353
Miscellaneous	662	853
Farm (Non-residential)	2,854	2,351
Public Utilities	12,991	15,664
Telephone	2,922	3,387
Electric light and power	7,466	9,084
Gas	1,553	1,792
Railroad	662	924
Petroleum pipelines	388	477
All other private	639	688
TOTAL PRIVATE CONSTRUCTION	80,136	101,203

*1980 forecast deflated using Department of Commerce composite index of 219 for 12 months ending June 1980.

TABLE 3.2 (Continued)

TYPE OF CONSTRUCTION	1980	1985
Public Construction		
Buildings	7,033	10,668
Housing and redevelopment	594	692
Industrial	639	2,649
Educational	3,037	3,821
Hospital	868	1,041
Other public buildings	1,895	2,465
Highways and Streets	5,023	6,882
Military Facilities	845	1,348
Conservation and Development	2,215	3,049
Other public construction	6,576	9,684
Sewer systems	3,105	4,437
Water supply facilities	1,005	1,470
Miscellaneous*	2,466	3,777
TOTAL PUBLIC CONSTRUCTION	21,692	31,631
TOTAL NEW CONSTRUCTION	101,828	132,834

Source: Construction Equipment Magazine, February 1980 and ORI interpolation.

*Includes electric power facilities, recreation areas, airports, and mass transit systems.

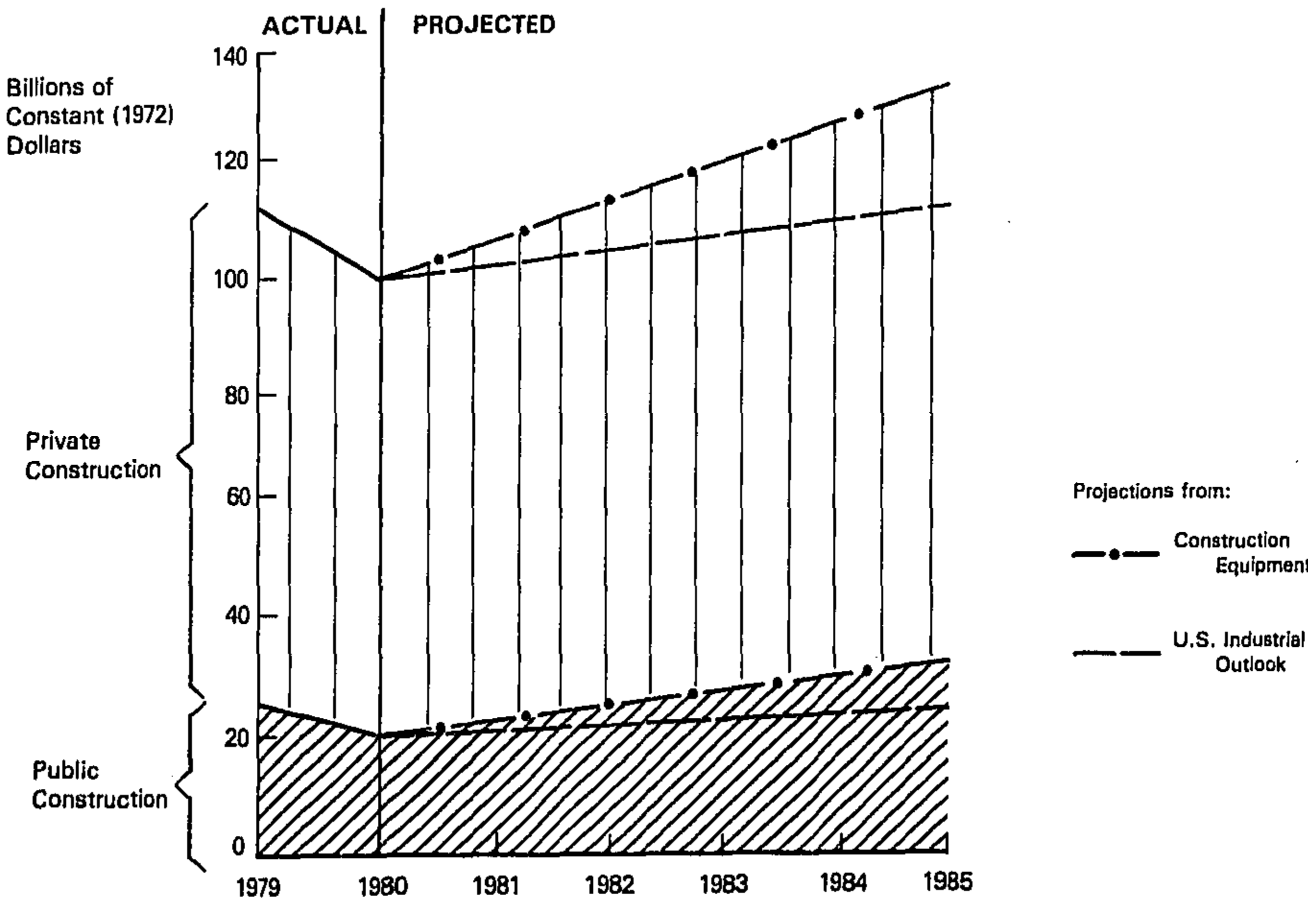


FIGURE 3.1. PROJECTED SPENDING FOR CONSTRUCTION 1979-1985

CONSTRUCTION SITES

Previous attempts have been made to quantify the number of construction sites in the United States for a given year. Table 3.3 presents the annual construction activity for 1970. However, this information includes only metropolitan areas. The average annual number of buildings constructed from 1972-1976 appeared in the 1977 SAI report, Characterization of Construction Site Activity. Table 3.4 presents their findings for both inside and outside SMSAs.

While all the figures in Tables 3.3 and 3.4 are not directly comparable, a dramatic increase in sites is clear for residential and non-residential building within metropolitan statistical areas. Information published in the June 1980 Construction Review indicates that total building sites increased again in 1978, but decreased in 1979 as construction activity decreased.

The trend in the number of construction sites appears to follow the trend in construction value put in place. If so, then the outlook for the next five years is for an increasing number of sites, both inside and outside the SMSAs.

Construction Machinery Industry

Construction machinery product shipments had a period of slow growth in the late seventies. The real rate of growth from 1978-1979 was 1.9 percent; while a 2.3 percent downturn is predicted for the 1979-1980 period. However, according to the 1980 U.S. Industrial Outlook, a 2.8 percent compound real rate of growth per year is forecast for 1979-1984.

An important impetus for growth in construction equipment sales will be energy-related projects. Transportation and production of oil and gas require large commitments for equipment. The introduction of a synthetic fuels industry, new coal mining projects coming on-line, and refinery construction will all contribute to the steady growth of the industry.

Standard and Poor's Industry Survey confirms an expectation of increased business due to energy-related projects. Water and sewer projects are also singled out as important for the industry.

TABLE 3.3

ANNUAL CONSTRUCTION ACTIVITY - 1970*

	METROPOLITAN REGIONS					
	LARGE HIGH-DENSITY CENTRAL CITIES	LARGE LOW-DENSITY CENTRAL CITIES	OTHER CENTRAL CITIES	URBAN FRINGE	MET. AREA OUTSIDE URBAN FRINGE	TOTAL
Residential Buildings (No. of sites)	8,708	21,578	102,559	262,800	118,779	514,424
Nonresidential Buildings (No. of sites)	1,952	4,903	12,021	30,915	13,758	62,549
Municipal Streets (Miles)	273	2,150	6,000	11,800	21,700	41,923
Public Works (Miles)	398	3,140	8,700	16,865	31,550	60,653

Source: EPA Report, Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances (1971).

*All figures x 10^3.

TABLE 3.4

FINAL CLASSIFICATION OF AVERAGE ANNUAL NUMBER OF BUILDINGS CONSTRUCTED (1972-1976)

SITE TYPE	STANDARD METROPOLITAN STATISTICAL AREAS (SMSAs)		
	Inside	Outside	Total
<u>Residential</u>			
Single Family	684,054	401,746	1,085,800
Buildings with 2-4 units	32,238	7,562	39,800
Buildings with 5 or more units	27,135	6,365	33,500
Total	743,427	415,673	1,159,100
<u>Non-Residential</u>			
Education	17,199	8,094	25,293
Hospitals	2,521	1,186	3,707
Other Buildings	50,695	23,856	74,551
Religious	3,545	1,668	5,213
Total	73,960	34,804	108,764
<u>Industrial/Commercial</u>			
Industry	18,753	8,825	27,578
Stores and other mercantile buildings	25,894	12,186	38,080
Service stations and repair garages	3,735	1,758	5,493
Amusement	3,665	1,725	5,390
Other non-residential	48,684	22,910	71,594
Total	100,731	47,404	148,135
<u>Public Works</u>[1]			
Highway, road and street sites	42,770	115,638	158,408
Road maintenance sites	40,624	119,016	159,640
Water	141,847	74,713	216,560
Sewer	169,074	89,054	258,128
Gas	60,260	31,740	92,000
Electric, above ground[2]	8,121	4,277	12,398
below ground	76,273	40,175	116,448
Total	538,969	474,613	1,013,582

[1] Site size is assumed as 1/8-mile except where otherwise designated.

[2] Site size is assumed as 1 mile.

Source: SAI Report, <u>Characterization of Construction Site Activity</u>, 1977.

EMPLOYMENT PROJECTIONS

Contract Construction Workers

The number of construction workers employed has increased each year from 1975 through 1979 from 2.8 million to 3.7 million. The total number of workers in April 1980 is only slightly less than in April 1979 despite the current slowdown in activity.

The steady increase in construction spending projected for the next few years almost certainly will bring a corresponding increase in construction employment. Only the assumption of increasing capital to labor ratios, or increasing productivity of construction workers would invalidate the projection of higher levels of employment in this industry.

Construction Machinery Production

Employment in this industry fell between 1974 and 1976 from 157,500 to 144,800. But from 1976 to 1979, the work force has grown to 165,200. Again, unless there is a great increase in productivity, the results of more new construction will be more workers in construction machinery production. The average rate of increase in employment each year from 1976 to 1979 was 4.5%. The trend of increased employment will most likely continue, although it may be at a slower rate.

CONSTRUCTION GROWTH AREAS

Construction Equipment magazine and the 1980 U.S. Industrial Outlook projections were in agreement on the sectors which they chose as being most important for the next five years: residential construction, energy, and urban development.

Residential Construction

Historically one of the largest sectors of construction activity, residential construction will continue to be important. Although currently in recession, new housing demand will rise from approximately 1.4 million units in 1980 to an average 1.9 million units per year for the 5 year period. The largest growth will take place in Florida, Nevada, Arizona, Texas, and California if present trends continue. These are also among the fastest growing states in terms of population.

Energy

The construction industry is expected to be a major beneficiary of the need for energy development to replace U.S. dependence on imported oil. Coal mines, nuclear power plants, and synfuel plants will require billions of dollars of work to bring them on-line. Plans for pipelines and hydroelectric power will also require heavy commitment to construction.

Urban Development

The 1980 U.S. Industrial Outlook notes the increasing emphasis on rebuilding central city areas, while a slowdown in the flight from the cities is occurring. One focus of this construction, particularly in the east, will be refurbishing the urban infrastructure. Water systems, sewers, roads, and buildings will need reconstruction and renovation. New systems will have to meet expanding needs. Public transit construction is slated to increase. Rail rapid transit systems will be spending billions on construction.

Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dallas, Dayton, Denver, Miami, New York City, Philadelphia, Pittsburgh, Portland, Rochester, San Diego, San Jose, and Washington, D.C. are all currently building or planning to build or expand their rapid transit systems. Construction of these systems will use all types of construction machinery, from earth movers and tunneling machines to cranes, pile drivers and pavers.

According to the Bureau of Economic Analysis, the next decade will bring an increase in the proportion of the population living in metropolitan areas. Most major metropolitan areas will grow during the decade. The sun belt cities are expected to show the greatest increases. This analysis of published projections indicates that construction activity will be greatest in the South, with the Northwest and North Central states following closely behind. The mountain and Pacific states will be heavily involved in energy related activities.

SUMMARY

The coming five years will see an increase in construction activity, both inside and outside major metropolitan areas. More construction workers will be on the job. More work will take place in urban settings. The number of sites will increase. The potential for increased population noise exposures seems great.

IV. FEDERAL AND FOREIGN GOVERNMENT REGULATION OF CONSTRUCTION NOISE

EPA REGULATION OF CONSTRUCTION EQUIPMENT

This chapter will consider the current status of U.S. and foreign regulation that apply to construction noise. The process of regulation is very complicated, and niceties of the process will not be treated here. The following comments on the regulatory status of equipment that has not yet achieved the status of a final regulation should be considered an over-simplification.

Identification of Major Sources of Noise

Under Section 5 of the Noise Control Act of 1972, EPA is required to publish reports identifying major sources of noise, to provide information on controlling noise from these sources, and to regulate these sources. The Agency has issued several separate identification documents. The first identification, published June 21, 1974, included portable air compressors and medium and heavy duty trucks* for which final regulations have been promulgated.

*Although the greatest use of trucks is in surface transportation, they are also an important source of noise associated with construction activity.

The agency has subsequently identified the following construction equipment:

- Wheel and crawler tractors
- Pavement breakers and rock drill.

These types of equipment are currently in the regulatory process, and other types of earthmoving equipment are currently under study (see p. 4-3).

Noise Emission Standards

The EPA is required under Section 6 of the Act, to promulgate noise emission regulations for any product identified as a major source if standards are feasible. The agency was specifically directed by the Act to consider construction equipment among other categories of products distributed in commerce. In addition to health and welfare effects, these standards must take availability of technology and cost of compliance into account.

Final Regulations Issued. On January 14, 1976, the agency published final regulations on newly manufactured portable air compressors. Portable air compressors, though not the noisest piece of equipment found on a construction site, have one of the largest product populations in construction. Also, portable air compressors are used in almost every type and during every stage of construction. As its the first construction noise regulatory action, the standard promulgated limits the noise emissions of portable air compressors manufactured after January 1, 1978 to 76 dB at 7 meters (approximately 23 feet).

The Federal noise emission standard affecting new medium and heavy duty trucks stipulates that all trucks manufactured after January 1, 1978, having a gross vehicle weight rating in excess of 10,000 pounds must exhibit noise levels below 83 dBA (measured at 50 feet) when operated under low speed, full throttle acceleration conditions.

Proposed Regulations. Wheel and crawler tractors, better known as "front-end loaders" and "bulldozers", were identified by EPA as major noise sources in May 1975. On July 11, 1977, EPA proposed noise emission regulations for new wheel and crawler tractors having noise power ratings from 20 hp to 500 hp (42 FR 3580-4). The Agency anticipates that the final rule will be promulgated in 1982.

Planned Regulations. Pavement breakers (including "jack hammers") and rock drills are generally integral to the use of portable air compressors. The latter being the primary source of motive power for pneumatic tools. However, the paving breaker and rock drill constitute distinctly separate noise sources in that they are frequently operated at some distances from other power sources, thus constituting a separate source of noise impact. In combination with a portable air compressor, breakers and drills frequently constitute the total equipment complement at many public works construction sites.

In February 1977, the agency identified pavement breakers and rock drills as major noise sources. EPA plans to publish proposed noise standards for these products in 1983.

The agency currently plans to complete its development of regulations for wheel and crawler tractors, pavement breakers, and rock drills during the next five years, and promulgate an additional regulation for earthmoving equipment (backhoes, scrapers, excavators, and trenchers) as shown in Figure 4.1.

NOT TO EXCEED STANDARDS	1980 1981 1982 1983 1984 1985
Wheel/Crawler Tractors	--------------F--------E
Pavement Breakers/Rock Drills	----------------------P-------F-----E
Earthmoving Equipment	-----------------------------P-----F--E

Legend: P = Proposed Rule
F = Final Rule
E = Enforcement Begins

Dotted lines show dates during which resources must be committed to each regulation.

Figure 4.1. Construction Regulation and Enforcement Schedule

OTHER FEDERAL REGULATIONS

Occupational Safety and Health Administration (OSHA), Department of Labor (DOL)

The Department of Labor's noise exposure standard was promulgated in 1969 under the Walsh-Healey Public Contracts Act. It was adopted under the Occupational Safety and Health Act on May 29, 1971, (29 CFR Part 1910.95), and is applicable under the general industry, construction, and longshore standards. It provides for protection against the effects of noise exposure. The combined effects of the amount of exposure at different sound levels are used to determine the maximum exposure permitted as shown in Table 4.1. When these permissible exposure limits are exceeded, feasible administrative (including a continuing hearing conservation program) and/or engineering controls must be implemented.

The standard sets the permissible exposure level for non-impulse noise at 90 dB(A) for an 8-hour-per-day duration and less than or equal to 140 dB peak sound pressure for impulse noise irrespective of its duration.

TABLE 4.1
OCCUPATIONAL SAFETY AND HEATLH ADMINISTRATION
PERMISSIBLE NOISE EXPOSURES
(29 CFR 1910.95)

Duration Per Day, Hours	Sound Level dB(A) Slow Response
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

Mine Safety and Health Administration (MSHA), Department of Labor (DOL)

MSHA has a mandate to protect mine workers through inspection of miners and enforcement of health and safety requirements. In fulfilling this mandate, MSHA has established limits of occupational noise exposure for miners very similar to those shown in Table 4.1.

Department of Housing and Urban Development (HUD)

HUD circular 1390.2,* "Noise Abatement and Control: Department Policy, Implementation Responsibilities and Standards," August 4, 1971 requires that noise exposures and sources of noise be given adequate consideration as an integral part of urban environments in connection with all HUD

*Revised by: Federal Register, Part V, Department of Housing and Urban Development, Office of the Secretary, Environmental Criteria and Standards July 12, 1979.

programs which provide financial support to planning. This consideration is to be of a form that provides assurance that new housing and other noise sensitive accommodations will not be planned for areas whose current or projected noise exposures exceed the standards cited in this circular.

Federal Highway Administration (FHWA), Department of Transportation (DOT)

The Federal Highway Administration issued noise standards and procedures (23 CFR Chapter 1, Subchapter J, Part 722) in June 1973. These standards and procedures are used by the FHWA and state highway agencies in the planning and design of highways approved pursuant to Title 23 United States Code and to assure that measures are taken in the overall public interest to achieve highway noise levels that are compatible with different land uses. These standards and procedures are limited to those which are primarily applicable to the task of evaluating the noise or operational characteristics of a highway construction site or equipment used in highway construction.

General Services Administration (GSA)

The General Services Administration issued "Public Buildings Service Construction Equipment and Practices", Guide Specification PBS4-D1100 in October 1973 which set maximum permissible noise emission levels for construction equipment at sites of Federal Government structures under contract with GSA. These noise levels became effective on July 1, 1973. More stringent limits became effective in January 1, 1975 as shown in Table 4.2. Equipment at Federal construction sites is prohibited from exceeding these prescribed limits measured in db(A) at a distance of 15 meters.

REGULATION OF CONSTRUCTION NOISE IN FOREIGN COUNTRIES

Foreign Construction Equipment Regulation

Prior to the issuance of regulations concerning air compressors, EPA/ONAC conducted a survey of foreign construction equipment regulation.*

---

*Foreign Regulation for Construction Equipment: A Status Report, March 25, 1974, Prepared by Informatics, Inc. for EPA/ONAC under Contract 68-01-1894. Since this study was done, some of the details of the foreign regulation have changed.

TABLE 4.2

GENERAL SERVICES ADMINISTRATION
EQUIPMENT REGULATIONS

Equipment	1 Jul 73 (dB(A) Measured at 15 m)	1 Jul 75 (dB(A) Measured at 15 m)
Earthmoving Equipment		
Frontloader	79	75
Backhoes	85	75
Dozers	80	75
Tractors	80	75
Scrapers	88	80
Graders	85	75
Trucks	91	75
Pavers	89	80
Materials Handling Equipment		
Concrete Mixer	85	75
Concrete Pumps	82	75
Crane	83	75
Derrick	88	75
Stationary Equipment		
Pumps	76	75
Generators	78	75
Compressors	81	75
Impact Equipment		
Pile Drivers	101	95
Jack Hammers	88	75
Rock Drills	98	80
Penumatic Tools	86	80
Other Equipment		
Saws	78	75
Vibrator	76	75

Although this survey concentrated on air compressors, it also contains a good deal of information on foreign construction noise regulation in general. Some of this information is given in this section. The referenced report contains a compilation of information on various foreign regulations concerning construction noise and specifically, where there is an applicable law, the noise of portable air compressors. The research for this document was carried out through a literature search of Informatics' available information on this topic and through over 300 inquiries made to foreign manufacturers of portable air compressors and representatives of foreign nations who are knowledgeable in the field of environmental noise. A list of foreign manufacturers of air compressors was obtained through a search of directories of foreign manufacturers and a search of the Foreign Trade List of the Department of Commerce.

From the material gathered in the survey, it was concluded that environmental noise construction regulations vary from country to country as much as they do from city to city and state to state in the United States. Many foreign nations still deal with the noise problem through general nuisance laws, if at all. Many nations however, realize the need for better defined (and therefore more enforceable) acoustical criteria.

Foreign cities and nations have laws that deal specifically with the problem of construction noise in the following ways:

1. Standards of recommended practice, such as the Guidelines for Noise issued by both the National Federation of Building Trades Employers and the Ministry of Public Building Works in the United Kingdom.

2. Contract specifications between buyer and builder, such as those in Norway or New South Wales, Australia.

3. General nuisance laws such as those in the various municipalities in Canada and in Paris, France.

4. Regulation of the noise level in various land use areas. These laws frequently differentiate between daytime and nighttime levels. Examples include Oslo, Norway, the City of Zurich, Switzerland, Sweden, and Vienna, Austria.

5. Regulations of the noise emission level for specific types of equipment, such as portable air compressors.

Loaders and Bulldozers Survey

A study was conducted* to provide a compilation of existing laws dealing with loaders and dozers. The compilation of laws was limited to those laws setting quantitative decibel limits on noise sources, and did not include laws using a "nuisance type provision." The compilation was to include a search for decibel standards in foreign laws, state laws, city and county ordinances and federal laws, other than the Noise Control Act of 1972. The information obtained on foreign legislation is discussed at this point.

At the time of the study (1976) few foreign governments had regulations specifically addressing loaders and dozers. An exception is Germany whose regulations are given in Table 4.3.

Several general construction noise limits are:

- Germany - for construction noise:

  60 dB(A) measured at receiving (primarily) residential property 6 a.m. - 10 p.m.
  75 dB(A) measured at receiving industrial property 6 a.m. - 10 p.m.
  Duration adjustments that increase these levels are allowed for short duration sound levels.

- Japan - for bulldozers, power shovels, backhoes or other similar excavators:
  75 dB(A) at 30 meters

*Summary of State, Local, Foreign and Federal Laws Dealing with Tracked and Wheeled Loaders, and Tracked and Wheeled Bulldozers, Science Applications, Inc., 1976 for EPA/ONAC.

- Osaka, Japan - for construction equipment:

  75 dB(A) at 30 meters

- Tokoyo, Japan - for bulldozers, power shovels, back hoes, or other similar excavators:

  75 dB(A) at 30 meters

- Vienna, Austria - for construction equipment:

  100 dB(A) at 1 meter

- Canton of Bern, Switzerland - construction equipment:

  85 dB(A) at 7 meters.

TABLE 4.3

GERMAN NOISE LEVELS FOR LOADERS AND DOZERS

Tracked Loaders		
	Allowable Sound Levels - dB(A)	
Test Mode	Up to 110 KW (Up to 148 hp SAE)	111 KW up (149 hp SAE up)
Sound levels effective January 1, 1977		
Machine stationary @ 7 meters	81	84
Work cycle	83	86
Tracked Dozers		
Sound levels effective January 1, 1977		
Machine stationary @ 7 meters	82	85
Machine drive-by @ 10 meters from center	87	89
Work cycle @ 10 meters from center	82	85
Wheeled Loaders		
	(Up to 150 hp SAE)	(151 hp SAE up)
Sound levels effective January 1, 1976		
Machine stationary @ 7 meters	82	85
Machine drive-by @ 10 meters from center	85	88
Work cycle @ 10 meters from center	81	85

V. STATE AND COMMUNITY REGULATION OF CONSTRUCTION NOISE

The first part of this section examines the views of State and community noise officials on the magnitude of the construction noise problem. The second part summarizes the regulation of construction noise by State and local governments. The sources of information are surveys of State and local noise control activities prepared for the EPA Office of Noise Abatement and Control.

VIEWS OF STATE AND LOCAL GOVERNMENTS ON CONSTRUCTION NOISE

EPA Survey

One of the most comprehensive source of information concerning State and local construction noise control activities is contained within an assessment undertaken by EPA/ONAC of the noise control activities of these governments.*

EPA conducted the assessment of the State and local noise programs in 1977 and early 1978 to obtain a better understanding of State and local requirements. The major element of the assessment was a survey questionnaire mailed to officials in the 50 States and 2 territories, and to 824 communities with a population greater than 25,000. Thirty-eight States,

---

*State and Local Noise Control Activities, 1977-1979, U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C., 20460.

2 territories and 562 communities returned completed questionnaires for an overall response rate of 69 percent.

The questionnaire asked a series of questions about each of 14 noise sources. It was based on the premise that the initial step in creating a noise control program was to develop an awareness of the seriousness of the noise problem. Development of awareness was assumed to be followed by the initiation of noise control legislation. Once legislation was enacted, the next step was the design of a program structured to carry out the mandate set forth in the legislation. An administrative structure was also assumed to be needed for the effective management of the program. Such a program was also assumed to require establishment of a fiscal budget for the necessary resources needed for enforcement. Following this sequence of questions, respondents were asked to evaluate the progress made in noise reduction as a result of their programs.

One of the 14 noise sources considered in the questionnaire was "construction equipment", which was not defined. Also, construction site noise was not mentioned. Most likely, most respondents interpreted "construction equipment" noise to mean any noise caused by construction activity, i.e., by one piece of equipment or by a group of construction equipment items.

A summary of the responses from the survey is given in Tables 5.1 and 5.2. Construction equipment noise ranks seventh in the State response and eigth in the community responses, and is viewed as a significant problem by 34% and 28% of the States and local respondees, respectively.

