Comprehensive System-Level Noise Reduction Strategies

WA-RD 247.2

Final Technical Report
September 1991

Washington State Department of Transportation
Washington State Transportation Commission

in cooperation with the
United States Department of Transportation
Federal Highway Administration

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. WA-RD 247.2	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.

4. TITLE AND SUBTITLE
Comprehensive System-Level Noise Reduction Strategies

5. REPORT DATE
September 1991

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
William Bowlby, Thomas O'Grady, R. Clay Patton and Lloyd A. Herman

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Vanderbilt Engineering Center For Transportation Operations and Research
Vanderbilt University, Box 96, Station B
Nashville, TN 37235

10. WORK UNIT NO.

11. CONTRACT OR GRANT NO.
WSDOT Y-4571

12. SPONSORING AGENCY NAME AND ADDRESS
Washington State Department of Transportation
Transportation Building
Olympia, WA 98504

13. TYPE OF REPORT AN PERIOD COVERED
Final Technical Report
4/90 - 10/91

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Technical Monitor: Ronald Rolfer, Environmental Unit
Washington State Department of Transportation

16. ABSTRACT

A comprehensive review of the state-of-the-art in traffic noise abatement was conducted. Key literature was reviewed, and surveys conducted with state DOT noise analysts, and local environment noise control programs, and vehicle manufacturers. Areas of interest included abatement strategies, effective vehicle noise control, land use compatibility programs, and programmatic and administrative issues.

Findings included:

1. the demand for noise abatement is increasing;
2. state DOTs need better sources of funds for retrofit ("Type II") noise barrier programs;
3. state and local noise control programs have suffered greatly since the end of the USEPA noise program in 1982;
4. truck manufacturers in the U.S. and Europe are successfully meeting the newly manufactured vehicle noise standards in their respective areas.

Current Washington initiatives were also examined. WSDOT has included noise abatement as a priority area in its 1991 Transportation Policy Plan and the legislature developed a Growth Management Act and Growth Strategies Act that calls for comprehensive land use plan development by cities and counties. Recommendations to WSDOT included the need for expanded staff, a dedicated source of funds for a phased retrofit abatement program and active involvement in implementation of the two growth acts.

17. KEY WORDS
Traffic noise, noise abatement, vehicle noise, noise barriers

18. DISTRIBUTION STATEMENT
No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22616

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified	296	

DOT FORM 310-022 (11/86) -1216-

Final Technical Report
for
Research Project Y4571
"Comprehensive System-Level Noise Reduction Strategies"

COMPREHENSIVE SYSTEM-LEVEL NOISE REDUCTION STRATEGIES

by

William Bowlby
Thomas O'Grady
R. Clay Patton
Lloyd A. Herman

Vanderbilt Engineering Center
for Transportation Operations and Research

Vanderbilt University
Box 96, Station B
Nashville, TN 37235

Technical Monitor
Ronald Rolfer
Environmental Branch, Design Office
Washington State Department of Transportation

Prepared for

Washington State Transportation Commission
Department of Transportation
and in cooperation with
U.S. Department of Transportation
Federal Highway Administration

September 1991

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Washington State Department of Transportation or (or another agency). This report does not constitute standard, specification or regulation.

TABLE OF CONTENTS

LIST OF TABLES

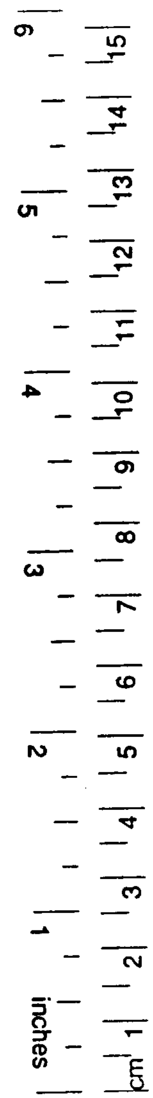
LIST OF FIGURES

LIST OF APPENDICES

METRIC CONVERSION FACTORS

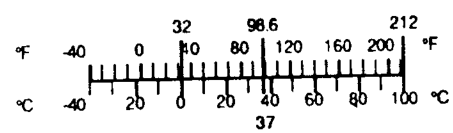
Approximate Conversion to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	2.54	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversion from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	sq. centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	sq. kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



n: Data. Adm. TRAC Adm: Metric

3/9/89

COMPREHENSIVE SYSTEM-LEVEL NOISE REDUCTION STRATEGIES

SUMMARY

The purpose of this research was to assess the state-of-the-art in a wide variety of areas related to traffic noise control and make recommendations to Washington State DOT (WSDOT) for its programs. The research was conducted in part because Washington citizens are becoming increasingly vocal about traffic noise and their state legislators are responding to their concerns. Also, it has been nearly a decade since similar comprehensive surveys were done, and major changes of many types have occurred.

The research had three objectives:

1. Review and evaluate the state-of-the-art,
2. Make recommendations to WSDOT for its traffic noise analysis and abatement program, and
3. Package the resulting information into a report useful to the state legislative transportation committee for potential traffic noise related legislation.

There were six areas of interest to WSDOT in the state-of-the-art review:

1. Noise abatement strategies at the source, at the receiving property, and along the path between them,
2. State and local noise ordinances, legislation and regulations,
3. Traffic noise research,
4. Successful noise program communications techniques,
5. Legal decisions, and
6. State DOT administrative and programmatic issues: staffing, funding and prioritizing abatement, and funding research.

Information was gathered from the literature and from surveys and telephone follow-ups conducted with: (1) state DOTs (with 49 responses, plus Puerto Rico and the Canadian province of Ontario); (2) six state environmental noise control programs; (3) thirty-five municipal noise programs; and (4) vehicle manufacturers.

Key findings of the state-of-the-art assessment include:

1. The demand for traffic noise abatement by citizens is growing throughout the country even in some of the more rural states.
2. This demand is especially strong along existing highways (noise abatement project on an existing highway is called a "Type II" project by FHWA).

3. State DOTs, in general, cannot meet this demand with the current funding mechanisms.

4. Our nation's state and local noise control programs, which are largely responsible for enforcing motor vehicle noise standards and encouraging/requiring noise compatible development, were decimated by the ending of the U.S. Environmental Protection Agency's (EPA) Office of Noise Abatement and Control and the EPA noise program in 1982.

5. Federal noise regulations for newly manufactured medium and heavy trucks, motorcycles and motorcycle exhaust systems are still in effect. The maximum allowable level for trucks was reduced by 3 dB in 1988 after six years of deferral on a legislated 1982 date. Truck manufacturers seem to be complying with this regulation.

6. The federal regulation for maximum in-use levels of motor carriers engaged in interstate commerce is still in effect, and while FHWA is charged with compliance testing, virtually no testing has been done since the early 1980's, even though the in-use maximum levels were reduced 3 dB for 1986 and later model trucks.

7. There is a need for more research, development, implementation and technology transfer to better understand the cost, benefits and trade-offs of various noise abatement strategies, to reduce abatement costs, and to improve analysis techniques.

The primary noise abatement measure used by state DOTs is the noise barrier. By the end of 1989, thirty-nine states and Puerto Rico have constructed over 720 miles of barriers at a cost exceeding $635 million (in 1989 dollars). The state DOTs indicated that they plan to spend between $130 and $147 million per year over the next 5 years for barriers as part of new roadway construction or major reconstruction.

Twelve states plan to spend an average of $75 million per year over the next five years for Type II barriers on existing highways (one-third of that in California alone). California voters recently passed Proposition 111 which increased the state gas tax and stipulated that $150 million in new money be directed to its Type II program over the next 10 years. Having a good project prioritization method is an important part of a Type II program.

Use of other abatement strategies, such as sound insulation of public facilities, depressing the highway, shifting the alignment, is fairly common. Many states also indicate a willingness to allow privately funded or locally funded barriers erected on the state right-of-way, but are reluctant to obtain easements to place their barriers off the right-of-way, where in certain situations they would be more effective. States are also generally reluctant to soundproof private facilities or reduce speeds on roads to reduce noise. There is much interest in "quiet pavement" research, but little implementation yet.

Communication techniques consist largely of public meetings and one-on-one or small group meetings in the project area. Use of slides, videos, and large aerial photographs are common, with occasional use of audio recordings. One state has recently used computer-generated images to display planned barriers.

The legal issues involving traffic noise have varied from lawsuits over decisions to not install barriers to justification of analysis techniques. Seeking of damages with and without partial taking of the property has occurred in a number of cases.

Staffing concerns include the difficulty in keeping properly trained personnel and having insufficient staff to handle increasing demands regarding noise as well as other environmental matters.

In summary, the public demand for abatement is increasing in many states while the resources--funds, staff, executive management support, legislation, regulations and technical tools--are inadequate or need improvement. Source control is generally beyond the jurisdiction of state DOTs, yet the USEPA programs on source control and technical assistance to local government have been virtually nonexistent since funding was cut in the early 1980's. Source control through use of quiet pavements is one area, however, that offers promise to state DOTs. Control at the receiving land use is also largely beyond the jurisdiction of the state DOTs, yet effective land use compatibility planning, zoning control and physical noise mitigation techniques could prevent many future noise problems from arising. Control along the path is the main option available to state DOTs, yet work is needed on issues such as abatement cost and cost effectiveness, and analysis tools for special situations.

The challenge of funding, especially for retrofit abatement on existing highways, seemed to be a common thread throughout the DOTs. In California, the public recently took its demand for more traffic noise abatement into its own hands passing a gas tax increase as a funding mechanism.

In most other states, however, traffic noise, while very serious, remains a minority-party issue. Its impacts can be severe, but probably do not affect a large enough population for a California-like proposition to succeed. Lacking such a voice, the impacted public must rely on the various branches and levels of government to protect and enhance the environment while carrying on the mission of providing safe, efficient, and economical transportation.

Washington State is fortunate in many ways compared to other states in the sense that environmental protection has maintained a high profile and priority among the public, the legislature, and the administration. The state legislature has shown its concern over growth and, to some degree, the resultant environmental impact with the passage of the Growth Management Act of 1990 and the Growth Strategies Act of 1991. WSDOT has demonstrated in leadership by a defining a State Transportation Policy Plan that gives top priority to environmental protection and delineates action strategies to minimize noise impacts from transportation systems and facilities. These strategies address: (a) minimizing noise impacts on new facilities; (b) requiring land use plans to identify noise impacts and locations of needed mitigation and to avoid future impacts through land use and building code strategies; (c) mitigating transportation noise impact identified in local land use plans; and (d) supporting development of quiet alternative transportation modes. However, noise abatement must compete with other important areas of environmental protection and other departmental priorities, and without adequate resources, laws and policies are of little use.

The emphasis on noise control through land use planning is important, and ties in with the Growth Management and Strategies Acts. The Acts require cities and counties experiencing rapid growth to develop comprehensive land use plans that include environmental protection as an important goal. While noise mitigation is not specifically required to be addressed in the plans, noise control is certainly a key item that could be made part of the plans. Many of the legislated aspects of the plans offer opportunities for WSDOT to play a role in mitigating existing noise or avoiding future noise impacts. Additionally, the department can be expected to be called upon by the Department of Community Development to assist in providing technical assistance to the cities and counties in development of the plans and subsequent regulations.

Organizationally, the WSDOT Noise Unit (one noise specialist) is located within the Environmental Branch of the Design Office within the Program Development Division. However, the Noise Unit provides technical support across organizational lines within its own division, to other main office divisions, and to the districts. Additionally, the Noise Unit represents the department in dealing with the public, the legislature, and other state and local agencies. WSDOT has taken an active role in the last several years defining and conducting a traffic noise research program and will easily become a leader in traffic noise research in this country with its current and proposed levels of effort. Research must be continued in the areas of noise mitigation and improved noise analysis techniques.

Given the Transportation Policy Plan, the Growth Management and Strategies Acts, and even the new National Aviation Noise Policy, the duties, responsibilities and work load of the Noise Unit and the district offices will increase if the state wants to successfully mitigating transportation noise on a system-wide basis. Based on staffing in other state DOTS, one or two new main office staff positions would be needed to carry out the full potential work load, especially if WSDOT implements a comprehensive Type II noise abatement retrofit program for existing highways. A six to eight year retrofit program, funded at a level of $3-$4 million per year (in current dollars) is probably needed to solve Washington State's existing highway noise problems. WSDOT should consider adding a new category of funding for highway improvements called Environmental Mitigation Enhancement Improvements, and seek to fund its Type II noise barrier program through this category possibly through a dedicated percent of the state gasoline tax. It should also investigate other funding opportunities through the provisions in the Growth Management and Strategies Acts.

Washington State has made a choice and put forth a policy to abate transportation noise. More legislation is needed and more administrative support within WSDOT is required, in terms of staff and funds, to succeed.

CONCLUSIONS AND RECOMMENDATIONS

There are nine key conclusions that can be drawn from this research:

1. There is a large unmet and increasing demand by citizens for traffic noise abatement.
2. There is a need for a dedicated source of funding for Type II noise abatement (that is, the addition of noise barriers to existing highways).
3. There is a need for more research, implementation, and technology transfer in the field of highway traffic noise abatement, especially as it relates to the costs and effectiveness of abatement strategies.
4. There is a need to reestablish a program in EPA headquarters to provide technical and financial assistance to state and local noise control programs.
5. There is a need to evaluate the current degree of compliance with the Noise Regulations for Motor Carriers Engaged in Interstate Commerce and to assess if further reduction in noise levels of newly manufactured trucks is or is not warranted.
6. There is a need to <u>consider</u> the need for national noise emission standards for automobiles and busses.
7. WSDOT views noise abatement as a high-priority policy issue, but it realizes that noise abatement must compete with other high priority environmental issues.
8. The Washington State Growth Management and Strategies Acts offer a significant opportunity to attack the transportation noise problem from the point of view of land use compatibility; implementation of the Acts should put demands on the WSDOT staff even if WSDOT chooses to not actively pursue the compatibility approach.
9. Staffing and funding, however, are inadequate for WSDOT to succeed with its Policy Plan "action strategies" on noise mitigation or to meet the opportunities possible through the Growth Management and Strategies Acts.

These conclusions will be amplified in the following discussion, which focuses on conclusions in the individual subject areas of the study.

TRAFFIC NOISE ABATEMENT MEASURES

There is a willingness on the part of state DOTs to try new noise abatement measures, but there has not been a great deal of actual use of these measures. The state DOTs need more information on the costs and benefits of all noise abatement measures. There appears to be inadequate information on the consequences and legal aspects of several abatement measures, such as locating state barriers off the right-of-way, or private barriers on the right-of-way, and insulating private facilities. More information needs to be gathered on design, implementation, and construction experiences.

In terms of specific strategies, not all sound-absorbing barrier systems currently being used seem to be designed for the highway environment. More study of the actual degradation in noise barrier insertion loss between parallel barriers is needed to better define those situations where special treatment is needed.

Tilting noise barriers is a feasible alternative to adding sound-absorbing material. There is limited field data on the effectiveness of this strategy other than at controlled test sites, and data for in-situ traffic situations is needed.

The use of transparent noise barriers is generally not a good idea when located at the roadside edge because of problems with grime accumulation. However, a transparent barrier in this location could help with winter shadow problems in states where snow is a problem. Transparent barriers seem to be a good alternative when the barrier location is near the right-of-way line. More experience on maintenance durability and UV yellowing is needed.

The use of the "planted" noise barrier system has potential for good aesthetic treatment but the costs are much higher than conventional barriers. Some maintenance and landscaping questions also remain.

The use of private funding to assist or pay for noise barriers on the state-right-of-way can be a very workable strategy. However, it is important that these barriers be designed to state standards, both in terms of physical and acoustical properties. The state DOT should be involved in all aspects of the project development, from review and approval to construction supervision. The state should assume liability for the wall after its installation and be responsible for maintenance. Those states unwilling to consider placing their noise barriers off of a state-right-of-way may be missing a good opportunity for cost effective noise abatement.

The use of barriers on limited access facilities should be considered where curb cuts are few; there is also a need to extend the barriers down the side streets for proper end protection.

A state DOT should be willing to be innovative as a situation demands. The use of depressed highways for noise abatement is a good strategy, and shifting of highway alignment should be considered where feasible. The use of buffer zones, while attractive, is limited because of the cost of land. Also, noise barriers would probably need to be incorporated into buffer zone design for adequate noise reduction. The installation of a decked facility, although extremely expensive, may be justified where concerns such as community cohesion and environmental enhancement are important.

Concrete pavement grooving and tine spacing can cause serious noise problems, but can be successfully mitigated with proper attention to spacing details. More effort should also be focused on reduction of overall traffic noise levels through the use of quiet pavements.

The insulation of public facilities is a good solution for interior noise impact situations. The California school noise abatement program is an excellent example of a major state commitment to a significant improvement in the educational experience.

The insulation of private facilities has its place, such as for non-residential buildings (churches and private schools). It could also be a low-cost strategy for solving severe, isolated residential impacts, where a barrier is unreasonable because of its cost. The legal issues are solvable through state legislation; an excellent model could be the airport soundproofing experiences throughout the country.

Traffic management schemes should only be considered for noise abatement in selected situations. The banning of trucks has merit if alternative routes are available (and if feasible in terms of road capacities). Reduced speed limits for noise purposes will only offer marginal benefits, and will usually be counterproductive to normal highway project purposes.

There is a significant need in the country for Type I noise barriers for planned new highways and reconstruction of existing highways. There is also an extremely large demand for Type II (retrofit) noise barriers that will probably only increase in the future. Having a good prioritization system for Type II projects is essential.

There is a need for state legislation to provide a funding source for a Type II program. Also, the new National Transportation Policy could provide the flexibility for use of federal funds to a Type II program. In that regard, it is a good idea to establish a policy regarding matching funds from local governments or affected homeowners. The Wisconsin idea of a local match for barrier costs exceeding its criteria and the local pay-back provision in the California Type II program may serve as useful models.

The state DOTs should insist on some type of action from local government for Type II projects, such as a municipal resolution supporting the project and development of a land use compatibility program for other existing highway situations.

Good communications with the public is essential for effective noise abatement programs. It is especially important to consider the views of the directly impacted residents, especially regarding their desire for a noise barrier. Effective visual aids are also important. More use should be made of computer technology to present views of the proposed project to the citizens. One-on-one project meetings with individual homeowners or small groups of homeowners can be extremely effective in resolving problems. The Colorado urban design committee idea is an excellent prototype for involvement of the DOT, the local government and the affected citizens.

In terms of legal decisions, careful analysis and proper documentation of methodologies is important. Potential legal issues should be identified early in a project's development, and state DOT council involved in the process.

Research for traffic noise analysis and abatement should receive increased emphasis in the future. The pooled-fund concept works well to allow states to make more efficient use of limited resources. WSDOT, because of its experience and leadership, should play an active role in helping FHWA shape its environmental research agenda for the next five years.

There is a need to examine the reference vehicle noise emission levels that the state is using for its traffic noise predictions. There is a need to better define when multiple reflection effects between parallel noise barriers degrade barrier performance. There is a need to develop improved traffic noise analysis techniques, taking full advantage of current CAD and roadway design technologies. More validation of the non-constant speed traffic noise prediction procedure (NCHRP 311) should be done. More evaluation of noise barrier field performance should be made, using the American National Standard as a guide.

Additional attention should be paid to the source height used in the prediction models, given Florida's results and given vehicle manufacturer's efforts to reduce truck noise through design. A long-term research effort on tire/pavement noise reduction of open graded asphalt should be continued, and benefits for wayside receivers should be quantified.

State DOTs are not doing enough to coordinate with local governments to prevent future noise problems from developing along existing highways. They are missing one of the most effective ways of controlling future noise problems from developing. The "noise element" of the California local government general plans has been a major success in leading to compatible development along highways and good mitigation when development is along side the roads. The state DOT should play an active role in technology transfer and assistance for local communities desiring noise compatible development.

The DOT should take every step necessary to insure a well-trained staff for noise analysis and noise barrier design. Noise abatement policy and philosophy are as important as technical skills. Main office staff should provide a strong support role to district office personnel.

When consultants are used on state DOT projects, the state should take every step to insure that the consultants are well qualified for noise analysis and noise barrier design. Establishing a list of qualified consultants for noise analysis should be considered, if not already in place.

The latest advances in traffic noise analysis tools should be considered for implementation by the state. There are some problems with the existing traffic noise prediction model that need to be resolved through either FHWA or pooled-fund action.

Nationwide, there is too much variability in the interpretation of the FHWA noise standards in terms of "substantial" increases in noise levels, noise barrier design goals and interpretation of the noise abatement criteria. In some cases, the FHWA noise standards are being interpreted incorrectly.

LOCAL AND NON-DOT STATE NOISE CONTROL PROGRAMS

Elimination of the EPA noise program, especially in terms of its state and local assistance, has had a serious, and often fatal, negative effect on state and local noise control programs in this country. The large infrastructure of experience within the federal, state and local levels of government has largely been lost. Nonetheless, noise control remains an important issue.

Local programs need financial assistance from state and/or federal programs, and state programs need federal assistance. EPA should reestablish its Office of Noise Abatement and Control and conduct a number of investigations on the extent of this nation's transportation noise problem, and the effectiveness of its current regulations.

The California, Colorado and Canadian programs offer good models for land use compatibility programs, especially regarding requirements on developers.

CONTROL OF VEHICLE NOISE AT THE SOURCE

The major American and European manufacturers have excellent noise control programs. They have proven that through a careful analysis of individual noise source components vehicle noise levels can be reduced. It appears that some further reduction over current levels is still possible as more sophisticated computer analysis techniques are used. Noise control is a key design element in overall vehicle design.

While a need for additional reduction in truck emission levels has not been proven at this time, several state DOT survey respondents identified such a need, including lowering of exhaust stacks, as a key issue. Additional noise reduction will be costly and difficult, but should not be ruled out pending a more comprehensive assessment of the national noise impact. The problem may be due more to the older trucks in the population than those newly manufactured.

There is a need, however, to assess if automobiles and busses should be regulated. As the heavy truck noise levels are reduced, their dominance over the total traffic stream will become less significant. Emission level data collected by state DOTs to calibrate their prediction models indicate that the automobile levels are increasing, probably in large part due to the great number of light trucks included in this class.

The European strategy of a joint government/industry initiative to reduce vehicle noise seems to be effective, much like the efforts in the United States in the early 1970's.

Finally, vehicle exterior noise reduction efforts should place more attention on minimizing tire noise contributions.

WASHINGTON STATE INITIATIVES

Washington State has seen a demand for traffic noise mitigation from the public. Concerns over growth have led the state legislature to pass a Growth Management Act and a Growth Strategies Act that call for the development of comprehensive land use plans by cities and counties. Environmental protection is a key planning goal articulated in the Acts. WSDOT has also responded by making environmental protection one of its top priorities in the State's 1991 Transportation Policy Plan. Four action strategies are delineated for transportation noise mitigation that will attack the problem at the source (research into quiet alternative modes), at the receiver (land use control and mitigation) and along the path between them (mitigation of existing noise impacts). Additionally, WSDOT has embarked on a process, "Choices in Transportation for Washington's Environment," aimed at helping WSDOT develop strategies and programs for implementing the state transportation policy as it relates to the environment.

The Growth Management and Strategies Acts give WSDOT a unique opportunity to have a profound effect on the control of transportation noise impacts on yet-to-be developed lands even through noise mitigation not specified mandated to be an element of the land use plans. Clearly, the most effective strategy for long-term control of traffic noise problems is through land use management and control. WSDOT must move quickly within the next year to be able to provide the needed technical assistance to cities and counties and to encourage them to develop noise control elements in their comprehensive plans. Further, WSDOT must move aggressively to ensure that funding mechanisms are in place to provide the noise mitigation that could be built into those plans. These funding mechanisms, with some amendment to the definitions in the Acts, could take the form of real estate excise taxes or impact fees for new development or state legislated funds for mitigation along existing facilities. There are many other sections of the Acts that warrant careful attention by WSDOT including items that could impinge upon its work load and offer opportunities for action.

The Noise Unit (which currently consists of one specialist) must wear many hats. It performs a line function within the Design Office of the Project Development Division but also acts as a resource to other offices in the division, and other divisions in the department as well as the District Offices. Additionally, the Noise Unit represents the department in dealing with the public, the legislature and other state and local agencies. The current traffic noise analysis methods used by the Noise Unit are sound, but continued methods development and research should occur. Providing the districts with the state-of-the-art analysis tools is essential if the state is going to embark on a successful retrofit noise barrier program.

The Noise Unit should take a proactive role and become heavily involved in providing technical assistance to the cities and counties for their comprehensive plan development and implementation related to transportation noise. Technical, physical, and philosophical consistency between the various state agencies and city and county governments are essential for attacking the problem of comprehensive noise in a comprehensive system-wide manner. Mitigation of existing noise impacts and prevention of future noise impacts are both key components of a successful program to improve the noise environment in Washington State's communities.

Many individual recommendations have resulted from this research, as detailed in the section on APPLICATIONS AND IMPLEMENTATIONS. Key among these are the following:

1. WSDOT should study a variety of issues on individual noise abatement strategies ranging from investigating innovative materials, developing specifications, considering use of barriers off the state-right-of-way, accepting private fund contributions toward the construction of Type II barriers, investigate legal issues regarding noise insulation of private dwellings, consider a noise insulation program for schools near highways, and continue its research on the noise properties of open-graded asphalt;
2. WSDOT should have an active involvement in the implementation of the Growth Management and Strategies Acts, especially related to providing technical assistance to cities and counties in the development of their comprehensive land use plans and subsequent development regulations. The department should take a lead role in the development of noise barrier design specifications for residential developers and in the testing and approval of proposed barrier materials and systems;
3. WSDOT should support the revival of a noise program in the US Environmental Protection Agency, related to both land use compatibility and source control, and expanded programs for noise control within the appropriate state agencies.
4. WSDOT should carefully examine its level of staffing to be able to adequately deal with the action strategies for noise abatement in the 1991 State Transportation Policy Plan and to be proactive in responding to the interest generated in cities and counties during the debate over the Growth Management and Growth Strategies Acts; expansion of activities beyond the current level of effort will require additional staff.
5. WSDOT should move to include departmental noise experts in the regional transportation planning process, much along the lines of what is done with air quality;

6. WSDOT should continue with its progressive policy in transportation noise research and should continue to move toward a leadership role within NCHRP and TRB;

7. The Noise Unit should continue to pursue the latest technology in video and computer-aided design in the preparation of information for communicating with the public, legislators, and upper management;

8. The WSDOT legal staff should investigate issues such as obtaining easements to construct noise barriers off the state right-of-way, the sound insulation of private facilities including schools, churches and residences, allowing privately contributed funds to move a Type II barrier up on the state's priority list, the use of impact fees, development fees, state real estate excise taxes, and the newly proposed growth management financing accounts for use in noise mitigation by cities and counties;

9. WSDOT should consider adding a new category of funding for highway improvements called Environmental Mitigation and Enhancement Improvements from which noise mitigation along existing state or federal-aid roads could be financed;

10. WSDOT should seek additional funding for the Type II program; a funding level of $3-$4 million per year (in current dollars) would allow the retrofit program to be completed in six to eight years;

11. WSDOT should be prepared to provide funding to increase the noise specialists on staff, both in the main office and those districts with large needs for both Type I and Type II noise analysis and design; as an example, a major effort in Type II abatement would seriously impact workloads in Districts 1, 2 and 5; WSDOT should provide adequate funding for noise related duties in the architecture, design standards and local programs offices;

12. The Noise Unit should reconsider its prioritization method for Type II projects to include all areas exceeding 55 dB in its definition of impact; and

13. The Noise Unit should raise its cost per residence per from $8,000 to $20,000-$25,000 for accessing the reasonableness of noise abatement features in project studies.

INTRODUCTION

RESEARCH OBJECTIVES

This research has three objectives. The first is to review and evaluate the state-of-the-art in the following areas:

1. noise abatement strategies at the source, along the path, and at the receiver,
2. successful state and local traffic noise laws, ordinances, codes and regulations with emphasis on emission level enforcement and land use compatibility,
3. traffic noise research results, including modeling and abatement,
4. successful techniques for communication with, education of and marketing to various audiences, such as the public, executive branch administrators, legislators and technical personnel in cooperating agencies,
5. traffic noise legal decisions, especially as related to state DOT's, and
6. state DOT administrative and programmatic issues, including prioritizing and funding for noise abatement on existing highways, funding for research, and staffing for noise analysis.

The second objective is to make recommendations to WSDOT, based on the state-of-the-art evaluation, for its traffic noise analysis and abatement programs. These recommendations will focus on both needed implementation efforts and future research needs.

The third objective is to package the information collected or developed to meet the first two objectives into a report that may be used as input to the state legislative transportation committee for potential traffic noise-related legislation.

The interim report presented the findings of the first phase of this study relative to the first objective. The second phase of the work was in regards to the second objective and is documented in this final report, which contains most of the material from the interim report. Collectively, the interim and final reports, plus a detailed final technical report, serve to meet the third objective.

THE PROBLEM

As noted by the Honorable Dick Nelson of the Thirty-Second District of the State House of Representatives in a recent letter to the Washington State Department of Transportation (WSDOT):

"Traffic noise will grow as a transportation problem as the level of use of our older freeways and state highways in the Seattle area and other urban areas continues to grow. Citizens will increasingly demand that the current noise problem be fixed before we address the need for the greater utilization of the existing roadways or additional roadway capacity."

While much work has been done in the field of traffic noise control both in North America and abroad, there has been little attempt at viewing this body of work in a comprehensive manner to gain a perspective on the state-of-the-art and a recommended course for future action. There is a need to examine both the research and implementation efforts of the past decade to better define the current state-of-the-art so that recommendations for further action may be made.

BACKGROUND

Traffic noise analysis and control grew as both an art and a science in the late 1960's and early 1970's in response to national environmental and highway legislation and resultant federal regulations. The problem has traditionally been divided into three sections: source control, path control and receiver control.

Source control efforts on a national level focused on emission level regulations for newly manufactured vehicles and on maximum allowable levels of operating trucks. State and local source control focused on enforcement of the federal in-operation regulations, state and local "nuisance" and "muffler" ordinances, and on traffic management strategies such as truck re-routing, curfews and bans.

Path control efforts have concentrated on blocking the path by which the noise reaches the receiver or on increasing the path's length. The focus has been the construction on the highway right-of-way of traffic noise barriers between source and receiver. Additionally, shifts in the vertical alignment have been used to also provide a shielding effect. The Federal Highway Administration (FHWA) and the National Cooperative Highway Research Program (NCHRP) have sponsored or conducted numerous research projects since the mid-1960's to develop and refine or revise mathematical models to predict traffic noise levels and to design noise barriers. Most of the use of these models and implementations of path noise control have been done by state

DOTs with certain notable exceptions, such as in California where private residential developers must provide abatement with review and approval by local government.

Receiver control has traditionally been divided into two categories of items. The first includes administrative strategies such as the zoning, building codes, subdivision laws, municipal ownership or control of land, and financial incentives for compatible use. The second category includes physical methods, such as site planning, architectural design, and acoustical construction (sound insulation). Most of the strategies in both categories fall under the jurisdiction of local government or indirectly through state DOTs. Also, some state DOT's have done sound insulation projects on public buildings, such as the comprehensive California School Noise Abatement program.

Much of the research, development and technology transfer for above work was done in the 1970's when federal emphasis was strong. In the 1980's, the EPA program was phased out under a new administration and its Office of Noise Abatement and Control closed. Also, FHWA programs shifted from active research, development and implementation to more of a maintenance effort as administration priorities shifted. Some new research was funded (construction noise modeling, sound-absorptive barrier literature review, traffic noise modeling, and an experimental noise barrier evaluation) but there was very limited implementation or dissemination of the results.

However, interest in noise control remained very high within many state DOTs often spurred by emphatic citizen demands of the type mentioned by Representative Nelson in his letter to WSDOT. Several states have had active programs in providing noise control along existing highways, and all states must abide by federal legislation and regulations when building or rebuilding federal-aid roads. Professional interest through the Transportation Research Board (TRB) remains high. A limited amount of new research and development has been funded or conducted by federal and state agencies. However, despite the efforts within the TRB and various states, and because of the reduced federal emphasis, there remains a need to examine how all of the various pieces of the puzzle fit or do not fit together. There is a need to assess current practices in source, path and receiver control and where the State of Washington should focus efforts in the future in terms of policy, legislation, implementation and research. Based on what other states have seen, Representative Nelson described exactly the problem that Washington will face in the coming years: citizens recognize that traffic noise can and should be controlled and that their voices will be heard over the roar of traffic by their legislators.

PROCEDURES

INTRODUCTION

The work done on this study consisted of six major tasks to meet the study objectives:

1. information gathering,
2. information analysis,
3. interim report preparation and briefing,
4. response to WSDOT comments,
5. additional analysis and preparation of recommendations, and
6. final report preparation and briefing

The first two tasks involved a four-part approach:

1. the relevant literature was reviewed;
2. contacts were made with State DOT noise analysts via a survey and telephone follow-up;
3. contacts were made with a group of non-DOT and local agencies known to have noise control programs based on a recent survey done for EPA; and
4. contacts were made with U.S. vehicle manufacturers.

The rest of this chapter describes these four parts in more detail, as well as the other work.

LITERATURE SEARCH

The first source of information in assessing the state-of-the-art is the formal literature in the various subject areas. A wide variety of materials was reviewed: the Vanderbilt transportation library of traffic noise related government reports and articles; annual "Proceedings of the International Conference on Noise Control Engineering;" the Journal of Transportation Engineering; the Transportation Research Record and the Journal of Noise Control Engineering. Three proceedings from recent Society of Automotive Engineers (SAE) noise and vibration conferences were also studied. Additionally, two searches were obtained from the National Technical Information Service (NTIS) on Motor Vehicle Noise and Urban Noise Pollution. Also, an on-line search using the Vanderbilt ACORN system was conducted. Finally, a search was provided to us by TRIS. The works were grouped by category area and were reviewed individually and collectively to assess the state-of-the-art.

CONTACT WITH STATE DOT ANALYSTS

A survey was prepared in coordination with WSDOT and was sent to the main office environmental unit of all 50 state DOTs plus Puerto Rico. Information was also requested from Ontario (the most active Canadian province in traffic noise control). Questions dealt with abatement measures, abatement expenditures, communication techniques, legal decisions, research, land use and local coordination issues, staffing, analysis tools, and issues and problems. Follow-up letters to initial non-respondents were also sent. All of the material on the returning questionnaires were collated by question and entered into the word processor. Items of interest to the researchers and WSDOT were identified and follow-up contacts made by telephone for additional information. The results were summarized on an item-by-item basis to assess the state-of-the-art.

At the request of WSDOT, attempts were made to obtain a mailing list of turnpike authorities to survey them on their noise control programs. No response was received from the Executive Director of the Association of Turnpike Commissions.

CONTACT WITH OTHER STATE AND LOCAL AGENCIES

Because source control and land use control are typically beyond the bounds of state DOTs, a survey was made on these subjects of state and local environmental and health departments with noise programs. The source of contact names was a recent report by Soporowski for the EPA that studied the effects of elimination of the EPA noise control funding in the early 1980's on agencies that had active noise control programs at the time. The purpose was not to try to catalog every noise program in the country, but rather to get a sampling of the current status.

Again, the questionnaire results were compiled by subject area and analyzed. The more promising and interesting programs were identified from the results and follow-up telephone calls were made to gather more information on subjects of interest. Survey questions focused on program development and operation, staffing, types of sources that were regulated, citizen complaints, violations and penalties, requirements placed on developers, services provided by the agency, and standards for analysis, documentation or abatement that might be imposed on developers.

CONTACT WITH VEHICLE MANUFACTURERS

To assist in the assessment of the state-of-the-art in motor vehicle noise control, a questionnaire was prepared and distributed to contacts within the major manufacturers of trucks and automobiles. The Motor Vehicle Manufacturers Association and the Society of Automotive Engineers provided mailing lists of the appropriate professional committees. Questions focused on facilities for research, design, engineering and testing, the major noise sources and corresponding levels that the manufacturers are trying to control, how they are meeting the EPA New Product Regulations for Trucks, current problems, and future challenges and innovations. As with the other questionnaires, follow-up by telephone was conducted.

INTERIM REPORT AND BRIEFING

After the information gathering and analysis, this interim technical report and an interim project report were prepared to present the reviewed material in a coherent, logical fashion for review by WSDOT and possible use with the State Legislative Transportation Committee. A briefing to interested WSDOT and legislative representatives was being conducted to inform them of the results and to seek comments.

FURTHER ANALYSIS AND DEVELOPMENT OF RECOMMENDATIONS

After the interim report briefing and subsequent review by WSDOT, the researchers responded to WSDOT comments, completed some additional analysis, and then developed recommendations for the State of Washington for implementation or future research. The additional analysis included study of the 1991 Washington State Growth Management Act, the 1991 Transportation Policy Plan for Washington State, WSDOT organizational structure and responsibilities, current WSDOT noise analysis and abatement policies and procedures, staffing and funding, and typical example of highway noise analysis study reports.

Recommendations were made in the following areas: incorporation of policies, programs, procedures and research results into current WSDOT practices; legislative initiatives for source, path and receiver noise control; follow-up on current or past research; and new research initiatives. Lastly, the final report and final technical report were prepared and a final briefing held.

REVIEW OF PREVIOUS WORK AND CURRENT PRACTICES

INTRODUCTION

This chapter presents the results of the review of previous work and current practices within state DOTs, state and local environmental noise control programs, vehicle manufacturers, and the relevant literature. The results are presented separately for each component of the information gathering. For the first three components, the results follow roughly the outline of topics in the questionnaires sent to each group. Synthesizing the results from these various components is not done until the next chapter, DISCUSSION.

STATE DEPARTMENTS OF TRANSPORTATION

Fifty-one responses, from 49 states plus the commonwealth of Puerto Rico and the Canadian province of Ontario (the most active of the Canadian provinces), were received. The results are presented below, grouped by category in the questionnaire.

Abatement Measures

Patterns of Usage. The state DOTs were presented with a list of twenty noise abatement measures. They were asked to indicate which ones they have used, would consider using, or would not use. They were also asked to provide project references on examples of interest.

Table 1 lists these abatement measures with the numbers of states in each category. Not included in the list were conventional sound-reflecting barriers. Data from FHWA indicates that 37 states have installed sound-reflecting barriers.(1) Beyond that, the most commonly used abatement strategies were to depress the highway, shift the highway alignment, insulate public facilities, use sound-absorbing barriers, and prohibit heavy trucks from the facility. The number of respondents having used the last three measures was surprisingly high. It was also interesting to see that 16 respondents had used noise barriers on non-limited access facilities, which are traditionally viewed as difficult to abate with barriers because curb cuts often need to be present. Another way of looking at the data is to examine patterns of usage by individual states. Thirteen states indicated that they have tried five or more of the listed strategies (excluding sound-reflecting barriers). In a

Table 1. Number of State DOTs* That Have Used, Would Consider Using or Will Not Use Various Noise Abatement Measures

Abatement Measure	Have Used	Would Consider Using	Will Not Use
Sound-absorbing barriers	15	32	4
Tilted barriers	5	33	11
Translucent/transparent barriers	4	23	21
Other innovative or low cost materials or designs	7	31	0
Barriers off state ROW	6	18	24
Privately-funded barrier on state ROW	6	32	9
Barrier on non-limited access facility	16	22	12
Deck (lid) over highway	6	9	30
Depressed highway	24	24	4
Shifted highway alignment	17	32	0
Provided buffer zones	4	30	10
Chose alternative corridor/mode	6	30	8
Canceled highway project	2	11	27
Pavement surface treatment	4	30	13
Noise insulation:			
1. Public facility	18	22	9
2. Private facility	7	13	27
Traffic management:			
1. Prohibit heavy trucks	10	24	14
2. Prohibit all trucks	2	21	24
3. Reduce truck hours	1	29	17
4. Reduce speed limit	2	27	18

* Including Puerto Rico and Province of Ontario, Canada

first tier would be (in alphabetical order) Alaska, Arizona, California, Minnesota, New Jersey, Oregon, Pennsylvania, Virginia, Washington and the province of Ontario. In a second tier in terms of number of strategies tried are: Illinois, Michigan, New York and Utah.

On the other end of the spectrum, four states--Montana, North Dakota, South Dakota and Wyoming--specifically noted that they have implemented no traffic noise abatement measures. Additionally, six states indicated that they have used none of the listed measures (which does not preclude use of sound-reflecting barriers): Idaho, Mississippi, Missouri, South Carolina and West Virginia. (Idaho did note that, historically, its primary abatement measure has been displacement of impacted residences and commercial establishments through right-of-way (ROW) acquisition. It has recommended local land use control measures and traffic management techniques to abate projected noise impacts but generally the low population and traffic levels precludes significant noise impacts.)

Additionally, ten of the responding states indicated that they have used only one of the listed strategies (again, excluding use of sound-reflecting barriers). These states are: Alabama (depressed highway), Arkansas (shift alignment), Hawaii (facility insulation), Indiana (facility insulation), Kentucky (public facility insulation), Louisiana (sound-absorbing barriers), Nevada (tilted barriers), New Hampshire (earth berms), Puerto Rico (depressed highway), and Vermont (shifted alignment).

It was also interesting to examine what measures states would or would not consider using. Sixty or more percent of the respondents indicated they would consider using: sound-absorbing barriers, tilted barriers, other innovative materials or designs, shifting the highway alignment, providing buffer zones, choosing alternative corridors or modes, using pavement surface treatments, and allowing privately-funded barriers to be constructed on state ROW. Additionally, 40 to 60 percent of the respondents said they would consider using translucent/transparent barriers, barriers on non-limited access roads, depressing the highway, insulating public facilities, or traffic management techniques to reduce speed limits or truck use.

These responses show a willingness to try new and different measures to control the noise problem. Of interest is the high percentage willing to allow privately funded barriers to be installed on the state-right-of-way. In contrast to that, however, is a general unwillingness to install barriers off the state ROW. Given the physics of noise attenuation, an unwillingness to install barriers off the right-of-way can severely limit an agency's options in successfully reducing traffic noise in the communities.

A very interesting finding is that a large number of states are willing to try pavement surface treatment, given that only three have indicated that they have already done so. It is the opinion of the researchers that many states are taking a wait-and-see attitude until more results from U.S. and European efforts are known, with the hope that these efforts will be successful.

It was also interesting that so many states indicate a willingness to try traffic management strategies, when again so few have actually done so (excepting the prohibition of heavy trucks). An openness to consider these strategies seems to be restrained by the primary goals of most highway projects (improve flow and reduce congestion).

Of those measures that the states would not consider using, the most commonly cited were decking over the highway, canceling the highway project, noise-insulating private facilities, installing barriers off the state ROW, and prohibiting all (not just heavy) trucks from a facility. Cost, other project objectives, and concern over legal issues are believed by the researchers to be reasons for these strategies being cited so often.

In summary, the data shows a willingness to try new and different ideas that is often not backed up with prior action. The willingness is tempered by a lack of information of the actual benefits and costs of these strategies. A general sense from elsewhere in the questionnaires is that hard data on the effectiveness of these strategies are not typically collected nor readily available.

FHWA has also compiled a fairly complete list of projects featuring "unusual" noise barriers and other non-barrier abatement measures implemented through the end of 1988.(2) The tables from that document are included in this report as Appendix A.

Sound Absorbing Barriers. Fourteen states indicated they have used sound-absorbing barriers. However, from some of the responses and subsequent follow-up, it appears that at least one of the respondents confused the terminology and were referring to sound-reflecting barriers; a second respondent listed an earth berm project as its sound absorbing barrier. The typical application of absorbing walls would be in a situation where reflections off other single or parallel noise barriers were of concern.

Several of the reported uses are of interest. For example, California retrofitted one noise barrier in a parallel barrier situation with sound-absorbing panels because of complaints from citizens living well over a thousand feet away about increased noise levels.(3) A study of measurements and predictions before and after the installation showed that increases in noise levels due to the reflections was not a problem to begin with, and as a result, the absorbing barriers did little to provide additional noise reduction.

Connecticut used perforated plastic panels with rock mineral wool filler in a parallel barrier situation on an overpass in East Hartford. Inadequate bracing at the bottom, center of the panels led to some sagging that had to be corrected after installation was completed. The barriers are made by Sound Fighters, Inc. The state paid an extremely high $37/ft² for these barriers compared to a typical value of $8/ft² for reflective walls, partially because this was the only product that it deemed suitable when the solution was needed. Louisiana has also used same product on the Natchez-Vidalia bridge project. Connecticut also used sound absorbing blankets called Sorba-Glass as part of temporary construction noise barriers in the New Haven area.