Interestingly, of those States having a construction equipment noise problem only 8% feel that they have achieved a significant noise reduction with their program, while 40% of the communities feel that their programs have been successful. If these opinions are correct, it is interesting to speculate on the reasons for the achievement of greater success in controlling construction noise at the local level. Among these may be the greater sensitivity of local governments to the complaints of their noise impacted citizens, and the traditional areas of jurisdiction

TABLE 5.1

RANKING OF THE MOST OFTEN IDENTIFIED STATE NOISE PROBLEMS, THE RESPONSES TO THESE PROBLEMS, AND THE EFFECTIVENESS OF THE RESPONSES

Rating	Noise Source	Number Having Problem (Percent of 38 Total Responses)		Number With Quantifiable Legislation & Specific Noise Provisions (Percent of Those Having Problem)		Number With Enforcement Actions (Percent of Those Having Problem)		Number With Significant Reduction (Percent of Those Having Problem)	
1	Motorcycles	22	(58%)	13	(59%)	3	(14%)	3	(14%)
2	Trucks	22	(58%)	12	(55%)	4	(18%)	3	(14%)
3	Industrial Activities	18	(47%)	8	(44%)	4	(22%)	6	(33%)
4	Automobiles	17	(45%)	10	(59%)	2	(12%)	3	(18%)
5	Aircraft	17	(45%)	1	(6%)	0	0	0	0
6	Buses	16	(42%)	9	(56%)	2	(13%)	2	(13%)
7	Construction Equipment	13	(34%)	5	(38%)	2	(19%)	1	(8%)
8	Railroad Operations	11	(29%)	3	(27%)	2	(18%)	0	0
9	Garbage Compactors	9	(24%)	4	(44%)	2	(22%)	0	0
10	Recreational Vehicles	8	(21%)	7	(88%)	2	(25%)	3	(38%)
11	Public and Private Entertainment	7	(18%)	8	(114%)	4	(57%)	4	(57%)
12	Public Service Vehicles	6	(16%)	3	(50%)	2	(33%)	0	0
13	Animals	6	(16%)	2	(33%)	1	(17%)	0	0
14	Home Power Equipment	6	(16%)	5	(83%)	2	(33%)	1	(17%)

TABLE 5.2

RANKING OF THE MOST OFTEN IDENTIFIED COMMUNITY NOISE PROBLEMS, THE RESPONSES TO THESE PROBLEMS, AND THE EFFECTIVENESS OF THE RESPONSES

Rating	Noise Source	Number Having Problem (Percent of 542 Total Responses)		Number With Quantifiable Legislation & Specific Noise Provisions (Percent of Those Having Problem)		Number With Enforcement Actions (Percent of Those Having Problem)		Number With Significant Reduction (Percent of Those Having Problem)	
1	Motorcycles	369	(68%)	165	(45%)	55	(15%)	53	(14%)
2	Trucks	353	(65%)	158	(45%)	46	(13%)	39	(11%)
3	Automobiles	315	(58%)	164	(52%)	48	(15%)	44	(14%)
4	Railroad Operations	226	(42%)	49	(22%)	19	(8%)	17	(8%)
5	Buses	188	(35%)	142	(76%)	16	(9%)	25	(13%)
6	Aircraft	188	(35%)	40	(21%)	9	(5%)	21	(11%)
7	Animals	170	(31%)	102	(60%)	57	(34%)	69	(41%)
8	Construction Equipment	151	(28%)	129	(85%)	44	(29%)	61	(40%)
9	Public and Private Entertainment	147	(27%)	149	(101%)	59	(40%)	104	(71%)
10	Industrial Activities	145	(27%)	166	(114%)	77	(53%)	98	(68%)
11	Garbage Compactors	124	(23%)	66	(53%)	27	(22%)	42	(34%)
12	Recreational Vehicles	79	(15%)	91	(115%)	16	(20%)	25	(32%)
13	Home Power Equipment	69	(13%)	109	(158%)	36	(52%)	46	(67%)
14	Public Service Vehicles	63	(12%)	68	(108%)	15	(24%)	25	(40%)

of each government level, e.g., highways by States, building codes by communities.

Also, note that communities rank considerably better than States, in having quantifiable construction noise provisions in their legislation (85% to 38%). Perhaps this explains their greater "success" percentages (40% to 8%).

Magnitude of the Problem

The survey described above can be used to gain an insight into the magnitude of the construction noise problem in the U.S., both in an absolute sense, and in comparison with other noise problems.

Tables 5.1 and 5.2 from the EPA/ONAC 1976-77 survey of State and local governments shows that 34% of the States and 28% of the local governments consider construction noise to be a serious problem. Of those governments that have identified noise as a problem, 38% of the States and 85% of the communities have noise regulations with quantitative provisions. Relative to other noise sources, construction noise ranks seventh or eighth among the 14 noise sources listed as a serious problem. However, examination of Tables 5.1 and 5.2 shows that if transportation noise sources (motorcycles, trucks, etc.) are eliminated, then "construction equipment" ranks second for both States and for communities.

STATE REGULATION OF CONSTRUCTION NOISE

In the EPA assessment of State and local noise programs, thirty-eight States responded to the survey. Five of these 38 States indicated that they had legislation with specific provisions for regulating construction noise.* These States are Colorado, Maryland, New Jersey, New York, and Washington. A summary of these regulations is provided here. This summary is based on information obtained in another EPA survey.**

*State and Local Noise Control Activities, 1977-1979, op. cit.

**Summary of State, Local and Foreign and Federal Laws Dealing with Tracked and Wheeled Loaders, and Tracked and Wheeled Dozers, op. cit.

Colorado sets the following levels for all construction activity:

80 dB(A) measured at 25 feet from the site 7 a.m. - 7 p.m.
75 dB(A) measured at 25 feet from the site 7 p.m. - 7 a.m.

Maryland sets the following levels for construction:

90 dB(A) measured at any receiving property 7 a.m. - 10 p.m.
50 dB(A) measured at residential receiving property 10 p.m. - 7 a.m.
62 dB(A) measured at commercial receiving property 10 p.m. - 7 a.m.
75 dB(A) measured at industrial receiving property 10 p.m. - 7 a.m.

New Jersey sets the following levels for commercial operations:

65 dB(A) measured at receiving residential property 7 a.m. - 10 p.m.
50 dB(A) measured at receiving residential property 10 p.m. - 7 a.m.
65 dB(A) measured at receiving commercial/industrial property anytime.

New York sets the levels given in Table 5.3 for construction site noise measured at 400 feet.

TABLE 5.3

NEW YORK CONSTRUCTION NOISE LEVELS

For Construction Activity Occurring In	Allowable Level dB(A)
Residential Districts day: 7 a.m.-7 p.m. night: 7 p.m.-7 a.m.	64
Commercial Districts during normal business hours	69
During non-business hours	74
Industrial Districts any time	74

Washington sets the following levels for construction noise:

45 dB(A) for receiving residential property if the site is located in a residential district 10 p.m. - 7 a.m.

47 dB(A) for receiving residential property if the site is located in a commercial district 10 p.m. - 7 a.m.

50 dB(A) for receiving residential property if the site is located in an industrial district 10 p.m. - 7 a.m.

All states except New Jersey allow duration adjustment to the above levels that increase the allowable level for short durations.

Colorado and Maryland reduce allowable levels by 5 dB(A) for impulsive noises. New Jersey states that any impulsive noise is excessive that exceeds 80 dB(A), presumably at receiving land. New York allows no impulsive noise over 120 dB(A); presumably measured at 400 feet.

Washington is the only state that pre-empted local control of construction noise levels. Washington mandates that local ordinances be consistent with state regulations, unless the local government can show special circumstances requiring different levels.

Maryland, New Jersey, and Washington give a specific exemption for emergency work. Only Washington and Maryland specifically provide for variances to the standards. Washington, New Jersey, and Maryland specifically require that State construction activities comply with the State law.

LOCAL CONSTRUCTION NOISE REGULATION

Bragdon Surveys

Dr. Clifford R. Bragdon of the Georgia Institute of Technology has conducted several surveys of State and local noise regulations. Table 5.4 has been prepared from the results of Bragdon surveys published in 1976 and 1980. While these surveys do not distinguish between different construction noise sources, they do distinguish between so-called nuisance ordinances and ordinances with quantitative provisions. The material in Table 5.4 is analyzed in Table 5.5.

TABLE 5.4

QUANTITATIVE PROVISIONS IN LOCAL CONSTRUCTION NOISE REGULATIONS

STATE	NUMBER OF JURISDICTIONS HAVING A NOISE ORDINANCE		NOISE ORDINANCE PROVISIONS-CONSTRUCTION			
			QUANTITATIVE		NON-QUANTITATIVE	
	1976	1980	1976	1980	1976	1980
AL	6	8	0	1	1	1
AK	3	3	0	0	0	0
AZ	5	5	0	2	0	1
AR	2	3	0	0	0	0
CA	116	127	16	23	19	21
CO	12	14	3	1	0	0
CT	7	21	1	3	0	0
DE	1	2	0	0	0	0
DC	1	1	0	9	0	0
FL	69	134	3	21	5	4
GA	29	32	2	3	2	4
HI	1	1	0	0	0	0
ID	3	3	0	0	0	1
IL	16	367*	3	367*	1	0
IN	8	15	0	0	2	1
IA	10	14	0	0	4	2
KS	3	3	1	1	0	0
KY	4	6	1	2	1	1
LA	2	6	0	2	1	2
ME	-	2	-	0	-	0
MD**	3	6	0	0	0	0
MA	9	18	0	1	1	2
MI	21	39	2	5	1	2

*361, 1987, 1491 given as totals in Bragdon's listing.
**Add MD State Law covering Construction Noise.

TABLE 5.4 (Continued)

STATE	NUMBER OF JURISDICTIONS HAVING A NOISE ORDINANCE		NOISE ORDINANCE PROVISIONS-CONSTRUCTION			
			QUANTITATIVE		NON-QUANTITATIVE	
	1976	1980	1976	1980	1976	1980
MN	8	15	1	4	1	1
MO	8	53	2	4	1	2
MS	1	1	0	0	0	0
MT	5	5	1	3	0	0
NE	6	7	0	0	2	0
NH	3	4	0	1	0	0
NJ	67	72***	1	2	4	6
NM	3	4	0	1	1	2
NY	42	48	0	2	3	7
NV	1	2	0	0	0	1
NC	55	58	0	1	3	9
ND	2	2	0	0	0	0
OH	12	23	1	1	1	2
OK	2	6	0	0	0	1
OR	23	30	1	1	2	4
PA	12	25	0	1	0	1
RI	5	5	1	1	0	0
SC	2	3	0	0	0	1
SD	2	4	0	0	0	0
TN	5	7	0	1	3	3
TX	17	22	0	0	6	9
UT	5	7	3	4	0	0

***Actual count = 80.

TABLE 5.4 (Continued)

STATE	NUMBER OF JURISDICTIONS HAVING A NOISE ORDINANCE		NOISE ORDINANCE PROVISIONS-CONSTRUCTION			
			QUANTITATIVE		NON-QUANTITATIVE	
	1976	1980	1976	1980	1976	1980
VT		0		-		-
VA	10	12	0	1	2	2
WA	15	24	1	1	4	3
WV		2		1		0
W[illegible]	5	10	0	3	0	1
WY	6	6	0	0	0	0
TOTALS	653	1290	45	465	71	98

TABLE 5.5

ANALYSIS OF COMMUNITY CONSTRUCTION NOISE ORDINANCES (BRAGDON DATA)

	1971 VALUES	1976 VALUES	1980 VALUES	RATIO 1980-1976
Number having a Noise Ordinance	NA	653	1290	1.98
Number and Percent Applying to Construction	15 NA	116 18%	563 44%	4.86
Number and Percent Applying to Construction Having Quantitative Provisions	5 33%	45 39%	465 83%	10.47

NA = not available.

Table 5.5 shows that the number of communities with noise regulations have increased by approximately 100 percent from 1976 to 1980, while ordinances pertaining to construction noise have increased almost 400 percent and the number with quantitation provisions have increased by more than 900 percent. The increase in the regulation of construction noise is even greater if the base for comparison is 1971 when there were only 15 communities in the United States with regulations pertaining to construction noise. In the next section, some of the specific provisions of local construction noise ordinances are examined.

Survey of Noise Regulations

In connection with the EPA/ONAC survey of state and local noise control activities described above, respondents were asked to submit copies of their noise legislation. This legislation was analyzed and summarized by Wyle Laboratories who supplemented this material with other material available to them.* No attempt was made to solicit copies of ordinances from States or communities not included in the survey. Therefore, the information contained in the Wyle report is not all-inclusive. Also, note that many States and communities who submitted responses to the questionnaire did not submit copies of their legislation. Thus, the Wyle data does not give an indication of the number of any law of a given type. It is useful however in giving an insight into the content of such laws.

Table 5.6 was prepared from material contained in the Wyle Report. It contains an abstract of the principal provisions of the local construction noise legislation submitted organized by land usage, noise source, and noise levels specified, together with special provisions.

Many communities specify successively higher allowable noise levels for impacted residential, commercial, or industrial land usage. In

*Noise Source Regulations in State and Local Noise Ordinances, Wyle Laboratories Report WR-78-21, August 1979.

TABLE 5.6

LOCAL CONSTRUCTION NOISE REGULATIONS*

State/ Jurisdiction	Land Usage	Source	Effective Date	Max Noise Level dBA	Other Noise Level dBA	Comments
ALASKA Anchorage		Construction Equipment	9/1/77	80		100' from Sources
CALIFORNIA Burlingame		Earth moving Scrapers, pavers Material handling Pile drivers Jack hammers Rockdrills Others	1/5/76	75 80 75 95 75 80 75		
Manhattan Beach	Residential	Contruction Equipment	5/8/74	50 45		8hrs during a day 7:00 AM - 10:00 PM 10:00 PM - 7:00 AM
San Bruno	Residential	Contruction Equipment	1975	85 60		7:00 AM - 10:00 PM 10:00 PM - 7:00 AM @ 100 ft from construction site
San Francisco		Contruction Equipment	9/18/76	80		100 ft from source, except impact tools
COLORADO Boulder		Construction Equipment	8/19/77	80 75		7:00 AM - 11:00 PM 11:00 PM - 7:00 AM
Colorado Springs		Construction Equipment	10/1/73	80 75		7:00 AM - 7:00 PM 7:00 PM - 7:00 AM
Denver	Residential Commerical Industrial Public	General Construction	6/18/74	50 76 70		10:00 PM - 7:00 AM 10:00 PM - 7:00 AM 10:00 PM - 7:00 AM 10:00 PM - 7:00 AM
Littleton		New Road Construction	1974		$70(L_{10})$	
CONNECTICUT Shelton	Residential Commercial Industrial		6/8/78 6/8/78 6/8/78		$70(L_{50})$, $80(L_{10})$ $75(L_{50})$, $85(L_{10})$ $80(L_{50})$, $90(L_{10})$	Except impact tools, e.g., pile drivers, jack hammers, paving breakers, etc.
		Utility Work	1/1/80	80		
FLORIDA Boca Raton Pompano Beach W. Palm Beach		Construction Equipment General Construction General Construction	12/11/73 6/28/77 2/3/75		$75(L_{10})$ $75(L_{10})$ $75(L_{10})$	7:00 AM - 6:00 PM 8:00 AM - 11:00 PM 7:00 AM - 7:00 PM
ILLINOIS Chicago	Residential Commercial Manufacturing		1/1/75 1/1/75 1/1/75	70 75 80		
		Construction Equipment excluding pile drivers		80		Manufactured after 1/1/80

* All sound levels are expressed in terms of A-weighted sound level measured at 50 ft unless noted otherwise.

TABLE 5.6 (Cont.)

State/ Jurisdiction	Land Usage	Source	Effective Date	Max Noise Level dBA	Other Noise Level dBA	Comments
INDIANA Evansville	Residential Industrial		12/29/75 12/29/75	75 80		Also Octave Bands 7:00 AM - 8:00 PM
IOWA Clinton	Residential	Construction Equipment except pile drivers	11/7/77	86		7:00 AM - 7:00 PM
Des Moines	Residential	General Construction	1/1/78		85(L_{eq})	7:00 AM - 10:00 PM
KANSAS Prairie Village		Construction	1/1/80	80		
MASSACHUSETTS Boston	Residential/ Industrial Business/ Recreational Industrial		3/16/70 3/16/70 3/16/70	86	75(L_{10}) 80(L_{10}) 85(L_{10})	
		Construction Devices	1/1/80	80		Except pile drivers
MICHIGAN Grand Rapids		Construction Equipment		80		Manufactured after 1/1/80
MONTANA Billings		Construction Equipment		80 75		8:00 AM - 8:00 PM 8:00 PM - 8:00 AM
NEW MEXICO Albuquerque	Residential	Construction	4/3/75	50		Within a radius of 500 ft around construction site
NEW YORK New Rochelle	Residential		4/13/76		70(L_{10}) 55(L_{10})	8:00 AM - 10:00 PM 10:00 PM - 8:00 AM
	Commercial		4/13/76		75(L_{10}) 80(L_{10})	During normal business hours During other time
PENNSYLVANIA Easton		Industrial & Construction Machinery	6/15/72	80		Manufactured after 1/1/80
State College		Construction & Industrial Equipment	8/29/75	86		Except pile drivers
VIRGINIA Alexandria		Construction Equipment General Construction	10/16/76 8/14/76	85 90		Purchased after 7/1/77
WISCONSIN West Allis		Public Utilization & Works	12/1/76	86		

some cases, only residential areas are specified. In others, land usage is not a factor.

Construction noise source ranges from the indefinite description, "general construction" to a very specific list of equipment, i.e., scrapers, pavers, jack hammers, etc. (see Burlingame, California). However, the greatest number of regulations specify "construction equipment" as the noise source.

Examination of Table 5.6 shows that, for communities that rely on specification of a maximum noise level, the allowable levels range from 60 dB(A) to 86 dB(A) with means about 75 dB(A) for impacted residential areas, and 80 dB(A) for industrial areas. Communities using other noise level descriptors usually employ the L_{10} descriptor.

The most common means of noise control listed under special provisions is restriction of the hours of construction operations. Allowable hours are usually from 7 a.m. or 8 a.m. to 9 p.m. or 10 p.m. Note that some communities prescribe the gradual phasing in of less noisy equipment.

SUMMARY

Regulations

Only five of 38 states which responded to the EPA 1977-78 Survey have laws pertaining to construction noise. These laws set specific day and night noise limits at the receiving property or measured 25 feet from the site (Colorado). It should be noted that these surveys were made in 1977-78 and other states may have enacted laws since these surveys were conducted.

The Bragdon survey showed that in 1980, 563 communities had ordinances pertaining to construction noise. Of this 83 percent contained quantitative provisions. The allowable noise levels range from 60 dB(A) to 80 dB(A) with a mean of about 75 dB(A) for residential areas and 80 dB(A) for industrial areas.

Construction Noise Problem

Construction equipment noise ranks seventh in the state responses and eighth in the community responses to an EPA survey on noise problems.

However, if transportation equipment noises were eliminated then construction equipment would rank second as a noise problem at both the state and local levels. Of those states having a construction equipment noise problem only 8% felt that they had achieved a significant noise reduction with their program, while 40 percent of the communities believe their programs have been successful. This is an indication that much work still needs to be done to reduce construction noise. Some of the programs that are underway to reduce construction noise will be discussed in the next section.

VI. FEDERAL PROGRAMS AND POLICIES RELEVANT TO CONSTRUCTION NOISE CONTROL

This section describes some of the Federal programs and policies which have a direct bearing on the construction noise technology initiatives which should be carried out by the Technology and Federal Programs Division of EPA/ONAC. The first of these is the EPA "Substrategy for Construction Noise" which is currently being circulated for comment in the Office of Noise Abatement and Control. Other programs and policies include "EPA's Quiet Communities Five-Year Plan" which sets forth a plan for the implementation of the EPA's Noise Control Program; the Urban Noise Control Program; Executive Order 11752, "Prevention Control and Abatement of Environmental Pollution at Federal Facilities;" and the "Buy Quiet" Program.

The impact that these programs and policies have on construction noise technology initiatives is discussed in Section VIII, Technology Needs.

EPA SUBSTRATEGY FOR CONSTRUCTION NOISE

The "Substrategy for Construction Noise" (Draft), August 1980, lists eight options for the control of construction noise. These options are described in Table 6.1.

The draft substrategy document indicates a preference for option 1 combined with options 5 and 8. Option 1, In-Use Controls would be exercised by State and local governments especially for rapidly growing jurisdictions with many housing developments and supporting public works projects. Under Option 5, EPA would promulgate new medium and heavy truck regulations which would be applicable to concrete mixers and other over-the-road construction

TABLE 6.1

OPTIONS FOR CONTROL OF CONSTRUCTION NOISE

Option	Description
1. In-Use Controls	• Limit hours of noisy construction project operations • Require all equipment to be operated with original noise control equipment in place and in good repair • Set not-to-exceed limits on noise levels at the property line.
2. Financial Incentives	• Charge higher building permit fees and require more documentation if noiser equipment is to be used • Institute buy-quiet program • Require quiet equipment and operations for government contract and assistance • Make size of performance bond a function of noise emissions.
3. Path Controls	• Require barriers and berms • Use stacks of building materials.
4. Conduct Information Campaigns	• Publicize quiet equipment and techniques to contractors and design engineers • Conduct demonstration projects for State and local governments and members of construction industry trade associations • Conduct information campaigns and participation conferences for citizens' groups
5. Promulgate New EPA Medium and Heavy Truck Regulations	• Applicable to concrete mixers and other over-the-road construction trucks • Lower noise limits than current regulations.

Source: EPA, Substrategy for Construction Noise, August 1980, (Preliminary Draft)

TABLE 6.1 (Cont.)

OPTIONS FOR CONTROL OF CONSTRUCTION NOISE

Option	Description
6. Promulgate Regulation on New Wheel and Crawler Tractors	• Regulate noise limits on new dozers, loaders, and some back hoes.
7. Promulgate Regulation on New Rock Drill and Pavement Breakers	• Regulate noise limits on rock drills and pavement breakers.
8. Promulgate Regulation on Labeling	• Require labeling of construction equipment: - Backup signals on all mobile equipment - Earthmoving equipment - Pile drivers - Fixed cranes and derricks - Mobile cranes

trucks. Option 8 would require labeling of construction equipment.

The planned promulgation of wheel and crawler regulation and the rock drill and pavement breaker regulation would be held in abeyance, while progress through this combination of options was evaluated.

The combination of options 1, 5 and 8 can be expected to achieve the following goals according to the draft substrategy document:

- Reduce the importance of noise from trucks which are a major and most ubiquitious source in construction activities of all kinds.
- Induce producers through labeling to design quiet equipment
- Provide EPA with data regarding changes in equipment noise
- Achieve rapid, significant noise reduction through the State and local in-use controls.

EPA'S QUIET COMMUNITIES FIVE-YEAR PLAN

EPA's Quiet Communities Five-Year Plan FY1981-FY1985 (draft) February 1980 sets forth a five-year plan for the implementation of EPA's Noise Control Program. The Plan lays out the objectives EPA has identified for the Agency's Noise Control Program over the next five years and the next 20 years and provides specific details for the accomplishment expected over the next five fiscal years. Priority for use of noise control resources has and will continue to be placed by EPA on abatement of surface transportation noise.

Year 2000 Noise Control Goals

EPA's goals for the next 20 years include reductions in the longer term average noise exposures of people. Human responses to noise are largely related to these long term exposures. The Agency believes that most of its efforts should be devoted to reducing the number of people living in areas characterized by especially high levels of noise that is L_{dn} 65 dB and above.

The Agency's goals for long-term average exposure are as follows:

- The number of people living in areas exposed to outdoor levels of L_{dn} 75 dB and above should be reduced to zero as soon as possible but not later than the year 2000.
- The number of people living in areas exposed to outdoor levels of L_{dn} 65 dB (but not greater than L_{dn} 75 dB) should be reduced by 20% from 1979 levels by the year 2000.
- The number of people who remain living in areas exposed to outdoor levels of L_{dn} 65 dB from aircraft sources by the year 2000 would be provided protection against activity interference (approximately L_{dn} 45 dB) inside their houses.

Implications of EPA's Year 2000 Noise Control Goals

EPA estimates that about 37 million persons in the United States are exposed to noise levels above L_{dn} 55 dB from construction activity and from 7 to 15 million are exposed to noise levels above 65 dB. Less than 10,000 persons are believed to be exposed to noise levels above L_{dn} 75 dB.

These goals imply that EPA must take action to reduce the number of people exposed to construction site noise greater than L_{dn} 65 by 20 percent or from 1.4 to 3 million people. These goals probably can be achieved by the currently planned regulatory action. The Construction Site Noise Impact Model results indicate that by the year 2000 the percent reduction in construction site noise from regulation of wheel and crawler tractors, portable air compressors, and medium and heavy duty trucks would range from 31.5 to 37.5 percent depending on the time schedule pursued for wheel and crawler tractor noise regulations.

Resources

The estimated cost of implementing the construction noise control five-year plan is shown in Table 6.2.

URBAN NOISE PROGRAM

Interagency Committee on Urban Noise

An Interagency Committee Urban Noise formed by EPA in 1978 to find ways to incorporate a noise program in the Administration's Comprehensive Urban Policy. The committee included representatives of the Department of Health, Education, and Welfare, the Environmental Protection Agency, and the Council on Environmental Quality. The Committee's initial report established a framework for an interagency approach to urban noise problems and identified nine initiatives, five of which were emphasized in the urban noise program initiated by President Carter on August 2, 1979.

Interagency Urban Noise Program

President Carter initiated an interagency urban noise program August 2, 1979 in his message to Congress on the Environment, which defines the administration's environmental policy.

The urban noise program focuses on the areas of sound proofing and weatherization, urban transportation, comprehensive urban development planning, markets for quiet products, and neighborhood self reliance. The agencies participating are the Departments of Commerce, Defense, Energy, Housing, and Urban Development, and Transportation, and the Environmental Protection Agency and the General Services Administration.

TABLE 6.2

ESTIMATE RESOURCES REQUIRED TO IMPLEMENT CONSTRUCTION NOISE CONTROL PROGRAM FY 1980-85
(Thousands of Dollars)

	CURRENT ESTIMATE	PROJECTIONS				
EXTRAMURAL	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85
Assessment and Demonstration of Construction and Site Abatement	45	35	100	100	100	100
Earthmoving Equipment Regulation	-	-	250	100	50	50
Pavement Breakers and Rock Drills Regulations	105	249	100	50	30	-
Wheel and Crawler Tractors Regulations	136	247	247	-	-	-
Enforcement of EPA Regulations	95	50	100	225	225	300
Modeling, Strategy Work, and Health and Welfare Support	53	48	81	130	102	93
Economic Analysis	-	(31)	34	20	18	17
Abatement and Control Extramural Subtotal	339	579	812	400	300	260
Abatement and Control Intramural						
Regional Offices	53	53	140	140	140	275
Headquarters	205	273	480	210	180	180
Intramural Subtotal	258	326	620	350	320	455
Abatement and Control TOTAL	597	905	1432	750	620	715

The Federal Interagency Committee on noise which is chaired by the Administrator of EPA, is responsible for coordinating this program.