Steel panels with a perforated face and four inches of rockwool filler made by the Industrial Acoustics Company were used by Illinois DOT on I-255 in Collinsville and Centerville. Some incidence of peeling of the Tedlar coating on the steel has been reported after two years in place.

New Jersey has used a foamed concrete finish to a Sierra Wall concrete noise barrier on its I-78 project in Watchung.(4) Some early questions had been raised about the durability of this finish, and performance is being monitored. Maryland has also used this product on an eight-lane section of I-695, where the walls are separated by a distance of 150 feet. The cost was approximately $200,000 for a section 480 feet by 20 feet high. Some noise level measurements have recently been made, but the data has not yet been analyzed. Maryland reports that the surface seems to "gouge easily", with the project beginning to weather already since its installation in 1987.

Pennsylvania has used a product called Durisol on several areas of the I-78 project in Allentown and on I-476 project in Philadelphia. Durisol is a mineralized wood shavings board with a concrete backing that has been used extensively in Europe and Ontario for nearly 20 years as a noise barrier. The I-78 project included use of the product on parallel barriers on a bridge high over a scenic public park and in a bench-cut section with a noise barrier opposite a retaining wall.

Colorado has designed but not yet constructed a series of three parallel barriers on I-70 at its interchange with I-25. The middle of the three barriers will be sound-absorbing, made of the Durisol product. Reported estimates of costs are $85 per linear foot and $120 per linear foot for 7.5-foot high walls.

A slotted concrete block called Soundblox was used on I-440 in Nashville by the Tennessee DOT.(5) This product was chosen to give a similar appearance to the sound-reflecting barriers elsewhere on the project. A field evaluation of the I-440 barriers is now underway. TDOT will also be using absorbing barriers on the Nonconnah Parkway in Memphis.

Three other states that have used absorbing barriers include: Utah (70th Street South), Virginia (Route 164, Portsmouth), and Pennsylvania (Vine Street, Philadelphia).

Tilted Barriers. Use of tilted noise barriers (as an alternative to sound-absorbing barriers to prevent reflections back across a roadway) have been reported by five states.

Nevada used 22-gage formed metal panels on a concrete safety-shape barrier on U.S. 95 in Las Vegas. The 11-foot high panels are tilted outward 10 degrees for the 4000-foot length of the project. Installed cost was approximately $6/ft^2.

New Jersey DOT has used tilted barriers in addition to sound-absorbing barriers on several sections of its I-78 project (4), as well as on Route 24 in Morris County. The designs are concrete post and panel, with the posts installed at an angle of 10 degrees off of the vertical. The Route 24 section is 1000 feet long and the I-78 section extends for 2600 feet. In both cases, tilted walls are on both sides of the highway. New Jersey also installed 4100 feet of walls tilted at 6 degrees on Route 17 in Bergen County.

Washington has used walls tilted at about 6 degrees on its I-90 project in Seattle (both retaining walls and noise barrier extensions above them), and on SR-14 in Kennewick. Arizona also reports use of tilted walls on the Pima Freeway.

On its Vine Street project in Philadelphia, Pennsylvania used sloped sides to retaining walls (5 degree angle) in a depressed section, but reports no free-standing tilted barriers yet.

Translucent/Transparent Barriers. Arizona, California, Massachusetts, and Maryland have reported use of these types of barriers. The Arizona project, constructed in the early 1970's, consisted of a series of vertical tubes of triangular cross-section with slots cut in them to act as Helmholtz resonators while allowing the drivers to look through the spaces between them. This "kinematic sound screen" was reported by the state as only marginally effective and has not been used in any other applications.

In California, 4-foot high Lexan panels atop a 3-foot block wall were used a coastal road where residents wanted to maintain their view of the beach. The California Coastal Commission, which had approval for authority over the project, also wanted a transparent barrier. The local government will be responsible for maintenance, but a potential problem is reported in that the panels cannot be cleaned with a cloth or by scrubbing, but must have a solution sprayed on them. California has also used Lexan in a number of its school noise insulation projects.

Maryland also used Lexan panels as an experiment on I-95 at Canton Pike along the edge of a ramp that was protecting a school from traffic noise. The 1/4-inch panels were installed between steel H-beams with clips. The posts were set on 7-foot, 6-inch centers, and the project was 435 feet long. The panels were 10 feet high. The state reports many maintenance concerns. No provisions were made for cleaning and some graffiti has appeared. There has apparently also been some damage from bullets. Finally, the panels which were initially smoke-gray in tint have now clouded through ultraviolet yellowing so that they cannot be seen through.

Massachusetts used transparent barriers on the I-93 project in Somerville, but reports that they will not use such a treatment again because of durability problems with the Lexan panels (cracks in panel corners in less than two years).

Ontario is conducting an experiment on the weathering and visibility degradation of 12 one-foot square samples of Lexan, laminated tempered glass and laminated annealed glass on a test section of barrier in Toronto. An excellent paper reporting on the experiment and investigating concerns over topics such as safety, design, flammability and cost was presented at the 1990 TRB Annual Meeting and recently published in a Transportation Research Record.(6)

The researchers also note that both the French and Japanese have used transparent and translucent walls. The French have used both glass and Lexan panels in several installations in Paris Lyon. Barriers close to the edge of road get very dirty and require periodic cleaning (several times per year). However, in those situations, the barriers are closer to the homes and away from the roads, a mixture of transparent and opaque materials have lead to visually interesting solutions. Relevant sections of a French report on the subject have been translated by Ontario.(7)

The Japanese have used a number of transparent and translucent solutions along many of their barriers. Generally these barriers are at the edge of pavement and are used to provide some visual relief for the driver who is in an environment of nearly continuous walls in the urban areas. The barriers are subject, however, to the same road grime problems as elsewhere.

Innovative or Low Cost Materials or Designs. Seven states reported using new concepts in materials and designs for noise barriers, and an additional four states mentioned such use elsewhere in their questionnaire responses.

Connecticut and Pennsylvania report use of the Soundzero light-weight composite material noise barrier in two of their projects. Pennsylvania installed this system on I-78 in Allentown in 1989 on several bridges, because it lightens structural load compared to concrete. The product cost approximately \$20 per ft^2 delivered and approximately \$40 per ft^2 installed. Pennsylvania reports that it would use the product on non-bridge barriers if it can compete in cost with other methods. Connecticut has used the product as a construction noise control measure on a bridge on its Route 104 project in Stamford.

Oregon used a precast concrete post and plank system that was supposed to be low cost, called Fleming Panelock. The system has a height limitation of eight feet, and because of the contractor's unfamiliarity with it, the expected savings were not achieved (2230 feet long at a cost of \$191,000). An attempt to contact the company met with a telephone number no longer in service. Washington reports use of a plain plywood wall in Wilburton to reduce costs, but at a price in appearance.

Florida has expressed interest in materials such as the Evergreen System, which is a series of decreasing-width concrete cribbing that are stacked atop each other, filled with dirt and planted to give the appearance of an earth berm with very steep sides. An 800-foot long, 16-foot high experimental section has been installed in Pennsylvania on I-476. The cost was reported at \$50/ft^2, and the state notes that the establishment of the desired vegetation has been slow. The product was invented in Switzerland, and is used there extensively for noise barriers and retaining walls. It is expensive and has raised questions with some DOTs regarding maintenance of the landscaping, safety for children climbing, and possible home for rodents.

Illinois reports being approached recently by several plastic (recycled) wall manufacturers. Iowa has expressed interest in any low-cost material especially recycled plastic panels.

In separate correspondence, Iowa also described an idea for noise abatement that came about during a value engineering session on a noise barrier project. Iowa has been concerned with minimizing winter shadows that would be cast onto the roadway by a barrier. An idea has been suggested of using some sort of "movable" wall whereby the top portion of the wall could be removed during the winter months to allow the sun to shine on the roadway. The resultant seasonal loss of noise reduction would conceivably be acceptable in the winter when outdoor yards are not being used as much. Suggested ways for removing the barriers included hinged sections (for wood and/or possibly steel walls) or actually completing removing panels between the supports. Concerns such as maintenance and the need for twice-a-year servicing need to be fully considered before such a strategy would be deemed practical.

California has studied the use of compost (derived from sewer sludge) and co-compost (derived from sewer sludge and refuse) as potential products for noise barriers.(8) They recommended against such use "do to uncertainty in the concentration of biological and chemical contaminants."

As a potential solution in parallel barrier situations, structural engineers in Utah have considered a design of a solid wall with a louvered or clapboard surface (angled at 10 degrees) to reflect sound upward instead of back across the highway. Such a design has been installed on at least one major project in Germany, with sound-absorbing material behind the louvered panels.(9)

Ohio reports that a product C-LOC by Environmental Plastics of Columbus, Ohio, has been approved for bidding but not yet used on any projects. The system consists of interlocking ribbed plastic sheets that can be driven into the ground like sheet piling.

Ontario also reports that three or four companies have approached it expressing interest in using recycled tires as a base material for noise barriers. The tires are chopped up into 1/16-inch to 1/4-inch particles and formed into panels with a binder. Another configuration uses 1/64-inch to 1/16-inch crumb, which may prove to give a more consistent product. Ontario has been conducting tests on the panels for a variety of properties. Key concerns include flammability and smoke. Flammability does not appear critical based on initial tests, being about the same as pine wood. Smoke output during burning is high, but one company is study its reduction by developing a retardant that focuses on smoke separate from flammability. The durability of the products appear excellent, and no leachate problems were found using standard tests. The potential toxicity of the product when burning is also a potential concern, but has not yet been tested.

Properly done sound absorption tests have not yet been made, so no conclusions can yet be drawn on that property. The expected cost would be greater than the currently used sound-absorbing product, Durisol, which Ontario routinely installs at a cost of $12/sq ft (Canadian). Structural details have yet to be seriously addressed until all of the other test results are in. There are concerns about the lack of stiffness or rigidity of the panels, which would be inserted between H-beams.

New Jersey notes that FHWA has recently insisted on alternative designs to encourage cost savings and has urged structural design to cut wind loadings in order to reduce the costs. Related to that, Texas notes that most of its barriers are planned for Houston, and are therefore designed to withstand hurricane force winds, at a high cost. Texas also noted that it build concrete noise barriers to minimize maintenance.

Finally, Delaware, Massachusetts, New Hampshire, and Maine report the use of earth berms as a low cost material solution. Many other states have also used earth berms, but did not chose to list them in response to this question.

Barriers Off State ROW. Often, the best location for a noise barrier, from an acoustical effectiveness point of view, is off the state's property. This is especially true in a case where the houses sit above the roadway on a hill or cut slope. Arizona reports such a situation on its I-17 project, where the property owners became involved with the state. A temporary easement was obtained for construction, and afterwards the property owners are responsible for maintenance. Wisconsin reports working with private subdivisions in the Madison area on barriers off the right-of-way.

Along Route 52 in San Diego, where houses were on a bluff, the State ROW extended only halfway up the slope. Working with the homeowners, a point of entries permit was obtained to construct the wall. During construction, liability was with the contractor, and afterwards, the landowners were in charge of maintenance.

In Georgia, a demonstration project was partially funded by the manufacturer on I-285 in Avondale Estates. The cost to protect an impacted property owner exceeded the Georgia DOT guideline of $12,000 per residence. The owner approached a manufacturer who agreed to provide the barrier at the $12,000 cost as a demonstration. Georgia agreed to installation but wanted no responsibility for maintenance, necessitating location of the barrier off the ROW.

Utah reports working with a homeowners association along I-215 to split the $35,000 cost of a 614-foot long, 8-foot high barrier. The project is located atop a 30-foot cut where the state had not originally planned to construct a barrier. After a reevaluation of the predicted levels using the then-new STAMINA 2.0 model, the state agreed to protect some of the homes. The state paid for the length of the wall needed to protect the residences that it determined to be impacted, while the homeowners paid for the rest of the cost to protect other homes in the neighborhood. The homeowners are now in charge of maintenance for the masonry block wall.

Oregon reported two cases where homeowners came to the state requesting an installation off the ROW. There were no problems with the first case, but in the second instance, 10 percent of the homeowners did not want the wall and the state had problems getting easements. Also, overhead power lines impeded installation. An agreement was finally reached with an abutting railroad to put the wall on railroad property between the highway and the residences.

Privately-funded Barrier on State ROW. In some situations, homeowners or developers may wish to install a barrier at their own cost to protect their properties. Often, however, the best location is on the state ROW. Five states report such instances.

In Fairfield, California, a developer along Route 80 indicated a desire to construct a wall for his development. He obtained an encroachment permit for construction, and had the wall designed to meet state standards. The state now maintains the wall.

In Ohio, a community in Moraine along I-75 desired a noise barrier and hired a consultant to produce the design. ODOT reviewed and approved the design and a contract was written to hold the state harmless and to make maintenance the responsibility of the community. From the state's perspective, the process was quite fast because it only had to approve the plans while the community did everything else. Other instances include:

1. Illinois, where local agencies have funded some extensions of barriers on IDOT ROW,
2. Michigan, on I-696 near Farmington Road, and
3. Washington, on SR 520, SR 14, I-90 (Northbend).

Colorado has reported some concern regarding liability issues and design standards, when a homeowners association had asked a district office about constructing a barrier on the ROW. Upon the Attorney General's recommendation, the district office denied the request, setting a precedent for the state.

Pennsylvania also reports that it is working on a policy on this issue using its "Partnership Act" as a rationale. Any design would have to meet the state standards, but the legal or maintenance issues have not yet been addressed. The state felt that such a policy would be useful in a Type II program, but expressed some concern that the policy could be viewed as exclusionary.

Barrier on Non-Limited Access Facility. Typically, noise barriers are used on limited access facilities where gaps for driveway access or cross roads are not needed. However, 16 states have reported use of barriers on situations where access is not limited. Arizona reports this to be a common practice in many of its cities where a standard 6-foot high masonry wall was used. No studies have been done on their effectiveness and no legal or safety concerns were reported. At the corners of the barriers, the walls step down in size.

In 1989, a barrier was constructed in the Denver area by Colorado to protect apartments along an arterial. The apartment building was U-shaped in plan view with the only entrance in the middle, eliminating the need for a multiple access points through the wall. No sight distance problems were expected.

Florida reports two projects in this category. Both projects involve widening of existing roadways from two lanes to four-six lanes, including ROW acquisition. Even though the barriers were constructed on the ROW line, legal agreements were drawn up to provide free construction easements and permanent maintenance easements. On both projects, the subdivisions had internal circulation roadways which exited on to other streets. On the Glades Road project in Palm Beach County, the barrier ends were extended far enough to minimize flanking around the barrier. On the 54th Avenue South project in Pinellas County, a property owner found it to be in his interest to donate a portion of his property to provide a 45 degree wrap on the barrier end to provide adequate sight distance per local specifications. On both projects, sight distance considerations were minimized due to the presence of signalized intersections at the barrier ends. In addition, signs were installed to prevent right-turn-on-red, which further reduced the sight distance problem.

Pennsylvania reports a similar case on its Route 512 project in Allentown, where the road was expanded from two to five lanes. There was no direct driveway access, and no safety problem encountered. The project was funded with 85 percent federal money.

In Jacksonville, North Carolina, a state highway widening project on Western Boulevard was being done at the same time as a major residential development was being constructed. A barrier was designed by the state with landscaping done by the developer so that the wall looked more like a simple property line fence. Also, part of the barrier was built off of the ROW, which had to be worked out with the developer before hand.

Decking Over Highway. Constructing a deck over the highway for noise control purposes was reported by six states. Two of the most recent examples are on I-90 in Seattle, Washington, and on nearby Mercer Island. These elaborate and complex designs were in areas where I-90 was to be in a deep cut and where community cohesion and visual impact were equally important as noise reduction. The reported cost for the combined 5100-foot length of the two decks is over $300 million. Elsewhere, on the I-10 Inner Loop in Arizona, a deck was constructed as 16 adjacent highway overpasses and then covered over. The Arizona project was 6 blocks long and was going through an historic district that included schools. There were long delays on the project and the beneath-ground solution was finally chosen to maintain the character of the area. The top of the deck is now a park/garden.

New Jersey reports partially decking Route 18 in New Brunswick to protect a portion of the Rutgers University campus, and Michigan notes three instances of decking on the I-696 in Southfield. Pennsylvania has used cut-and-cover to deck over wide one-block section of I-95 in Philadelphia in its Society Hill area. A park was created atop this deck for community use. Both noise and aesthetics were reasons for this treatment. New York claims the earliest such project with the Brooklyn-Queens Expressway in Brooklyn being covered by a cantilevered section in the 1930's.

This strategy is more common in Europe and Japan. The French have developed light and heavy covers: a heavy cover would be able to support development of a park on top of it, while a light cover would be designed for no additional weight. The Japanese have built elevated tunnel sections along several of their more difficult sections in some of their densely developed urban areas.

Depressed Highway. Nearly half of the respondents reported the use of depressed highways as a noise abatement measure. By lowering the vertical alignment of the road, the tops of the cut slopes can act as noise barriers to nearby residence.

On the I-78 project in Allentown, Pennsylvania, a proposed interchange was re-designed during the new noise barrier analysis to put the main line below ground instead of going over an existing road. Because of previous material imbalances, several million dollars in construction cost were saved, and noise levels were reduced 6 to 8 dB over the alternative, prior to any additional barrier construction.

In Tennessee, most of the I-440 project in Nashville was depressed for noise control purposes after a long public involvement and legal process.(10) Much of the cutting was through stratified rock layers, and has led to an extremely attractive project to drive. Additionally, the waste material was able to be used for extensive filling at the Nashville International Airport to support construction of its new terminal.

Shifting Highway Alignment. Because noise decreases with increasing distance from the source, shifting the location of a highway can be used a noise abatement measure, if adequate space is available. Sixteen states reported having used this strategy for noise control, although no interesting or unusual instances were described.

Buffer Zones. As with shifting of a roadway's alignment, provision of a buffer zone between the road and the residences can serve to reduce noise levels. Alaska, New York, and Oklahoma have reported use of this strategy. Alaska noted use in several instances where a buffer zone with vegetative cover was judged sufficient to create an "out-of-sight, out-of-mind" situation.

Alternative Corridor/Mode or Project Cancellation. The highway noise problem in an area can be avoided entirely by choosing an alternative corridor for the highway or choosing an alternative mode to provide the transportation solution. Connecticut, Minnesota, North Carolina, New Jersey, and Virginia all reported use of this strategy for noise control.

Even more extreme, Florida and Utah each reported instances where a highway project was canceled largely because of noise issues. The Utah project was the proposed widening of Antelope Drive. The Florida project was in Escambia County and involved new construction at the end of a proposed conversion of two streets into a one-way couple. This state wanted to do an EA/FONSI but FHWA insisted on an EIS because of noise. In response the state district office dropped the project.

Pavement Surface Treatment. The subject of using pavement surfaces to reduce tire noise and undercarriage noise radiation has seen a great deal of interest in the last few years. However, only three states reported having used treatments for noise abatement. In addition, three others report work on the subject.

Both Minnesota and Oregon have studied the spacing of the transverse tining used to put a finish on fresh concrete pavement as a means of controlling the noise that is generated by tire/pavement interaction. Oregon has responded to complaints from residence along highways and from drivers regarding the frequency shift in the noise when their vehicles travel over transversely tined pavement. The studies lead to a change in the state specification. Oregon now requires shallower tining (1/8-inch depth ± 1/16-inch, with 1/8-inch widths) and a random spacing pattern (7/8-inch, 1/2-inch, 1-inch, 5/8-inch, 3/4-inch, 1/2-inch, 5/8-inch). Minnesota also changed its specifications for tine spacing.

New York reported using an asphalt overlay to solve a noise problem from the steel grating used on the Brooklyn Bridge deck. Pennsylvania reports using an open-graded asphaltic surface on the I-476 "Blue Route" in Philadelphia instead of its original plan for concrete.

Maryland and Washington are involved in ongoing research studies on the differences in sound levels between porous asphalt and other surfaces. The Washington research is currently inconclusive about the relative benefit of open-graded asphalt for roadside receivers.

Noise Insulation. Soundproofing a building will not solve the exterior noise problem, but will improve interior noise levels. Eighteen states have reported using noise insulation on public facilities, and seven on private facilities.

Virtually all of the examples of public facility insulation deal with schools. In most instances, only one project per state has been done. The major exception is the California school noise abatement program, where a state statute required noise insulation for both public and private schools.(11) The program is nearing completion with 116 schools treated at a cost of $23,000,000, and nine more left to be done with a projected cost of $3-4 million dollars. Eighty percent of the projects involve only sealing the windows and providing air conditioning treatment. In several instances, noise barriers have been constructed where the project runs right next to a school. Prior to 1982, the qualification for treatment was a maximum interior noise level from exterior noise of 50 dB. The current criterion for eligibility is an interior L_{eq}(1 hour) of 52 dB. The result was to eliminate quite a few of previously qualified schools and reducing the abatement costs on many others. California reports that most of the schools are happy with the treatment but also notes that the program does not include universities. The latest text of the legislation (Section 216 of the Streets and Highways Code) is included in Appendix C.

Oregon has been involved in seven insulation projects, six of which have been with schools and one with a church. Three of the school projects only involved ventilation work while three have involved ventilation work plus storm windows. The addition of storm windows resulted from one school wanting the state to provide maintenance and operating costs due to any air-handling insulation measures. The state investigated storm windows, finding that they only added approximately 10 percent to the total cost and resulted in a reduction in the school's operating costs. Cost for the school insulation projects have ranged from $22,000 to $85,000. Modifications are only done on the impacted rooms of the schools. For the church, the state provided a ventilation system to which the church could add an air conditioning system at its own cost at some future time.

In one project, New Jersey built a false facade on one side of a classroom facility at Rutgers University near the highway project.

Georgia DOT provided sound insulation for five dormitories at Georgia Tech that were impacted by I-75/I-85 in Atlanta. A 25-foot barrier had been proposed although many of the receptors on the upper stories of the buildings would still not benefit. As an alternative, air conditioning was added to the building and some reglazing of windows was accomplished rather than installing the barrier. The treatment achieved a 25 dB interior noise reduction.