Urban Noise Construction Initiative

An urban noise construction initiative, which is included as one of the nine initiatives, will continue to be considered by the Inter-agency Committee on Urban Noise. However, initiatives on construction noise will come from the "Buy Quiet" Program and the "Quiet Neighborhood Self Help Program," rather than directly from a construction noise initiative. For example, the use of quiet construction equipment has been made on eligible expense by FHWA, UMTA, and FAA under their respective programs giving a boost to the "Buy Quiet" initiative. The "Buy Quiet" Program is discussed near the end of this section.

POLICY ON NOISE CONTROL AT FEDERAL FACILITIES

Executive Order 11752 which became effective on December 19, 1973, outlines policies and responsibilities to be followed by the heads of Federal agencies in upholding Federal, state and local standards and acts. This order also specifies cooperation with those agencies for prevention, control, and abatement of environmental pollution* under this order, both the Corps of Engineers and the General Services Administration have taken steps to control construction noise.

The U.S. Army Corps of Engineers is one of the largest construction contractors in the world. The Corps of Engineers is responsible for construction of Army and Air Force installations and for the U.S. Army civil works programs which involves dredging of harbors and rivers, construction of hydro-electric

---

*Prevention, Control, and Abatement of Environmental Pollution at Federal Facilities," Federal Register, Vol. 38, No. 243 (December 19, 1973), p. 34793.

dams for electric energy and flood control. The Corps has developed and published specifications to be used in construction contracts to limit the permissible noise, methods to test compliance with specifications and a compilation of methods to attenuate site noise.*

The General Services Administration which is responsible for the construction of Federal buildings, has issued specifications for regulating the construction equipment noise of all Federal construction contractors. These regulations were discussed above in Section IV.

"BUY QUIET" PROGRAM

Rather than require industry to design products that meet specific noise emission standards, EPA has initiated a program that uses government's substantial purchasing power as an initiative for manufacturers to develop quieter products. The "Buy Quiet" Program encourages Federal, state, and local governments to buy quieter products.

The National Institute of Governmental Purchasing (NIGP) and the National League of Cities are cooperating with EPA, the National Bureau of Standards, and the General Services Administration in initiating a "Buy Quiet" program. The General Services Administration and some State and local agencies have, in fact, been successful in the procurement of products that have a significantly lower noise level. The City of New York, for example, included noise level limitations in its specifications for garbage and trash equipment. Other agencies have been successful in the procurement of compressors and earth-moving equipment with reduced noise levels.**

Specifications of the performance type, such as a noise level requirement, encourages vendors to submit new products and new concepts. Experience to date indicates that industry is not only generally receptive to these requirements but also has been able to meet the noise specifications without adversely affecting quality or prices.

---

*Schomer, P.D. and Homans, B., Construction Noise: Specification Control, Measurement, and Mitigation, Construction Engineering Research Laboratory, Technical Report E-53, April 1975.

**Spangler, Lewis, "Can City Hall Buy Peace and Quiet?", Environmental Reporter, National League of Cities, July 23, 1979.

VII. FEDERAL CONSTRUCTION NOISE ABATEMENT RESEARCH, DEVELOPMENT AND DEMONSTRATION PROGRAMS

U.S. GOVERNMENT SPONSORED RD&D

The United States Government is involved in research, development and demonstration (RD&D) activities related to construction noise abatement and control through a number of its agencies and departments.

Section 4 of the Noise Control Act of 1972 (PL 92-574) directed that Federal agencies carry out programs within their control to "promote an environment for all Americans free from noise that jeopardizes their health and welfare."

Section 4 further requires the Administrator of EPA to "coordinate the programs of all Federal agencies relating to noise research and control."

In partial fulfillment of its responsibility for coordinating Federal noise research, EPA/ONAC has established interagency research panels. These panels were first established in 1974. The Federal Interagency Machinery Construction noise research panel is one of the four panels. It has published reports summarizing ongoing and planned machinery and construction noise research, development, and demonstration programs within the various agencies and departments of the Federal Government.

The extent of Federal activity on construction noise RD&D is indicated by levels of funding shown in Figures 7.1 and 7.2. Figure 7.1 shows the levels of funding of each Federal Agency and Departments from FY 1975 through

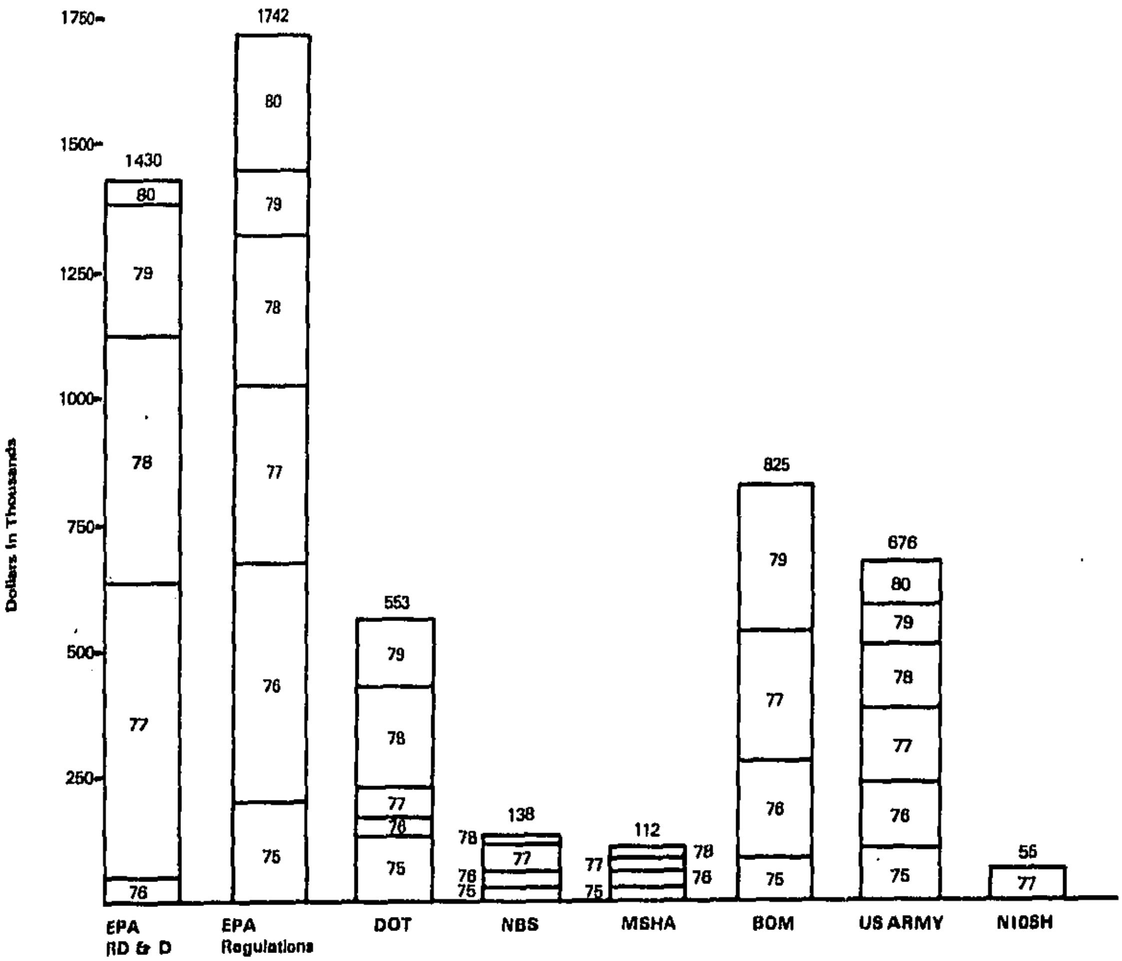
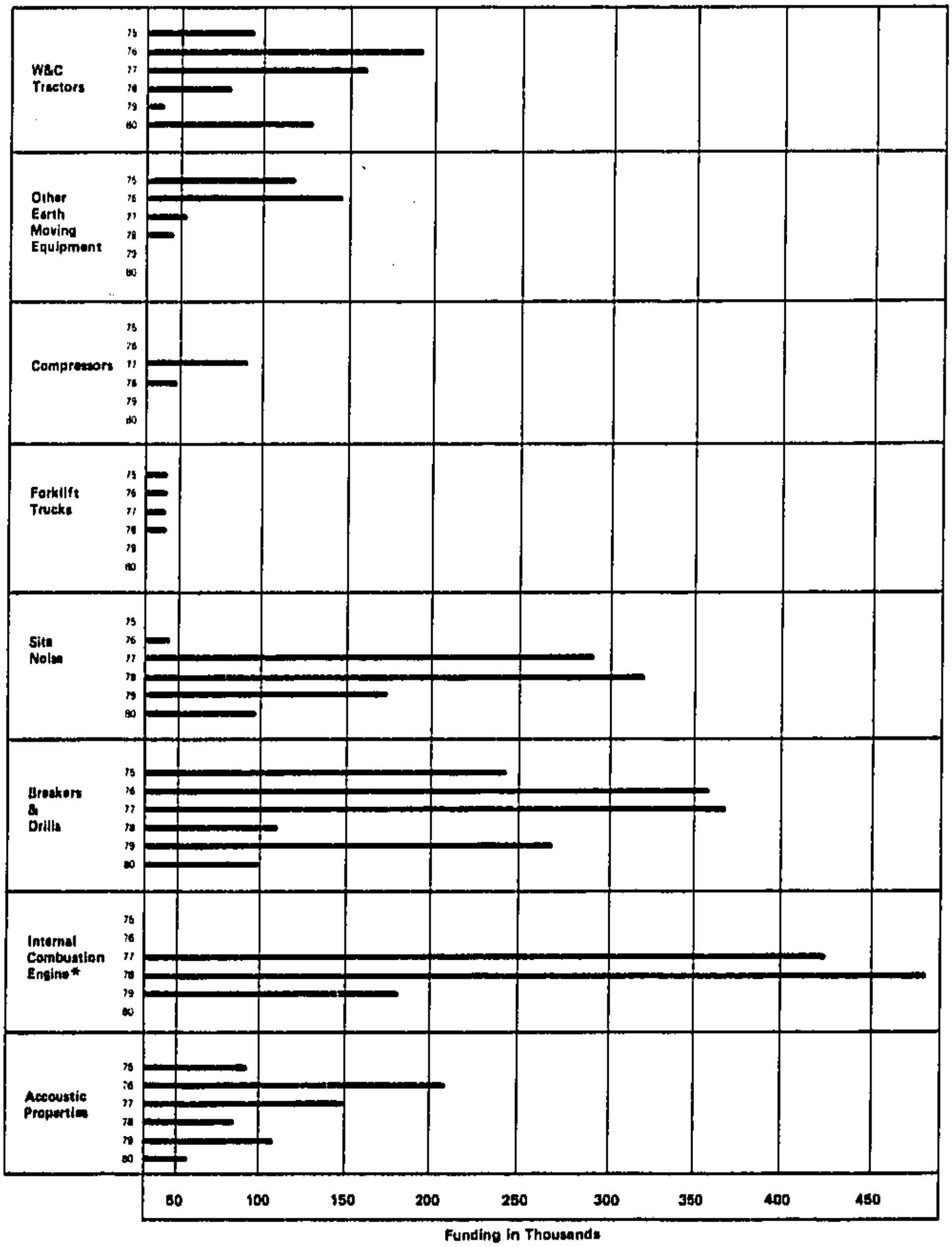


Figure 7.1. Funds Obligated for Construction Noise RD&D and Regulatory Support FY 1975-FY 1980



*Program includes applications other than construction. Since 1979, all EPA work has been directed toward surface transportation.

Figure 7.2. Funds Obligated for Construction Equipment Noise RD&D and Other Research FY 1975-FY 1980

FY 1980. Figure 7.2 shows the level of funding by construction equipment or activity for each of the fiscal years FY 1975 - 1980.[1/]

ENVIRONMENTAL PROTECTION AGENCY

Authority

The Noise Control Act of 1972 gives EPA the authority to identify major noise sources, issue labeling requirements, and issue noise emission standards.

In addition, the 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 RD&D Efforts

There was little EPA funded RD&D activity in the construction equipment area prior to FY 1977. The few programs undertaken dealt primarily with noise measurement methodologies and technology assessment in support of the regulatory process. Starting in FY 1977 there was an increase in EPA noise RD&D activity with the undertaking of a source control program to reduce internal combustion engine noise which was applicable to both surface transportation and construction areas. However, in FY 1980 this program was redesigned and is now focused entirely on surface transportation applications.

Current Construction Equipment RD&D

Two projects are currently underway, both sponsored by EPA/ONAC and other Federal agencies.

The first of these projects was initiated in July 1978 jointly with the FHWA, to investigate the noise associated with highway construction, to demonstrate the effectiveness and viability of implementing specific noise mitigation measures, and to develop an analytic model that will be used to access potential noise impact and to plan abatement measures. More information on this project is included in the discussion of FHWA projects.

[1/] Data for FY 1975-78 are from Federal Research, Development and Demonstration Programs in Machinery and Construction Noise. EPA 550/9-78-306, February 1978. Data for FY 1979-80 are from Federal Agency Noise Control Technology: Research, Development, and Demonstration Projects on Industrial Manufacturing, Mining, and Construction Equipment During the Fiscal Year 1980, EPA 550/9-80-317, July 1980.

The second project is jointly sponsored with the U.S. Army Construction Engineering Research Laboratory to study and demonstrate available retrofit technology and administrative control mitigating noise from general construction equipment. Noise control for a pile driver was selected for this study. More information on this project is included in the discussion of CERL projects.

DEPARMENT OF LABOR

Mine Safety and Health Administration (MSHA) has a mandate to protect mine workers through inspection of mines and enforcement of health and safety requirements, and, pursuant to fulfilling this mandate, it establishes limits for occupational noise exposure for miners, inspects mines, and enforces noise regulations. MSHA provides technical support to its enforcement activities and conducts noise control projects designed to provide retrofit solutions that can be applied in a short period of time. MSHA also performs a major service in identifying noise problems for research and by serving jointly with BOM on their Research Review Committee.

Scope of Past Efforts (FY 1975-78)

During this period MSHA was in the Department of Interior and was designated the Mining Enforcement and Safety Administration (MESA). Two projects were conducted by MESA of relevance to the construction equipment noise reduction. Noise control measures were developed for surface mining equipment including dozers, frontend loaders, trucks, and scapers. The second project was designed to reduce noise emitted by the pneumatic stoper drill. Field evaluations were conducted to determine the effectiveness of muffling systems developed by various manufacturers.

Current Activity

Although the Mine Safety and Health Administration (MSHA) does no research, its Technical Support Center does carry out demonstration projects. A current project that might find application on construction sites concerns demonstration of the use of resonators to increase the attenuation achieved by barriers. One characteristics of this technology that may limit its applicability is that it is best used on large stationary equipment that contains pure tone components, such as transformers and pumps.

DEPARTMENT OF INTERIOR

The Bureau of Mines (BOM) conducts noise R&D to develop the technology necessary to reduce the occupational health, safety and environmental problems associated with coal, metal, and non-metal mining operations. It should be noted that Figure 7.1 underestimates the contribution of BOM to construction noise RD&D because it was impossible to allocate specific funds to particular projects. In general, about one-third of BOM's $2.5 million annual noise RD&D budget is applicable to construction.

Scope of Past Efforts (FY 1975-78)

Research has been directed primarily at reducing noise at its source in existing equipment. Research efforts have been directed primarily on identifying existing problems and developing retrofit techniques to control the noise. The cooperation of both the manufacturers and coal companies is usually sought because of the high cost and limited availability of mining machinery. Some of the noise control technology developed that is applicable to the construction industry includes the reduction in noise levels of the stoper drill (a tool somewhat similar to the jackhammer) from 120 dB to as low as 107 dB. This technology has been adopted commercially in an available noise control retrofit kit.

In addition to the stoper drill retrofit efforts, BOM conducted research to reduce stoper noise through redesign. Prototype models were built to demonstrate the noise levels of 95 to 100 dB.

Current Efforts

The Bureau of Mines (BOM) sponsors a great deal of noise research, and, since some types of equipment are used in both mining and construction, it is reasonable to expect that some of the noise control technology developed by BOM would be applicable to the control of noise at construction sites. Three projects have been identified that may yield information useful for construction equipment. One project involves compiling a noise control handbook for the mining industry. The handbook will provide both general noise control techniques and detailed examples of mining machinery to which noise control technology has been successfully applied. Another project involves development of design concepts for noise control. The emphasis in this project is the development of design concepts that will be incorporated into future generations of equipment. A third project involves the design, development, and demonstration of noise control technology to percussion rock drills. Some aspects of the technology developed in the course of this project may be applicable to pavement breakers. The projects of BOM merit a careful review, for there may be technological advances whose applicability to construction equipment is not obvious from a brief summary.

DEPARTMENT OF TRANSPORTATION

The Department of Transportation (DOT) has a mandate to undertake research and development relating to transportation, including noise abatement. The department administers large trust funds which finance the construction of highways and urban mass transportation systems. Construction of these systems impact surrounding communities.

Scope of Past Efforts (FY 1975-1978)

The DOT program in the construction area - carried out by the Office of Noise Abatement and the Federal Highway Administration focused on the transfer of demonstrated truck noise abatement technology to construction equipment and the development and dissemination of guidelines for measurement, prediction and mitigation of highway construction noise for use by community planners and interested groups and individuals who must deal with such problems.

The Office of Noise Abatement was disbanded in early 1979.

Current Efforts

The Federal Highway Administration (FHWA) and ONAC have a cooperative project for analysis and abatement of highway construction noise. A major part of this project is the development and validation of a noise prediction model. The model will provide the following capabilities: reliable prediction for fenceline and community noise levels by personnel with minimal acoustical training, noise prediction techniques for use during project planning and bidding phases, evaluation of noise abatement alternatives involving equipment selection and usage, evaluation of noise abatement alternatives involving scheduling and existing of activities, and propagation characteristics prediction over varied terrain including barriers and vegetation. Detailed source emission levels and time and motion (duty cycle) data for individual pieces of equipment will be included in the bank of data for the model. Algorithms have been developed for point, line, and area noise sources, and geometrical formats of sources have been developed. The model will be verified by independent measurements at the boundry of a construction site.

Several demonstrations are also part of the project. The effectiveness of earth berms will be demonstrated and evaluated. A portable concrete breaker with and without an exhaust muffler and both compressors that do and do not meet the EPA noise emission standard will be demonstrated. Further, the effectiveness of replacing mufflers and erecting enclosures for stationary equipment will be demonstrated.

DEPARTMENT OF DEFENSE

The U.S. Army Corps of Engineers is responsible for the construction of Army bases and Air Force bases and for the U.S. Army Civil Works Program. The Army Civil Works Program involves such activities as the dredging of habors and rivers, construction of dams for electric energy and flood control, and other activities.

The Construction Engineering Laboratory (CERL) under the U.S. Army Mobility Equipment Research and Development Command (USMERADCOM) conducts research on many different aspects of noise, providing support to the Army for both the military operations as well as the civil works projects. CERL is the only activity within DoD engaged in noise research relating to the construction area. CERL's R&D has addressed specific noise sources involving construction related equipment such as dozers and diesel generators.

Scope of Past Efforts (FY 1975-1978)

Some of the projects completed in the FY 1975-1978 period include the reduction in noise levels of rough terrain forklifts at the operator positions to 90 dB. Retrofit kits have been developed for the forklifts and also for wheeled dozers.

Current Efforts

A cooperative demonstration project with the participation of the Construction Engineering Research Laboratory (CERL) and ONAC has recently been completed. The pile driver was selected as the type of equipment to be demonstrated, and several important results were obtained. L_{eq} was decreased by about 10 dB by means of retrofit controls, and an additional 2 dB benefit was obtained by using a vibratory piledriver. In addition to technical results, it was also found that: the bid document can be used to require noise control measures; a contractor can prepare noise abatement measures without extensive instruction or using a consultant; a contractor can provide reasonably accurate estimates of the cost of noise control, and a contractor with little expertise can design and build noise abatement enclosures for equipment.

CERL has two projects concerned with impulse noise. One project concerns the development of techniques for shielding structures from impulse noise, and the other project is an investigation of the use of aqueous foam to attenuate blast noise.

DEPARTMENT OF COMMERCE

The Department of Commerce (DOC) conducts noise R&D through the National Bureau of Standards. 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 the Noise Control Act of 1972.

The NBS role is unique in that its mission is primarily restricted to addressing questions about the validity and adequacy of measurement procedures.

Scope of Past Efforts (FY 1975-1978)

Recent work has been directed at determining the adequacy of present noise measurement standards and in providing technical assistance to EPA to support the development of regulations for specific noise sources. Specifically, NBS has provided:

- Measurement methodology for portable air compressor noise
- Evaluation of existing data bases and measurement procedures for six major noise sources including bull dozers and loaders

- Measurement of impulsive noise emission of pavement breakers and work drills
- Evaluation of alternative measurement techniques for characterization of asphalt surface acoustic properties
- Identification of difficulties or ambiguities in measurement by using different methodologies.

Current Activity

No activity was reported which directly relates to construction noise.

DEPARTMENT OF HEALTH AND HUMAN SERVICES

National Institute of Occupational Safety and Health (NIOSH)

NIOSH conducts research and demonstrations related to the safety and healthfulness of working conditions through its systems of grants and in-house research. Contract work is done only to disseminate information on noise control technology. With respect to noise, the NIOSH effort is directed toward protecting the hearing of industrial workers.

Scope of Past Efforts (FY 1975-1977)

Noise reduction efforts during this period were for the most part directed at four industrial noise sources, one of which was pneumatic tools. These studies identified noise sources, mechanisms of noise generation, and methods of noise control. Major efforts were directed toward the textile noise problems.

Current Activity

No R&D activity was reported which relates to the construction industry.

FOREIGN NOISE RESEARCH IN CONSTRUCTION EQUIPMENT

EPA/ONAC Survey of Foreign Noise Research

In December 1977, EPA/ONAC published the results of a survey of foreign noise research in machinery and construction equipment.[2] The emphasis was on research and not laws and regulations.

The information was collected by means of inquiries to foreign noise contacts, both individuals and organizations. The contacts were queried about their research activities and the names of other individuals or organizations that they were aware of who might be involved in pertinent noise research. These referrals were then contacted to ascertain their national efforts. In addition, inquiries were made at the Ninth International Congress on Acoustics, July 1977, in Madrid, Spain. In total, approximately 1300 requests were made. The foreign researchers were asked to respond with information on their noise abatement research projects that have been completed since January 1976, are in progress, or are planned. Among the several technical areas about which information was solicied was one relevant to this report, i.e., "machinery and construction equipment noise source control technology."

In almost all the 20 countries from which information was obtained, the majority of the research was government sponsored. In the Socialist countries such as East Germany and the USSR the government sponsorhip rate is 100%. Australia, Denmark, Japan, the United Kingdom, and West Germany showed levels of private sponsorship that are possibly significant.

Only a few projects have been reported on earthmovers and related equipment. Of note is a study in Japan in which a hydraulic power shovel was quieted from 70 dBA to 55 dBA at 30m distance. In West Germany, The Institute for Construction Machinery conducted a project on low-noise excavation techniques for urban application. There were also two studies on forest vehicles from West Germany, and a Polish study which includes quieting of earthmovers.

2/ Foreign Noise Research in Machinery/Construction Equipment, December 1977, Office of Noise Abatement and Control, U.S. Environmental Protection Agency, Washington, D.C., EPA 550/9-78-302.

Research on compressors was reported from Japan, United Kingdom, West Germany, Australia and the USSR. The studies related to the use of silencers, resilient mountings and screening for noise and vibration. Most of the projects in this area were developed and demonstration oriented. Kobe Steel, Japan has acoustically treated a compressor reducing its noise level from 78 dBA to 62 dBA, at an additional cost to 50 to 100 dollars. In Australia, Comp Air, Ltd., has marketed a line of mobile air compressors silenced from 75 dBA to 70 dBA. In the United Kingdom, Compair Industrial, Ltd., was developing an enclosed and acoustically treated compressor plant to give an average sound pressure level of 70 dBA. In West Germany silo compressors and axial-flow compressors were being studied.

A number of reported projects dealt with noise abatement at general construction sites, in the concrete industry and at track laying sites. Pile drivers were being studied in Japan, the Netherlands, West Germany, and the United Kingdom. According to a Japanese report there was a 30 dBA reduction achieved by using a cover on a pile driver. In the United Kingdom, the Building Research Establishment was working on a quiet pile driver, nibbler, and dumper. The Institute of Sound and Vibration was studying propagation of noise from pile drivers. Two projects from Denmark were concerned with the concrete industry, and a Germany study involved rail ballasts. In the USSR, a universal plant for molding concrete into various products was constructed with noise levels of 93 to 96 dBA. There were also a number of studies on construction site noise prediction and measurement and the collection and assessment of data for regulatory purposes.

Jackhammers and drills were considered the worst noise offenders and difficult to quiet. Projects specifically concerned with the development of low-noise hammers and drills were reported from Australia, France, the USSR, and West Germany. In France, the INRS has shown that a noise level of 96 dBA can be obtained with acoustical treatment, and they have plans to develop a quiet hammer in conjunction with a manufacturer.

Two research projects from West Germany dealt with noise abatement of engines by such methods as exhaust damping of chain saw motors and by applying material to the walls and covers of engines to isolate them from inner power transmitting parts.

VIII. SURVEYS OF CONSTRUCTION NOISE TECHNOLOGY AND IMPLEMENTATION NEEDS

This section provides a summary of the opinions of knowledgeable individuals, both in the Federal government and in the construction industry, on construction noise technology needs. The purpose for investigating technology needs is to identify areas where initiatives of the Technology and Federal Programs Division (T&FPD) would have the greatest beneficial effect on implementation of noise control technology in construction activity. Thus, the most promising areas for T&FPD initiatives will be found where there exists a technology need or where there has been insufficient implementation of available technology. The information on technology needs has been gathered from the EPA Office of Noise Abatement and Control sponsored Noise Technology Research Symposium, which included a workshop on machinery and construction equipment; discussions with the personnel in Federal government departments and agencies who have been directly involved in construction noise control RD&D, and a survey of representatives of the construction equipment manufacturers, the equipment operators, and noise consultants. A rationale for developing implementation needs is given in Appendix F.

NOISE TECHNOLOGY RESEARCH NEEDS SYMPOSIUM

The findings of the January 1979 Machinery and Construction Workshop indicated that the following activities should be undertaken by the Federal Government:[1]

[1] Noise Technology Research Needs and the Relative Roles of the Federal Government and the Private Sector. EPA 550/9-79-31, May 1979.

- Conduct high-risk research, (coordinate with private sector)
- Provide technical coordination of demonstrations
- Coordinate research activities within the government and between government and the private sector; establish joint research planning committee with representatives from Federal Departments and Agencies, universities, and industries
- Conduct noise research on needs unique to government, e.g., DOD
- Collect and disseminate information, e.g., establish center for coordination with a technical information center
- Major types of equipment and processes for which further noise source control RD&D efforts are necessary include:
    - Work tool interface (rock bit striking rock)
    - Internal combustion engine (diesel and gasoline)
    - Back-up and forward warning systems.

SURVEY OF FEDERAL DEPARTMENTS AND AGENCIES

Federal departments and agencies that would be presumed to have an interest in control of noise generated by construction activity were surveyed to determine whether such an interest does in fact exist, and, if the interest exists, what needs are felt with respect to the development or demonstration of noise control technology. The list of persons contacted is included in Appendix B.

Housing and Urban Development (HUD)

HUD has no programs in control of noise produced by construction activity. It is the consensus of HUD that the transient nature of construction work prevents it from becoming a serious environmental problem, except when there are large scale projects near schools, hospitals, or high density residential areas. The largest number of complaints involve subway and highway construction and street maintenance. It was felt that the most troublesome activities involve earthmoving, trucks, and blasting. The Chelsea, MA energy efficient, quiet home project could be used to demonstrate quiet construction site techniques.

Federal Highway Adminstration (FHWA)

There was interest expressed in developing a manual for the application of noise control technology to highway construction, and interest was expressed in further demonstrations of noise control technology of the type recently conducted by EPA and FHWA. Future demonstrations will have to be increasingly thorough if they are to have a beneficial effect on the practice of constructing highways.

Construction Equipment Research Laboratory (CERL)

CERL feels that the principal technology needs lie in the areas of control of noise from impulsive sources, pile drivers, pavement breakers, jack hammers, rivet guns and blasting. Of these sources, pile drivers are the most important because they are the least transitory and most widely used. Pile drivers are used at the vast majority of large construction sites and their activity may continue for as long as two or three months. The technical feasibility of several abatement techniques was demonstrated in a joint EPA/CERL project, but the longevity of the techniques and their cost have not been evaluated. Further, the operational procedures needed to accompany the use of the abatement techniques has not been fully developed and learned by the construction workers.

Bureau of Mines (BOM), Department of Interior

The principal technology needs felt by BOM are to determine what are the noise generating mechanisms in machinery and to determine how to design machinery to eliminate them.

Tennessee Valley Authority

TVA feels that its strongest technology need in construction work is noise generated by heavy equipment, for they have no effective way of dealing with it at present.

National Bureau of Standards (NBS), Department of Commerce

NBS has no programs and no plans for programs in the noise control technology for construction equipment, although there is some interest in urban noise propagation.

Occupational Safety and Health Administration (OSHA), Department of Interior

OSHA feels that the most important sources from point of view of occupational health are wheel and crawler tractors and rock drills. There are also problems with improper operation of air compressors, but they felt the situation could be remedied.

Office of Noise Abatement and Control/EPA

Individuals in the several divisions of ONAC were contacted to obtain their views on construction noise technology needs. These individuals described needs on a variety of items including the development of a construction equipment noise control handbook which would document current technology and could be used in conjunction with the Urban Noise Program; research and demonstration of the applicability of quiet truck technology to construction equipment; research on increasing the effectiveness of the air compressor regulation by improving maintenance and ensuring proper use; the development of dynamic test measurement methodology for mobile construction equipment; development of strategies for quieting construction site noise; development of retrofit kits where there is excessive operator noise exposure; updating the data base for the Construction Noise Impact Model; reducing the noise from back-up warning signals; publishing a report on testing methodology for construction equipment labeling, and improving the exhaust (mufflers) systems which are hard to maintain.

A summary of the technology needs expressed by knowledgeable individuals with the Federal government is provided in Table 8.1 at the end of this section.

SURVEY OF EQUIPMENT MANUFACTURERS AND USERS

During August 1980, a limited telephone survey was conducted of the following to determine their views of the following on construction noise technology needs:

- Construction equipment manufacturers
- Construction equipment users
- Noise consultants
- Construction trade organizations.

A summary of the technology needs as expressed by those contacted is provided here. Appendix C provides a more detailed report on the survey and a listing of the organizations and persons contacted.

Equipment Users

Mufflers. Engine exhaust mufflers do not stand up well in the field. Too often supervisors on the site are unwilling to shut the equipment down for replacement. Some users felt that insufficient muffling was being employed by manufacturers in order to minimize back-pressure.

Noise Baffles. Where noise baffles are employed, they are generally removed to permit lubrication or other service and not replaced.

Cooling Fans. Many users felt that a large diameter fan could be run at a slower speed to reduce noise.

Noise Barriers. Techniques have been developed for the effective use of noise barriers around sites but they are not in widespread use.

Noise Measurement. ANSI Spec J-88 is felt to be too complicated for general site use although it may be suitable for type-test measurement at an equipment vendor's plant. A considerably simpler procedure is needed.

Noise Consultants

The comments for two noise consulting firms were to the effect that the equipment they had the occasion to survey for noise emissions generally complied with the manufacturers' or users' specifications if they were adequately maintained (underscoring added).

Trade Organization Comments

The general criticism was received that too often equipment does not stand up under site conditions and that probably the manufacturers could solve present maintenance problems but hesitate to do so because of increasing costs in a highly competitive industry.

Equipment Manufacturers

The consensus among the manufacturers is that they are now producing equipment to the state-of-the-art; that they could effect some reduction by known add-ons which would add cost and weight but no technology breakthroughs are anticipated. One company indicated some interest in a joint project with EPA to develop an improved muffler.

Summary

Technology needs expressed by the equipment manufacturers and users can be summarized as follows:

- Improve equipment maintenance practices and reduce tampering with noise suppression devices
- Develop and provide a simpler noise test measurement standard
- Reduce cooling fan noise
- Development and demonstration of improved engine exhaust mufflers (possibly a joint project with EPA)
- Demonstrate construction site noise control integrated with effective time and budget controls
- Reduce the cost and weight of noise suppression devices.

SUMMARY OF TECHNOLOGY NEEDS

The construction technology noise needs which summarize the views of the participants in the EPA Noise Technology Research Symposium in January 1979 and those of personnel in government and industry as expressed in August 1980 are listed in Table 8.1. With a list of technology needs now in hand, it is possible to examine it to determine which of them could be met in some measure by increasing implementation of existing technology.

Appendix F describes a method that was developed to isolate methods of noise control that have received little implementation and the actions that could be taken to achieve more widespread implementation. Some of the methods of control listed in Appendix F (p.F-10) are:

1. Maintenance procedures
2. Equipment enclosures
3. Operator techniques
4. Sequencing of operations
5. Site access (truck routes).

Of the control methods and actions listed in Appendix F, only those applicable to the technology needs under discussion are repeated here. These methods will be cited by the numbers associated with them in discussing the technology needs.

Of the technology needs given in Table 8.1, the following have the characteristic of available technology that has been insufficiently implemented.

Quieting Internal Combustion Engines

Technology has been developed for control of cooling fans, but it has yet to find widespread implementation on construction equipment.

Develop Manual for Construction Equipment Noise Control Technology

Such a manual would at least encourage implementation of technology, for it would be a source of what technology is available and how to apply it.

TABLE 8.1

SUMMARY OF CONSTRUCTION NOISE TECHNOLOGY NEEDS

RESEARCH NEED	TECHNOLOGY RESEARCH SYMPOSIUM	FEDERAL AGENCIES	EQUIPMENT MANUFACTURERS/ USERS
1. Establish joint research planning committee	X		
2. Establish Center for Coordination, including a technical information center	X		
3. Reduce work-tool interface noise, i.e., bit striking rock	X		
4. Quieting internal combustion engines	X	X	
- mufflers		X	X
- cooling fans			X
5. Back-up and forward warning systems	X		
6. Reduce construction noise in high density urban areas, e.g., subway, street maintenance etc.		X	
7. Quiet heavy trucks, mixers		X	
8. Quiet earthmoving equipment		X	
9. Reduce blasting noise		X	
10. Develop manual for construction equipment noise control technology		X	
11. Demonstrate quiet construction site techniques		X	X
12. Improve maintenance on noise suppression devices, e.g., compressors, mufflers		X	X

TABLE 8.1 (Continued)

RESEARCH NEED	TECHNOLOGY RESEARCH SYMPOSIUM	FEDERAL AGENCIES	EQUIPMENT MANUFACTURERS/ USERS
13. Demonstrate effectiveness of noise barriers at construction sites			X
14. Develop manual for quieting construction site, integrated with scheduling and budget constraints		X	X
15. Develop and demonstrate retrofit kits where there is high operator exposure		X	
16. Update data base for Model		X	
17. Reduce cost and weight of noise suppression devices			X
18. Develop methods to reduce tampering (removing) noise suppression devices		X	X
19. Reduce impulse noise emissions (pile drivers, paving breakers, rock drills, rivet guns, and blasting)		X	
20. Develop and publish dynamic testing methodology		X	
21. Develop and publish testing methodology for labeling construction equipment		X	
22. Develop simpler noise measurement standard (than ANSI Spec. J-88)			X

Develop Manual for Quieting Construction Site Integrated with Scheduling and Budget Constraints

To be convincing, such a manual would have to incorporate cost and operational data provided by long-term demonstrations on full-scale construction jobs.

Demonstrate Quiet Construction Site Techniques (3, 4, 5)

This need primarily concerns how the job is organized, how it is performed and the use of equipment barriers. Data from such techniques would provide information necessary for compiling the manual listed in the immediately preceding item.

Improve Maintenance on Noise Suppression Devices (1)

Demonstrations of maintenance costs and benefits in decreased noise levels would provide solid information on a problem that is now primarily an area for speculation.

Demonstrate Effectiveness of Noise Barriers at Construction Sites (2, 3)

Two problems that require particular attention in this connection are the development of convincing cost and durability data on the use of enclosures and the development of techniques that will enable workers to get their jobs done efficiently when barriers are present.

Develop and Demonstrate Retrofit Kits Where There Is High Operator Exposure

BOM has developed detailed plans for retrofit barriers that can be installed on all major models of bulldozers. A demonstration of this type of retrofit directed to the construction industry could have a salutary effect on operators. Similar retrofits could be developed and demonstrated for other types of equipment.

In the next section, we will describe the technology initiatives which could be undertaken in the FY 1981-85 time period by the Technology and Federal Programs Division in response to the technology and implementation needs expressed in this section.

IX. CONSTRUCTION NOISE TECHNOLOGY INITIATIVES

This section is divided into two parts. The first part outlines the framework of an ONAC Construction Noise Control Technology Program and describes major goals and objectives. The second part briefly discusses how the specific projects were developed based on the technology needs described in Section VIII and the ONAC goals and objectives. This section is concluded with a brief description of a priority ranking scheme that was developed to assign a relative priority to each project and a listing of the priority projects.

CONSTRUCTION NOISE CONTROL TECHNOLOGY PROGRAM

In developing projects that would reflect the technology needs described in the preceding sections, and at the same time to contribute toward the achievement of ONAC goals and objectives, the first step is to identify the goals and objectives of the ONAC construction noise control technology program.

Goals and objectives described below are based on the missions and functions assigned to ONAC by the Noise Control Act of 1972 as amended by the Quiet Communities Act of 1978 which were discussed in Section I.

Program Goals

The overall goals of the Construction Noise Control Technology Program are to:

- Reduce the number of people living in areas exposed to outdoor levels of L_{dn}75 dB and above from construction activity to zero as soon as possible but not later than the year 2000.
- Reduce the number of people living in areas exposed to outdoor levels of L_{dn}65 dB and above (but not L_{dn}75 dB or greater) by 20% from 1979 levels by the year 2000.

Program Objectives

The following are the specific objectives to be carried out to achieve the program goals described above:

- Demonstrate equipment noise reduction through development of new equipment designs, retrofitting of existing on-site equipment, and by impeding equipment degradation
- Demonstrate construction site noise control through sound path modification; and preferred positioning and routing of construction equipment
- Demonstrate alternative construction processes, operational techniques, and scheduling to minimize construction noise impact.
- Develop construction incentives such as the use of contractual specifications and performance specifications for the "Buy Quiet" Program in order to minimize construction noise impact
- Develop, maintain and validate construction noise impact models to evaluate the effectiveness of construction noise reduction techniques
- Establish and support a national coordination and technical information center for construction noise control to provide state and local officials,

public interest groups, construction contractors, and consulting engineers with information concerning the noise problems and the alternative solutions

- Coordinate all Federal construction noise RD&D and noise control programs; conduct and publish a biennial assessment of the status and progress of Federal activities relating to construction noise research and noise control.

<u>Program Structure</u>

The structure of a construction noise control technology program that is designed to achieve the goals and objectives set forth above is depicted in Figure 9.1. This structure also reflects the methods which are available for the control of construction site noise; development of incentives to the manufacturers and construction contractors to reduce noise levels; development, validation and maintenance of models to evaluate the effectiveness of construction noise techniques; information dissemination; and program coordination and assessment. The program categories shown in Figure 9.1 are described below:

- Quieting the noise source (WBS 1000)
- Interrupting the path of noise from source to receiver (WBS 2000)
- Use of quieter construction techniques, processes, and other strategies (WBS 3000)
- Development and use of incentives to reduce noise levels (WBS 4000)
- Development, validation and maintenance of construction noise impact models (WBS 5000)
- Dissemination of noise control information (WBS 6000)
- Coordination and assessment of Federal noise control RD&D (WBS 6000).

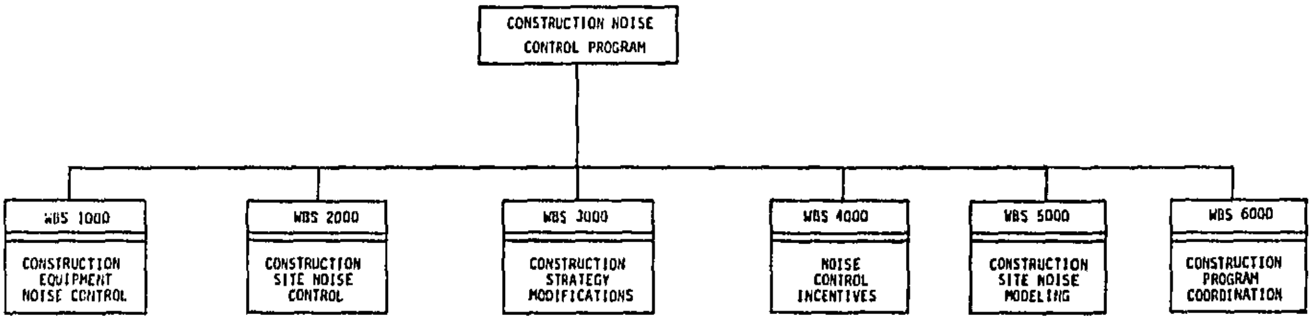


Figure 9.1. EPA Construction Noise Program Structure

TECHNOLOGY INITIATIVES

To develop the technology initiatives each member of the ORI project team was asked to list the construction noise control technology initiatives that should be undertaken by ONAC based on their interpretation of the technology needs reflected in the previous sections of this report. The result was a list of 29 initiatives shown in Table D.1 in Appendix D. The next step was to prepare a project description for each initiative which includes the justification of need, expected payoff, scope, estimated cost and period of performance. These project descriptions are included in Appendix D.

The next step was to assign a relative priority to each project. The method used to assign a priority to each of the 29 projects is described next.

Priority Ranking

A simple and somewhat subjective ranking procedure was devised to assign a priority to each project.

If a project is required by the Noise Control Act, it is assigned to highest priority - A, and a weight of 5. The following ranking criteria and weights were used:

	WEIGHT
• Supports new equipment regulations	2
• Top 5 in level weighted population impact (Table 2.6)	2
• Continues current T&FD project	2
• Needed by ONAC division (other than S&RD and T&FD)	2
• Possible interagency agreement in FY 1981	2

	WEIGHT
• Extends research of another Federal agency	1
• Supports labeling standards	1
• Implementation need (Appendix F)	1

Each project was assigned a priority, A, B, C, D, or E based on the following scores:

A - Required by NCA

B - 7 or 8

C - 5 or 6

D - 3 or 4

E - less than 3.

Table D.2 in Appendix D shows how each project was scored and the priority assigned. The projects which ranked A, B and C are listed in Table 9.1. The development of a low noise back-up warning device is included in Table 9.1 because of the high degree of annoyance caused by these devices. The machinery and construction equipment workshop specifically mentioned this project as a priority research need. It is also the opinion of the ORI project team that this project should be included in the top ten technology initiatives.

Functions of Technology and Federal Programs Division

There was one additional screen that had to be considered. As stated in Section I, the purpose of this report is to develop and rank order a list of technology initiatives that fall within the mission and functional responsibilities of the Technology and Federal Programs Division. The results of this final screen are described next.

Under the Noise Control Act of 1972, EPA was mandated to:[1/]

[1/] EPA, Noise Control Program-Progress to Date, April 1979.

TABLE 9.1

PRIORITY LISTING OF TECHNOLOGY PROJECTS

(Priorities A, B and C)

Priority	Project Title	Est. Cost $(000)	Ref 1/
A-7	Coordinate and Assess Federal Construction Noise RD&D and Noise Control Programs	30	D-60
B-8	Conduct Demonstration on Pile Driver Noise Control	120	D-4
B-8	Develop and Publish Guidelines for Construction Site Noise Control	50	D-38
B-7	Demonstrate Cooling System Noise Reduction in Construction Equipment	65	D-26
B-7	Investigate Maintenance Requirements and Procedures	65	D-24
B-6	Develop and publish Engineering Noise Control Handbook(s) for Construction Industry	200	D-34
C-6	Conduct Feasibility Studies and Demonstration Using Quiet Truck Technology on Concrete Mixers and Other Construction Over-the-Road Vehicles	135	D-28
C-5	Develop Site Specific Construction Noise Impact Model	50	D-54
C-5	Demonstrate Construction Site Noise Control Techniques	50	D-40
E-2	Develop Low Annoyance Back-Up Alarms 2/	65	D-12

1/ Page Number in Appendix D.

2/ It is the opinion of the ORI project team that this project should be included in top 10 projects because of high degree of annoyance caused by these devices.

1. Identify major sources of noise
2. Regulate those identified sources
3. Propose aircraft noise standards to the FAA
4. Label noisy products
5. Engage in research, technical assistance and public information
6. Coordinate all Federal noise control efforts.

The Technology and Federal Programs Division is assigned full or partial responsibility for mandates 3, 5, and 6 listed above. For example, the Division carries out the following functions which are relevant to the construction noise technology program:

- Conducts technology research, e.g., quiet truck technology program
- Sponsors noise research technology symposia (e.g., symposium held at Dallas, Texas in January 1979
- Coordinates all Federal noise research and control program by carrying out:
    - Communications and information exchange
    - Joint special studies and demonstration programs
    - Research coordination and assessment
- Prepares reports on status and progress of Federal noise control activities.

Each of the 29 projects listed on Table D.1 was reviewed to determine if that project fell within the responsibilities of the Technology and Federal Program Division (T&FD). The results of this review indicate that each of the projects listed in Table 9.1 falls within the scope of the assigned functions of T&FD.

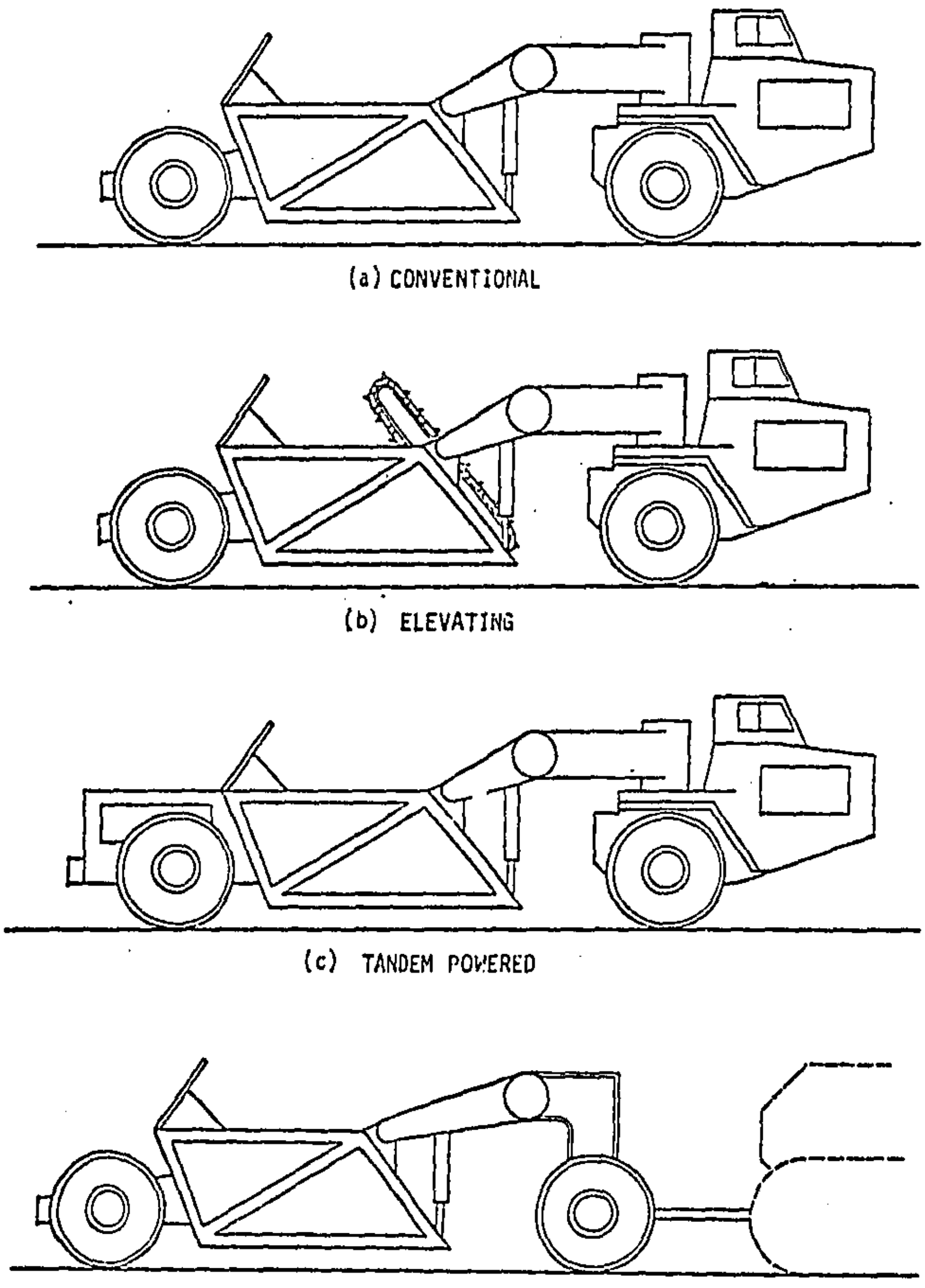
CONCLUSIONS

Based on the demonstrated need to reduce construction site noise and general consensus on technology needs, it is concluded that:

- The Technology and Federal Programs Division should initiate the projects listed in Table 9.1 as soon as available funding permits
- EPA/ONAC should develop and implement a five-year construction noise abatement technology program plan that supplements the current EPA/ONAC "Quiet Communities Five Year Plan, FY 1981-FY 1985."