Virginia has indicated that it has provided air conditioning to a number of public schools and libraries affected by new construction or highway expansion.

The idea of insulating private facilities is much less popular among the states than public facilities. Indeed, over half of the respondents said they would not provide noise insulation on private facilities. To date, seven have done so: Alaska (hotel), California (two experimental projects), Delaware (private school), Iowa (experimental, single-family home), Virginia (many projects), Michigan (I-696) and Minnesota. The Alaska project involved a hotel in Juneau on its Egan Expressway. The expressway was raised above grade, going right past the corner of the hotel. The installation of storm windows and wall insulation to protect the affected rooms seems to have solved the problem. The Delaware situation involved the Lady of Fatmina School along U.S. Route 13, where two state legislators pooled some discretionary funds to provide for air conditioning installation. The DOT was only involved in the project to help in administration. Virginia has insulated private facilities such as churches and private schools. The state only provided air conditioning for the impacted areas of the building, using window units most of the time. In one case, a church installed central air conditioning throughout the facility but the state only paid for the installation cost in the impacted areas.

The Michigan project is by far the most extensive and innovative. Through 1988, about 60 residences had been treated as part of the I-696 construction project, and as many as 70 more may be treated. The work includes air conditioning and some attic insulation, at a cost of $3,500 to $4,500 per residence. This project also involves noise barrier construction.

California has tried two experimental projects on noise insulation of private facilities.(12) The first, in San Francisco, involved three houses where ventilation was improved and windows were sealed. The second project involved ventilation and air conditioning work in one residence in Los Angeles. California reports that it is not normal state practice to insulate private facilities.

Florida reports that sound insulating even public facilities is prohibited by Florida law unless right-of-way taking is involved; then, insulation can be handled as a cost-to-cure item in the settlement.

Traffic Management. The last category of measures included in the survey was traffic management, which included prohibiting heavy trucks, prohibiting all trucks, reducing truck hours, and reducing the speed limit. In its June 1989 guidance on unusual noise abatement measures(2), FHWA noted the following regarding truck restrictions:

> "FHWA does not generally allow restrictions of truck trailer combinations on those facilities on the National Network for large trucks. Facilities on the National Network were designated by FHWA in response to the 1982 Surface Transportation Assistance Act, as amended, and include interstates and some other federal-aid primaries. An exception to this position is possible only if environmental considerations necessitate truck restrictions as part of a particular federal-aid highway project or if the state can justify removal of the facility from the National Network based on safety consideration."

Ten states have reported prohibiting heavy trucks, although not always for noise purposes. These states are: Alaska, California (two locations, but not for noise), Florida (I-375, Pinellas County), Georgia (Presidential Parkway and interstate highways inside the Atlanta beltway (for safety purposes)), Kansas, Maryland (MD 43 and MD 702), Minnesota, New Mexico (Paseo del Norte, Albuquerque), Oregon (4 city streets), and Virginia (I-66 in Fairfax County and Arlington).

The Florida case involved two spurs (I-375 and I-175) off of I-75 in St. Petersburg. Because there was no compelling need for both the spurs to carry trucks, the south spur (I-175) was designated a truck route and no trucks were allowed on the I-375 spur. Eliminating trucks allowed the noise barriers on I-375 to be reduced in height to 6 feet at an approximate savings of $50,000 in capital cost. Enforcement is handled through the use of signs and local police, with good motor carrier compliance.

The Virginia project, I-66 in Fairfax County, is interesting in that only car pools or other high occupancy vehicles are allowed to use the facility during rush hour; additionally noise barriers have been added along most of the project. Because of the controversial nature of this project, the U.S. Secretary of Transportation had mandated that noise abatement be provided. Enforcement is handled by normal police patrol, and while some complaints have been received from truckers, the abatement strategies have been successful in reducing community noise levels.

The Minnesota project, along I-35E in St. Paul and Maplewood, is unique in its combination of a truck ban, a speed limit reduction to 45 mph, use of bituminous surface, and use of relatively low earth berms with walls atop them (for 1/3 of the 7 mile long project).

Maryland and Oregon were the only states to have reported prohibition of all trucks (both medium and heavy) from facilities for noise purposes. For Oregon, there were four projects involving city streets where all trucks are prohibited except for emergency and local delivery. Noise barriers were considered but were rejected because the residents needed access to the streets. Enforcement is handled by local police. In Maryland, the prohibition of all trucks from MD-702 in Baltimore County allowed the noise barriers along the project to be designed at lower heights (8-10 feet) than would be otherwise needed. Signing has been effective and good existing alternative routes are available parallel to the new facility.

Alaska was the only state to report use of truck hour restrictions for noise abatement; it also reported use of reduced speed limits, although details were not given on either project.

Planned Noise Barrier Expenditures

The state DOTs were asked to comment on their expected expenditures per year on noise barriers over the next five years for Type I (involving highway construction) and Type II (noise barriers on existing highways) projects.

Type I Projects. Planned annual expenditures for Type I barriers over the next five years varied considerably. The following numbers should be viewed with caution. The reported values by some states represent what is programmed or planned; for other states, they represent what is needed, but not necessarily committed.

1. None planned: 14 states (AL, DE, ID, IN, KS, MA, MS, MT, ND, SD, WV, WY)
2. Less than $1 million: 7 states (AK, IA, MO, NE, NV, SC, VT)
3. Between $1-5 million: 15 states (FL, IL, KY, LA, MD, MI, NM, NY, OK, OR, PR, TN, UT, WA, WI), plus Ontario ($4 million CDN)
4. Over $5 million: 6 states (CA, CO, NJ, OH, TX, VA)
5. Could not determine: 8 states (AR, AZ, CT, GA, ME, MN, NC, PA)

As may be seen, the states with no expenditures planned are generally rural and vary geographically from the northeast to the south to the midwest to the Rocky Mountain region.

By far, the states with the largest reported funding plans or needs for Type I projects were California, with $30-$40 million per year, New Jersey with $20 million per year, and Texas with $30 million per year. Not including the eight states that indicated they could not determine the exact amount, the anticipated annual total expenditures for Type I noise barriers range between $130 million and $147 million per year.

Type II Projects. Desired annual expenditures for Type II projects over the next five years also varied considerably. Again, these numbers must be viewed from the perspective of, in some cases, representing need rather than programmed expenditures.

1. None planned: 36 states
2. Under $1 million: 2 states (MI and WA)
3. Between $1-5 million: 6 states (CO, MA, NY, PR, UT, and WI)
4. Over $5 million: 4 states (CA, CT, MD, and NJ), plus Ontario ($30 million CDN)

New Jersey has indicated a need of over $100 million. It is listed in the "over $5 million" group above because even though no funding is available currently, the state hopes to start a $15 million per year program soon. Highway construction bids have been running 20-30 percent below engineering estimates, providing a pool of money that some legislators hope to tap for a Type II program. Ohio also reported that it had $5 million authorized for a Type II program by the legislature, which was later removed, so it is not listed above.

Connecticut completed a re-evaluation of its retrofit noise abatement program in 1986 and developed a 10-year, $125 million program (in 1987 dollars, and reflecting an inflation factor of 5 percent per year).(13) In its re-evaluation, Connecticut noted that current DOT staffing would not allow for initiation of such a large long-term program. They estimated the need for 10 additional positions in both acoustics and structural engineering during the 10-year period. The Maryland program also appears on hold at the current time due to budget problems.

California has programmed $130 million to be spent for Type II projects over the next five years, with an estimated need of $240-275 million to complete the statewide retrofit program.

Including California and New Jersey, the average annual expenditure planned by the responding states for DOT Type II barriers is $6.3 million per year (a total of over $75 million per year). Excluding New Jersey because of the uncertainty of its funding, the average annual planned expenditure drops to $5.5 million. Including New Jersey but excluding California because of the enormity of its program, the average annual expenditure would be $4.5 million.

Utah was listed as planning to spend $1 million per year for Type II projects. Realistically, the state expects to get only one half of that amount. No formal Type II program exists at this time, but studies along the urban interstates show extensive needs for abatement. Coupled with a recent large increase in noise complaints, Type II funding appears to be inevitable in the near future. The state is also contacting local authorities about developing land use compatibility ordinances in conjunction with the Type II funding push, reporting some success with Salt Lake County.

<u>Type II Program Administration</u>

States with Type II programs were asked to comment on five items:

1. reasons behind development,

2. funding mechanisms,

3. seeking of funding from local governments or affected citizens,

4. seeking of actions from local government in support of a project, and

5. prioritization methods.

Reasons Behind Development. As described above, twelve of the states indicated that they had a Type II program. The most common reason given for starting a Type II program was in response to citizen complaints. New Jersey also cited a 1977 community lawsuit. Legislative complaints, requests and inquiries were also a common beginning point for the programs. Six states cited legislative action: California, Connecticut, Massachusetts, Minnesota, Utah and Wisconsin.

Connecticut began its Type II program in 1973 using Federal-Aid Interstate (FAI) construction funding with 90 percent federal participation. Between 1973 and 1982, 122 areas were prioritized and six noise barriers constructed. Since 1982, Connecticut had only constructed three other retrofit noise barrier projects because of lack of funds. Connecticut notes that it has a "deferred" file of over 50 noise complaint locations that has grown between 1981 and 1986. These complaints, coupled with legislative interests led to the passage of Special Act 85-107, which directed the department to revise the department's noise barrier priority listing and develop a ten-year plan for installing noise barriers, including cost estimates. Appendix D provides details on the resultant reevaluation report.

The California Type II program began as a voluntary effort, but was formalized through state legislation as Section 215.5 of the State of California Streets and Highways Code, Priority System for Noise Barriers.(14) Section 215.5 required the department to develop and implement a system of priorities for ranking the need for retrofit noise barriers along California freeways. The legislation specified prioritization criteria and directed the department to include in its proposed State Transportation Improvement Program a program of noise barrier construction beginning with the highest priority sites. The department was directed to prepare a priority list on an annual basis. Appendix C provides the text of Section 215.5.

In Wisconsin, the 1987 Wisconsin Act 27, s.3052(3g)(b), required the department to develop criteria and procedures for siting noise barriers. The department responded with Administrative Rule TRANS 405, approved by the legislature in 1989. (See Appendix F for details).

Hawaii noted that its legislature has asked for a pilot noise study along one of its freeways. The study, which is limited to a one-mile section, should be completed soon.

Massachusetts recently completed a Type II Noise Attenuation Study in 1988. The first public meetings on proposed Type II barrier projects were being held in the Summer of 1990 to determine the residents' reactions. Appendix E provides details on Massachusetts' policy.

Funding Mechanisms. The 1982 Surface Transportation Act eliminated the use of FAI money for retrofit noise barriers, stating that federal "4R" (Resurfacing, Reconstruction, Restoration and Rehabilitation) funding could be used for Type II noise barriers. In many states, this smaller funding source was generally already earmarked for other 4R projects. The lack of a separate federal funding source specifically dedicated to Type II projects has been cited by many states as their primary reason for not having such a program. When asked about funding mechanisms, the majority of the responses identified regular 4R highway funds.

On one project in 1984, Connecticut used the Interstate Trade-in Program set up in the 1982 Act, which was structured to allow a high level of local input by eligible communities for setting priorities for the use of trade-in funds. The town of Wethersfield chose installation of a noise barrier on I-91 its highest priority.

It should be noted that the new National Transportation Policy developed by the USDOT and presented by President Bush in March of 1990 has as a theme giving state and local communities more flexibility in use of the funds. It is anticipated that the next Surface Transportation Act, which will be written to begin in Fiscal Year 1992 will be structured to allow that flexibility. Such a structure may give interested states and communities a ready mechanism for funding Type II projects.

One of the most interesting programs is in California. The California Type II program was originally a volunteer program with a volunteer funding level, but as noted in the previous section, was subsequently legislated via Section 215.5 of its code. In June of 1990 the voters approved a five cents per gallon (increasing to nine cents in four years) gasoline tax increase under Proposition 111. One part of Proposition 111 stipulated that the Type II noise abatement program shall receive an additional $150 million over the next 10 years. Prior to Proposition 111, the annual funding level was reported as barely keeping up with inflation.

This new money would be in addition to the 1988 State Transportation Improvement Program (STIP) budget of $75 million over five years (the 1990 STIP stated a need for $180 million over seven years).

Minnesota indicated that there is currently a legislative moratorium on its Type II program after major expenditures in the 1970's for Type II barriers in Minneapolis-St. Paul area funded largely by a one-quarter of a cent per gallon state gas tax set aside. Also, as noted earlier, New Jersey is now seeking legislative action to direct its construction funding surplus to noise barriers. Oregon listed all levels of government, including federal, state, county and city as its mechanism, as well as Local Improvement Districts (LID's), defined as any group of people who get together and tax themselves (see next section for more details). The city/county funds are sometimes requested as "local match" to supplement regular 4R or FAI state/federal funds. Utah is looking to receive money from an extra diversion of general transportation funds or as a special fund authorized by the state legislature as it pursues development of a Type II program.

<u>Seeking Funds from Local Government or Affected Citizens</u>. Six states indicated that they have sought or would seek funding from local government or the affected citizens for their Type II Programs (IL, MD, MI, OR, UT and WI).

Wisconsin seeks this extra funding on projects where barrier costs exceed $30,000/dwelling unit. Oregon will sometimes seek 25% of the project cost if the local government is partially responsible for the noise problem, such as when they design and build a road without following the NEPA process or when a city allows development along an existing highway. Connecticut, however, believes that the solicitation of funds does not generate a positive attitude about funding.

California does not actively seek this funding but will accept it. This enhances project priority. For California, if the cost is reduced, the prioritization index goes up. Money can come from both local government and/or citizens. State legislation stipulates that the state will pay the party back with no interest in the year that the wall is programmed to be built. However, only one year is fixed funding and later years may change. As a result, that wall might keep getting pushed back in funding priority. Additionally, if a wall is only partially funded, then there is no pay back by the state. Most projects on which funding is provided are done by cities. As an example, the Orange County Transportation Commission is currently financing a project for which the state will pay them back at the appropriate time. Recently, also, federal advance construction funding allows the FHWA to approve the plan and concept and will then later help repay the cost.

Actions of Support Sought from Local Government. Concurrence with the planned abatement project is asked of local governments by a number of states including New Jersey, Massachusetts, New York, Wisconsin, Colorado and Connecticut.

Colorado invites local and county agencies to meet with the Planning Division of the Department of Highways to present information on a prioritized Type II set of projects. The department then studies all presentations and incorporates the selected projects into the five-year plan.

Utah is pursuing a program of having local governments develop land compatibility ordinances use for land abutting state highways, and Wisconsin calls for documentation of noise sensitive land use controls. Minnesota and Connecticut look to see that the people in question indeed want the barrier. Iowa also wants any projects to be consistent with local planning, and looks to local government for aesthetic considerations.

Connecticut has formalized a process of obtaining signed agreements with affected citizens who oppose construction of a barrier planned for their area. The agreements state that the citizen "shall never directly or indirectly ask, request, petition or otherwise seek the erection, construction or maintenance of a noise barrier within state limits." A total elimination of a proposed project can be accomplished only through a total consensus by each of the residents and property owners to receive primary benefit from the barrier. The agreement must be executed by each of the benefitting property owners, with authorized concurrence from the FHWA and the local government, per FHWA requirements. See Appendix D for sample documents.

Project Prioritization. Each of the states with a Type II program has some method for prioritizing among potential projects. The methods vary, but most have a common thread, a prioritization index of some sort. Factors typically include: (1) cost, (2) dwelling units affected, (3) noise level, and (4) achievable reduction.

In general, eligibility is pegged to the 1976 change in FHPM 7-7-3 (the FHWA noise standards) (15) and whether or not the development was in place prior to then.

As an example, California uses the following formula(16):

$$PI = [AR \times (NL-67)^2 \times LU]/\text{cost } (\$1{,}000)$$

where: PI = priority index

AR = achievable reduction

NL = measured noise level (L_{eq})

LU = number of living units

Barriers considered under the California program must provide a minimum of 5 dB reduction to be included. The existing measured levels include an adjustment for future growth in traffic of +2 dB for situations currently experiencing Level of Service A and +1 dB for a current Level of Service B. Residences located above the first floor in multi-story units are included in the count of LU if the barrier will provide at least 5 dB reduction for these units. Appendix C contains Chapter 1100, Highway Traffic Noise Abatement, of the Caltrans Highway Design Manual, which includes more details on this and other subjects.

As a contrast, Connecticut computes a Project Priority Ranking Number PPRN which, while also a ratio of benefits over costs, does not figure in achievable reduction.(13) It also bases costs on a 15-foot high barrier at fixed unit prices for normal construction, construction on structures and construction with crash barrier protection. In computing benefits, Connecticut includes a 1/3 weighing for receptors in existence after the highway was built and computes equivalent receptors based on the percentage of time (hours/day, days/week, weeks/year) that the facility used.

Most recently, Wisconsin DOT developed a complex ranking factor that includes the following variables(17):

1. average sound energy, averaged over all modeled receptors,
2. traffic exposure (the average daily traffic divided by 24 times the Level of Service volume),
3. an age factor (an average of the ages of the residences weighted by the difference in ages between the residences and the freeway), and
4. the cost effectiveness of the barrier (total barrier cost divided by number of residences divided by average noise reduction).

A ranking factor was then computed by summing the four factors using weights of 50 percent, 25 percent, 15 percent and 10 percent, respectively. Finally, according to Wisconsin DOT, "the ranking of each noise barrier relative to the other barriers was performed by normalizing each of the barrier factors using standard deviation techniques and summing all four factors with the appropriate weighing factor for each barrier to arrive at a score." Wisconsin used a cutoff of an L_{eq} of 67 dB for inventorying its needs. Appendix F includes details on these calculations.

Finally, details on the New Jersey priority system are presented in Appendix G.

Communications Techniques

The state DOTs were asked to describe any interesting or innovative techniques that they have used to communicate with, educate, or market their noise analysis and abatement programs to the general public, people living in the immediate project areas, executives or other staff in the agency, legislators, and officials in other agencies or jurisdictions (such as federal, state, local or regional).

By far the most commonly cited method of communication with the public is through public meetings. However, once at a meeting, several different presentation methods are employed. For example, Massachusetts and Virginia have used audio recordings of traffic noise. On the Dulles Toll Road, Virginia used a tape containing existing noise (without the project) and noise after construction both with and without a barrier. Construction of a noise barrier was going to require the donation of some land to the ROW by the residents. After hearing the tapes, the residents decided that the 5-7 dB reduction that they heard was not sufficient to donate their land. Virginia indicated that it would only use this technique in special circumstances such as that one.

Colorado reports the use of computer imaging to show views of a planned project where high occupancy vehicle lanes are being added along I-25 requiring changes to the existing noise barriers. The computer images give residents a view of the noise barrier, any traffic that could be seen above it and the Denver skyline. This work was done by project consultants who also developed views of the I-70/I-25 interchange area showing how the roads would look driving down the highway. New Jersey also reports the use of barrier "animation". Other techniques include the use of slide presentations and slide shows, artist's renderings (including noise barrier overlays on existing photos), and posters of predicted noise contours on aerial photos. North Carolina has published a pamphlet on highway traffic noise and its abatement for distribution upon request, and New Hampshire and Illinois indicated the use of questionnaires to gather information.

In addition, for people in immediate project areas, various DOTs have used informal discussions, open house workshops, and small group meetings. Arizona, Florida and New Hampshire report the use of individual meetings with affected homeowners, often in the field, to discuss the project and proposed abatement. Florida reports success on one project in that the number of planned barriers was reduced from 13 to 3 with substantial cost savings, as Florida's barrier costs were running \$15-24/ft^2. The cost in time was 3-4 weeks for 3-4 people.

Illinois notes that attempts are made to organize adjacent property owners through their local city or county representatives, and has used separate field meetings. Massachusetts notes that all residents within 500 feet of the highway receive notification of public meetings for proposed Type II projects, while Georgia has distributed information packets to the first row houses along a project in Atlanta. In its field meetings, Oregon has illustrated the proposed height of noise walls by raising a rod to the wall elevation. Videos are used by Florida, Kentucky, New Jersey, Pennsylvania.

For communication with executives or other staff within the DOT, most states rely on personal contact, one-on-one briefings, inter-office memoranda, and occasional field visits. Massachusetts notes that all executive heads of its bureaus, district offices, and the MPO's reviewed and commented on its Type II noise policy and received copies of its Type II attenuation study. Florida notes that its staff receives field/computer training and Washington has given classes to contractors regarding construction noise abatement. Maryland uses large scale status boards for its metropolitan areas to keep the staff informed. One respondent noted whimsically that few of his agency's executives are being educated by living near one of the interstate belt routes.

Most of the states involve their legislators by inviting them to public meetings as well as providing them with correspondence, literature and reports. In several cases, the contact is in response to a request for information or action by a legislator.

Officials from other agencies or jurisdictions are kept informed through public meetings, scoping meetings, briefings, reports and field visits. Colorado reports the use of urban design committees to involve other agencies. An urban design committee is a multiagency group consisting of representatives from the city and county of Denver, the local neighborhood, the Department of Highways main office and district, and the appropriate state legislator. A local urban planning firm provides direction as the groups study aesthetic and visual elements of the project as well as noise issues.

Legal Decisions

The respondents were asked to comment on any noteworthy traffic noise legal issues, decisions, settlements or precedents in their states. Fourteen states reported legal decisions with consequence to their noise abatement programs.

In California, a land owner sought severance damages on a partial take of his yet-undeveloped property mainly due to an alleged increase in noise from a state-built truck inspection station. The jury's verdict was for the state.

Kentucky reported two cases involving out of court settlements, one for damages with a recording studio on a highway widening (approximately $40,000), and one for condemnation regarding an apartment complex and the widening of I-254 in Louisville (approximately $400,000). Texas reports a settlement of $31 million regarding impacts on a school in Houston for a proposed highway construction.

In Michigan, a class action suit alleged that as a result of the taking of certain properties for highway purposes, the remaining properties were damaged without payment of just compensation. Integral to their case was that a restrictive covenant had previously required that the properties be used for residential purposes only. No outcome was reported. In New Jersey, however, the appellate court has ruled that noise is a compensable item in ROW negotiations.