APPENDIX A

CONSTRUCTION EQUIPMENT



(a) CONVENTIONAL

(b) ELEVATING

(c) TANDEM POWERED

(d) TRACTOR DRAWN

Figure A.1. Scrapers

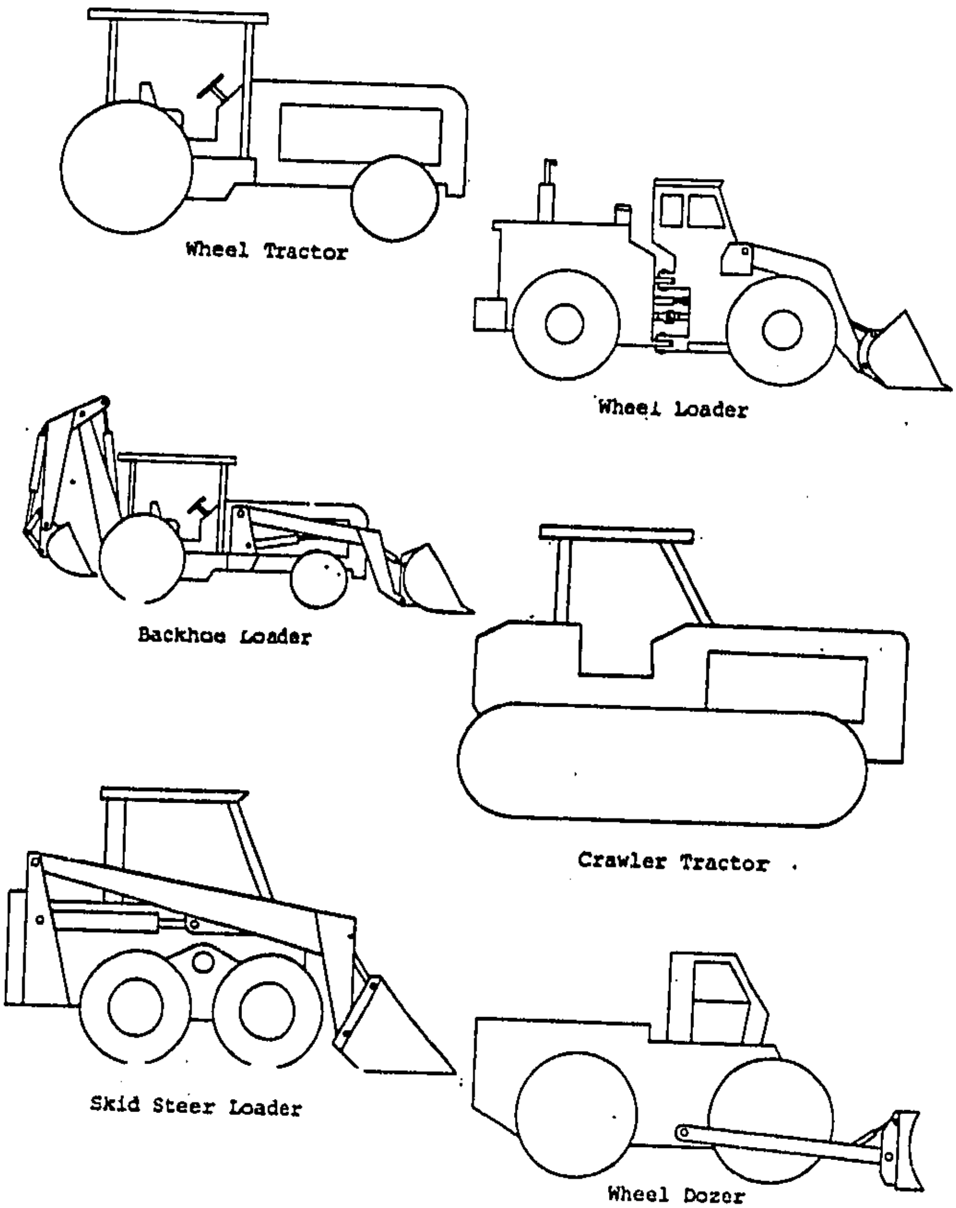


Figure A.2. Line Drawing of Wheel and Crawler Tractor Types

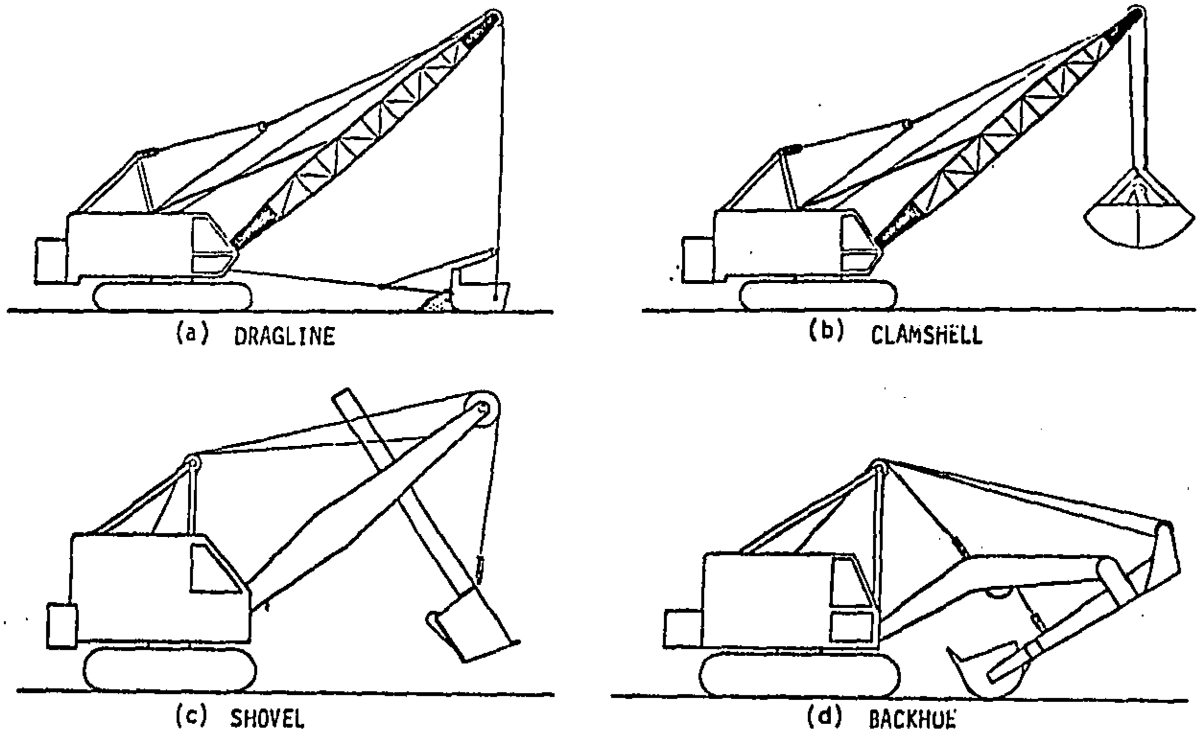
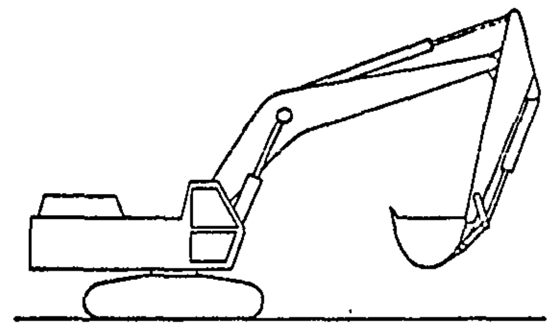
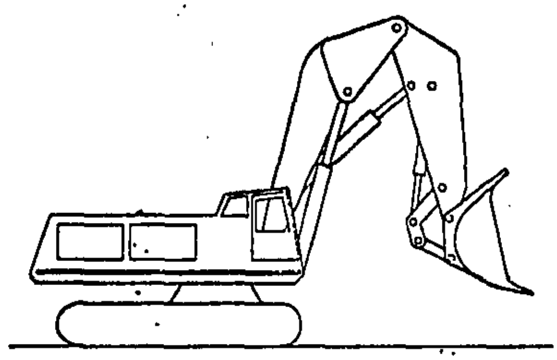


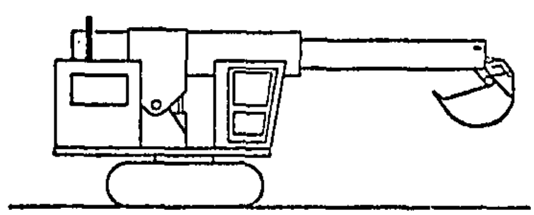
Figure A.3. Cable Operated Excavators



BACKHOE



SHOVEL



TELESCOPING BOOM

Figure A.4. Hydraulic Excavators

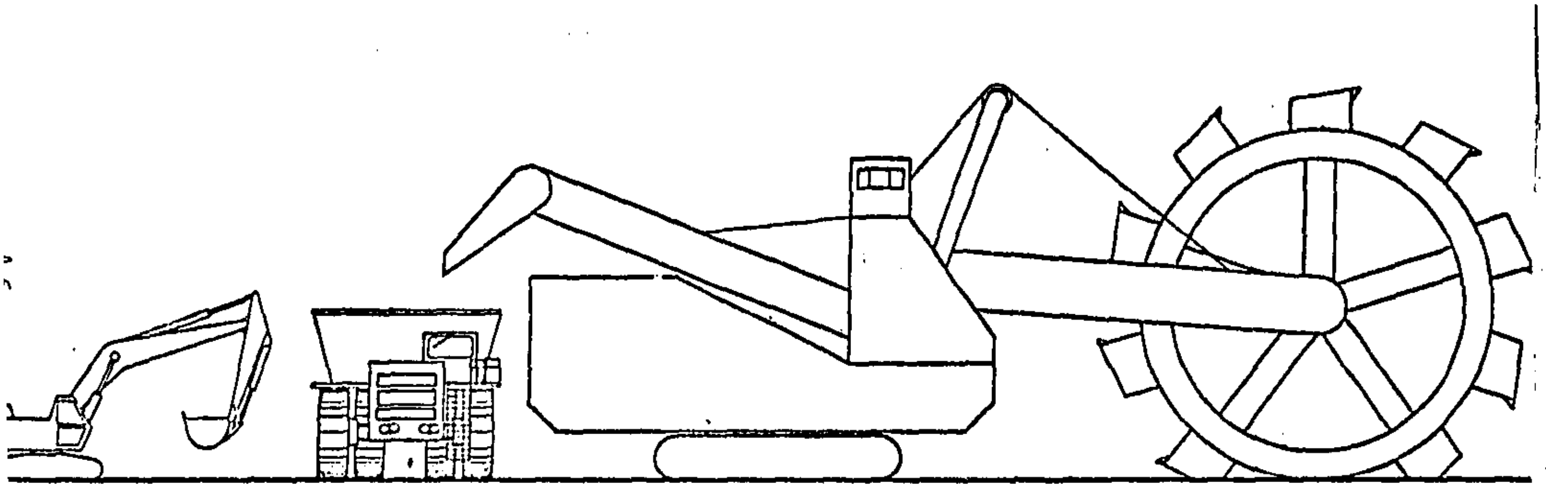


Figure A.5. Wheel Excavator (Excavator and truck for size comparison)

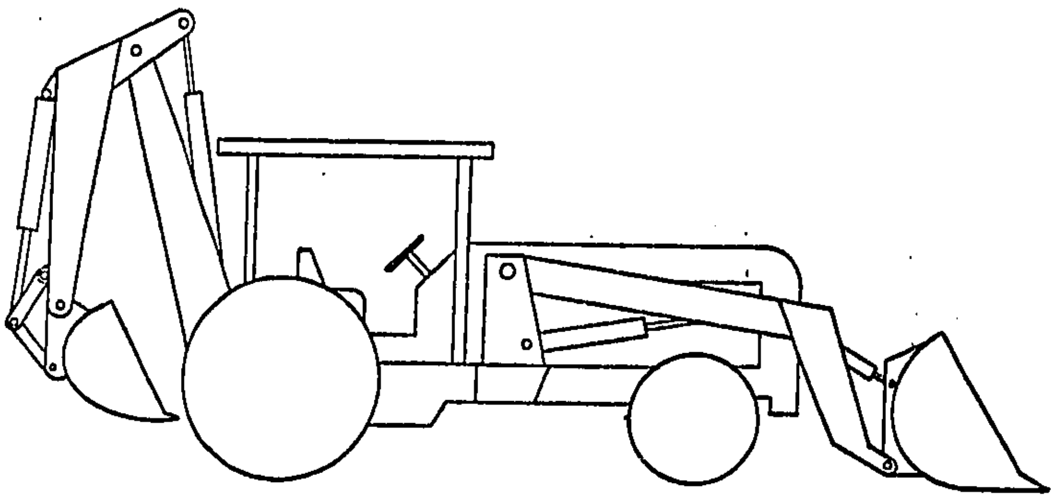
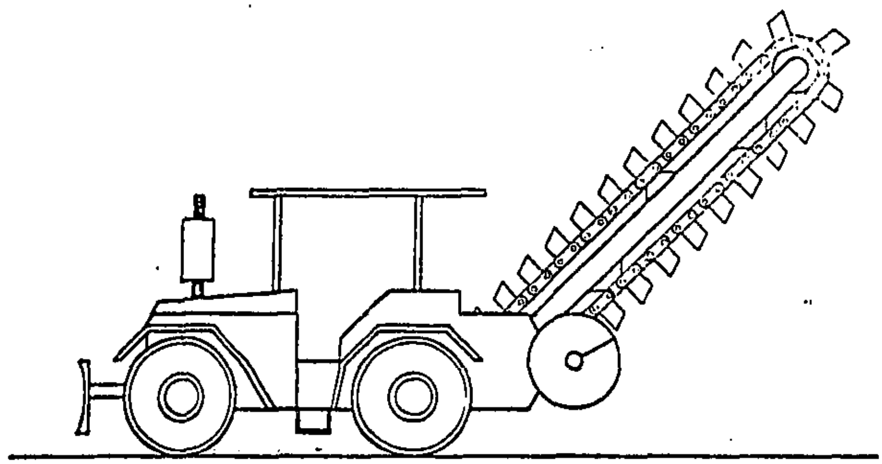
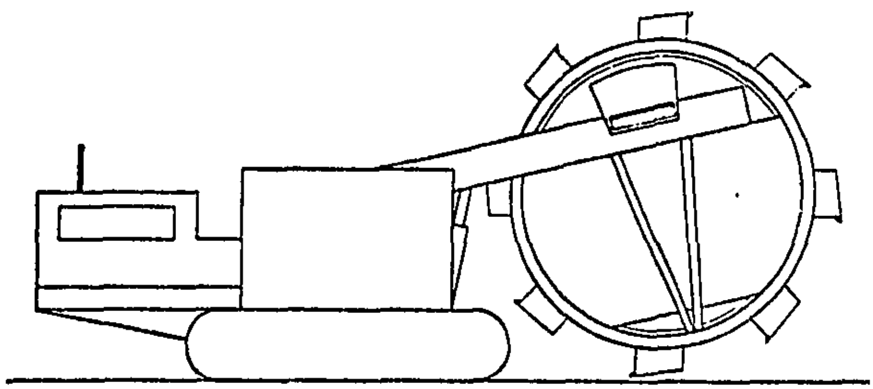


Figure A.6. Integral Backhoe/Loader



LADDER



WHEEL

Figure A.7. Trenchers

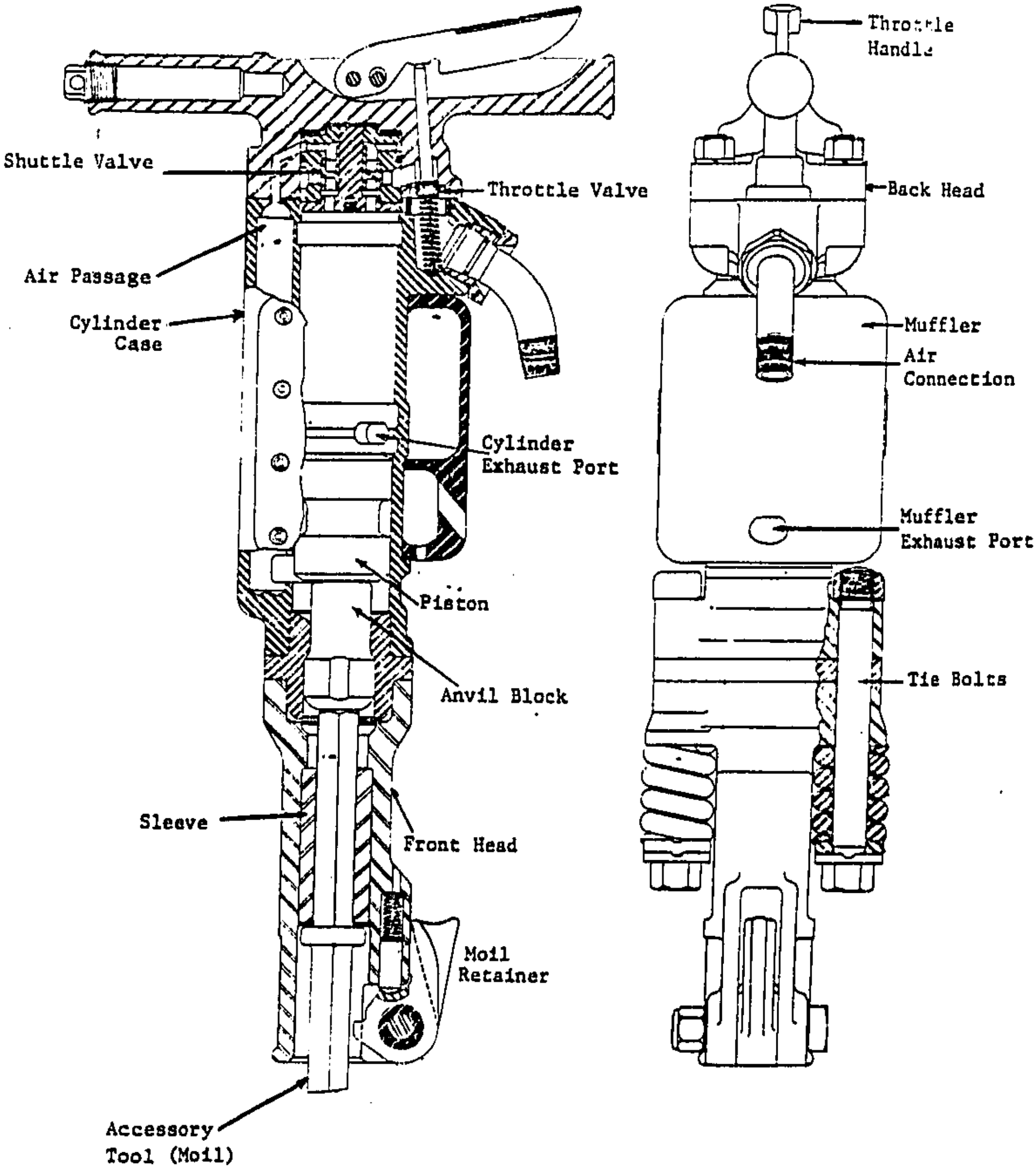


Figure A.8. Schematic of a Portable Pneumatic Paving Breaker
(Courtesy Chicago-Pneumatic)

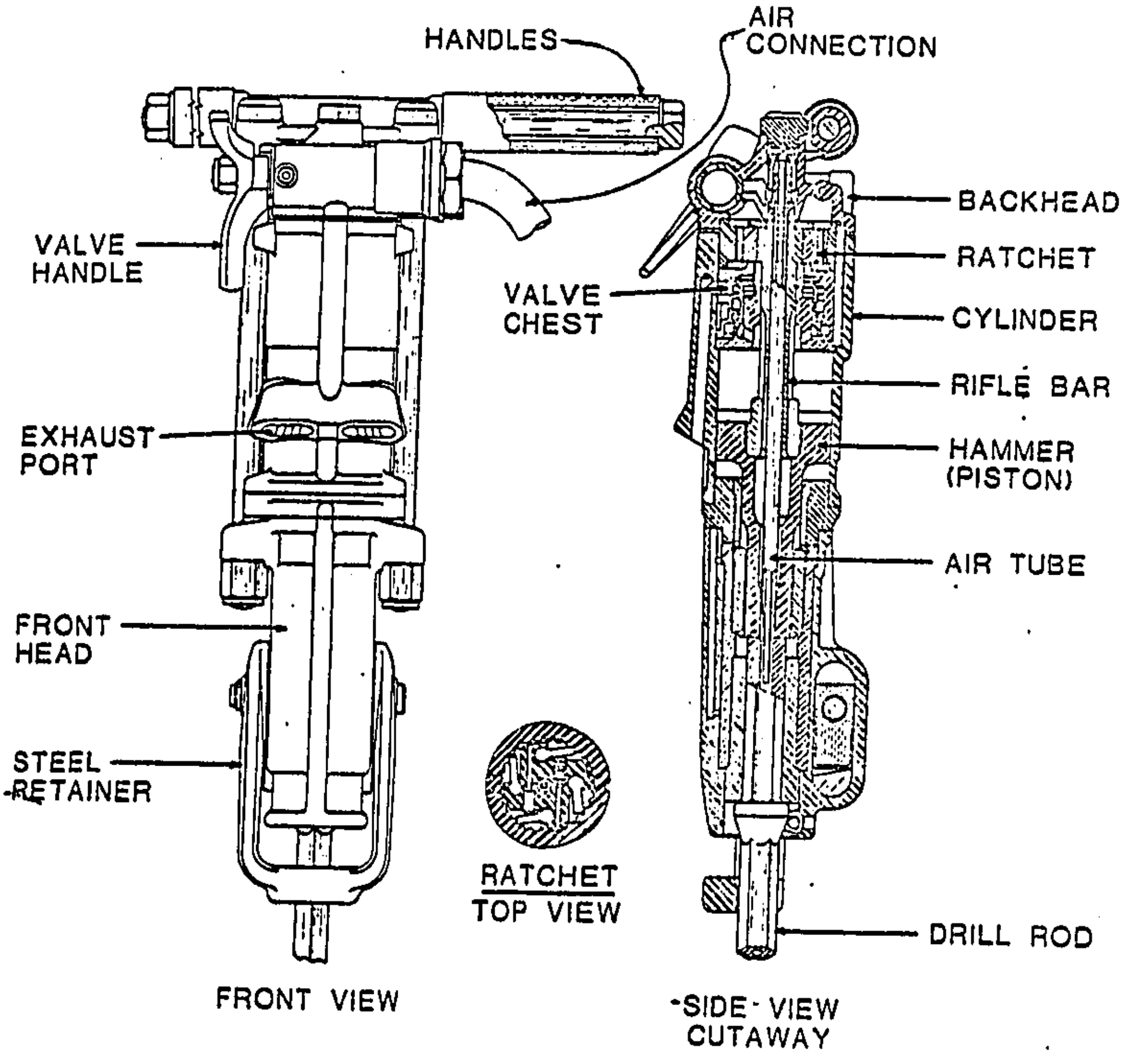


Figure A.9. Portable Pneumatic Rock Drill Schematic

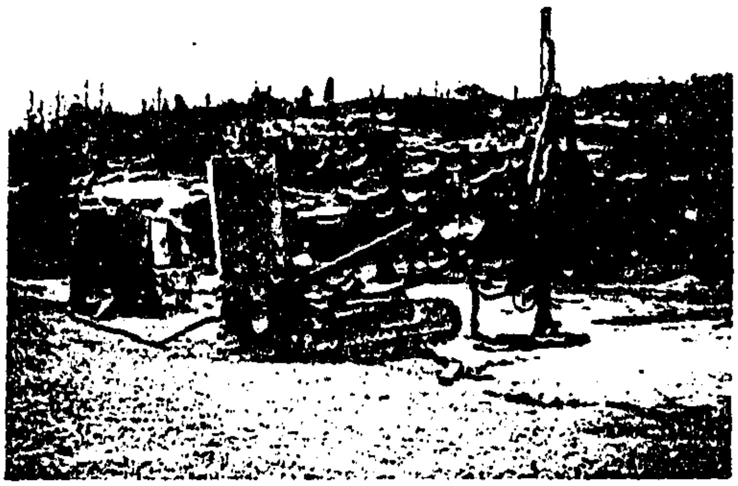


Figure A.10. Mounted Pneumatic Rock Drill
(Ingersoll-Rand URD-550A Drifter)

APPENDIX B

LIST OF CONTACTS IN FEDERAL AGENCIES

APPENDIX B

LIST OF CONTACTS IN FEDERAL AGENCIES

<u>EPA, OFFICE OF NOISE ABATEMENT AND CONTROL</u>

John Fuchs
Damon Gray
Dr. David Mudarri
Dr. Paul Pawlik

<u>U.S. ARMY</u>

Dr. Paul D. Shomer, CERL

<u>DEPARTMENT OF COMMERCE</u>

Fred Rudder, NBS

<u>U.S. DEPARTMENT OF TRANSPORTATION</u>

Fred Romano, FHWA

<u>DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT</u>

James Miller
George Winzer

<u>DEPARTMENT OF INTERIOR</u>

Roy C. Bartholomae, BOM

DEPARTMENT OF LABOR

Raymon G. Kunicki, OSHA
Thomas Tower, OSHA

James R. Petrie, MSHA

TENNESSEE VALLEY AUTHORITY

Charles Thornton

APPENDIX C

SURVEY OF CONSTRUCTION EQUIPMENT MANUFACTURERS AND USERS - AUGUST 1980

TABLE OF CONTENTS

1. Introduction

The following information was compiled from a telephone survey of the following sources most of which were provided by ORI on August 4, 1980:

a) Construction equipment manufacturers
b) Construction equipment users
c) Noise consultants
d) Construction Trade Organizations

The use of a formal set of survey questions was impractical because of the inability to conduct the interviews in a structured manner via telephone. However, essentially the same areas of inquiry were covered with each candidate. The depth of interest in the problem and responses by those interviewed proved to be extremely varied depending on whether the persons consulted had become knowledgeable of the noise problem through engineering experience, site exposure, field maintenance or administrative duties only. A table is included as Figure 1 to present a relative ranking of the responses. A listing is presented of the equipment manufacturers, general contractors, industry organizations and noise consultants who were reached by the surveyor. A listing is included of the firms and individuals who were interviewed.

2. Manufacturers' Initiative

The companies which were surveyed, both equipment manufacturers and users, were very much aware of the noise problem both by way of OSHA regulations to protect their operators and site workers and by way of laws which they encountered at various construction sites, primarily within cities. Almost uniformly the response to the inquiry concerning motivation to reduce the noise of their product received a response that any added equipment would increase the weight, initial cost and cost for servicing the equipment. They would add it only if the customers demanded it in order to comply with Federal, state or local regulations. All were aware that noise regulation in Europe is generally closer controlled, primarily because of more congested living. Some companies, notably Caterpillar Tractor, sell their equipment in that market with an add-on quieting package of better muffler, shields and shrouds which permit the equipment to comply. This package, however, finds little demand in the United States. A photograph of a Caterpillar Tractor is shown as Figure 2.

3. Equipment Manufacturers' Efforts

From the equipment manufacturer point of view, hope for a radical breakthrough is generally extremely doubtful due to the fundamental nature of the problem i.e. "large effort creates loud noise." Although the use of hydraulically generated force is being examined in competition to the use of compressed air, nothing radical has emerged due to the convenience of the air operated devices. In fact, nothing that each company is doing is now proprietary. An example of this is the Quiet Truck Program which is being conducted for United Parcel Service by both Mack Truck Co. and General Motors Truck Div. While they are separate attempts to solve the same problem and have not had detailed joint engineering consultations, both have used the same general approaches to reduce the noise generation and radiation i.e. declutching the cooling fan when the engine temperature allows; using sound absorbing shields under the engine, crankcase and transmission; and wrapping shafts and gear housings with sound absorbing materials.

4. Mufflers

Of great interest was the discussion of engine exhaust mufflers. Some of the users felt that insufficient muffling was being employed by manufacturers in order to minimize back-pressure. Comments were received that more advanced technology was undoubtedly available but was not being used because of cost. On the other hand, the equipment manufacturers stated that they were using the state-of-the-art in mufflers and accused the users of frequently not replacing mufflers when they were removed because of the need for service. Ingersoll-Rand Co., one of the principal suppliers of engine driven air compressors stated that their equipment as well as that of their competitors meets the applicable EPA regulations and in fact is useable in New York City where construction noise is closely monitored. This includes equipment such as air operated drills, pavement breakers and vibrator compactors which they and those companies build. The equipments meet ANSI standards, customer standards, or the company standards. In fact, I-R inspection carry noise meters to check equipment out before releasing it.