Washington reports that a condemnation case caused the state to defend FHWA's use of L_{eq}. The plaintiff argued that the impact was actually caused by increased incidences of peak noise and intensity. The court allowed the jury to consider this argument. The degree to which the jury was influenced by it is unknown. However, an award was made to the plaintiff.

New Hampshire notes that it has relocated residents adjacent to highway projects and then sold their houses to others. Delaware noted a 1976 court decision that required the installation of a barrier along I-95 to protect a school building. Since that time, the building was demolished as part of an urban renewal project. Connecticut has developed a lengthy, comprehensive process when requests are made to remove or alter proposed barrier systems (described earlier in this report).

In Utah, because of the threat of litigation, the state attorney general's office has given several opinions regarding the protection of second-story receivers (if exterior use, such as a deck), rented dwellers (must be considered on an equal basis with non-rental residential land use), and redeveloped sites (do not qualify for abatement). FHWA has indicated to the state that it cannot extend the project limits to include noise abatement for sites that are impacted but are outside of the construction limits.

Illinois described a case involving a section of roadway that was built by a local agency and included as a commitment in its EIS the posting of a certain speed limit to control future traffic noise levels. The project is now open and the judge is failing to find guilt with offenders issued speeding tickets, apparently questioning the legality of a speed limit not based on "properly analyzed speed study."

Florida also reports that a recent Section 4(f)/106 agreement has resulted in a signed agreement between FHWA, FDOT and the state historic preservation officer regarding a noise wall in an historic district in Tampa. A widening project would only benefit marginally from noise barrier installation in terms of reduce noise levels. The barriers did serve, however, as privacy fences and were included in the project.

An excellent discussion of traffic-related noise as a factor in eminent domain proceedings in Florida was published by Lindeman in a recent Transportation Research Record.(18) Through the examination of five case studies, the impact of noise in condemnation cases was highlighted. Florida is known as a "taking" state rather than a "damage" state which means that the state pays only for the taking of property and not for damages to that property. However, this principle can vary once the site passes the test of "severe damage", which the courts have treated as a "taking". However, to date, Florida courts have held that traffic noise has not caused "severe damage", and therefore was not compensable. Severance damages that have been allowed for partial takes often involved the "cost-to-cure", which restores the remaining property to its original use and value.

In a case in northern Palm Beach County, condominium homeowners were awarded $172,400 as cost-to-cure, for the purpose of erecting a noise barrier on the homeowner association property. Also in Palm Beach County, a church was awarded $73,000 for payment for the property taken, and for damages to the remainder, which included approximately $34,000 to relocate the front entrance of the church, replace a single-paned windows with double-glazed windows, and to relocate portable classrooms. Another church, in

Tallahassee, was awarded $10,000 for a small taking of property for an arterial construction. Noise was not separated out from other damages, but its contribution was considered to be negligible by the court.

Finally, the partial taking of a small portion of a city park in West Palm Beach led to a circuit court award of $644,275 for the value of land taken and $1.7 million in severance damages, mostly for the construction of a noise barrier. Upon FDOT appeal, the lower court's decision was reversed regarding the severance damages. In his ruling, the judge noted that the park was already exposed to high noise levels from the nearby International Airport, the adjacent railroad and busy arterials. The $1.7 million in severance damages was reduced to $72,500.

Research

Agencies were asked to comment on their past, current, and future research, development, implementation or technology transfer efforts on traffic noise. Eighteen states indicated that they have done work in these areas in the last ten years, while eleven indicated that work was planned in the next five years.

For fourteen of the positive respondents, some or all of their research activity has been their involvement in a National Pooled-Fund Study on parallel barrier effectiveness (the Dulles noise barrier project).(19) These states are: CA, CT, FL, GA, HI, IA, MD, MA, MI, NJ, NY, OH, PA, and VA. The pooled fund study is being conducted by the USDOT Transportation Systems Center under the guidance of FHWA and the 14 states. A proposal for additional new work is currently being reviewed by the participating DOTs.

FHWA has also supplied a list of recent Highway Planning and Research (HP&R) studies. Table 2 provides a listing of these projects, some of which are mentioned in the following discussion. Appendix B provides summaries of each project.

There are three major thrust areas for the research that has been and will be conducted:

1. improving the prediction modeling,
2. evaluating noise barrier performance, and
3. studying tire/pavement noise.

Table 2. Summary of Federally-Funded Noise Research

Project Title	Performing Organization	Type of Funding	Beg. Date	End Date
Public Response to Noise Barriers	New Jersey DOT	HP&R	3/87	2/89
Program Computer to Optimize Noise Barrier Design	Caltrans/ Translab	HP&R	6/81	6/82
Specialized Noise Barriers for Use on Bridges	New Jersey DOT	HP&R	11/89	9/91
Tire Noise-Effects of Roadway Wear II	Trac/Univ. of Wash.	HP&R	9/89	9/91
Update Vehicle Noise Emission Levels	Cal. DOT - Div. of Hwys.	HP&R	6/81	9/87
Design of Noise Barriers Using Artificial Intelligence	Caltrans	HP&R	5/89	6/91
The Effect of Roadway Wear on Tire Noise	Univ. of Washington	HP&R	9/87	8/89
Update on New Jersey Truck Noise Levels	New Jersey DOT	HP&R	5/89	3/92
Alaskan Way Viaduct Traffic Noise Abatement Plan	Univ. of Washington	HP&R	11/88	11/90
Field Eval. of Reduction in Acoustic Performance of Parallel Noise Barriers	Caltrans	HP&R	3/89	6/90

Table 2. Summary of Federally-Funded Noise Research (cont'd)

Project Title	Performing Organization	Type of Funding	Beginning Date	End Date
Extension of Reference Emission Factors for STAMINA Model to Include 55-65 MPH Range	Univ. of Cent. FL	HP&R	7/90	12/91
Parallel Noise Barrier Prediction Procedure	Dr. Simon Slutsky	Admin.	1/85	5/87
Investigation of Structural Design Criteria for Noise Walls	Analysis Group, Inc.	Admin.	8/84	5/86
Predicting Stop-and-Go Traffic Noise Levels	Vanderbilt Univ.	NCHRP		
Evaluation of Performance of Experimental Highway Noise Barrier	Transport. Systems Center	Pooled-Fund Studies	1/87	9/91
Investigation of Tire/ Pavement Interaction Noise Mechanisms: Phase I -- Mitigation of Tire/Pavement Noise through Optimized Pavement Design: Phase II	RSPA	Admin.	3/84	9/90
Stop-and-Go Traffic Noise Prediction Procedure	Polytech. Inst. of NY	Admin.	2/80	8/82
Standard Test Procedure for Evaluating Noise Barrier Effectiveness	Acoustical Society of America	Admin.	6/81	
An Investigation of the Effectiveness of Noise Barriers along I-275 and I-95	Fla. Atlantic University	HP&R	3/87	
Traffic Noise Attenuation as a Function of Ground and Vegetation	Caltrans	HP&R	8/85	
Evaluation of Innovative Noise Barriers	New Jersey DOT	HP&R	5/85	

Table 2. Summary of Federally-Funded Noise Research (cont'd)

Project Title	Performing Organization	Type of Funding	Beginning Date	End Date
Determination of Noise Source Height of Vehicles on Florida Roads and Highways	Fla. Atlantic University	HP&R	7/86	4/89
Evaluation of Traffic Noise Barrier Design Methods		HP&R		
Acoustic Characteristics of Roadway Surfaces		HP&R		
Evaluation of Compost and Co-Compost Materials for Highway		HP&R		
Determination of Truck Noise Levels for New Jersey		HP&R		

Research on the noise prediction modeling has focused on:

1. modifying the reference energy mean emission levels used in the STAMINA 2.0 traffic noise prediction computer program,
2. studying noise attenuation rates over various ground surfaces,
3. analyzing multiple reflection effects between parallel noise barriers,
4. studying non-constant speed traffic noise levels,
5. investigating meteorological effects on traffic noise propagation, and
6. developing CAD and expert systems techniques for noise analysis and barrier design.

Within the last ten years, four states indicated that they have revised or are revising their noise prediction emission levels: California (which also studied the emission levels for trucks on grades)(20), Georgia(21), New Jersey, and Florida.(22) Florida is also currently doing work on extending the database to a speed of 65 mph. Tennessee also has similar plans to develop a revised emission level database.

The National Cooperative Highway Research Program (NCHRP) also funded work to develop a method to use the STAMINA 2.0 traffic noise prediction computer program (23),(24) for non-constant speed traffic.(25) This work included developing emission level databases for accelerating and decelerating heavy trucks. The various emission levels studies are finding that the mean truck noise emission levels are lower than the "national averages" of the FHWA traffic noise prediction model while automobile levels are the same or slightly higher than the national averages. The report for the NCHRP project also contains an extensive review of emission level data both for constant and non-constant speed vehicles.

Recently, California has converted its mainframe noise prediction programs to the microcomputer for use by its consultants(26) and is researching the use of expert systems for noise barrier design. New Jersey is also studying the use of expert systems for noise barrier design through a project-related study.

Florida has done research on the effective height of the noise sources to use in the prediction models. The initial research results indicated that source heights used for medium and heavy truck noise predictions are higher than the data indicates that they should be.(27) In FY 90-91, Florida plans a second-state follow-up to this work for conditions of varying speed and grade. Florida also hopes to do other STAMINA 2.0 model enhancement projects.

The subject of multiple reflections between parallel noise barriers has a received a great deal of interest. Previous work in Japan and Europe have shown that large reductions in the insertion loss can occur.(28) Recent work in the United States has focused on field evaluations of this problem. The National Pooled-Fund study showed effects of 2-6 dB. However, a 1987 study by Iowa showed minor increases in noise under actual traffic on I-380 (the ratio of barrier height to barrier separation is not known at this time).(29) California also studied the effectiveness of adding sound absorbing panels to one wall of the parallel barrier system in an attempt to appease homeowners living over 1000 feet from the road who complained of increased levels after the "far-side" wall was built. Because of the wide separation between the barriers relative to the barrier heights, little benefit was expected and little was found. California is now doing a much more detailed study, involving no barrier, single barrier and parallel barrier area along a single roadway. Again, however, the barrier height to barrier separation ratio is very small.

Another aspect of the National Pooled-Fund study is to evaluate the performance of a parallel noise barrier prediction program called Barrier 2.1.(30) The study is also aimed at assisting in the evaluation of the American National Standards Institute (ANSI) method for measuring noise barrier effectiveness.(31)

Additional studies of noise barrier effectiveness have been conducted by Florida (I-275 and I-95), Kentucky (I-471), and California (a number of sites). Kentucky used a combination of "before" predictions and "after" measurements, finding that the barrier was indeed effective and that the predicted STAMINA 2.0 levels with the barrier agreed quite well with the measured levels.(32) Florida also found that the barriers in its study were as effective as predicted in all cases, and slightly more effective than predicted in several locations.(33) California found that the FHWA model predicted 3 to 4 dB higher than the measured noise levels, but that the calculated barrier noise attenuation averaged about 1 dB lower than measured attenuation.(34) Iowa has also studied the effects of a noise barrier on community noise levels and air quality, findings that the barrier reduced noise levels and did not much change in measured pollutant concentrations.(35)

In the coming years, both Pennsylvania and Michigan will be researching the effectiveness of some of their noise barriers, as well as the I-696 house insulation project in Michigan. Florida also hopes to do field studies of noise barrier effectiveness, and California is researching sound propagation rates over various ground surfaces.(36)

Wisconsin has just completed a study of the freeway locations with the potential for Type II noise barriers (as noted earlier and described in Appendix F). Also Illinois DOT recently began a study on developing procedures to consider and reduce existing freeway noise in Northern Illinois noting that the state is experiencing increased citizens' demand for noise abatement to be a high priority in its highway program. IDOT will be investigating other states' Type II programs and identifying areas of significant impact through a field review.

Field testing of different pavement surfaces is being done by Maryland and Washington. Maryland is studying the noise reduction from open-graded asphalt pavements at wayside measurement points.(37) Washington on the other hand, is using a microphone mounted at a fixed distance from the side of a test tire. Both studies indicate a noise reduction from open-graded asphalt. Both states plan to continue their research in these areas in the coming years.

Minnesota has also researched tire/pavement noise, especially generated by transverse grooving. As noted earlier, Oregon has also developed a "random" grooving pattern for reducing noise. New Mexico is just beginning a study on psychoacoustic effects due to different surface treatments on a road and bridge area in Albuquerque. Iowa has also studied the effects of pavement surface texture on noise and frictional characteristics.

Finally, it is interesting to note that in a 1987 survey by the Transportation Research Board, state DOTs identified some 50 items of needed research.(38) Despite the work that has been done or is being programmed, the list of needs is long. The TRB Noise Committee plans on playing a major role in helping FHWA prepare its greatly expanded environmental research program for FY 92 through FY 96 (a total of $25 million for all environmental areas compared to $90,000 for FY 90). A recent updating of the survey identified the following five top priority needs (Polcak, Maryland SHA, unpublished):

1. multiple reflections model,
2. multiple diffraction in STAMINA/OPTIMA,
3. compile data on vegetation effects,
4. cost-effectiveness: absorptive barriers, and
5. insertion loss model, propagation over many surfaces.

Land Use Compatibility and Coordination with Local Agencies

The FHWA noise standards(15) require state DOTs to coordinate with local officials in whose jurisdiction a highway project would be located. The survey asked the DOTs what they or their state legislators have done to encourage or require land use compatibility. They were also asked how their coordination efforts with local officials have paid off in terms of project-specific actions, generalized actions or policy changes by the local government.

DOT Involvement. Involvement by DOTs in the area of land use compatibility tends to be more of a passive nature, mostly in terms of providing general information on noise and its effects, as well as project-specific data on noise levels at various distances from the proposed facility. Most of the DOTs affirmed it was the responsibility of the local agency to coordinate land use compatibility. Illinois noted that while its state legislature has enacted laws and rules to prevent noise that creates a public nuisance, IDOT's actions have been limited to providing information to local officials.

Four states specifically noted meeting with MPO's on noise issues. Kentucky reported that it worked with the Louisville Planning Commission to enact a requirement for a 250-foot setback for proposed new development next to I-265 in Jefferson County. Oklahoma indicated its participation in the 3-C planning process, while Puerto Rico reported close coordination with the Planning Board, which is in charge of approval for all requests for development on the island.

Colorado notes that local governments sometimes asked the department to review proposed subdivision actions/plans, and Delaware indicated that during its review of subdivision plans it has required the use of berms to protect residents from future impacts. Delaware has also encouraged the rearrangement of subdivision plans, such as having an apartment complex locate its parking lots closer to the roads with the buildings away from road.

California noted that all local agencies were notified that for any development adjacent to freeways after November 1, 1974, the local agency has the responsibility, through land use control, ordinances, etc., to require the development to be compatible with the freeway (i.e., require noise mitigation).

Florida has a State Comprehensive Plan which includes noise as an element. The plan does not mandate specific noise levels, but encourages land use developers to consider noise in their projects. The main purpose is to insure that infrastructure details such as roads, sewers, etc. are considered in developments or else impact fees would be exacted.

Hawaii also noted that it has a comprehensive land utilization plan. The state of Vermont has both a development review law (Act 250) and a land use planning law (Act 200).

Michigan asks local governments to change their zoning policies as a condition to building Type II noise barriers. Wisconsin has an administrative rule that requires documentation of noise compatible land use control adjacent to <u>all</u> freeway and expressways before <u>any</u> Type II barriers will be built.

Finally, Virginia noted:

> "the state noise abatement policy requires that in order for the DOT to provide noise abatement on non-federal aid projects, the local jurisdiction must assume 50 percent of the abatement cost, and must have a noise ordinance requiring developers to include noise abatement in their plans for noise sensitive developments adjacent to existing highways and approved highway corridors. No jurisdiction has yet met these requirements."

<u>Successes Resulting from Local Coordination Efforts</u>. Few of the respondents replied with specific project examples of successes from their coordination efforts, although some effects have occurred.

As noted in the above section, Colorado and Kentucky have worked with some local authorities, upon request, regarding subdivision approval and proper setbacks. North Carolina reports that some local officials are now requiring set-back distances for developers based on information provided to them in highway noise study documentation. Oregon also reports that some local jurisdictions are now requiring noise barriers as a condition for the subdivision. Wisconsin also reported some success in working with local municipalities in requiring noise compatible uses. Also, Tennessee and Utah report that some developers are including abatement measures for their developments, such as earth berms and noise barriers. Finally, counties and cities in Washington have been requiring noise mitigation in new developments next to noisy highways and major metropolitan areas.

Both Indiana and Mississippi indicated that some communities have been making zoning changes from commercial to residential near high-traffic volume roads while Alaska reported that aviation noise problems lead to rezoning for compatible use around the Fairbanks and Anchorage International Airports.

In terms of payoffs in the form of local policy changes or generalized actions, again most states reported little or no effect. However, 14 did provide positive responses. Seven of those actions involved noise ordinances for the following:

1. Fairbanks and Anchorage, Alaska,
2. most local agencies in California,
3. Denver Metro Area suburbs, Colorado,
4. Boise, Idaho,
5. several communities in Illinois,
6. several communities in Michigan, and
7. several localities in New York.

Michigan DOT also reports helping a number of communities through training and loan of noise measurement equipment, leading to improved noise ordinances. Wisconsin indicates that it will be working toward encouraging noise ordinances.

Illinois provided a good summary on this subject:

> "In driving through urbanized areas in Illinois, some local policy changes or generalized actions obviously have occurred in the last ten years in some communities and counties. Some developments can be found that concentrate residential development in the interior or have partial berming around the exterior or other obvious measures to try to control noise problems. IDOT is aware of perhaps a dozen locals that have adopted some sort of noise ordinance, relatively speaking, a very small number."

Staffing

State DOTs were asked to describe their staffing for traffic noise work in both their main office and district offices. Of interest were the roles that the staff played in each office and the number of "full-time equivalent" people assigned to noise work. The DOTs were also asked to describe the level of education and training of their noise staff. Finally, they were asked to describe the degree to which they used consultants for project noise work or research.

Main and District Office Staffing Levels. The responses could be divided into two groups, based on whether the normal project development responsibilities were assigned to either the main or district office personnel.

Table 3 presents a matrix of state DOTs staffing in terms of main office and district office full-time equivalents. These numbers represent a mix of full-time people in some states, part-time people in others, and combinations of both categories in many. All of the states had at least one person who, at a minimum, works part-time on noise.

Those states that are organized for most of the project development work to be done in the district offices have a small main office staff of one or two full-time (or nearly full-time) people. These states include Arkansas, California, Colorado, Florida, Illinois, Minnesota, Missouri, New York, Ohio, Pennsylvania, Texas, Washington and Wisconsin. In these cases, the main office people are responsible for such tasks as:

1. policy development,
2. methods development,
3. review and approval of district and consultant studies,
4. provision of technical assistance and training,
5. some individual or specialized studies,
6. some conduct of research,
7. response to administrative or legislative inquiries, and
8. overall program direction and coordination.

In these states, the district personnel are generally involved in project analysis and abatement design, meeting with local officials and directing and reviewing consultant work in their districts. Five states reported having five or more full-time equivalent staff over all of their districts: Arkansas, California, Florida, Illinois, and Texas. California reports having a total of 48 registered engineers and technicians in its district offices involved in noise studies and measurements. Utah also has environmental specialists in each district that help with noise part time.

Connecticut notes that while project development work is centralized in its state, a sound level meter is available in each district for on-site monitoring at major construction projects. The district personnel in Washington are also involved in construction monitoring.

In those states with centralized project development functions, the staff with traffic noise responsibilities perform all of the above mentioned activities. Eight of these states have less than one full-time equivalent person, and 13 had at least one but less than two full-time equivalent staff. Eleven centralized

Table 3. State DOT Staffing for Traffic Noise Work

Main Office "FTE" Staff*	District Office "FTE" Staff: None	Less than 1	Between 1 and 5	5 or more
0 to less than 1	8	0	3	2
1 to less than 2	13	1	4	2
2 to less than 3	4	0	0	1
3 to less than 4	4	1	0	0
4 to less than 5	2	0	0	0
5 to less than 6	2	1	0	0
6 to less than 7	1	0	0	0

* FTE = Full-Time Equivalents

DOTs have three or more full-time equivalents for noise work. These are: Connecticut (3); Kansas (5-6); Maryland (3); Minnesota (3-4); North Carolina (4); Nebraska (3); New Jersey (5); Oregon (4); Puerto Rico (6); Tennessee (3); and Virginia (5).

Level of Education and Training. The large majority of the states have staff with at least one four-year degree. Most members have a bachelor of science in civil engineering, while a number list bachelor degrees in such diverse fields as engineering science, physics, mathematics, chemistry, statistics, geography, business administration and forestry. Twelve states indicated that some of their staff also have graduate degrees, listing such majors as engineering, urban and regional planning, applied science/biology, environmental science (air pollution), business administration, and biology. Several states report that technicians have associate (2-year) degrees in civil engineering technology.

Formal training in traffic noise analysis has included FHWA fundamentals and advanced training courses, FHWA demonstration project workshops, in-house and/or privately run short courses, and some university course work. Several states report no formal training, relying on learning on the job. One respondent noted the frustration of "inheriting" the noise analysis responsibility while budget constraints prohibited attendance at training courses.

Use of Consultants. The states were asked to what degree they used consultants for project noise work and noise research. A breakdown of the responses for consultant use on project noise work is as follows:

1. None: 12 states
2. Rarely: 8 states
3. Frequently, but less than half of the time: 20 states
4. About half of the time: 4 states
5. Extensively (over half the time): 6 states

Those states with infrequent use of consultants will typically use them on selected projects where the project delivery schedule cannot be met by the in-house staff or on large, controversial projects. Some states use consultants only for EIS-level analysis, while others use them only for preliminary engineering or noise barrier design. The states making the most frequent use of consultants are: Illinois, Massachusetts, Maryland, North Carolina, Pennsylvania, and Utah. One respondent expressed frustration in being able to find qualified consultants for its work.

In terms of research work, Florida reported that 95 percent of its work is done by consultants. Illinois indicated that 100 percent is done by consultants although the total is minimal. Tennessee indicated that consultants do 80 percent of its research while Minnesota reported 0 percent.

Traffic Noise Analysis Tools. Most of the states report using the FHWA STAMINA 2.0/OPTIMA traffic noise prediction and noise barrier design computer programs(39),(23),(24). Fourteen report doing work on IBM-compatible computers, 12 report using mainframe systems (VAX, IBM, Wang, Unisys), and 16 report having both mainframe and microcomputer capabilities. Several states still report the occasional or exclusive use of hand-held programmable calculators and nomographs for the FHWA traffic noise model. A few states made mention of the use of digitizing systems for file creation and graphics software for file display. California recently had its mainframe SOUND32 programs (a combined STAMINA/OPTIMA) downloaded to the IBM-PC.(26)

The states report having a variety of noise measurement equipment capabilities. Included are sound level meters and integrating sound level meters and analyzers made by General Radio, B&K, CEL, Metrosonics, and Quest. A much more comprehensive analysis of state noise measurement equipment and procedures may be found in Transportation Research Circular 288, Synthesis of Highway Practice: Environmental Noise Measurements, published in 1985.(40)

Problems and Issues

Three of the survey questions dealt with issues and problems perceived by the state DOTs:

1. What are the issues of concern to the agency on traffic noise policy, program administration, analysis, or funding?
2. What are the key issues in noise control (1) at the source, (2) along the path, and (3) at the receiver?
3. What is the agency's biggest problem or challenge concerning traffic noise?

Administrative Issues. State DOT respondents to the first question listed a number of issues of concern. Probably the most serious issue is funding for noise abatement, especially for Type II projects. Eight states listed funding as the primary problem within their noise programs, four of these mentioning specifically Type II projects.

Funding concerns include:

1. a general lack of funding (both state and federal) for traffic noise abatement,
2. a lack of a separate federal funding category for Type II noise barriers,
3. competition of noise abatement with highway construction for funds (one state noted the difficulty in trying to decide which highway projects its 5-year plan are to be pushed back to make room for a Type II budget; another has difficulties finding enough funds for barriers while meeting mileage and other program commitments), and
4. lack of funds and potential locations for noise barrier product evaluations and experimentation.

Several states note an "increasing demand by the public and politicians" or "great need" for noise abatement on the existing highway system, but complain of lack of executive management support or state-level funding and policies for such abatement. Traffic noise control is not listed as high on the priority list in several states. One respondent also notes frustration with political pressure to circumvent current Type II policies by requiring special analysis on previously studied areas.

Policy and program administration issues that were raised include:

1. lack of priority at federal level,
2. inexperience in federal agencies,
3. lack of specific State DOT policies,
4. disregard for current federal policy,
5. variability or lack of consistency in the interpretation or application of FHWA guidelines, both within the State DOT and FHWA, and
6. need for changes in current FHWA policy regarding multi-story building abatement.

Technical Issues. Technical issues of concern regarding noise analysis include:

1. cost effectiveness of barriers,
2. expense of noise barriers per protected residence,

3. overdesign by conservative structural engineers increases costs,

4. the need for improved capabilities for analyzing sound reflection situations (buildings and parallel barriers), and

5. the need for more work on the subject of stop-and-go noise analysis, emission levels, shielding factors, and short source-receiver distances.

Developing aesthetics acceptable to the public is also of concern, not only for residents but for the motoring public, especially visitors in tourism-oriented states, as noted by the state of New Hampshire.

Source Control Issues. In the second survey question, the DOTs were asked to identify key issues in noise control at the source, along the path and at the receiver.

The key source control issue among the respondents is the need for quieter heavy trucks, including lowering of truck exhaust stack heights, which was mentioned by four states. This need includes better legislation of vehicle noise emissions, rejuvenation of the EPA programs regarding manufacturing controls and local program support, more federal support for manufacturers' noise control efforts, and better enforcement both at the federal and local levels (e.g. proper mufflers). Motorcycle noise and recreational vehicle tire noise were also cited as problems.

As a positive example of recent source control efforts, California's vehicle code requires a gradual reduction in vehicle noise emissions for all vehicles for sale in California to a level of 80 decibels (at 50 feet per appropriate SAE tests) by 1988 for all vehicle classes. (This code matches the EPA New Product regulations in accordance with the preemptive nature of the federal regulations as discussed later in this report).

Another source control issue is the potential use of pavement surfaces or surface treatments to reduce noise. Finally, the ideas of reducing congestion and maintaining efficient traffic flow were cited as possible remedies to certain noise control problems.

Path Control Issues. Issues for noise control along the path between source and receiver include:

1. the need for Type II funding along interstates,

2. the high cost of barriers and the need for reducing those costs (or improving cost effectiveness),

3. providing effective barriers while maintaining access and sight distance (one state requires barriers to be placed at the right-of-way line for safety, which generally makes them infeasible because of the needed height and associated cost), and

4. dealing with barrier maintenance (including development of graffiti-resistant surfaces), landscaping, snow removal, and the loss of view by residents, and making better utilization of earthen berms on new construction.

Receiver Noise Control Issues. Noise control issues at the receiver revolve around the effects that increased noise levels might have on altering nearby land use, coupled with the need for provision of liveable sound levels in an aesthetic manner, but in the face of the inability of DOTs to get local governments to control land use. Specific issues include:

1. the need for better zoning and building code requirements,

2. the need for inclusion of acoustical considerations in building layout and orientation of home lots and city streets,

3. better planning for land use compatibility, including prevention of future incompatible land use development, and a better educational process for local governments, developers and the general public, and

4. the need to make developers include noise abatement as part of their residential development proposals (including more use of earthen berms, sufficient set-backs and soundproofing).

Problems and Challenges. The third survey question on issues and problems asked the DOTs for their greatest problems and challenges regarding traffic noise. By far the greatest challenge is funding, or the lack thereof, both for Type I projects (abatement on new highways or on highway reconstruction projects) and Type II projects. One state notes a 15-20 year waiting list for Type II projects at the current level of funding. Another notes the challenge of balancing the great need for abatement against very limited available funds. A third calls for dedicated Federal funds for Type II projects that are not tied to the 4R program.

Related to the funding problem is the challenge of high costs and the economic feasibility of mitigation. Also related to this problem are the increasing public and legislative pressure for abatement, especially along existing roads, and the increase in noise levels as traffic volumes grow.

The challenges of training and keeping adequate professional staff to do noise studies were also cited by a number of states, as was the challenge of overcoming in-house resistance to the concept of noise abatement (to quote one state, "keeping all concerned amenable to finding best solutions").

Additional administrative challenges include:

1. getting local government to consider traffic noise in decisions affecting future development and to prevent uncontrolled development along roads (lack of state legislation on the subject was also cited as a problem),
2. a concern that while federal policy encourages, public involvement, education and solution-sharing, it only superficially guides these activities, and
3. dealing with the public whose demands for abatement might be termed excessive in terms of current federal and state policies or in terms of physical or economic feasibility.

Finally, technical challenges include:

1. analyzing and providing abatement for high-volume urban freeway expansions,
2. achieving consistency between in-house offices concerning materials and field conditions,
3. identifying and controlling noise reflection effects due to barriers,
4. predicting noise levels at speeds below 30 mph,
5. reducing cost, and
6. new noise abatement product evaluation.

Other Recent Information on State DOT Noise Abatement Programs

In addition to the results of the extensive survey conducted for this study, eight documents were obtained that provided information on state DOT noise abatement programs and/or FHWA policy and activities.

The first document(41) provides a good summary of the general nature of the traffic noise problem in the United States, a brief summary of land use planning and control and source control, a discussion of the FHWA noise abatement procedures, and summary data on noise barrier construction as of 1986. The barrier construction summary data in it were taken from the second article, by Weiss of the FHWA.(1) As of 1986, over 467 miles of noise barriers had been constructed with highway funds at a cost exceeding $338 million. Over 350 of those miles were constructed by ten states (California, Minnesota, Colorado, Virginia, Oregon, Michigan, New York, Arizona, New Jersey and Washington). California alone accounted for over 30 percent of that construction, which explains why the most common material is masonry block, which also accounts for just over 30 percent of the total mileage. According to FHWA, "the cost data . . . should not be used to draw conclusions about which states construct the most or least expensive barriers. . . [comparable] cost data are difficult to obtain for many barrier installations. . ." Also, a 1987 estimate for the completion of the U.S. Interstate Highway System has shown a need for approximately $142 million for noise barriers. The Weiss article presents a variety of views of the barrier cost data. Of interest are the findings that the "average" barrier is approximately 12 feet high and costs about $\$12/\text{ft}^2$ in 1986 dollars. Weiss also looks at trends in the quantity and cost of noise barriers over time.

The third article briefly examines the national Type II program and includes detailed discussion of the priority systems in California, Michigan and Massachusetts.(42) As of 1986, fifteen states had constructed over 157 miles of Type II noise barriers at a cost exceeding $139 million (in 1986 dollars). Appendices C, E, F and G contain the Type II policies or priority systems for California, Massachusetts, Connecticut and New Jersey, respectively.

The fourth article updates the inventories in the second and third articles.(43) As of the end of 1989, over 720 miles of barriers had been constructed by 39 states and Puerto Rico at a cost of over $635 million in 1989 dollars ($555 million in actual dollars). Table 4 presents data from that article on the states and the greatest barrier lengths and costs. Table 5 presents barrier lengths by material type. Finally, Table 6 lists states that have built Type II barriers (although not all of these states should be considered as having a formal program).

The fifth article presents revised data for potential use in the FHWA OPTIMA noise barrier design computer program.(44) The researchers took cost data for more than 700 barrier projects in 37 states and factored them to 1988 dollars using the construction price index. The results are presented for barrier heights ranging from 1 foot to 35 feet. It should be noted, however, that only one percent of the barriers were less than 5 feet in height and only 3 percent were over 20 feet in height; that is, 96 percent of the data were between 5 and 20 feet. Use of the cost data outside of this height range should be done with caution.

Table 4. Noise Barrier Construction By State
(10 Leading SHAs by miles and cost) (43)

State	Miles	State	Actual Cost Millions	State	1989 Dollars Millions
California	242.9	California	180.0	California	205.3
Minnesota	56.9	New Jersey	61.1	New Jersey	62.8
Pennsylvania	41.1	Pennsylvania	59.3	Pennsylvania	60.8
Colorado	40.9	Maryland	40.4	Minnesota	47.8
New Jersey	35.4	Minnesota	32.5	Maryland	42.7
Oregon	29.1	Michigan	25.2	Virginia	29.7
Michigan	28.3	Virginia	22.2	Michigan	29.0
Virginia	26.8	Connecticut	18.6	Connecticut	20.3
Connecticut	22.7	New York	12.6	Colorado	14.5
Maryland	20.9	Colorado	12.2	Tennessee	14.2
10 State Total	545.0	10 State Total	465.5	10 State Total	527.1

Table 5. Total Noise Barrier Length by Material Type (43)

Single Material Barriers		Combination Barriers	
Material	Length In Miles	Material	Length In Miles
Block	229.3	Berm/Wood	22.2
Concrete/Precast	147.6	Berm/Concrete	19.0
Berm Only	50.5	Wood/Concrete	16.9
Wood/Unspecified	39.2	Concrete/Brick	12.2
Wood/Post & Plank	36.4	Wood/Metal	7.4
Concrete/Unspecified	29.8	Metal/Concrete	7.0
Metal/Unspecified	27.2	Berm/Block	6.5
Wood/Glue Laminated	25.0	Concrete/Block	6.3
Brick	6.9	Wood/Block	4.5
Other	7.2	Berm/Metal	3.5
		Berm/Wood/Block	3.1
		Berm/Wood/Metal	3.0
		Other	10.8
Total	599.1	Total	122.4

Table 6. Type II Noise Barrier Construction By State By Total Barrier Length (43)

State	Length In Miles	Actual Cost (Millions)	Cost in 1989 Dollars (Millions)
California	113.4	90.4	107.7
Minnesota	26.2	17.7	29.0
Michigan	15.3	11.9	14.6
Colorado	12.9	4.6	5.4
Maryland	12.2	26.6	28.2
Connecticut	3.2	2.1	2.9
Wisconsin	3.0	5.3	5.7
New York*	2.7	2.9	3.2
New Jersey	1.3	3.0	3.2
Louisiana	1.0	0.2	0.3
Washington	0.9	0.9	1.0
Oregon	0.8	1.0	1.1
Iowa	0.7	0.4	0.5
Georgia	0.6	0.5	0.5
Massachusetts	0.2	0.7	0.8
Ohio	0.2	0.2	0.2
Total	194.6	168.4	204.3

*Total through 1986

The sixth article, on unusual abatement measures, has been mentioned earlier in this report(2). Appendix A contains the tables on these unusual features from this document.

The seventh article is a discussion paper on the needed level of analysis depending on the project classification as a categorical exclusion, and environmental assessment, or an environmental impact statement.(45) It presents a detailed example for a categorical exclusion illustrating the use of the FHWA "soft site nomograph."

The eighth article represents the latest in a series of field reviews conducted by FHWA headquarters staff.(46) A total of eight state highway agencies were visited, selected to include some that had not built any traffic noise barriers and some that had. The review found a wide variation in the interpretation of the Noise Abatement Criteria (NAC) in the FHWA noise standards (FHPM 7-7-3). Some states still view the NAC as federal standards, desirable noise levels, or design goals for barrier construction. The proper interpretation is that the NAC are levels that indicate serious enough impact to warrant consideration of abatement. States should look to obtain a substantial noise reduction below them.

The FHWA found that the eight visited states defined "substantial increase" in the existing noise environment as either 10 dB, 15 dB or on a sliding scale combining the increase in level with the value of the levels themselves. Other aspects of the field review dealt with "reasonableness" and "feasibility" of abatement measures, the existence of formal written state noise policies, efforts at coordinating with local officials, addressing the "likelihood" of noise abatement in the final environmental document, and the need to consider public attitudes towards highway traffic noise. Regarding the last point, FHWA notes:

> "Highway traffic noise is one of the pervasive noise sources in society today. From peaceful, rural roadways to busy urban freeways, traffic noise is ever present. [State highway agencies] . . . make decisions on whether it is reasonable and feasible to implement abatement measures. Public reaction to the problem of traffic noise plays a large role in the implementation decision. In several densely populated states, the citizens have come to expect and almost demand that abatement of traffic noise be a very high priority in the highway program. Citizens in almost all states expect that traffic noise abatement be part of the highway program - that is, it should not be overlooked or avoided. . . Per the FHPM 7-7-3, the view of the impacted residents should be a major consideration in the decision to implement traffic noise abatement measures on new highway construction projects. The will and desires of the general public should be an important factor in dealing with the overall problems of highway traffic noise, particularly the decision to implement Type II noise abatement. State highway agencies should incorporate traffic noise consideration in their ongoing activities for public involvement in the highway program."

The last document was actually two combined reports prepared for Maryland DOT based on a survey of DOTs on a number of noise policy issues of interest to Maryland as it developed a state noise policy.(47),(48) The survey focused on the following areas: policy, funding, Type I criteria, Type II eligibility and prioritization, abatement goals, construction criteria, construction costs, alternative methods, abatement monitoring and model calibration, and court action. Tables 7a-e provide summary information from that survey on the following subjects:

1. what constitutes a "substantial" increase if comparing "build" and "no-build" alternatives,
2. the cut-off date for new residential developments for eligibility as Type I projects,
3. insertion loss goals when providing noise abatement,
4. cost per residents criteria in judging reasonableness for abatement, and
5. average installed unit costs for noise barriers.

The first set of data shows that the most commonly used criterion for judging a "substantial" increase in noise levels is an increase of 10 or more dB (i.e., "greater than 9 dB"). It should be pointed out that this question did not inquire as to an increase in the existing levels over the "build" levels (which is called for in FHPM 7-7-3), but referred to a comparison of future "no-build" and "build" cases. The data also show that the most commonly used cutoff date for new developments to qualify for Type I treatment is the location approval of the proposed project. The third set of data shows a wide range in noise abatement goals. While many of the respondents tried to achieve 7 or more dB insertion loss, the most commonly cited range was 5-10 dB. Two states showed unreasonably low goals of 3-5 dB.

The data on cost per residence also showed a wide spread in the values, ranging from $8,000 per residence (Washington) to $37,000 (New Jersey). Only one state (Oregon) stated its criteria in terms of dollars per residence per dBA loss. In this researcher's opinion, use of this latter type of criteria is a better way of accounting for differences in marginally effective and very effective noise barriers. The barrier unit cost data tends to confirm the recent FHWA finding of an average cost of $12 per square foot.

The Maryland report also providing very brief information on a number of legal cases not reported by states responding to this study's survey:

1. Connecticut: protection of second-story receivers;

Table 7. Summary Data from Maryland DOT Survey on Noise Abatement Program Issues

a. "Substantial Increase" if Comparing No-Build and Build Alternatives

Criterion	Number of States
> 5 dB	3
> 7 dB	2
> 9 dB	14
> 14 dB	9

b. Cut-off Date for Type I Eligibility for New Developments

Milestone	Number of States
Location Approval	11
Design Approval	4
P S & E	5
Public Hearing	2
"Time of Investigation"	1

c. Abatement Insertion Loss Goals

Insertion Loss (dB)	Number of States
3-5	2
5	6
6,6-7,8	1 each
5-10	12
7-10	2
8-10	1
10	5
8-15	1
20	1

Table 7. Summary Data from Maryland DOT Survey on Noise Abatement Program Issues (cont'd)

d. Cost per Residence Criteria for Justifying Abatement

Cost per Residence*	Number of States
$ 8,000/dB	1
$ 15,000/dB	3
$ 16,500/dB	1
$ 20,000/dB	2
$ 25,000/dB	2
$ 30,000/dB	1
$ 37,000/dB	1
$ 3,000/dB	1

* Typically, residences with insertion losses of 3 or more dB or 5 or more dB are counted.

e. Average Barrier Construction Costs

Cost Range	Number of States
$ 5-10/ft^2	10
$ 10-15/ft^2	15**
$ 15-20/ft^2	6***
Over $ 20/ft^2	1

** Includes 5 states that include costs such as engineering, right-of-way and utilities in addition to the barrier system.

*** Includes 2 states that include costs such as engineering, right-of-way and utilities in addition to the barrier system.

2. Oregon, New Jersey, California: challenging decisions to not construct noise barriers because of excessive costs; the Oregon and California cases were settled out of court (California found replacement housing for the resident);

3. Washington: barrier not feasible;

4. Michigan: second-row residents claiming property values were lessened and they should be compensated like the first-row residents (decision in favor of the state);

5. Montana: provide abatement or pay damages on an existing urban roadway where increased traffic volumes had impacted long-established residences (preliminary stage of lawsuit);

6. Nevada: recording studio seeking damages to soundproof its building (still pending); damages paid to mobile home park because of decrease in value due to adjacent traffic noise;

7. Ohio: loss of view and increased pollution due to barrier installation (still pending); and

8. Texas: two cases where the state has been required to re-evaluate and re-write the EIS for major reconstruction of existing highways.

No additional details on these court cases were provided.

LOCAL AND NON-DOT STATE NOISE CONTROL PROGRAMS

Introduction

Noise problems are very specific geographically by their nature and thus one of the most appropriate control elements would be at the local level. Local noise programs and ordinances are generally concerned with all types of noise sources such as construction, industrial plants and nightclubs. In terms of transportation noise, a local government's main power lies in its ability to control land use and to require developers to mitigate noise levels to certain standards using any number of abatement measures. The one problem that may be encountered within local government is a lack of expertise. However, some state governments are prepared and equipped to provide the necessary expertise whenever needed. The federal government used to be able to provide a great deal of assistance through the EPA Office of Noise Abatement and Control (ONAC), but cutbacks have closed that option.

In order to present a clearer picture of the current status of state and municipal noise programs, a brief history of the federal noise program will be presented. The federal noise program effectively ended in

1982 and there has been concern with noise pollution and how it is controlled by other federal agencies and state and local governments. Former New Jersey Congressman James J. Florio, concerned with that question, requested that the General Accounting Office (GAO) investigate the situation with respect to transportation noise. The GAO report, issued in October of 1989, is summarized in this section. Another report was commissioned by the EPA Office of Air and Radiation to investigate the status of key state and local noise programs that existed prior to the closing of ONAC. The report, dated January 1990, was prepared by Soporowski of Rutgers University(49) and its results are summarized here as well.

In order to determine the most current status of state and local control programs, questionnaires were sent to all of the respondents to Soporowski's survey who indicated that they currently had a noise control program. The responses are summarized and discussed with respect to transportation noise.

The final step in the information gathering process was to follow-up with interesting or informative questionnaire respondents, as well as Canadian cities with noise programs, and to learn more about the current activities of the National Association of Noise Control Officials (NANCO).

Background

In 1970, the Office of Noise Abatement and Control (ONAC) was established by the EPA. In 1971, ONAC issued a report, Report to the President and Congress on Noise. This report and additional congressional hearings led to the passage of the Noise Control Act in October 1972. According to this act, state and local authorities are primarily responsible for the control of noise; however, the federal government is responsible for major noise sources in commerce where uniformity is requested.

The Quiet Communities Act of 1978 amended the Noise Control Act to emphasize assisting state and local governments. One aspect of the amendment required EPA to administer the Quiet Communities Program which would provide for grants to state and local governments, the purchase of noise monitoring equipment for loan to state and local governments, and technical assistance in the development of state and local noise control programs. Another requirement of the EPA was to provide assistance to state and local governments by preparing model legislation.

Immediately following passage of the Noise Control Act, the EPA began identifying and regulating major sources of noise, including medium and heavy trucks, buses and motorcycles. In 1977, the EPA began to expend more of its resources on providing the aforementioned technical support to state and local governments. The Quiet Communities Program, which studied and demonstrated effective means of local noise control, and the Each Community Helps Others Program, which sent state and local noise experts on a voluntary basis to provide technical assistance to other communities, were major activities of this type. Other activities included financial and technical assistance to help identify and correct noise issues and problems, surveys of state and local programs, training workshops, development of a training manual and preparation of model legislation for state and local governments.

The Reagan administration decided that noise control is a highly localized type of problem and that state and local efforts would exist at the state and local levels without further federal assistance. This position allowed the administration to decide to terminate EPA's noise program and close down the ONAC in order to reduce the federal budget. The noise program was budgeted $2.2 million for FY 1982 for an orderly phaseout and nothing for FY 1983. When Congress passed the budget, EPA began the phase-out immediately and put emphasis on transferring knowledge and experience to state and local governments. The program phase-out was completed by September 30, 1982. Nonetheless, the Noise Control Act remained in effect.