In this regard, the practice of the Raymond International Co. is of interest where they have installed very large diameter mufflers called "residential silencers" on equipment which does not have to be mobile i.e. cranes, and obtain excellent noise reduction. These are called Donaldson-Kittell Residential Silencers and are built by the Donaldson Co. in Minneapolis. Closer investigation from Donaldson reveals that their Silencers are used by Caterpillar Co., GM-Terex and others on their very large equipments which can handle the increased size and weight. Donaldson states that the present silencers contain no radically new principals but contain the hot gases until they have expanded to a volume whose release does not create offensive noise levels. They quoted 10-20db noise reduction on certain models. That company is presently investigating the use of more formal acoustic design which may achieve similar results in volumes which are applicable to more mobile equipment. Mr. Julian Imes (Chief Engineer) stated that their company has performed muffler development for the Department of Transportation and may be interested in a jointly sponsored development for the EPA. In this regard, he referred inquiries to Mr. Dale Andersen, Marketing Div.

5. Fans

Of similar nature was the discussion of gasoline engine and diesel engine cooling fans. Many users felt that a large diameter fan could be run at a slower speed and reduce noise. The equipment engineers however stated that a complete redesign of the engine configuration would be required to more completely expose the hot surfaces which in turn may increase the noise which is radiated from the engine block. A response from the General Motors Co. was to the effect that they, if anyone, would know if anything radical would be obtained from their equipment being made in their Terex Div. They advised that nothing new existed.

6. Tampering

Mr. Brittain of Bechtel Corp. stated that some equipment such as mufflers do not stand up too well in the field. This component, handling hot, oxidizing gases, deteriorates fairly rapidly. Too often the supervisors on the site are unwilling to shut the equipment down for replacement. Where noise baffles are employed, they generally are removed to permit lubrication or other service and not replaced. He challenged this interviewer to ride around Philadelphia and note the numerous equipments operating without mufflers. Mr. Rietz on the other hand stated that his company inspectors make regular inspection to insure mufflers and barriers are being used where they are part of the original equipment. These two examples are probably typical of the situation. If a company wishes to expand the manpower to "police" the equipment against tempering, it can at least obtain the performance for which it was purchased.

7. Noise Barriers

Two construction companies mentioned their use of noise barriers. Mr. Michael Gabor of the J. E. Brennemen Construction Co. in Philadelphia, described his company's use of numerous 4x8 plywood sections of a noise barrier which is used in long installations on frames and trailers around certain sites where added precautions are required. While mostly effective at a very low angle, they have proved to be advantageous. Mr. Ben Rietz of the Morrison-Knudsen Co., Boise, Idaho described another approach wherein wooden enclosures, lined with sound absorbent materials are used to enclose noisy equipment - even some pieces that must move. He stated that to his knowledge, this approach was not being employed elsewhere.

8. Scheduling

An inquiry as to the practicability of scheduling the use of noisy equipment met with little favorable response. Some attempts are being made on a day vs. night basis to minimize interference near certain strategic locations, i.e. office buildings. In fact, this seems to be quite frequently employed.

Usually however, the general contractor subcontracts his operation to numerous smaller companies who too often have schedule problems of their own due to maintenance, weather, labor, finances, materials, etc., all of which make overall scheduling a "nightmare." Contractor A may have some leaway in planning his own equipment use but it bears little relation to Contractor B's equipment schedule on the same site. A typical location may have pile driving, grading, and concrete mixing all progressing concurrently by separate subcontractors. Although the general contractor has initially given all of his subs schedules, a project frequently has to be pulled back into line when the subs become too far off schedule.

9. Noise Reduced Site

An attempt was made to sound out contractors on witnessing a demonstration of maximally quieted equipment using available noise shielding fences, enclosures, etc. operating on a "typical" construction site. The response was that the variety of sites include buildings, dams, roads, foundation, demolition, etc. These might employ pile driving, hoisting, pavement breaking, tamping, earth moving, concrete mixing and many more operations either singly or collectively. The sites could be deep in the ground for foundations or stretching for miles as in highway construction. It was felt that no site could be selected that would demonstrate anything generally practical to the large variety of contractors.

10. Test Specifications

Mr. Frank Brittain of the Bechtel Corp. stated that he considered the ANSI Spec. J-88 too complicated for general site use although it may be perfectly suitable for type-test measurement at an equipment vendor's plant. He mentioned that a considerably simpler procedure was needed. Mr. Antonucci of the Contractor's Association of Eastern Penna. went even further in stating that certification by the manufacturer should be sufficient since site placement usually made detailed compliance a geographic impossibility. He stated that he had received no feedback of complaints for excessive noise in this area from the members of his organization.

11. Joint Funded Improvement Programs

None of the prime equipment firms who were contacted expressed enthusiasm to participate in joint Federally and Company funded programs - for the reasons gathered by the interviewer but not impressed by the interviewee - that they did not have anything radical to propose. Of interest in this regard is a program of the Bureau of Mines, Pittsburgh, Penna. where a Stoper-Drill, which is used to bore holes in the roof of a mine tunnel, is being worked on by the Creare Products, Inc. of Lebanon, N.H. Due to the confined mine tunnel, a quieter drill is vitally required. The present drill emits approximately 114-115 dbA noise. The improved drill emits 94-99dbA noise. The effort has required an expenditure of approximately $800,000 of which about 18-20% has been contributed by the vendor. The device is about the size of a compressed air operated pavement breaker. The use of hydraulics for the application was considered but rejected due to the convenience of using the compressed air system which is always present in the mines. One exception to the above initial comment in this paragraph is The Donaldson Co. of Minneapolis, whose products are discussed under "Mufflers." This company showed interest in a joint program and mentioned that such an EPA sponsored R&D program should be discussed with their sales and engineering department.

12. Noise Consultant Comments

Comments received from two noise consulting firms were to the effect that, in general, the equipments they had had occasion to survey for noise emission complied with the manufacturers' or users' specifications if they were adequately maintained. They suggested that the only way contractors could be made to reduce noise was for EPA to issue regulations rather than guidelines thus forcing the users to either purchase newer equipment which manufacturers would produce or use add-on components where they were made available. Sufficient cut-in time would have to be recognized by any regulating authority.

13. Trade Organization Comments

A general criticism was received that too often equipment is sold which does not stand up under site conditions. It was suggested that before an equipment was released for general sale, it should be loaned to a contractor for a 3 to 4 month use period under truly operating conditions. Mr. Larmore of CIMA was of the opinion that manufacturers are competent to do somethings about the present problems but hesitate to do so since the equipment would increase in costs and older equipment which has at least a 10 year life would be obsoleted. Equipment manufacturers were not particularly in agreement.

14. General Note

In summary, it might be stated that a consensus existed among the manufacturers that they were now producing equipment to the state-of-the-art; that they could effect some reduction in noise by known add-ons or equipment redesign which would add cost and weight but that no technology breakthrough was anticipated which might yield radical results. Users uniformly felt that they are employing equipment which results in a minimum of noise complaints on their sites from individuals or municipalities; that the costly equipment they owned or leased had such a long life that it was impractical to obsolete it for noise emission reasons; and that the frequency and severity of complaints due to noise was not particularly troublesome at this time.

15. Equipment Manufacturers

Ingersoll-Rand Co. Phillipsburg, N. J. 201-859-7000
Ed Auerbach, Manager Sound and Vibration
Pavement Breakers; Air Rock Drills; Vibrator Compactors;
Air Compressors

Ford Motor Co. Dearborn, Michigan 313-643-2511
Farm Eqpt. Div. Arthur Tobiassen, Manager Noise Activity
Farm equipment

General Motors Corp. Detroit, Mich. 313-575-1635
Terex Div. Lansing Mich., Don Whitney Envir. Control Staff
Heavy Earth Moving Equipment

Caterpillar Tractor Corp. Peoria, Ill. 309-675-5395
Lester Bergsten, Eng. Mgr.
Tractors, Graders

Fiat-Allis Corp. 217-789-3000
Dennis Lokern
Crawlers; Tractors; Front-End Loaders; Bull Dozers; Rippers

Mack Truck Co. Allentown, Pa. 212-947-0255
David F. Steinling
Engineering Development and Test Center

The Donaldson Co. Minneapolis, Minn. 612-887-3721
Julian Imes Eng. Mgr.
Silencers and Mufflers

16. Construction Companies

Bechtel Corp. San Francisco, Calif. 415-768-5741
Frank Brittain, Supervisor of Noise Codntrol)

Morrison-Knudsen Co., Inc. Boise, Idaho 208-345-5000
Ben Rietz, Safety Engineer

Brennaman Co., Phila. Pa. 215-893-4100
Michael Gabor

Raymond International Co. Houston, Texas 713-623-1500
H. F. LeMieux

James D. Morrisey, Inc. Phila., Pa. 215-333-8000
C. Measey, Engineer

John Meehan & Son Phila., Pa. 215-673-7800
M. Duffy, Engineer

Ashland Warren Co. Atlanta, Ga. 404-261-2610
C. Hart, Safety

Bureau of Mines Pittsburgh, Pa. 412-675-6400
Ray Bartholomew, Engineer

17. Construction Industry Organizations

Construction Industry Mfg. Assoc. 414-272-0943
H. T. Larmore

Contractors Assoc. of Eastern Penna. 215-LO 3-4455
Mr. Antonucci

American Road and Transportation 202-488-2722
Builders Assoc.

18. Noise Consultants

Cavanaugh and Tocci 617-655-1300
Cavanaugh, Noise Consultant

Lewis S. Goodfriend & Assoc. Cedar Knolls, N. J. 201-540-8811
Martin Alexander, Environ. & Safety Engineer

19. Standards Organization

American National Standards Institute (ANSI) 212-354-3300
1430 Broadway, New York, N. J.
Judith Follman, Program Admin.

20. Construction Equipment Types and Average Noise Level (Unregulated) Denoted by Index K

K	Construction Equipment Type	Noise Levels at 50 Feet, dbL_A
1	Air Compressors	81.0
2	Compactors, Man.-Guided*	84.6
3	Concrete Mixers, Truck Mounted	83.0
4	Concrete Mixers, Non-Truck	79.0
5	Concrete Pumps	82.0
6	Concrete Vibrators	77.0
7	Cranes, Derrick	82.0
8	Cranes, Mobile	81.0
9	W & C Tractors, 20-89HP	79.5
10	W & C Tractors, 90-199HP	81.0
11	W & C Tractors, 200-350HP	83.5
12	W & C Tractors, 351-500HP	86.0
13	Excavators, <375HP	84.2
14	Excavators, 376-500HP	86.7
15	Excavators, Cable	85.0
16	Forklift Trucks*	83.4
17	Generators	75.0
18	Graders	84.0
19	Integral Backhoe/Loaders	81.3
20	Pavers and Mixers	85.0
21	Paving Breakers, Portable	84.6
22	Paving Breakers, Mounted	89.1
23	Pile Drivers	99.0
24	Pneumatic Tools	82.0
25	Pumps	74.0
26	Rock Drills, Portable	87.8
27	Rock Drills, Mounted	95.8
28	Rollers	81.0
29	Saws	78.0
30	Scrapers, <375HP	83.5
31	Scrapers, 376-650HP	85.6
32	Skid Steer Loaders*	73.5
33	Trenchers, Ladder <20HP	71.7
34	Trenchers, Ladder >20HP	76.2
35	Trenchers, Wheel	76.2
36	Trucks, Off Highway	88.0
37	Trucks, Rear Dump	88.0

*Equipment types not included in original noise impact model (see References 4, 14, and 15).

FIGURE C.1. RELATIVE RANKING OF RESPONSES

No.	Information Item	Relative Ranking L-Low	M-Medium	H-High
1.	Industry Technology initiative and funding of R&D	L	M	H
2.	Identified customer need will be funded by manufacturer	L	M	H
3.	Cost impact on product	L	M	H
4.	Employment of State of the Art Technology	L	M	H
5.	Requirement for Radical Technology	L	M	H
6.	Application of Incremental Improvements in Technology	L	M	H
7.	Desire for Federal Funding for research and development	L	M	H
8.	Demonstration funding for advanced noise suppressive techniques	L	M	H
9.	Joint funding interest	L	M	H
10.	Concern for noise emission	L	M	H
11.	Impact on weight, maintenance and fuel	L	M	H
12.	Replacement Frequency of Product by Customer - Motivation For Model Change	L	M	H
13.	Stimulation by Regulation	L	M	H
14.	Construction environment stimulate the purchase of quieter equipment e.g. foreign market	L	M	H
15.	Restraint by Proprietary Interest	L	M	H
16.	Technology use is based on size of firm	L	M	H
17.	Costs for R&D for Radical Improvements	L	M	H
18.	Willingness of Industry to Cost Share R&D	L	M	H

FIGURE C.1. (Continued)

No.	Information Item	Relative Ranking L-Low	M-Medium	H-High
19.	Compatibility of factory and field test procedures and specifications	L	M	H
20.	Deterioration of furnished Noise Suppression devices	L	M	H
21.	Motivation For Replacement	L	M	H
22.	Real Life Equipment Evaluation Requirements	L	M	H
23.	Contractor's reliance on Manufacturer's Specification	L	M	H
24.	Scheduling of Construction Equipment Usage	L	M	H
25.	Construction Management Practices	L	M	H
26.	Priority for Study of Effectiveness of Barriers at Site	L	M	H
27.	Significance of Construction Site Noise/Cost Impact	L	M	H
28.	Planning Performed for Collective Noise Impact	L	M	H
29.	The Importance of Noise Emission Monitoring	L	M	H

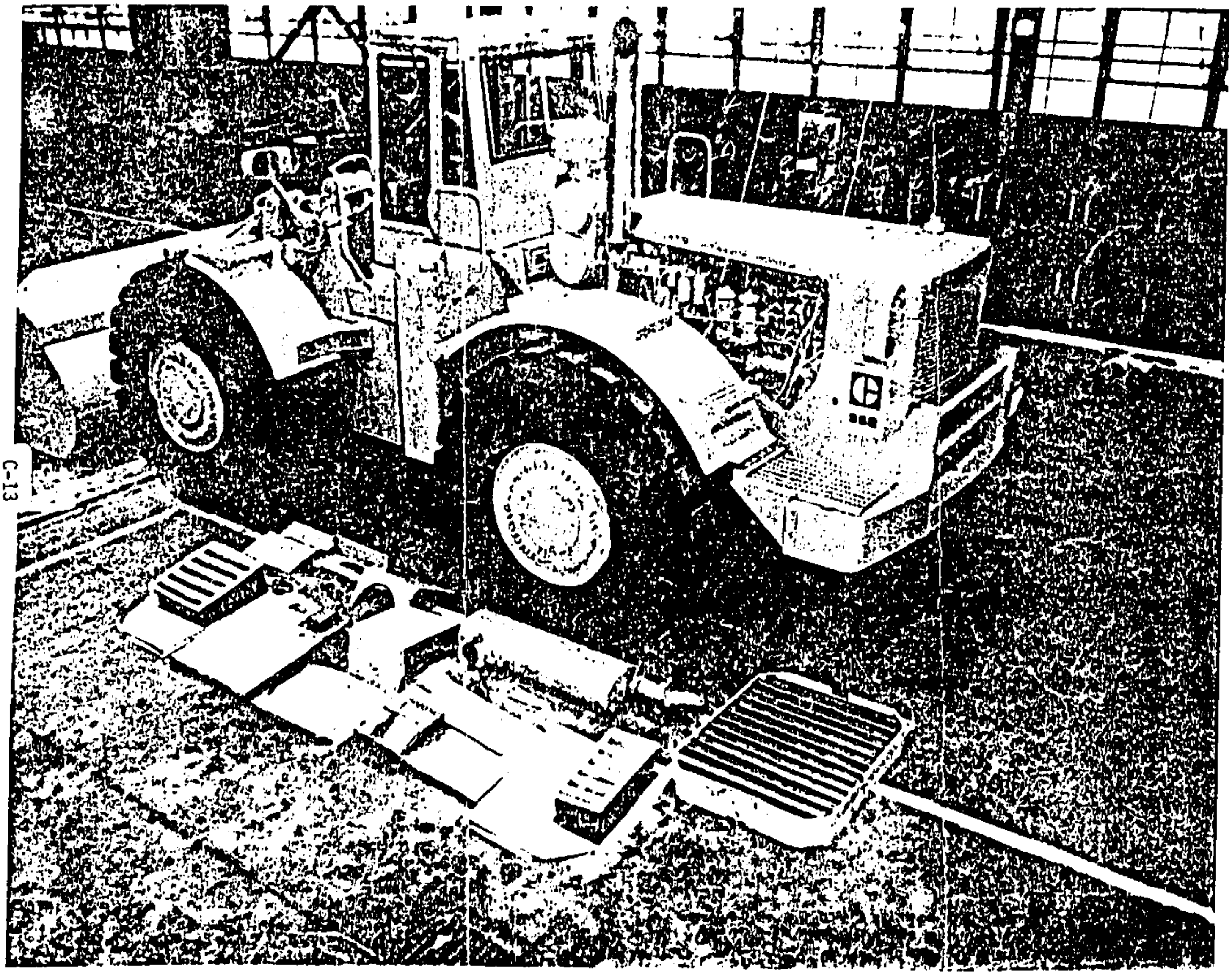
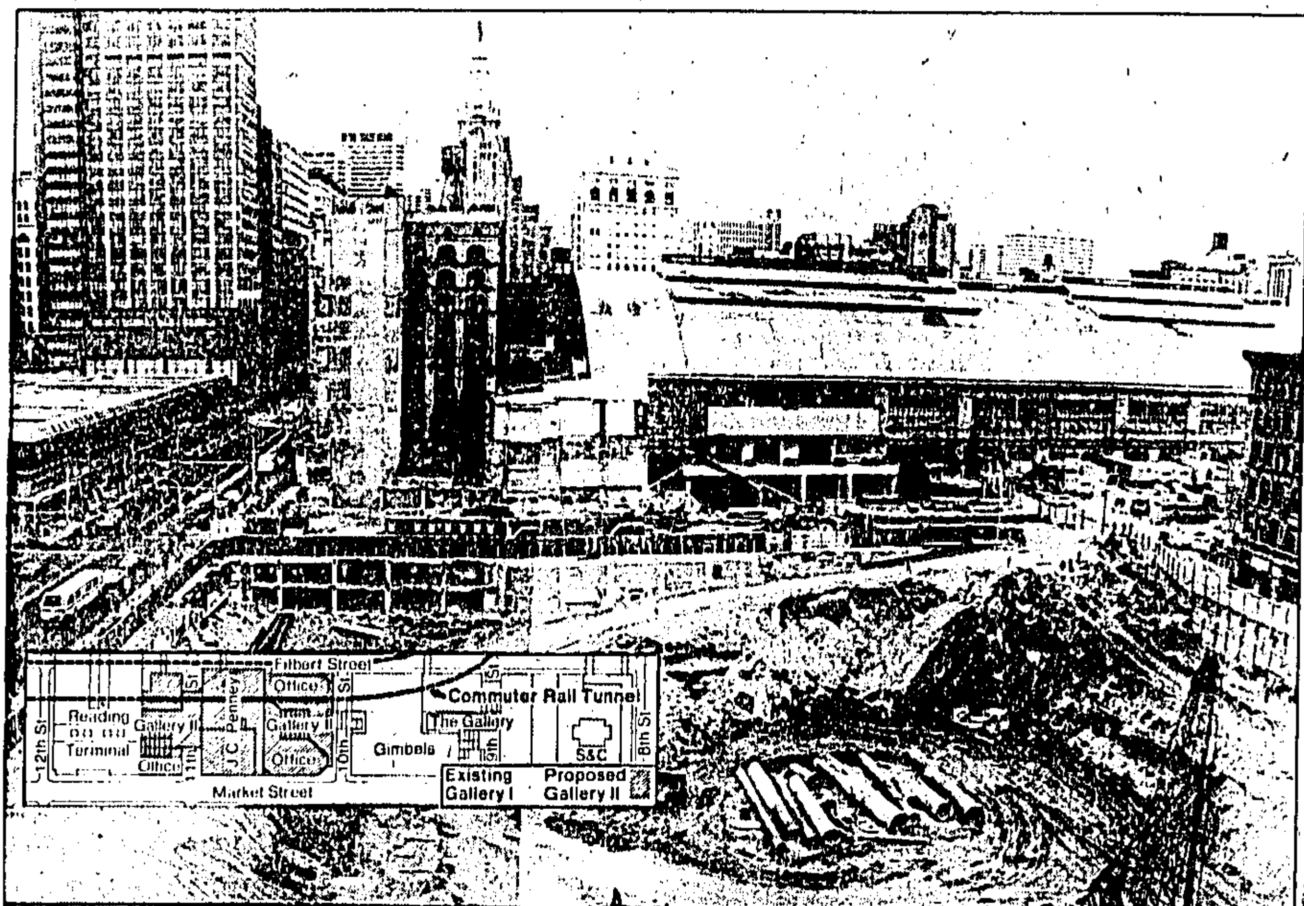


FIGURE C.2. CATERPILLAR TRACTOR AND ADD-ON QUIETING PACKAGE

BLACK COPY

The Bulletin
Business
Monday, August 11, 1980



Bulletin graphics

Gallery II, a complex of three office towers and 125 to 130 retail shops in an enclosed mall, will rise from this huge excavation on the north side of Market st., between 10th st. and the Reading Terminal, in the Market Street East development in center-city Philadelphia.

Figure 3

APPENDIX D

PROJECT DESCRIPTIONS

TABLE D-1

CONSTRUCTION NOISE
TECHNOLOGY INITIATIVES
FY 1981-FY 1985

Priority	Title	Est. Funding ($000)	Est. Person Months	Page Ref.
Construction Equipment Noise Control (WBS 1000)				
B-8	Pile Driver Demonstration	100	24	D-4
D-3	Demonstrate Improved Drill Noise Control Technology	100	18	D-6
D-3	Develop Construction Equipment Noise Test Procedures	130	12	D-8
D-3	Conduct Comprehensive Construction Equipment Noise Survey	200	18	D-10
E-2	Develop Low Annoyance Back-up Alarms	65	12	D-12
D-4	Demonstrate W&C Tractor Noise Control	200	24	D-14
D-4	Update Noise Control Technology Assessment Paving Breakers and Rock Drills	65	9	D-16
D-4	Demonstrate Paving Breaker and Rock Drill Noise Control	100	18	D-18
E-2	Update Noise Control Technology Assessment-Earthmoving Equipment	65	9	D-20
D-2	Demonstrate Earthmoving Equipment Noise Control	200	24	D-22
B-7	Identify Equipment Maintenance Requirements and Procedures	65	9	D-24
B-7	Demonstrate Cooling System Noise Control	65	9	D-26
C-6	Conduct Feasibility Studies and Demonstrate Noise Reduction on Concrete Mixers and other Construction Vehicles using "Quiet Truck" Technology	135	18	D-28
E-2	Develop Lower Cost/Lighter Weight Noise Control Devices	65	9	D-30

TABLE D-1 (Cont.)

Priority	Title	Est. Funding ($000)	Est. Person Months	Page Ref.
Construction Equipment Noise Control (WBS 1000) (Cont.)				
D-3	Conduct Demonstrations of Noise Reduction for Forklift Trucks	100	18	D-32
C-6	Develop and Publish Engineering Noise Control Handbook for the Construction Industry	200	12	D-34
Construction Site Noise Control (WBS 2000)				
D-3	Demonstrate Improved Barrier Designs	65	12	D-36
B-8	Develop and Distribute Guidelines for Construction Site Noise Control	50	6	D-38
C-6	Demonstrate Construction Site Noise Control Techniques	50	6	D-40
Construction Strategy Modification (WBS 3000)				
E-2	Investigate Construction Techniques to Replace Pile Driving	65	6	D-42
E-2	Conduct Study on Substituting Alternative Equipment (other than Pile Drivers) to Reduce Noise	65	12	D-44
E-2	Conduct Demonstration of Noise Control Using Optimum Equipment Operating Techniques	50	6	D-46
D-3	Investigate Minimum Noise Sequencing with Time and Cost Controls	50	6	D-48
Noise Control Incentives (WBS 4000)				
E-2	Develop Standardized Noise Control Contractual Specifications	50	4	D-50
D-4	Develop "Buy Quiet" Specifications	50	6	D-52
Construction Site Modeling (WBS 5000)				
C-5	Develop Site Specific Construction Noise Prediction Model	50	6	D-54
E-2	Update National Construction Site Noise Impact Model Data Base	65	9	D-56

TABLE D-1 (Cont.)

Priority	Title	Est. Funding ($000)	Est. Person Months	Page Ref.
Construction Noise Control Program Coordination (WBS 6000)				
E-0	Establish and Sponsor Coordination and Technical Information Center	35/yr.	Con-tinuing	D-58
A-7	Coordinate and Assess Federal Construction Noise RD&D and Control Programs	30/yr.	4/yr.	D-60

CONSTRUCTION EQUIPMENT NOISE CONTROL

PROJECT PLAN DESCRIPTION

I. Title

Conduct Pile Driver Demonstration

II. Objective

To demonstrate the economic feasibility of noise control techniques the technical feasibility of which has been demonstrated in a previous joint EPA/CERL project.

III. Project Description

The noise control techniques used for pile drivers in the EPA/CERL project will be demonstrated as part of an actual construction project of about one year's duration. The duration of the project will allow workers to develop and learn efficient operating procedures to use with the abatement techniques and would allow an evaluation of the longevity of the techniques. The fact that the demonstration will be part of an actual construction project will allow realistic assessments of the costs of the techniques.

IV. Justification

A. Need for Project. The project is needed because the limited scope of the previous project did not allow the economic feasibility of the techniques to be demonstrated, and the limited time did not allow the workers to become sufficiently accustomed to the techniques for them to develop efficient operating procedures.

Table 2-6, in Section II, shows that pile drivers with 10.95 percent of the LWP is second highest equipment type in terms of impact on the population.

B. Expected Payoff. If successfully completed would allow objections to the practicality of the techniques to be met, and it would allow estimates of costs to be made with a considerable amount of exactitude.

V. Scope

It is anticipated that this project will require about 2 persone years of effort over a 12 month period.

VI. Estimated Cost

$120K

PROJECT PLAN DESCRIPTION

I. Title

Demonstrate Improved Drill Noise Control Technology

II. Objective

To adapt the drill technology developed by BOM for its stoper drills to the type of drills used in construction and to demonstrate and evaluate effectiveness in a field demonstration.