Currently, only a few personnel in the Office of Federal Activities and the Office of Air and Radiation respond to noise questions. EPA, when asked by citizens and state and local governments for help with noise problems, usually refer the "involved party" to published documents and/or to another federal or state agency. EPA continues to review and comment on environmental impact statements and environmental assessments for federally funded activities. Noise is one of the impacts that is considered in the review and comment phase.

General Accounting Office Findings

A report issued in October, 1989 by the General Accounting Office (GAO) entitled Transportation Noise: Federal Control and Abatement Responsibilities May Need to be Revised dealt with the potential inadequacy of the federal government in dealing with transportation noise.(50) It focused on the change in noise control programs since the closing of the EPA Office of Noise Abatement and Control (ONAC) in 1982 and how federal agencies, states and municipal governments had kept up in the control of transportation noise.

The 1982 phase-out of ONAC was expected by the EPA to have only a slight to minimal impact. The agency had concentrated on strengthening state noise control programs so that they would be able to assist local programs. The EPA estimated that, of the 20 state programs receiving federal funds in 1980, 16 would continue after federal support ended. However, the GAO report noted several EPA officials have stated that "few states other than California and New Jersey now have noise control offices".

The GAO limited the scope of its investigation to include transportation noise control programs within the EPA, FAA, FHWA, FRA, California, New Jersey and nine local governmental programs in California and New Jersey.

The EPA's main efforts in the past were in promulgating noise standards. Prior to the closing of ONAC, the EPA also provided local governments with assistance in land use planning along highways. Current EPA noise activity involves only the review of environmental impact statements and responding to inquiries from the public regarding transportation noise. The EPA had concentrated on noise standards for trucks, buses and automobiles and its five year plan for FY 1981 to 1985 included the designation of even stricter standards than it already had. However, with the phase out of ONAC, the only new standard issued was for motorcycles, and, indeed, the EPA "no longer routinely enforces the standards it has issued".

The GAO study also examined the FHWA role in noise control at the "receiver". The FHWA Office of Environmental Policy sees a three-part approach to control transportation noise: (1) land use near highways be controlled, (2) vehicles themselves be quieted, and (3) noise mitigation be undertaken on individual highway construction projects. The federal government has virtually no authority to govern land use planning, so the FHWA believes that the first part is a local government responsibility. The FHWA's main role in the control of transportation noise has been the construction of highway noise barriers.

While the FHWA cannot control land use planning directly, it encourages local authorities to regulate directly land use along highways so that either noise sensitive land uses are not present, or, if they are, that the noise impacts are minimized through planning, design and construction mitigation measures. Some state and local governments have ordinances that regulate land development. California has a state statute that requires local authorities to consider noise problems in the land development planning. The FHWA stated that although California has a good program, in general it is very difficult to determine the progress of noise control through land use because of the complexity of the land development process. One major problem is the economic aspect, in that adjacent land becomes much more valuable when a highway is built so that highways built in undeveloped areas may soon be surrounded by development, some of which may certainly be noise sensitive. FHWA officials further noted that efforts with state and local authorities to institute land use control programs had generally not been very successful and that the EPA used to provide technical assistance to local governments in land use planning when it had a program.

The FHWA currently has the responsibility of enforcing the existing interstate motor carrier noise standards. Basically, the FHWA is doing very little because of high compliance rates and higher priority items. States can adopt and enforce standards but the states contacted by the GAO (California and New Jersey) had not done so. In fact, in California, state noise laws for automobiles and trucks are not even enforced. California also has a law that prohibits the sale of new motor vehicles which emit noise in excess of California and EPA standards. Dealers must certify compliance but the accuracy of the certifications is never tested.

[Further research was conducted in this study to discern which other states had regulations governing maximum noise levels of new vehicles. After speaking to several vehicle manufacturers, the following data was gathered. Federal regulations provide standards for heavy trucks (currently 80 dBA) and states are pre-empted by the federal law. However, Nebraska has a standard for new vehicles over 10,000 pounds of 80 dBA in their regulations and Colorado has one of 86 dBA in their regulations. The federal government has not regulated automobiles; therefore, state and local governments can do so. The following states and municipalities have a standard of 80 dBA for new vehicles under 10,000 pounds: Washington, Oregon, California, Maryland, Florida, Washington, D.C., Boston, Massachusetts, Grand Rapids, Michigan, Cook County, Illinois, Chicago, Illinois, and Des Plaines, Illinois. Colorado and Madison, Wisconsin have a standard of 84 dBA. Oregon, Maryland and Florida require a statement of compliance before a new vehicle is allowed to be sold.]

GAO staff talked with nine local governments in California and New Jersey about their efforts to reduce community noise. Cerritos, California, began adding noise barriers along the freeways within the city in 1975. Homes on major arterials are protected by 8-foot tall landscaped barriers. The barriers have cost approximately $10 million, but, according to city officials, they have been effective. Land use control is another area where cities may be able to control the undesired effects of noise. Los Angeles requires noise sensitive land uses to be located and designed to mitigate noise effects. Pleasanton, California, encourages loop roads so that major traffic is diverted from residential areas. Sacramento County simply discourages residential development along highways.

The final option open to local governments is to require sound proofing against possible traffic noise. Developers in Concord, California must identify current and future noise sources and, if noise problems exist, handle them through incorporating noise mitigating construction methods such as sealing windows, using alternative internal ventilation and using solid core doors and double glazed windows. Design measures include facing doors and windows away from noise and modifying ceilings, roofs and walls.

The GAO concluded that the federal government needed to strongly consider expanding its efforts in several possible areas. The enforcement of current standards should be done although revising standards and enforcing these would be much preferable. It is important to note that states can adopt and enforce the federal noise emission requirements but that two leaders in transportation noise control, California and New Jersey, do not. The provision of technical assistance to local governments in the area of land-use control is also an important aspect to consider. The GAO does not suggest that these be done; rather, that the responsible agencies study the problem and consider these options as ones that have potential.

Summary of "The Status of Key State and Local Noise Control Programs that Served as a Basis for Discontinuing a Federal Program in 1982"

A report, entitled as above, was prepared in January 1990 by Soporowski for the EPA Office of Air and Radiation.(49) The report was basically the findings of a survey of the current status of non-DOT state programs and local programs that had existed prior to the phase-out of the EPA ONAC. The report was initiated to determine the validity of the EPA assumption that noise control programs would continue to exist, and more programs would be started, even with the discontinuation of ONAC.

Basically, the report states that 76 of the 93 responding municipalities still had noise control programs. There were 112 non-responding municipalities and one from each EPA Region was chosen at random and telephoned. Eight of the ten municipalities stated that their programs no longer existed. Soporowski stated that he was of the opinion that the majority of the non-responding parties no longer had programs and that they were non-responding because there was no one to handle noise related matters anymore. Eight of twenty responding states currently have active noise programs. The assumption that programs would continue is obviously invalid.

Overall, the report found that, in addition to the decline in programs, there are a limited number of individuals currently active in the field. Transportation noise has been the area with the least amount of progress at the local level. Of the responding municipalities, only 24% are more active, while 37% are less active. No state agency is more active than before. Fifty-three percent of the municipalities felt that reinstating a federal program would be of help while only 25% did not think so. Twenty-two percent were unsure and no state thought that reinstitution would be bad.

The report concluded that the assumptions made by the EPA in closing ONAC were incorrect. While regulations brought about by the Noise Control Act of 1972 and the Quiet Communities Act of 1978 are still in effect, the state and local programs are not doing what the EPA expected them to do after discontinuation of the federal program. The report stated that a new federal program should provide for public information materials, national/state/regional workshops, on-site technical assistance, noise monitoring equipment and manpower training workshops.

Questionnaire Results

Forty-one municipalities and non-DOT state agencies responded to a questionnaire conducted for Washington DOT as part of this study of the state-of-the-art in traffic noise abatement. The surveys were sent to approximately 90 municipal and non-DOT state agencies based on previous responses to the Soporowski survey.(49) This method of distributing questionnaires was felt to be the best way of obtaining a good cross-section of local and state noise control programs that had been reported to be "active" despite having lost USEPA funding.

The questionnaire was broken down into three main areas: program development, staff and responsibilities, and program evaluation. There were several questions in each of the first two areas and the last section simply called for comments by the respondent. The results in these three areas are presented first for the state programs and then for the municipal programs.

State Program Development. Six state noise control programs were represented in the questionnaire responses:

1. Office of Noise Control, Berkeley, California,
2. Department of Environmental Protection, Noise Control Unit, Bethany, Connecticut,
3. Department of Health, Noise and Radiation Branch, Honolulu, Hawaii,
4. Environmental Protection Agency, Springfield, Illinois,
5. Field Services and Noise Control Division, Maryland Department of Environmental Air Management Administration, Dundalk, Maryland, and
6. Department of Environmental Protection, Trenton, New Jersey.

All of the programs began by acts of the respective state legislatures between 1970 and 1974 with five of the six beginning after passage of the Noise Control Act of 1972. The reasons given for the establishment of the programs all closely parallel the idea set forth in the Noise Control Act of 1972 which basically states that noise is detrimental to the health and welfare of the general population.

The costs for establishing the program and the annual operating costs range from $60,000 - $250,000 and $48,000 - $270,000, respectively. Currently, there is no federal assistance available to any of the programs except the Illinois EPA, which receives federal money through monitoring noise emissions at Superfund hazardous material cleanup sites for compliance with state standards. Hawaii mentioned that EPA assistance was available during program establishment, but presently no government assistance is received. The other respondents probably received support earlier also but did not mention it in their answer.

State Program Staff and Responsibilities. The full-time equivalent staff range from one to eight and one-half. Five have one person and Hawaii has the most with eight and one-half. Some of the respondents stated that they need between three and five full-time personnel.

Only the Hawaii and California programs regulate motor vehicles. The other four specifically exempt motor vehicles. It is important to note that the California program does not have enforcement responsibility, but rather they provide assistance to other state and local agencies in various areas, one of which is motor vehicle noise. Honolulu conducts on-site inspections on an individual case basis when a complaint is received.

The number of complaints and violations reported by the agencies included all types of noise complaints so it was impossible to determine from the responses the specific number of motor vehicle noise complaints. In Hawaii, violation of a vehicular noise control rule carries a fine ranging from $25 to $2,500.

All of the programs provide other services beyond investigation and enforcement. These services range from processing of noise permits, comments on environmental impact statements, training and certification of government personnel, teaching local agencies about regulations and enforcement, assisting development of local ordinances, and dissemination of information to the general public.

None of the state agencies place requirements on developers except to keep construction noise within limits and/or times stated in regulations. However, Hawaii does make comments and recommendations on proposed projects in terms of possible noise impacts, mitigation and regulatory requirements.

State Program Evaluation. All of the respondents were asked for general comments on their program and each responded in different ways.

The Department of Health in Hawaii stated that they had major achievements including: control of vehicle noise, among other sources; a program to work jointly with Honolulu Police Department for control of excessive vehicle noise emissions; and noise studies conducted at various schools to determine noise levels that were interfering with classroom activities.

The comments from Illinois mainly concerned noise levels at Superfund clean-up sites. However, they also stated that they would not like to see the EPA ONAC re-opened because the "regulatory legacy has prevented Illinois from solving many simple railroad noise problems due to federal pre-emption. The federal dollars are not worth the lax noise standards states are forced to accept."

Maryland noted that the program has abated many environmental noise problems by several different means including barriers and topographic features. Their main setback was the closing of the EPA ONAC and the cutting of the federal noise budget in 1981, which resulted in cuts in their programs. They have never fully recovered and are still using equipment bought in the mid-1970's. Basically, they need to resolve their deficiencies in the financial and personnel areas in order to have the type of program they would like.

Connecticut briefly mentions that enforcement actions have been upheld in the courts, regulations need to be revised, and more staff is needed.

New Jersey's main point involves the funding problem. Noise control is the first program to be cut and the last to receive funding. In 1980, their office had six and one-half full-time personnel and now they have one and one-quarter.

Municipal Program Development. Thirty-five municipal programs responded to the questionnaire. Twenty-two states and Washington, D.C. were represented by the responding municipalities. Of the thirty-five local programs, California was the most represented with seven respondents and Colorado was second with three. The states represented by responding municipalities ranged from North Dakota to New Jersey. A complete list of responding programs can be found in Appendix H.

All of the respondents indicated that noise regulation was initiated by city ordinance. The dates of program establishment ranged from 1961 to 1986. Three of the programs started in the 1960's, four in the 1980's and the rest in the 1970's. Twenty of the programs started between 1972 and 1978, most probably due to the passage of the Noise Control Act of 1972.

A wide variety of reasons were given for the establishment of the programs. Some were very similar to the reasons given by the responding state programs and the Noise Control Act as mentioned earlier. Other responses included ". . . noise control high priority with citizens", control of industrial noise, general noise complaints, ". . . effort to control commercial zone noise pollution migration in residential zones", "no expert witness . . . or proper equipment if litigation was necessary", motor vehicle noise, and passage of program pushed by a local otolaryngologist.

The sizes of the communities varied greatly and thus the establishment cost and annual operating cost varied greatly also. The establishment costs range from $0 to $150,000 (the latter including aircraft noise monitoring equipment for the program in Lorraine, CA). In general, most of the establishment costs were for sound level meter equipment, which averaged between $1,000 and $1,200 per meter purchased. Other costs cited by some respondents were for administrative costs while trying to get programs into the municipal code and for training. Due to the wide variations in the costs that respondents included in this answer, presenting an average cost would not be useful or meaningful. The annual operating costs range from $130 (East Windsor, NJ) to $214,000 (Colorado Springs, CO). Five of the respondents indicated that their annual operating budget is greater than $100,000 (Lorraine, CA; Washington, DC; Boulder, CO; Sacramento County, CA; Colorado Springs, CO). The rest, where a money value response is given, were in the range of $130 to $74,000. The most commonly stated reason why some did not report a cost was that the noise control work was incorporated in standard programs and not budgeted separately.

A question on government assistance availability was approached differently by different respondents. Some interpreted the question as focusing on funding while others included technical assistance and advice. All of the respondents indicated that they received no government funding. Some indicated that funding assistance was available from the USEPA before its noise program was drastically cut in the early 1980's. Many stated that they had received technical assistance and advice from the USEPA prior to that cutback. A few others (Beaverton, OR; Boulder, CO; Arlington Heights, IL; East Windsor, NJ; Baltimore, MD) noted that state technical assistance was available but rarely used. California's Office of Noise Control, discussed in the state program section, exists primarily as a resource to local governments. The office acts as a consultant to state agencies and motor vehicle noise control.

Municipal Program Staff and Responsibilities. According to the respondents, anywhere from one-hundredth (0.01) to seven full-time equivalent (FTE) employees are needed. Most of the respondents state that one or less FTE is required because the noise control program is just a small part of a local agency.

Regulated noise sources encompassed many varied areas. For the purpose of this study, motor vehicle noise is important, and will be the focus of this discussion. Twelve of the respondents specifically note motor vehicle noise as a regulated source, while several others just indicate "community noise". Five municipalities specifically exclude motor vehicles/normal traffic from their regulations within their respective codes. Most ordinances dealing with vehicle noise are applicable to individual vehicle noise such as broken or removed mufflers, screeching tires, etc. In terms of transportation noise, municipal ordinances would most likely deal with it in their land-use planning duties by preventing noise sensitive development in high noise areas and/or by requiring noise mitigation in noise sensitive structures such that will reduce the noise by specific levels.

In answering the questions on violations and complaints, none of the respondents singled out motor vehicle noise so it is impossible to relate the given answers to the area of concern. In terms of overall complaints, the annual numbers varied from one to 1800 per year. Generally, the main goal of a local noise program is compliance, not the penalizing of people. Penalties listed vary from $5 fines (Arlington Heights, IL) to $1000 and/or six months in jail (Los Angeles, CA). In terms of transportation noise, it is difficult to penalize the noise source operators because the local governments have little or no power to enforce standards. Developers who are required to mitigate noise can have penalties levied against them if they fail to do so but penalties for this are not known from the survey questionnaire.

The ability of a local noise control program to provide services beyond reacting to complaints could be a very valuable function. However, thirteen of the respondents indicate no other services are offered. Two others indicated that their department handled many areas other than noise and that, as a result, they provided no services pertaining to noise other than reacting to problems. For the rest, responses included: providing general information; education; information on the acoustical attenuation of buildings; voluntary motor vehicle testing; school lectures; limited technical assistance; noise surveys not related to ordinance such as special surveys requested by other agencies; information in code to prospective builders, land development and community planning.

Municipal Program Evaluation. A wide variety of comments were received from the responding municipal programs. In order to remain focused, only those comments dealing with vehicle noise control will be highlighted.

Specific comments were made by the Garland, TX, Dept. of Health concerning vehicle noise. Basically, elected officials provided for very little funding and no personnel for enforcement of the vehicle noise standards because of the lack of community support for the ordinance. Land-use provisions have been enforced, however. Overall the program has been valuable as a positive tool for land-use management.

The Placentia, CA, Planning Department indicates that their biggest success has been having developments in high noise areas constructed with noise mitigation measures in place. The developments have proven to be very liveable. Double pane glass and wing walls are two examples of mitigation measures used in construction.

More general concepts centered on the need for the re-opening of the EPA ONAC so that technical and funding support would be available, allowing interested programs to be proactive rather than reactive.

Follow-up and Other Investigation

After receiving and evaluating the questionnaire responses, the final step in the information gathering process was to research existing documents and to contact by telephone certain survey respondents and interesting programs found through research. This telephone survey was done to obtain more detailed information on the more advanced and interesting programs. Through research and evaluation, three specific areas were found to be very advanced in terms of transportation noise control programs, Canadian provinces and cities, Colorado cities and California cities. A brief discussion of the National Association of Noise Control Officials (NANCO) is also included.

Canadian examples. The province of Ontario and the cities of Calgary and Saskatoon were studied with regard to their transportation noise control programs.

Ontario has had a requirement since 1976 that residential developers are required to build noise barriers for housing being constructed along its roads. The design requirement is a 1 hour-L_{eq} of 55 dB at the exterior activity area of the property. Protection only has to be provided to the lower story of the buildings, and for outdoor recreation areas for apartments. The Ontario Ministry of Transportation has major concerns about the quality of these developer-built walls because the Ministry has responsibility to replace a wall if it fails. Currently, there is serious concern about the durability of a concrete-based barrier (Evercrete) that has seen widespread use and is failing structurally. The extent of the privately built developer barriers was put in the range of "thousands of kilometers". The Canadian Standards Association (CSA) is currently developing specifications to certify noise barrier products (materials) and their design, construction, and inspection processes. Residential developers would be covered by these specifications, and would actually pay CSA for its services for the site-related review and inspections. These specifications should be available early in 1991.

Calgary is in a good position to have a strong, well-developed transportation noise control program because it operates within the province of Alberta with almost complete power over all municipal matters within its city limits. The noise control program in Calgary began in the early 1980's and currently has a staff of one and an annual budget of one million dollars. The budget reflects all of the design and construction costs of building noise barriers as well as the program's administrative and other costs.

Calgary has identified the following three opportunities to control transportation noise: "(1) construction of, or upgrading of a roadway adjacent to existing development, (2) development or redevelopment adjacent to existing transportation corridors, and (3) development or redevelopment adjacent to a future transportation corridor."(51) The first opportunity clearly requires the city to pay for required berms and barriers along its new or improved roadway. The second two opportunities allow for city/developer negotiation.

The city has set a standard of 60 dBA L_{eq} (24h) that all developers must meet when developing near a roadway. As long as they meet the standard, there are very few limitations on how it is done. Developments constructed where there is no noise problem roadway, but where there may ultimately be one, have to be designed and constructed to ultimately meet the standard or provide for the opportunity to do so in the future. Final attenuation would be done by the city when the ultimate roadway is constructed.

Obviously, not all developments will be in an area impacted by noise, so Calgary uses a classification program to determine potential impact zones. Basically, determination is made as to where a development will be in a Potential Noise Impact Zone (PNIZ). Areas are classified as PNIZ using traffic volumes, speed, vehicle type roadway category and the geometry of the situation. Overall, therefore, Calgary uses a combination of barrier construction and developer implemented attenuation measures to control noise levels. It is important to note that it is Calgary's power over land use that allows for the requirements placed on developers.

Saskatoon, Saskatchewan, is another Canadian city which has recently placed a high priority on transportation noise. The city prepared a Traffic Noise Policy in 1984 but has only done noise level monitoring at selected sites until recently. The 1984 policy recommended finding impact assessment by using the peak hour average sound level (L_{eq}(1h)) while the Day-Night Level (DNL) be used for abatement design. A 65 dBA DNL was the desirable standard for residential developments. The City of Saskatoon has decided to have a complete study and a 1990 Traffic Noise Policy done which will review the current policy, recommend changes, review the city's noise level readings inventory, inspect existing equipment and recommend new, state-of-the-art, equipment, review and recommend a noise prediction model, identify areas of the city which warrant annuenuation under new policy guidelines, review noise attenuation devices in use and recommend acceptable existing and new devices, identify a retrofit program, establish on-going monitoring, and investigate financing methods for noise attenuation construction.(52) Obviously with the decision to go ahead with the above plan, Saskatoon has made a clear choice that transportation noise is a high priority item.

Colorado examples. Three cities in the state of Colorado responded to the survey: Denver, Boulder and Colorado Springs. According to Soporowski's report, Colorado does not have a state noise program, and with the absence of a federal program, these local programs are pretty much on their own.

Denver's program is rather minimal with an annual budget of $15,000 and less than one full-time equivalent employee. They are mostly concerned with stationary noise sources although they did do vehicle monitoring between 1973 and 1978 before budget cuts removed this part of the program.