III. Project Description

When BOM has completed its development work in 1981, additional development will be initiated to adapt the technology to the types of drills used in construction. Rock drills or pavement breakers would appear to be likely prospects for such an effort. It should be possible to achieve noise reductions that are roughly comparable to those obtained for the stoper drill (about 15-20 dB(A) at the operator's position). The project will have the advantage of building on previously successful development work. Demonstrations of noise reduction under field conditions will be conducted and evaluated.

IV. Justification

A. Need for Project. Rock drills were identified in the Noise Technology Research Symposium as an area where there is a technological need.

B. Expected Payoff. The project will have important benefits for occupational health and may have beneficial environmental impact.

V. Scope

It is estimated that this project will require about two person years of effort over a period of 18 months.

VI. Estimated Cost

$100K

PROJECT PLAN DESCRIPTION

I. <u>Title</u>

Comprehensive Test Procedure for Construction Equipment

II. <u>Objective</u>

The purpose of this project is to develop simplified test procedures which identify and quantify all noise generating phases of equipment operation which may arouse adverse response by exposed individuals. Operating phases addressed must include those inducing backup alarm actuation and material dumping impacts in haul vehicle beds, for example.

III. <u>Project Description</u>

Equipment will be categorized with common noise generating phases. These phases will then be classified to establish operating conditiuns and microphone locations for which measurement can be made. Equipment categories may consist of haulage equipment (dump trucks), ground-breaking equipment (dozers, power shovels, backhoes), loading equipment (loaders), and pneumatic equipment (poving breakers and rock drills). The end product of this project will be a set of measurement standards for each of the equipment categories.

IV. Justification

A. Need for Project. The need for this project arises from the practical consideration that many construction site-induced complaints arise from equipment operations which are not quantified by existing standards, such as, the SAE earthmoving equipment standards. These situations, for example, backup alarm actuation or material impacts on haulage vehicle beds, must be quantified to allow construction site operators to predict their levels, determine controls, and assess their effectiveness.

B. Expected Payoff. The proposed measurements provide a basis for determining construction site noise levels. The measurement standards will also support the development of equipment labeling regulations.

V. Scope

This project will require an estimated two person years of effort over a period of performance of 12 months.

VI. Estimated Cost

$130K

PROJECT PLAN DESCRIPTION

I. Title

Comprehensive Survey of Construction Equipment

II. Objective

The purpose of this project is to develop a sound level inventory for every commonly used type, make, and model of construction equipment. This will provide a data base for use by construction site operators which will be particularly valuable in the absence of a EPA Section 8 labeling program.

III. Project Description

This project would be expected to use the comprehensive test procedure described in another proposed project such that for each category of equipment each of the makes and models would be enumerated and the sound levels in each of the identified noise generating phases would be provided. This result may be included in a construction noise handbook or used as a data base for a site-specific construction noise model.

IV. Justification

A. Need for Project. This project will allow the prediction of construction site impacts on a site-specific basis and also facilitate the purchase of quieter equipment by the publication of comparative data on equipment makes and models.

B. Expected Payoff. This project will provide a comprehensive data base of the sound levels of commonly used types, make, and models of construction equipment. This data base will be used in the "Buy Quiet" program and will be published in the construction noise handbook described in another project.

V. Scope

It is estimated that this effort will require three person years of effort over a period of 18 months.

VI. Estimated Cost

$200K

PROJECT PLAN DESCRIPTION

I. Title

Development of Low Annoyance Back-up Alarms

II. Objective

The purpose of this project is to develop an equipment backup alarm with minimal exposure to off-site persons, while maintaining the effectiveness of the alarm to construction workers.

III. Project Description

This project should investigate backup alarm amplitudes, spectra, directivity, and temporal modulation in the context of human aural detectability in the construction site noise background. The result of this study should be recommendations for alarm device designs which result in minimum extraneous noise exposures.

IV. Justification

A. Need for Project. The relatively recent implementation of backup alarms has resulted in an increase in construction worker safety but an additional source of noise at construction sites. It is expected that with proper attention these alarms can be optimized for their purpose without incurring additional noise exposures to surrounding persons. Research on backup alarms was singled out by the EPA Noise Technology Research Symposium in January 1979 as one of three major types of equipment requiring further noise source critical RD&D.

B. Expected Payoffs. It is anticipated that this research will result in a substantial reduction in construction site noise from backup alarms without reducing worker safety.

V. Scope

This project is expected to require one person year effort over a period of 12 months.

VI. Estimated Cost

$65K

PROJECT PLAN DESCRIPTION

I. Title

Wheel and Crawler Tractor Noise Control Demonstration

II. Objective

The purpose of this project is to demonstrate the state-of-the-art of noise control technology for the use by the EPA/ONAC Standards and Regulations Division in developing their wheel and crawler tractor regulations and/or to encourage equipment manufacturers and users to quiet their equipment by demonstrating the viability of noise controls.

III. Project Description

This project is expected to be very similar to the Bureau of Mines bulldozer demonstrations and would extend these demonstrations to construction equipment. It is expected that it would consist of the selection of typical wheel and/or crawler tractors, identification of their component noise sources, specification of design goals, and the implementation of retrofit noise controls to achieve these goals. Finally, an in-use demonstration to assess the viability of the noise controls in practical applications would be performed. The result of this effort will be a kit of noise control treatments for which the acoustical performance has been measured and reliability and maintainability has been demonstrated.

IV. Justification

A. Need for Project. These machines are among the most commonly used construction equipment types and are also among the most intense sources of noise on a construction site.

B. Expected Payoff. The results of this study will provide added support for EPA/ONAC regulating their sound levels and/or also provide technological support to both equipment manufacturers and users for quieting their equipment in the absence of regulatory motivation.

V. Scope

The scope of this effort will depend on the number of machines selected for demonstration with efficiencies of scale accruing from a multiple machine demonstration project. It is expected that for the first machine approximately 3 man years effort will be required over a period of 24 months.

VI. Estimated Cost

$200K

PROJECT PLAN DESCRIPTION

I. Title

Noise Control Technology Assessment - Paving Breakers and Rock Drills

II. Objective

The objective of this project is to update the state-of-the-art assessment for the reduction of noise emissions from paving breakers and rock drills.

III. Project Description

This report will update a previous EPA study conducted by Dames & More (1978) to identify present and feasible noise control technology.

IV. Justification

A. Need for Project. EPA has identified paving breakers and rock drills as major noise sources and plans to publish proposed noise standards for these products in FY 1983. This project is necessary to determine the best available technology for reducing noise from these products.

B. Expected Payoff. This project will help provide the basis for new equipment regulations and will provide the material required to update the handbook on construction equipment noise control.

V. Scope

It is estimated that this project will require one person year of effort over a 9 month period.

VI. Estimated Cost

$65K

PROJECT PLAN DESCRIPTION

I. **Title**

Paving Breaker and Rock Drill Noise Control Demonstration

II. **Objective**

The purpose of this project is to demonstrate the state-of-the-art of noise control technology for the use by the EPA/ONAC Standards and Regulations Division in developing their paving breaker and rock drill regulations and/or to encourage equipment manufacturers and users to quiet their equipment by demonstrating the viability of noise controls.

III. **Project Description**

This project is expected to be very similar to the BMB bulldozer demonstrations in both its content and relevance to the construction industry. It is expected that it would consist of the selection of typical paving breakers and rock drills, identification of their component noise sources, specification of design goals, and the implementation of retrofit noise controls to achieve these goals. Finally, an in-use demonstration to assess the viability of the noise controls in practical applications would be performed. The results of this effort will be a kit of noise control treatments for which the acoustical performance has been measured and the reliability and maintainability has been demonstrated.

IV. Justification

A. Need for project. These equipment are among the commonly used construction equipment types and are also among the most intense sources of noise on a construction site.

B. Expected payoff. The results of this study will provide added support for EPA/ONAC regulating their sound levels and/or also provide technological support to both equipment manufacturers and users for quieting their equipment in the absence of regulatory motivation. Proposed new equipment regulations are to be issued in 1983.

V. Scope of Effort

The scope of this effort will depend on the number selected for demonstration--with efficiences of scale accruing from a multiple machine demonstration project. It is expected that for the first machine approximately 1.5 person-years effort will be required over a period of 18 months.

VI. Estimated Cost

$100K

PROJECT PLAN DESCRIPTION

I. <u>Title</u>

Noise Control Technology Assessment - Earthmoving Equipment

II. <u>Objective</u>

The objective of this project is to update the state-of-the-art assessment for the reduction noise emissions from earthmoving equipment.

III. <u>Project Description</u>

This project will update a previous EPA study (1976) to evaluate the current and best available noise control technology for earthmoving equipment such as scrapers, backhoes, excavators, and other similar equipment except wheel and crawler loaders and tractors.

IV. <u>Justification</u>

A. <u>Need for Project</u>. EPA plans to issue proposed noise emission regulations on new earthmoving equipment in FY 1984 according to the Five Year Plan. This project is necessary to determine the best available technology for reducing noise of earthmoving equipment.

B. <u>Expected Payoff</u>. This project will help provide the basis for new equipment regulations and will provide information for updating the noise control handbook.

V. Scope

It is estimated that this project will require one person year of effort over a 9 month period.

VI. Estimated Cost

$65K

PROJECT PLAN DESCRIPTION

I. Title

Earthmoving Equipment Noise Control Demonstration

II. Objective

The objective of this project is to demonstrate the state-of-the-art of noise control technology for the use by the EPA/ONAC Standards and Regulations Division in developing their new earthmoving equipment regulations and/or to encourage equipment manufacturers and users to quiet their equipment by demonstrating the viability of noise controls.

III. Project Description

This project is expected to be very similar to the BOM bulldozer demonstrations in both its content and relevance to the construction industry. It is expected that it would consis of the selection of typical earthmoving equipment, identification of their component noise sources, specification of design goals, and the implementation of retrofit noise controls to achieve these goals. Finally, an in-use demonstration to assess the viability of the noise controls in practical applications would be performed. The result of this effort will be a kit of noise control treatments for which the acoustical performance has been measured and reliability and maintainability has been demonstrated.

IV. Justification

A. Need for Project. These machines are among the most commonly used construction equipment types and are also among the most intense sources of noise on a construction site.

B. Expected Payoff. The resuts of this study will provide added support for EPA/ONAC regulating their sound levels and/or also provide technological support to both equipment manufacturers and users for quieting their equipment in the absence of regulatory motivation.

V. Scope

The scope of this effort will depend on the number of machines selected for demonstration with efficiencies of scale accruing from a multiple machine demonstration project. It is expected that for the first machine approximately 3 man years effort will be required over a period of 24 months.

VI. Estimated Cost

$200K

PROJECT PLAN DESCRIPTION

I. Title

Identify Maintenance Requirements and Procedures to Reduce Noise from Construction Equipment.

II. Objective

To investigate the amount and type of maintenance required to prevent any increase in original equipment noise emission levels with age.

III. Project Description

Since actual data on the sound degradation of equipment with age is scarce or non-existent, this program would be the initial step in a continuing program in this area. Thus, after selection of a particular equipment item, e.g., air compressors, a program to collect the required data would be laid out. Two possibilities for collection of data exist, i.e., a search of users of compressors, and a rigorously supervised experimental program. In this study the feasibility of each of these approaches would be investigated. Data required includes increase in emission with time, time between maintenance actions, actions taken, etc.

VI. Justification

A. Need for Project. Sources contacted in ONAC and OSHA indicated that lack of maintenance of noise suppression devices including mufflers was a primary reason for excessive noise emissions. There is also a belief that on noise suppression devices air compressors are not being used and/or are not properly maintained. Investigation is needed to (1) reduce tampering and (2) improve maintenance of noise suppression devices.

B. Expected Payoff. This project begins to provide the quantitative basis upon which future regulations can be constructed or current regulations (e.g., air compressors) strengthened to prevent degradation of noise emission levels.

V. Scope

It is anticipated that this project will require one person year of effort over a six month period.

VI. Estimated Cost

$65K

PROJECT PLAN DESCRIPTION

I. <u>Title</u>

Engine Cooling System Noise Control Demonstration

II. <u>Objective</u>

The objective of this project is to demonstrate the effectiveness of existing noise reduction methods applicable to internal combustion engine cooling systems.

III. <u>Project Description</u>

The cooling system (fan) is the dominant noise source on most typical construction equipment powered by internal combustion engines. A number of noise reduction techniques have been identified. However, relatively few demonstrations have been performed to assess the effectiveness of these noise control techniques. This project will involve identifying existing cooling system noise control techniques applicable to construction equipment. The effectiveness of individual or combinations of these techniques will be determined by performing field demonstrations using various construction equipment types. The noise control methods demonstrated will be limited to in-use equipment retorfit designs. The results of this project will provide a data base for selecting and assessing existing cooling system noise control devices for in-use construction equipment.

IV. Justification

A. Need for Project. Fan noise represents a significant percentage of the total noise emission level generated by internal combustion engines. Therefore, reductions in fan noise levels will have a significant affect on lowering total noise emission levels producted by construction equipment powered by gasoline and diesel engines.

B. Expected Payoff. As a result of the project, construction equipment users will have a means of identifying existing fan noise control devices and an incentive for applying these devices.

V. Scope

It is estimated that this project will require approximately nine months and about one man year of effort to complete.

VI. Estimated Cost

$65K

PROJECT PLAN DESCRIPTION

I. Title

Feasibility Study and Demonstration Using Quiet Truck Technology

II. Objective

The objectives of this project is to determine the feasibility and demonstrate the applicability of the Quiet Truck technology to-over-the road vehicles used in construction.

III. Project Description

This project would be conducted in two phases. Phase I - Feasibility study would determine the potential for reducing noise emissions from concrete mixers and other over-the-road vehicles used in the construction industry. If warranted, a demonstration plan would be prepared.

Phase II - Demonstration. Depending on the outcome of Phase I, a demonstration would be conducted to show in actual operation the noise reduction achieved by the use of the "Quiet" truck technology being developed by Technology and Federal Programs Division.

IV. Justification

A. Need for Project. EPA/ONAC draft "Substrategy for Construction Noise" states that a new truck regulation with noise level limits lower than current limits and with applicability to concrete mixers and other over-the-road construction trucks is one of the preferred options for controlling construction noise.

Trucks are the most commonly used single piece of equipment for all construction projects and rank third in terms of population impact (see Table 2.6). This project will support EPA regulatory action for a new lower standard for medium and heavy duty trucks.

B. Expected Payoff. This projected is expected to demonstrate the applicability of technology developed under the quiet truck program to concrete mixers and other over-the-road vehicles used in construction, thus providing the technology base needed for lower medium and heavy duty truck standards applicable to construction vehicles.

V. Scope

Phase I is estimated to require six months and 6 person months of effort. Phase II is estimated to require 12 months and 1.5 person years of effort.

VI. Estimated Cost

Phase I - $35K
Phase II - $100K

PROJECT PLAN DESCRIPTION

I. <u>Title</u>

Develop Methods to Reduce Cost and Weight of Noise Suppression Devices

II. <u>Objectives</u>

To investigate ways to reduce the cost and weight of noise control devices that are currently available to reduce noise emissions of construction equipment.

III. <u>Project Description</u>

A survey of manufacturers conducted in August 1980 by Innovative Systems Research (see Appendix C to this report), indicated that one of the principal reasons that currently available techniques are not being used to reduce construction equipment noise is the cost and weight of these devices. Under this project, alternative materials and installation techniques for noise control devices will be investigated to reduce the cost and/or weight of these devices.

IV. Justification

A. Need for Project. Almost uniformly the response of manufacturers to the inquiry concerning motivation to reduce the noise of their products received a response that any added equipment would increase weight, intial cost, and cost for serving the equipment.

B. Expected Payoff. This project, is successful, will reduce the cost and/or weight of noise control devices thus permitting manufacturers to sell quieter equipment.

V. Scope

It is estimated that this project will require about one person-year of effort over a period of 9 months.

VI. Estimated Cost

$65K

PROJECT PLAN DESCRIPTION

I. Title

Conduct Demonstration of Noise Reduction Techniques for Forklift Trucks

II. Objective

To adapt the noise reduction techniques developed by U.S. Army for its rough terrain forklift trucks to the forklift trucks used in construction and to demonstrate and evaluate the effectiveness in a field demonstration.

III. Project Description

The U.S. Army during the period FY 1975-78 developed retrofit kits to reduce the noise emissions of its rough terrain forklift trucks. This project will determine the feasibility of adapting these noise reduction techniques to the forklift trucks used in construction industry and if determine to be feasible, to demonstrate the noise reduction at a selected construction site.

IV. Justification

A. Need for Project. Forklift trucks are one of the major contributors to construction site noise (see Section II).

B. Expected Payoff. This project could have important benefits by reducing operator noise exposure and by reducing construction site noise.

V. Scope

It is anticipated that this project will require about two person years of effort over a period of 18 months.

VI. Estimated Cost

$100K

PROJECT PLAN DESCRIPTION

I. Title

Develop Engineering Noise Control Guidelines for the Construction Industry

II. Objective

The objective of this project is to provide guidelines to the construction industry for the selection, design, and implementation of effective abatement methods for construction machinery noise.

III. Project Description

A noise control handbook(s) will be developed for the construction industry that provides guidelines for the selection, design, and implementation of effective abatement methods for construction equipment use. This handbook will be similar to the handbook developed by the Bureau of Mines for the Coal Mining industry. This handbook will be updated periodically, probably every two years or sooner if required.

IV. Justification

A. Need for Project. There is a demonstrated need for the proposed guidelines, the Urban Noise Program requires a manual in order to convince construction contractors to try noise reducing techniques. State and local governments need such a manual in order to develop noise ordinances that are capable of being met by the construction contractors. The Noise Technology Research Needs Symposium stressed the role of the Federal government in collecting and disseminating information.

B. Expected Payoff. Wide distribution of the manual would result in the design of quieter equipment, retrofit of some existing equipment, and the development of noise regulations and ordinances based on the current state-of-the-art.

IV. Scope

It is estimated that this project will require about 2½ person years of effort over a period of 12 months for the development of first handbook. Subsequent updates will probably require about 25% of the initial effort.

V. Estimated Cost

Initial Publication, $200K
Subsequent Updates $50K

PROJECT PLAN DESCRIPTION

I. Title

Demonstrate Improved Barrier Designs

II. Objective

To demonstrate the effect of improved barrier design on noise from construction sites.

III. Project Description

A MSHA project has demonstrated the use of resonators around the edges of barriers to increase the amount of insertion loss they will produce. This project would apply the technology to barriers used at construction sites. Since the techniques use tuned resonators, it is applicable only to sources with relatively large tonal components. Thus, careful consideration will be required to identify pieces of equipment for which the improved barrier can be used. Diesel engines, generators, and pumps are examples of equipment that the technique might be applied to. Since the backup signal on trucks was identified in the Noise Technology Research Symposium as a problem area and since it is a source of complaints about construction noise, it may be worthwhile to investigate the possibility decreasing the environmental impact of the signals using the improved barriers.

IV. Justification

A. Need for Project. This improvement in barrier design has only very recently been demonstrated in the mining industry and is unheard of in the construction industry.

B. Expected Payoff. If applied properly, the improvement can increase barrier insertion loss by something on the order of 6 dB.

V. Scope

It is estimated that this project will require one person year of effort over a period of 12 months.

VI. Estimated Cost

$65K

PROJECT PLAN DESCRIPTION

I. <u>Title</u>

Develop Guidelines for Construction Site Noise Control

II. <u>Objective</u>

The objective of this project is to provide guidelines to the various segments of the construction industry, e.g., residential, highway, etc. for quieting construction activities.

III. <u>Project Description</u>

These guidelines would be a companion document to the engineering noise control guidelines for construction equipment. They would provide information on noise mitigating techniques such as the use of barriers, operations scheduling, use of alternative equipment, methods, etc. Separate guidelines would be prepared for the various segments of the construction industry, e.g., highway construction.

These guidelines would be updated periodically, probably biannually, more frequent updates could be made when justified by the development of new techniques which have important noise reduction potential.

IV. Justification

A. Need for Project. There are a number of ways that a contractor can reduce the noise at the property line but this information has not been widely disseminated. For example, Morrison-Knudsen Co., Boise, Idaho has used wooden enclosures lined with sound absorbent materials to enclose noisy equipment. This approach is not widely used by the industry. This project is a candidate for joint funding with FHWA which currently has plans to develop a manual for highway construction. Similar manuals are needed for residential construction, industrial construction, etc.

B. Expected Payoff. The proposed manuals will provide information for reducing noise from construction sites. It is expected that some contractors will adopt the technique voluntarily, others will adopt the techniques to meet local noise ordinances. State and local governments could use these guidelines to establish realistic noise standards.

V. Scope

It is estimated that this project will require 0.75 person-years of effort over a 6 month period for the initial development and publication. Subsequent updates will probably require about 25% of the initial effort and resources.

VI. Estimated Cost

Initial publication $50K
Subsequent updates $20K

PROJECT PLAN DESCRIPTION

I. Title

Identify and Demonstrate Construction Site Noise Control Techniques

II. Objectives

The objectives of this project are to identify construction site noise control techniques and to perform field demonstrations to assess the effectiveness of these techniques in reducing construction site noise exposure.

III. Project Description

Utilization of sound barriers, earth berms, equipment enclosures, and natural shielding to break the line-of-sight between the noise source and the receiver are perhaps the most effective means of reducing construction site noise impact. This project will involve identifying noise control techniques applicable to construction site noise control. These techniques will include, but not limited to, equipment enclosures which may be applied to stationary equipment such as pumps, compressors, etc., and sound barriers and shields which may be moved from site-to-site. Demonstrations of each type of noise control technique will be performed for various types of construction project types and construction activities. Information identifying the most appropriate noise control techniques for various construction project types and activities will be presented in a technical report.

IV. Justification

A. Need for Project. Construction site noise control appears to be one of the most cost-effective measures for reducing noise exposure. However, there is currently little available information regarding actual implementation procedures of site noise control devices or the costs of applying these devices. This project would support the ONAC urban initiatives program which is interested in such a demonstration in conjunction with The Pennsylvania Avenue Redevelopment Project in the District of Columbia.

B. Expected Payoff. Results obtained from this project will provide a means of identifying and applying appropriate construction site noise devices and a data base which can be used to assess the effectiveness of various control devices.

V. Scope

It is estimated that approximately 0.75 man-years over a six month period will be required to complete this project.

VI. Estimated Cost

$50K

CONSTRUCTION STRATEGY MODIFICATIONS

PROJECT PLAN DESCRIPTION

I. Title

Investigation of the Applicability of Construction Techniques to Replace Pile Driving

II. Objective

To provide data that will identify and justify requiring the use of a particular substitute construction technique for pile driving.

III. Project Description

A set of 5 to 10 alternatives to sheet steel on foundation piles will be selected. This may include various augering methods, cast in place piles, slurry wall techniques and others. For each substitute, the technical and economic factors influencing its use will be investigated. Technical factors may include, for example, soil conditions, closeness of sensitive receptors, size of working area, type of structure supported, tec. Economic factors, include incremental cost of alternative, investment in existing pile driving equipment, added construction time, training of operators, etc. Also, if available, the relative noise mitigation ability of each alternative should be listed. Data will be generated from examination of past and contemplated projects, contractor interviews, etc. The end product will be an organized set of conditions under which substitutes should be required. When two or more alternatives are applicable to a set of technical conditions, they will be ranked according to cost and noise mitigation ability.

IV. Justification

A. Need for Project. Pile driving has been identified in many studies as a major noise source. In addition to quieting the pile driving operation itself, a number of alternative construction techniques exist that eliminate the need for pile driving and which are much less noisy.

B. Expected Payoff. This project will provide EPA with a means of justifying the requirement to use the best alternative in particular cases.

V. Scope

It is estimated that this project will require one person year of effort over a 6 month year.

VI. Estimated Cost

$65,000

PROJECT PLAN DESCRIPTION

I. Title

Substitution of Alternative Equipment for Performance of Particular Construction Tasks

II. Objective

The objective of this project is to identify alternative equipment types which may be substituted for other equipment types in order to reduce total construction noise exposure.

III. Project Description

This project will involve identifying alternative equipment types to perform particular construction tasks or alternative construction task procedures and thereby utilization of alternative equipment types. In order to identify alternative equipment types, construction activity will be categorized according to project type and phase, e.g., highway construction/clearing and grubbing phase. For each project type and phase combination, the types of construction equipment and construction processes will be examined. Based on this information, alternative equipment types and/or construction task procedures will be identified. Demonstrations will be performed to assess the reduction in noise level and to evaluate the feasibility and practicality of the equipment substitution or task procedure modifications.

IV. Justification

A. Need of Project. This project may provide information which can be used as an incentive for construction contractors to use alternative equipment and task procedures which result in reduced noise exposure.

B. Expected Payoff. Potential reduction in construction noise exposure without significant increases in construction costs and time.

V. Scope

It is estimated that this project will require approximately 12 months and about one person year of effort to complete.

VI. Estimated Cost

$65K

PROJECT PLAN DESCRIPTION

I. Title

Demonstrate Noise Control Using Optimum Equipment Operating Techniques

II. Objective

The objectives of this project are to identify construction equipment operating procedures which minimize noise emission levels, and to perform field demonstrations to assess the effectives of these procedures in reducing equipment noise emission.

III. Project Description

Noise-conscious equipment operation may significantly reduce the total noise emission levels from construction equipment. This project will involve evaluating the levels of noise reduction which may be achieved through gear selection, throttle controls, governor setting, idling duration, blade to pavement contacts, and working direction relative to noise-sensitive areas and existing noise barriers. Other operational techniques will be identified during the course of the project study. Demonstrations of all operational noise control techniques will be performed using appropriate equipment types. As a result of this project, recommended operational procedures to minimize noise emission levels from various equipment types will be presented.

IV. Justification

A. Need for Project. Noise-conscious operation is an attractive means of reducing equipment noise emission levels since there appears to be little or no increase in operating costs. In fact, depending on the equipment type, some reduction in operating costs may be realized. There is currently little, if any, data available regarding noise reduction using equipment operating techniques.

B. Expected Payoff. Results obtained from this project will provide a means of identifying and applying appropriate operating techniques to minimize equipment noise emission levels. The results may also provide an incentive to use these operating techniques if it is found that a reduction in operating costs can be realized.

V. Scope

It is estimated that approximately 0.75 person years of effort over a six month period will be required to complete this project.

VI. Estimated Cost

$50K

PROJECT PLAN DESCRIPTION

I. **Title**

Investigate Minimum Noise Sequencing with PERT/Time and PERT/Cost Construction Control Techniques

II. **Objective**

To provide contractors with a technique for minimizing the noise impact of large projects without reducing the effectiveness of current contractor management controls.

III. **Project Description**

This would be an analytic study to determine the disturbance to the extensively used PERT technique produced by added time or number of units constraints on the use of construction equipment. An analysis of the means of minimizing these disturbances would be attempted. The end product would be a modified technique suitably documented.

IV. **Justification**

A. Need for Project. On large construction projects, contractor cost and time limits are achieved by an elaborate scheduling of expenditures and construction events. Using the so-called PERT techniques, many thousands of such event may be used on large projects by sophisticated contractors. If site noise considerations limit the number or scheduling of equipment at the site, the elaborate schedule of construction events is upset and time and cost will increase. To avoid this, a means of integrating these noise-inspired equipment use constraints into the PERT system is needed.

B. Expected Payoff. The use of such a modified technique will minimize the time and cost impact of equipment in-use noise controls.

V. Scope

It is estimated that this project will require 1.5 person years over an eight month period.

VI. Estimated Cost

$100K

NOISE CONTROL INCENTIVES

PROJECT PLAN DESCRIPTION

I. Title

Generation of Standardized Noise Control Contractual Specifications

II. Objective

To provide government and private contracting groups with construction noise control specifications which could be incorporated into contract documents.

III. Project Description

For each set of selected noise control techniques (time-of-day, use of barriers, maintenance of equipment, etc.) a technically coached, operationally feasible, and legally enforcable specification will be produced.

IV. Justification

A. Need for Project. The control of construction noise at the State and local level (particularly the local) is frequently accomplished by writing noise control provisions into the contracts for particular projects. Unfortunately, such provisions are sometimes non-existent, unprecise, not legally enforcable, and vary widely from project to project. This mainly results from the lack of capability at the local level.

B. Expected Payoff. The uniform specifications proposed would:

- Insure the use of noise control techniques on projects.
- Limit contractual disputes.
- Provide a uniform base for contractor's bids.
- Help to put construction noise control in a uniform basis throughout the country.

These uniform specifications could be distributed through the EPA Technical Assistance Centers.

V. Scope

It is estimated that this project will require .75 person years over a four month period.

VI. Estimated Cost

$50K

PROJECT PLAN DESCRIPTION

I. Title

Develop "Buy Quiet" Specifications

II. Objective

To develop model procurement specification for each type of construction equipment which will establish performance specifications for procurement of that equipment under the "Buy Quiet" program.

III. Project Description

EPA/ONAC conducts a "Buy Quiet" program (see Section V on Federal Programs and Policies Relevant to Construction Noise). This project will develop performance specification for noise emission levels for each major type of construction equipment. These specifications will be included in the Buy Quiet data bank and disseminated to Federal State and local purchasing Officers.

Information for the development of the noise emission standards will be obtained from the project "Comprehensive Construction Equipment Noise Survey."

IV. Justification

A. Need for Project. The "Buy Quiet" program has proven to be a cost effective way to encourage equipment manufacturers to design and build equipment with lowest possible noise emissions levels.

B. Expected Payoff. It is expected that this project will result in lowering the noise emission levels of new construction equipment.

V. Scope

It is estimated that this project will require 0.75 person years over a period of six months.

VI. Estimated Cost

$50K

CONSTRUCTION SITE MODELING

PROJECT PLAN DESCRIPTION

I. Title

Develop Site Specific Construction Site Noise Prediction Model

II. Objective

The objectives of this project are to develop an site-specific construction site noise prediction model, and to provide information on the uses and the implementation of the model by potential users.

III. Project Description

The site-specific construction noise prediction model will provide a means of estimating construction site noise emissions levels before the construction work is initiated. The output from the model will be presented in the form of equal-noise level contour plots surrounding the construction site and extending into the adjacent community. The contours may be generated by computerized representation of the model or generated manually using a detailed calculation procedure.

IV. Justification

A. Need for Project. The site specific construction noise prediction model will provide a capability to identify potential

noise problems in the communities surrounding construction sites and to determine appropriate noise control measures.
This project may be jointly funded by FHWA for the development of highway construction site models.

B. Expected Payoff. The noise prediction model will allow local jurisdictions and construction contractors to assess noise control requirements and to evaluate cost-effectiveness of implementing various noise control methods.

V. Scope

It is estimated that this project will require approximately six months and about 0.75 person years of effort to complete.

VI. Estimated Cost

$50K

PROJECT PLAN DESCRIPTION

I. Title

Update of the EPA's National Construction Site Noise Impact Model's Data Base

II. Objective

The objective of this project is to update the data base and assumptions used with the national construction site noise impact model. Specifically, these updates will include: revising the critical data elements, filling existing data gaps, providing additions to the existing data base, and revising obsolete or poorly documented assumptions.

III. Project Description

The EPA's national construction site noise impact model is used to provide a quantitative assessment of the noise impact from construction activity. This model can therefore be used as a means of assessing the effectiveness of implementing construction noise control measures and for identifying noise control requirements. This project will involve updating the data base and assumptions used with the noise impact model. The results of this project will increase the reliability of the noise impact estimates generated by the national noise impact model.

IV. Justification

A. Need for Project. The data base and assumptions used with the construction site noise impact model are based on population and construction activity statistics which change from year-to-year. Therefore, periodic updates of the model's data base should be performed. Additionally, the assumptions used to construct the noise impact model should be revised if such revisions are found to be appropriate.

B. Expected Payoff. Results obtained from this project will assure that the effectiveness of implementing various construction noise control measures or the identification of noise control requirements based on the model's impact estimates are reliable and represent the best available prediction capability.

V. Scope

It is estimated that approximately one person year of effort over a nine month period will be required to complete this project.

VI. Estimated Cost

$65K

CONSTRUCTION NOISE CONTROL PROGRAM COORDINATION

PROJECT PLAN DESCRIPTION

I. Title

Establish and Maintain a Center for Collection and Dissemination of Information

II. Objective

The objective of this project is to establish and maintain a center for the collection and dissemination of information on construction equipment and operations noise control.

III. Project Description

A center for the collection and dissemination of noise control information would be set up and supported by EPA/ONAC for about five years. At that time it is anticipated that the center would be self supporting. This project would identify possible candidate institutions for the location and operation of the center.

IV. Justification

A. Need for Project. The need for this project was identified by the Machinery and Construction Equipment Workshop during the Noise Technology Research Symposium in January 1979. Dissemination of noise control information is specifically mandated by the Noise Control Act of 1972 as amended.

B. Expected Payoff. It is anticipated that construction site noise exposure would be reduced through the dissemination of all available information of noise control techniques to State and local governments, equipment users and manufacturers.

V. Scope

This is a continuing project which will require about 0.5 person years of effort per year.

VI. Estimated Cost

$35K/year

PROJECT PLAN DESCRIPTION

I. Title

Coordinate Federal Construction Noise RD&D and Noise Control Programs

II. Objective

The objective of this project is to coordinate all Federal Construction noise research and control programs and to publish reports on the status and progress of these programs and assess the contribution of these programs to the Federal government's efforts to control noise.

III. Project Description

This project will provide the basis for continuing the coordination of all Federal programs relating to construction noise research and control and to assess their contribution to the overall efforts to control noise. EPA/ONAC will prepare and publish a report at least biennally on the status and progress of the Federal activities relating to construction noise research and noise control as required by Section 4c of the Noise Control Act (NCA).

IV. Justification

A. Need for Project. This project is required to comply with Section 4 of the NCA.

B. Expected Payoff. This project should result in a coordinated Federal effort in construction noise research and control .

V. Scope

This project is estimated to require about 0.5 person-year of effort per year.

VI. Estimated Cost

$30K per year.

TABLE D-2

CONSTRUCTION NOISE TECHNOLOGY INITIATIVES RANK ORDERING

PROJECTS \ RANKING CRITERIA	REQUIRED BY OCA	SUPPORTS NEW EQUIPMENT REG.	TOP 5 IN POPULATION IMPACT (Table 2-6)	EXTENDS CURRENT TNTD PROJECT	REQUIRED BY OTHER ONAC DIVISION (NOT S&RD)	MENTIONED MORE THAN ONCE TABLE B-1	POSSIBLE FY 81 JOINT FUNDING	EXTENDS CURRENT RESEARCH OTHER FEDERAL AGENCY	SUPPORTS LABELING STANDARD	IMPLEMENTATION NEED (APPENDIX F)	RELATIVE RANK*
Construction Equipment Noise Control (WBS 1000)	Weight 5	Weight 2						Weight 1			
Conduct Pile Driver Demonstration			X	X		X	X				B-8
Demonstrate Improved Drill Noise Control Technology			X					X			D-3
Develop Construction Equipment Noise Test Procedures		X							X		D-3
Conduct Comprehensive Construction Equipment Noise Survey		X							X		D-3
Develop Low Annoyance Back-up Alarms						X					D-2
Demonstrate W&C Tractor Noise Control		X	X								D-4
Update Technology Assessment Paving Breakers and Rock Drills		X	X								D-4
Demonstrate Paving Breaker and Rock Drill Noise Control		X	X								D-4
Update Technology Assessment Earthmoving Equipment		X									E-2
Demonstrate Earthmoving Equipment Noise Control		X									E-2
Identify Equipment Maintenance Requirements		X	X			X				X	B-7
Demonstrate Cooling System Noise		X	X	X						X	B-7
Conduct Feasibility Studies and Demonstrate Noise Reduction on Construction Vehicles		X	X	X							C-6
Develop Lower Cost/Lighter Weight Noise Control Devices		X									E-2
Demonstrate Noise Reduction for Forklift Trucks			X					X			C-3
Develop and Publish Engineering Noise Control Handbook					X		X	X		X	C-6

*A - Required By OCA
B > 7
C ≥ 5 < 7
D ≥ 3 < 5
E < 3

TABLE D-2 (Continued)

PROJECTS \ RANKING CRITERIA	REQUIRED BY QCA	SUPPORTS NEW EQUIPMENT REG.	TOP 5 IN POPULATION IMPACT (Table 2-6)	EXTENDS CURRENT TAPD PROJECT	REQUIRED BY OTHER ONAC DIVISION (NOT SBRD)	MENTIONED MORE THAN ONCE TABLE B-1	POSSIBLE FY 81 JOINT FUNDING	EXTENDS CURRENT RESEARCH OTHER FEDERAL AGENCY	SUPPORTS LABELING STANDARD	IMPLEMENTATION NEED (APPENDIX F)	RELATIVE RANK*
Construction Site Noise control (WBS 2000)											
Improve Barrier Insertion Loss							X	X			D-3
Develop Guidelines for Construction Site Noise Control					X	X	X	X		X	B-8
Demonstrate Construction Site Noise Control Techniques				X		X		X		X	C-6
Construction Strategy Modification (WBS 3000)											
Investigate Techniques to Replace Pile Driving			X								E-2
Conduct Study on Substituting Equipment (other than Pile Drivers) to Reduce Noise			X								E-2
Conduct Demonstration Using Optimum Equipment Operating Techniques					X						E-2
Investigate Minimum Noise Sequencing with Time and Cost Controls					X					X	D-3
Noise Control Incentives (WBS 4000)											
Develop Standardized Noise Control Contractual Specifications			X								E-2
Develop "Buy Quiet" Specifications			X		X						D-4
Construction Site Modeling (WBS 5000)											
Develop Site Specific Construction Noise Prediction Model		X					X	X			E-2
Update National Construction Site Noise Impact Model Data Base		X									E-2
Construction Noise Control Program Coordination (WBS 6000)											
Establish and Sponsor Coordination and Technical Information Center											E-0
Coordinate and Assess Federal RD&D and Control Programs	X	X		X							A-8

*A - Required By QCA
B ≥7
C ≥5 < 7
D ≥3 < 5
E < 3

APPENDIX E

TABLES OF FUNDING

TABLE E-1

SUMMARY OF FUNDS OBLIGATED
BY AGENCY BY FISCAL YEAR

	Fiscal Year						
Agency	75	76	77	78	79	80	Total
EPA, T&FP	-	50	575	506	254	45	1430
EPA, S&R, et al.	204	488	349	236	71	294	1742
DOT	136	42	60	190	125	-	553
DOC	25	31	55	27	-	-	138
DOL	25	29	42	16	-	-	112
DOI	90	188	298	-	249	-	825
DOD	104	140	139	123	85	85	676
HEW	-	-	55	-	-	-	55
TOTAL	584	968	1573	1198	784	424	5473

TABLE E-2

SUMMARY OF FUNDS OBLIGATED
BY APPLICATION BY YEAR

	Fiscal Year						
Application	75	76	77	78	79	80	Total
W&C Tractors	95	201	171	82	13	136	698
Other Earth-Moving Equipment	125	142	62	40	-	-	369
Compressors	-	-	83	45	-	-	128
Fork-Lift Trucks	25	25	25	25	-	-	100
Site	-	28	285	315	175	98	901
Breakers & Drills	243	365	372	126	277	105	1488
Internal Combustion Engines	-	-	425	481	234	-	1140
Acoustic Properties	96	207	150	84	85	85	707
TOTAL	584	968	1573	1198	784	424	5531

The information presented in the preceding tables was compiled from the following sources.

- Current Noise Contracts and Cooperative Agreements, No. 9, Fourth Quarter FY 79, Contract No. 68-01-5015, EPA.
- Current Noise Contracts and Cooperative Agreements, No. 12, Third Quarter FY 80, Contract No. 68-01-5015, EPA.
- Federal Agency Noise Control Technology. EPA 550/9-80-317, July 1980.
- Federal Research Development and Demonstration Programs in Machinery and Construction Noise. EPA 550/9-78-306, February 1978.
- EPA's Quiet Communities Five-Year Plan, FY 1981-FY 1985. Draft, February 1980.

APPENDIX F

IMPLEMENTATION NEEDS

APPENDIX F

IMPLEMENTATION NEEDS

BASIS FOR ANALYSIS

It is possible to use the material on noise control activities generated in Section IV, V, VI, and VII to develop programs that will lead to reduction of construction noise. Such programs could take a number of forms; among them are:

- RD&D programs in various areas of construction technology
- New Federal, State or local laws/regulations concerning construction equipment characteristics or usage control
- Noise control provisions to be written into construction contracts
- Contractor initiatives to use noise control techniques or quieter equipment
- Manufacturer initiatives to design and produce new generations of quiet construction equipment.

It is perhap worth noting explicitly that the demonstrations implicit in RD&D can be demonstrations of available technology, not just demonstrations of the results of an R&D program. Further, demonstration must be considered a necessary condition for acceptance of many types of technology by the private sector.[1]

The objective of the method outlined in this section is to uncover technology needs that would be amendable to one of these approaches and that could serve as the basis for new construction noise initiatives by the Technology and Federal Programs Division of EPA/ONAC.

GENERAL APPROACH

The general approach used to derive the needs that will be adaptable to the types of programs described previously consists of the following steps:

- Create three lists of items: areas, activities, and groups (a three-way matrix)
- For each matrix element, list those that represent conventional items or areas of control that have been used until now. For example, local governments have traditionally used ordinances to impose hours-of-the-day controls on construction
- From the material contained in Sections IV, V, VI and VII list those areas in which "substantial" use has been made of the activity to control the item or area. Again, using the previous example, a substantial number of local governments have time-of-day noise controls
- Isolate those cases in which there is not a substantial number of agencies or groups using the activity to control the item or area. For example, placement of equipment within a construction site is not controlled by local ordinances by any large number of communities

[1]See Noise Technology Research Needs and the Relative Roles of the Federal Government and the Private Sector. EPA 550/9-79-31, May 1979 for details on this point.

- Examine the above cases to determine the reasons the situation exists. For example, lack of "placement of equipment" ordinances may be due to lack of understanding of where equipment could be placed to minimize noise impact or how to specify placement in a legally enforceable way.
- List the "technology need" that could overcome the reason for non-use
- Categorize the technology needs under the headings given previously.

GENERATION OF TECHNOLOGY NEEDS

Noise Control Elements

The noise control actions uncovered in the various surveys outlined in previous sections can be listed under the item or area controlled. In one case, the emphasis is on controlling the noise emitted by individual items of equipment. In an alternative approach, the emphasis is on limiting the total noise emitted from a construction site. An obvious third is to use a combination of the first two approaches.

The two approaches are not precisely equivalent. In the first case, if the noise emitted by all, or almost all, the equipment at a site is low, then the site noise is low. In the second case, the total noise from a site can be reduced by using quieter equipment, by controlling the manner in which relatively noisy equipment is used, or by physically containing the sound within the site. A list of commonly used or suggested items of equipment control and construction site areas of control are shown in the left hand column of Table F.1.

A few items listed need clarification. "Designed Emission Level" is the noise emission level originally designed into the equipment item by the manufacturer. "Equipment Capacity Level" allows for the possibility of using lower powered equipment to reduce noise or higher powered equipment to speed up the work. "Alternate Technique Equipment" means using a completely different technique to achieve the same result, e.g., slurry-wall

TABLE F.1

INTERACTION OF NOISE CONTROL ELEMENTS

CONTROLLED ITEMS OR AREAS	GROUP AND ACTIVITY								
	SPECIFICATION BY LAWS/REGULATIONS			MANUFACTURERS DESIGN-MAKE SELL	RESEARCH GROUP ACTIVITY	CONTRACTORS USE-ADHER TO	CONTRACTING AGENCIES' CONTROL		
	FEDERAL	STATE	LOCAL				FEDERAL	S&L	PRIVATE
<u>Equipment</u>									
Allowable Emission Level (New Equipment	CS				CS				
Allowable Emission Level (Existing Equipment)		CS	CS			CS	C	C	
Designed Emission Level				CS					
Mufflers		CS	CS	CS	CS	CS	C	C	
Maintenance Procedures		C	C	C	C	C			
Equipment Enclosures		C	C		C	C		C	
Equipment Capacity Levels									
Alternate Technique Equipment		C	C		CS	C	CS	CS	CS
Operator Techniques									
<u>Construction Site</u>									
Allowable Level at Boundary		CS	CS			CS	CS	CS	CS
Allowable Level for Sensitive Neighbors		CS	CS			CS	CS	CS	CS
Time of Day		CS	CS			CS			
Scheduling of Equipment Use		CS	CS			CS			
Placement of Equipment									
Enclosure of Site/Use of Barriers		CS	CS		CS	CS		C	
Sequence of Operations					C	CS			
Contractural Requirements						C	C	C	C
Access Control		C	C			C			
Public Relations						C			

CODE: C = Conventional items or areas of control in the past.
S = Substantial continuing activity.

construction instead of pile driving. "Scheduling of Equipment" means, for example, limiting pile driving to 15 minutes in each hour. "Sequence of Operations" means an attempt to arrange basic construction stages (clearing, excavating, etc.) in a manner that will minimize noise generation.

Although all of the above means of construction noise control have been suggested and discussed, only a few have been employed to any significant degree. For example, under equipment control, the largest effort by far goes into the design of quieter items. Under site control, time-of-use is the overwhelming choice.

Across the top of Table F.1 are the groups of agencies that have an impact on noise control, and the activities they perform to produce that impact.

<u>Conventional Items/Areas of Control</u>

The elements in Table F.1 marked "C" are those which are, or have been under the control or cognizance of the group shown either by law, tradition, or technical capability. For example, time-of-day ordinances are always State or local, never Federal. Certain other elements, "could be" used in the future. For example, local ordinances to control placement could be passed, but thus far, have not been.

<u>Areas of Substantial Activity</u>

The elements in Table F.1 marked "S" are those in which an examination of Sections IV, V, VI and VII disclosed that a "substantial continuing activity" is taking place. A Federal Highway Administration survey showed that 31 out of 46 States surveyed have "time-of-day" controls.

The term "substantial" has not been given a precise quantitative value, since this depends on the type of group and activity. However, something over 40% to 50% of the possible members in the group is "substantial".

<u>Lack of Activity</u>

Examination of Table F.1 shows three major groups of control possibilities in which there is little or no activity. These groups are:

(1) State and local laws covering:

- Maintenance procedures

- Use of equipment enclosures
- Specification of equipment capacity levels
- Operator training and qualifications.

(2) Contractor:

- Integration of optimum noise sequencing of operations with time and cost control methods.

(3) Contracting agency use of contract provisions to require:

- Optimum placement of equipment
- Minimum noise site access
- Public relations efforts.

Note that items in group (1) have more general applications and thus lend themselves to control by ordinance/law. Group (3) items are more site specific and thus more amenable to control by project contract provisions.

Reasons for Non-Application and Technology Needs

In accordance with the approach laid out previously, it is necessary to examine the reasons for the non-applicability of the noise control methods listed in the previous section. Without connecting reasons with methods at this time, a set of possible reasons can be generated a priori. Such a list is given in Table F.2.

Having a list of reasons, and again not considering noise control methods for the moment, it is possible to generate a set of "Technology Needs", that is, a set of possible actions that could be taken to negate the reasons. A list of Technology Needs is also shown in Table F.2. As explained under "Basis of Analysis", "Technology Needs" can take a number of forms in addition to RD&D programs. A few of these Technology Needs in Table F.2 require explanation:

B- A set of uniform noise specifications that could be used in project contract documents.

D- Voluntary initiatives undertaken by contractors to enhance their competitive positions.

F- Authorized by the Quiet Communities Act of 1978.

TABLE F.2

REASONS VS. NEEDS CORRELATION

REASONS FOR NON-APPLICABILITY OF CONTROL	TECHNOLOGY NEEDS (ACTIONS)							
	A	B	C	D	E	F	G	H
	RD&D PROGRAM	GENERATION OF SPECIFICATIONS	ADDITIONAL LAWS OR ORDINANCES	CONTRACTOR COMPETITIVE INITATIVES	COMMUNITY EDUCATION PROGRAM	GRANTS TO LOCAL GOVERNMENTS	INCENTIVES TO MANUFACTURERS	TECHNOLOGY TRANSFER
1 Lack of Knowledge Concerning Effectiveness	X				X			
2 Lack of Legal Authority			X					
3 Lack of Community Pressure					X			
4 Difficulty of Implementation	X	X						
5 Limited Applicability	X							
6 Unawareness of possibility				X	X			X
7 Lack of Capability at Local Level		X				X		
8 Unavailability of Quiet Equipment	X						X	
9 Unavailability of Alternative Techniques	X						X	

Correlation of Reasons and Needs

The correlation between reasons for non-applicability of a noise control possibility and the Technology Needs has been shown in Table F.2 by placing a "X" in the appropriate square. Note that there is not necessarily a one-to-one correspondence between reasons and needs.

The reasoning behind the placement of the "X's" is subjective and therefore subject to individual opinion. A few examples are given here to illustrate the reasoning involved.

A-1 If a control method is not being used because there is no reliable or available knowledge concerning its effectiveness, then an RD&D program could be established to provide the data or knowledge.

E-1 If a method is effective but not used, it may be simply a matter of making this knowledge available to local governments.

A-4 If a method is not used because it is difficult to implement for technical reasons, then an RD&D program may remove the technical difficulties.

B-7 Local governments frequently do not have the technical expertise to require a public works contractor to use certain noise control techniques. A set of standard noise control specifications that could be incorporated into contracts would alleviate this situation.

Technology Needs and Control Possibilities

Each of the correlations shown in Table F.2 have been generated up to this point, without considering the actual control possibilities that have not be implemented. The association of these correlations with the control possibilities completes the approach previously given. This association is shown in Table F.3.

Note that Table F.2 and F.3, taken together constitute a three-way correlation of:

- Noise control techniques not being used

TABLE F.3

GENERATION OF TECHNOLOGY NEEDS

AREAS WHERE CONTROL POSSIBILITIES HAVE NOT BEEN IMPLEMENTED	TECHNOLOGY NEEDS VS. REASONS-TABLE F.2															
	A-1	A-4	A-5	A-8	A-9	B-4	B-7	C-2	D-6	E-1	E-3	E-6	F-7	G-8	G-9	H-7
<u>Group 1 -- S&L Laws Covering</u>																
Maintenance procedures	X	X				X	X	X		X	X		X			X
Equipment Enclosures			X					X			X					X
Equipment Capacity	X						X	X		X	X		X			
Operator Training						X	X	X			X					
<u>Group 2--Contractors</u>																
Sequencing of Operators									X							X
<u>Group 3--Contract Provisions Covering</u>																
Placement of Equipment	X	X	X				X			X						X
Site Access							X				X					X
Public Relations	X								X	X		X				

- The reason or reasons for their non-use
- Actions (Technology Needs) that could be taken to negate these reasons.

As in Table F.2, the reasoning behind the placement of the X's in Table F.3 is subjective and subject to interpretation. An example of the reasoning involved follows:

- Local laws mandating construction equipment maintenance procedures may not be used by a local government because: (see Table F.2)
  - 1. Their effectiveness is unknown both locally and generally.
  - 2. The local government does not have legal authority to pass such ordinances.
  - 3. There is no community pressure to react to construction noise.
  - 4. Implementation of maintenance procedures is considered a difficult task.
  - 5. The local government does not have the expertise to develop such procedures.
- From Table F.2, the Technology Needs that could overcome this set of possible difficulties are:

  A. An RD&D program to determine quantitively the noise reduction achieved by maintenance procedures.

  B. An education effort to make the community aware of the construction noise problem.

  C. A grant of legal authority from the State legislature.

  D. A set of standard construction noise specifications the community could use in its contract documents.

  E. A financial grant to the local government.

Note that, all these reasons/needs do not apply to any one particular community but are distributed over many States and local governments. Also, the relative distribution of reasons/needs cannot be quantified at this time.

FINAL TECHNOLOGY NEEDS

A number of major new Technology Needs can be identified in Table F.3. A need exists for RD&D programs to determine the effectiveness of: equipment maintenance procedures, equipment enclosures, changing equipment capacity, placement of equipment, and public relations efforts. Technology dissemination and a community education programs to increase awareness of the construction noise situation would obviously be desirable. In many cases grants of authority to local governments from State legislatures may be necessary. Finally, the generation of a set of standard construction noise specifications would be desirable.

In addition to these major needs, two other needs can be deduced from Table F.2 and F.3:

- Grants to local governments
- Contractor competitive initiatives.

The first of these is underway by EPA/ONAC in its implementation of the Quiet Communities Act of 1978. The second is an interesting concept that should be undertaken. It is discussed further in Section IX.

ORI, Inc.
1400 Spring Street, Silver Spring, Maryland 20910
(301) 588-6180