Boulder has a relatively substantial program with an annual budget of $105,000 and two and a half full-time equivalent employees. In their response, Boulder indicated that they regulated all ground-based noise sources. In a follow-up discussion specifically concerning transportation noise, it was found that the program has a pro-active and reactive patrol to enforce two different regulations. The first is subjective in that a motor vehicle making more noise than one would with a stock muffler kit is in violation. The second is more objective. Motor vehicles 10,000 pounds and less can create noise levels no greater than 80 dBA measured at 25 feet from the road surface. The limit is 88 dBA for vehicles over 10,000 pounds. The follow-up also revealed that the noise program is not generally involved in the land development planning process. However, they used to be one of the participants in the planning cycle, so they are occasionally asked to comment when a certain development plan is expected to generate a noise problem (commercial, industrial complex) or when a development might be subject to a noise problem. According to an official in Boulder, this does not occur very often. With regard to general traffic noise, the program has not really addressed it in the past. However, they are becoming involved in a project in which a main city thoroughfare is being widened from four lanes to include more lanes and various turning lanes. There is a plan being studied whereby the city would purchase all of the homes fronting the roadway and build a berm/barrier noise attenuation combination to control traffic noise in the adjacent areas. Currently, this plan is just in the early study phases, but it is an interesting project, especially to the Boulder noise program.

The Risk Management Office of Colorado Springs has, by far, the largest annual budget for a municipal noise program at $214,000. The noise program has four full-time employees making it the biggest in that area also. The program regulates individual vehicles similar to the way Boulder does. Colorado Springs' program also includes land development and community-planning responsibilities. The Noise Control Supervisor sits on the Land Development Technical Committee which reviews all development planning documents. One area they study is the development of residential units along roadways in order to ensure that there will not be a noise problem.

California examples. California has been a leader in transportation noise control for many years. As such, there are important, innovative ideas that they have had and that are in use today. Therefore, further research was done by studying existing reports and telephoning various state and local officials.

One of the respondents to the survey was the Office of Noise Control in the California Department of Health Services. This department has no enforcement authority. Instead, it acts as a consultant to other departments in the state government and, more so, to county and city governments throughout California. Basically, the office assists in land use planning, motor vehicle noise control and developing noise ordinances. In the past, the office has been able to assist with noise monitoring but at present there are not enough resources to do so except on an extremely limited basis. One reason why this consultant type of office is necessary is the existence of the California Noise Element. In 1972, California passed a requirement that all cities and counties must develop a noise element to become part of their general plan. The requirement is part of the planning and zoning law. Briefly, the noise element requires a basic statement regarding a community's intentions regarding noise sources, maximum sound levels by land use category, standards and criteria from transportation facilities and fixed sources, a guide to implementation and a technical appendix on the development of the noise element.

The Orange County Noise Control Office was contacted by telephone to get some information on their program. First, they do not address freeway noise because of preemption by Caltrans. However, they have done noise studies along freeways when requested by the County Board. Secondly, this particular office is not involved with land use planning. The County Planning Department has jurisdiction and handles the noise element portion from within.

Sacramento County was a respondent to the survey and a follow-up telephone call was made to gather more information. The program's main focus with respect to transportation noise is land use control and developer's requirements with respect to mitigating noise. They also contract their services to the City of Sacramento for the same functions. One important point made was the fact that the noise element is part of the planning process which is ever-changing and therefore the noise element should also be updated regularly. The City of Sacramento updated its noise element in 1985-1986 but it has been ten years since the county noise element has been updated and that is too long according to the county official.

Case studies issued by the Office of Environmental Policy of FHWA were also researched(*). Three of the studies involved the following California cities: Cerritos, Fullerton and Irvine. Some highlights of the Cerritos case study include its ability to convince Caltrans to allow developers to encroach on state right-of-way in providing berms, the ability to require planted buffers between residential developments and arterials, the development of a city-wide network of truck routes to prevent truck noise from intruding on residential neighborhoods. Fullerton has a requirement that developers must meet interior noise level standards and that an acoustical analysis is required in noise impact zones, local ordinance which requires open space in residential neighborhoods without excessive noise. Also of interest was Irvine's ability to require that noise standards be met but allowing the developer to meet them in any way he sees fit.

As a final note, the league of California Cities designed a Model Noise Ordinance. (The age is uncertain but a copy can be obtained from the researchers.) In the same vein, the National Environmental Health Association released a Model Community Noise Control Ordinance in July/August, 1977.(53)

NANCO. The final part of the follow-up research was to find out about the status of the National Association of Noise Control Officials (NANCO). Ellwyn Brickson, a member of the group, indicated that NANCO was still in existence but that it was not nearly as active as it used to be. Prior to the phase out of the EPA noise program, EPA subsidized NANCO and NANCO did several studies for EPA. They also released a newsletter entitled Vibrations every month but due to the decline in membership and interest in general, it is difficult to get enough articles to publish every month. According to Mr. Brickson, Edward DiPolvere, with the New Jersey Department of Environmental Protection, is the current Executive Director and Frank Gomez, with Los Angeles County, is the President.

Summary

Currently, state and local noise control programs do exist and are useful in preventing noise pollution which may harm the health and/or welfare of the general public. Although some programs, especially those in California, do address transportation noise, many do not. The most viable and widely-used transportation noise control available to the local governments is land and community planning, local authorities are able to force developers to consider noise problems and to mitigate these problems in any number of ways if they wish to proceed with the development.

Although there are programs in existence, the number has fallen since the closing of the Office of Noise Abatement and Control (ONAC) in 1982. The Office of Noise Abatement and Control was established in 1971 and the Noise Control Act of 1972 was the major work of the ONAC in its formative years. This Act was the impetus behind the start of many of the state and local noise control programs. Through this office, the EPA was able to provide funding and technical assistance to state and local programs. When the EPA noise program was phased out in 1982, the EPA assumed that the state and local programs would be able to survive on their own and that more programs would start across the nation. The reports issued by the GAO and Joseph Soporowski (for EPA) both concluded that noise control at all levels of government has suffered due to the phase-out of the EPA program.

The survey and follow-up involved in this research was to determine the characteristics of the various state and local programs that still exist. The characteristics can then be used to improve individual programs and to help create effective new programs. As stated, land use planning is one of the more powerful weapon available, but city constructed barriers and other opportunities do exist for the control of transportation noise at the local and state levels.

CONTROL OF VEHICLE NOISE AT THE SOURCE

Introduction

The third component of the three-part approach to transportation noise control is the source, that is, the cars, trucks and other vehicles on the road. Significant strides to reduce vehicle noise have occurred since the early 1970's, both in the U.S. and Europe, largely driven by government legislation and regulation. Indeed, in Europe today, manufacturers are working hard to achieve a newly-reduced noise level standard that goes fully into effect late in 1990. Also, in the U.S., manufacturers continue to look to reduce noise largely to improve the driving experience for both the passenger car and truck driver, and to compete in the European market.

This section of this report will examine the state-of-the-art in source control. First, the history of the U.S. and European legislation and regulations will be explored. Then, the most recent regulations will be presented. Following that will be a discussion of findings from recent literature on work to quiet vehicles. Included in the discussion will be information gathered from telephone conversations with noise control specialists for U.S. manufacturers based on a questionnaire prepared for the study. Contacts within the industry were provided by the Motors Vehicle Manufacturers Association (MVMA) and the Society of Automotive Engineers (SAE).

U.S. Vehicle Noise Control Legislation

Work on vehicle noise control in the U.S. began in earnest in the early 1970's after passage of three key pieces of legislation, all pointing toward a concern about environmental impact from highways and excessive environmental noise.

NEPA and the 1970 Federal-Aid Highway Act. The 1969 National Environmental Policy Act (NEPA) required preparation of environmental impact statements on major projects using federal funds. It also directed federal agencies to examine their procedures and develop methods to study environmental impacts. The 1970 Federal-Aid Highway Act addressed these requirements by specifying, in part, that highway traffic noise standards be developed. The USDOT and its FHWA realized that analysis and control of traffic noise would become key parts of highway project development. The USDOT also realized that project abatement measures alone would not be sufficient nor always reasonable or feasible. The "three-part approach" to traffic noise control -- source, path, receiver -- was recognized early on as the only way to achieve the most efficient and effective results.

Noise Control Act of 1972. The third key piece of legislation was the 1972 Noise Control Act. This Act set an agenda for the USEPA, which had been created in 1970, and for its Office of Noise Abatement and

Control (ONAC), which had been established as part of the 1970 Clean Air Act Amendments. The Noise Control Act directed the EPA Administrator, among other things, to:

1. Identify "major sources of noise" among products distributed in commerce, and prescribe standards limiting noise emissions from products so identified, including transportation equipment, motors and engines, and

2. Promulgate regulations limiting the noise generated by motor carriers engaged in interstate commerce after consultation with the USDOT.

In the mid-1970's, the EPA identified a number of sources as "major sources of noise" for regulation, including medium and heavy trucks, motorcycles and motorcycle replacement exhaust systems, truck-transport refrigeration units, buses and garbage trucks. It also conducted preidentification studies for possible identification of automobiles, light trucks and tires as "major noise sources". The EPA then issued new product noise emission regulations for newly manufactured medium and heavy trucks, garbage trucks (later rescinded due to industry pressure), motorcycles and motorcycle replacement exhaust systems, and portable air compressors.

It also issued in-use noise regulations for motor carriers engaged in interstate commerce and interstate rail line and railroad activities. The motor carrier regulations applied to both trucks and buses engaged in interstate commerce.

<u>Ending the EPA Program.</u> The Reagan Administration, soon after taking office, decided to end the EPA noise program and eliminate ONAC. Some funding was provided for FY 1982 for an "orderly phase-out" of the program, which was completed by the end of FY 1982. However, the Noise Control Act was not rescinded by Congress and remains in effect, with important consequences. The Act states that where there are federal noise control regulations for equipment and facilities of interstate rail and interstate motor carriers, no state or local government can adopt or enforce noise control requirements for those items unless they are **identical** to the federal regulations. This principle of "federal preemption" prevents state and local agencies from issuing stricter regulations for noise from medium and heavy trucks, both newly manufactured and in-use. Congress was concerned that if federal preemption did not apply, states and locals could develop a wide variety of differing regulations that could put undo burden on manufacturers and harm interstate commerce.

New Product Regulation for Medium and Heavy Trucks. The newly manufactured medium and heavy duty truck standard was published in 1976 and applies to trucks over 10,000 pounds (Gross Vehicle Weight Rating).(54) The level was set at 83 dB (A-weighted, fast response) at 50 feet, effective January 1, 1979. The level was to be reduced to 80 dB on January 1, 1982, but that change was deferred to 1982, 1986 and finally January 1, 1988, when it went into effect. Appendix I contains this standard. The level is measured according to a very strict test procedure(55) using a full throttle acceleration starting at an initially low speed and not exceeding 35 mph in the test zone.

New Product Regulation for Motorcycles. The newly manufactured motorcycle and motorcycle exhaust system regulation was published on December 31, 1980. The levels are a function of cycle type and model year, as shown in Table 8. For certification as "Low Noise Emission Products" (per 40 CFR Part 203) a lower set of levels had to be met. The motorcycle standard is also in Appendix I.

EPA Noise Regulations for Motor Carriers Engaged in Interstate Commerce Regulations. The in-use interstate commerce motor carrier regulations were established in 1974.(56) They were amended in 1986 to reduce the levels by 3 dB for trucks manufactured during or after the 1986 model year. The standards apply to the total noise level of the vehicle, including auxiliary equipment. Included are levels for trucks and buses on roads with speed limits of 35 mph or less and over 35 mph. These levels apply to any condition of highway grade, load, acceleration or deceleration. Also included is a stationary wide-open throttle run-up test to governed engine speed. The regulation also banned the use of certain extremely noisy tread tires on the regulated vehicles and required exhaust systems to not be defective. The interstate motor carrier limits are shown in Table 9.

The standard is presented in Appendix J.

Federal preemption applies to these standards as well. While the Noise Control Act permits state and local governments to adopt and enforce those standards, they may not establish or enforce standards different from the federal ones. However, the Act does allow the EPA, after consultation with the USDOT, to determine that state and local ordinances are necessary because of special local conditions and are not in conflict with the EPA standards.

Table 8. EPA New Product Regulations for Motorcycles

Type	Model Year	A-Weighted Sound Level (dB)
Street motorcycle	1983	83
Street motorcycle	1986	80
Moped-type street motorcycle	1983	70
Off-road motorcycle	1983	83
(170 cc or smaller engine)	1986	80
Off-road motorcycle	1983	86
(with engine over 170 cc)	1986	82

Table 9. Noise Regulations for Motor Carriers Engaged in Interstate Commerce

Condition	A-Weighted Levels (dB) at 50 feet	
	Pre-1986 Model	1986 or Later Model
Stationary (wide-open throttle run-up)	88	85
Speed limit of 35 mph or less	86	83
Speed limit over 35 mph	90	87

Responsibility for enforcement of the motor carrier standards was given to the USDOT and delegated to the FHWA. The previously reviewed GAO study(50) found that the FHWA Office of Motor Carrier Safety stopped conducting routine noise tests around 1983. While the FHWA will investigate complaints that it receives, only four exterior truck noise tests were made in 1988 and 1989 across the entire nation.

Enforcement has been reduced, according to the FHWA, because of the high compliance rates found in previous testing and because of shifted priorities. Between 1978 and 1980, approximately 15,000 vehicles were tested and only 1.3 percent failed the interstate commerce motor carrier standards. Also, in a three month period in 1981, about one-half of a percent of 1550 vehicles failed.

The FHWA Office of Motor Carrier Safety reports that the tests were time-consuming and difficult to perform. High background noise levels on busy highways make it difficult to perform the stationary test without moving the vehicle to another site. Staff turnover also has reduced the number of people trained to make the measurements.

Despite the high compliance in the early 1980's, no formal testing has been done since the standards were lowered 3 dB in 1986. However, the author of this report was involved in data collection of cruising and accelerating heavy trucks as part of the development of a procedure to use the FHWA STAMINA 2.0 computer program for non-constant speed traffic.(25) Of the 633 heavy trucks measured at an offset distance of 50 feet during acceleration from a stopped position, 24 (or 3.8%) had levels exceeding the 83 dB post-1986 model standard for speed limits under 35 mph. More importantly, of the 269 heavy trucks measured (again at 50 feet) travelling at an average speed of 60 mph, 54 of them, or a full 20%, exceeded the post-1986 87 dB maximum limit. While this data did not account for the model years of the trucks, the large number of trucks exceeding the 83 and 87 dB levels warrants further attention. Thus, while the newly manufactured truck standard will eventually reduce average fleet noise levels due to turnover of aging vehicles, there appears to be a likely violation of the current interstate commerce motor carrier regulations.

Prior to the abolition of ONAC, EPA planned to continue to place great emphasis on surface transportation noise control. According to the GAO review, the 5-year EPA plan from FY 1981 to FY 1985

> "states that noise from these sources impacts for more people than noise from any other source. In its analysis of ways to abate traffic noise, the [EPA] report states that the most direct attack for solving the problem is on the source itself--the motor vehicle. The [EPA] plan concluded that federal regulations were needed to reduce overall vehicle fleet noise levels. The agency planned to promulgate regulations for newly manufactured motorcycles,

buses, and refrigeration units on truck trailers; to make trucks even quieter; and to implement the provision for special local conditions exemption from the interstate motor carrier standards. In addition, it planned to devise and implement strategies for controlling noise from light vehicles (including automobiles) and tires and assist localities in land-use planning along highways."(50)

While no U.S. federal regulation exists on automobile or light truck noise levels, several states require certification of vehicle noise levels, including Oregon, Florida and California, as noted in the section on state and local noise programs. Washington State also has Motor Vehicle Noise Performance Standards as Chapter 173-62 of the Washington Administrative Code.

European Vehicle Noise Regulations

Efforts in Europe vehicle noise control began in 1970, when a British working group on research into traffic noise recommended a program to develop a heavy truck with a sound level at least 10 dB below the 1970 levels. The study led to a goal of 80 dB at 25 feet per European measurement standards (ISO 362).(57) The British Transport and Road Research Lab (TRRL) began a Quiet Heavy Vehicle (QHV) demonstration program in 1971 that showed that the technology existed to produce an 82 dB truck "without excessive penalties on capital and operating costs."(58)

Despite this success, achieving a low level on production vehicles has taken 20 more years. A series of directives from the European Community (EC) has been promulgated since 1970 that defined progressively stricter truck noise emissions. Table 10 is taken from an article by Mitchell to illustrate these standards. Effective October 1990, all new heavy trucks exceeding 3.5 tons with "engine power not less than 150 kW" have to meet a standard of 84 dBA at 25 feet per ISO 362. The reduction in level from Directive 70/157/EEC (effective 1974) to Directive 84/424/EEC is nominally 7 dBA. However, a change in the measurement procedure produced a 2 dB increase in the measured levels, meaning that the actual needed reduction between 1974 and 1990 is 9 dBA. (The vehicle now has to be driven in all gears in which the approach speed is below 50 km/h compared to the previous requirement of only a single gear). Figure 1 is a graphical depiction of the standards for medium duty trucks (between 2 and 3.5 tons).(59) The figure also indicates the U.S. standards at its base, and shows that the current 80 dB U.S. level would translate to an approximate 84 dB level if measured by European procedure.

Table 10. Allowable Noise Levels for Goods Vehicles (58)

Item	Directive		
Directive Number	70/157	77/212	84/424
Effective date for type approvals	-	April 1980	October 1989
Effective date for all new vehicles	-	October 1982*	October 1990
Vehicle type	Allowable Sound Level, dBA		
Goods vehicles weighing more than 3½ tonnes --			
--with an engine power of not less than 150 kW	91	88	84
--with an engine power of not less than 75 kW but less than 150 kW	89	86	83
--with an engine power of less than 75 kW	89	86	81
Goods vehicles weighing more than 2 tonnes but not more than 3½ tonnes	85	81	79 (80 for DI diesel)
Goods vehicles weighing not more than 2 tonnes	85	81	78 (79 for DI diesel)

Note: In October 1984 the drive-by test for type approval was modified (Directive 81/334). This had the effect of requiring a vehicle to be about 2 dBA quieter on the road to achieve the same measured noise level during the drive-by test. This will apply to all new vehicles from October 1985.

*October 1983 in Britain.

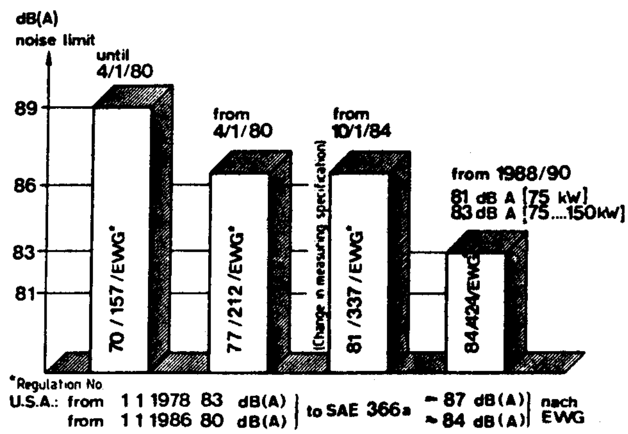


Figure 1. Noise limits and regulations for trucks> 3.5 t > 75 <150 kW in the EC, from Reference (59)

Directive 84/424/EEC also indicates that:

"The Council should, not later than 31 December 1990, decide on a further review of the provisions of Directive 70/157/EEC on the basis of a Commission report concerning possible new measures relating to rules in the motor vehicle sector, which is to be established with due regard to safety, environmental protection and energy conservation factors."

Mitchell concludes that, as a consequence, allowable vehicle noise could be further reduced in the 1990's. In response to this directive, TRRL embarked upon a QHV-90 program in the mid-1980's aimed at meeting the 1990 standards. This joint government/industry effort has focused on quiet versions of six trucks and eight engines.

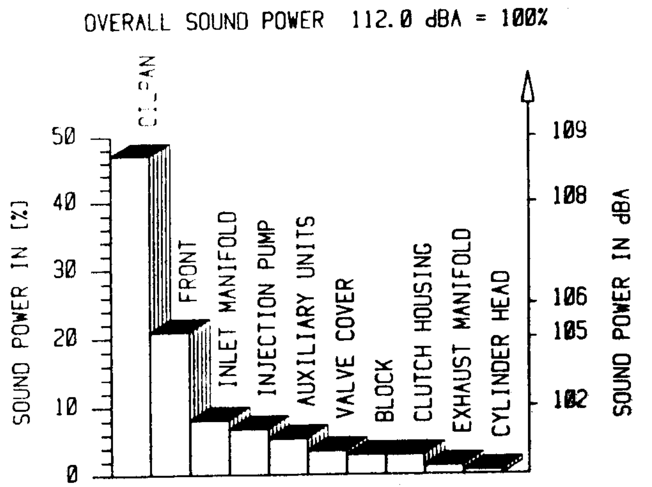
To meet the 84 dB standard for the heavy trucks, European researchers have determined that the engine noise at a distance of 3.3 ft needs to be below 95 dBA, leading to the terminology of a "95 dB engine." The main source of engine noises are mechanical or combustion-related. Brandl et al(60) list these sources on a direct-injected diesel engine as:

1. oil pan,
2. front,
3. inlet manifold,
4. injection pump,
5. auxiliary units,
6. valve cover,
7. block,
8. clutch housing,
9. exhaust manifold, and
10. cylinder head.

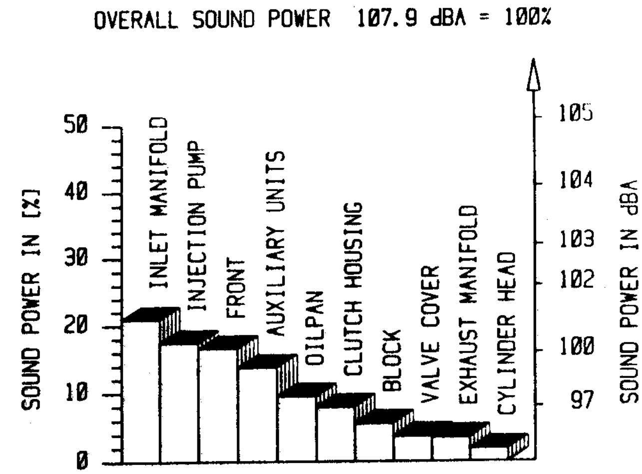
These researchers found the airborne A-weighted sound level at 3.3 ft could be reduced by about 2 dB at 700 rpm and about 4 dB at 2100 rpm by a combination of:

1. optimizing combustion excitation,
2. improving the structural response of the crank case and engine block assembly (e.g. finite-element optimized crank case and oilpan), and
3. adding a highly damped front cover and pulley shield, and a vibration-isolated valve cover.

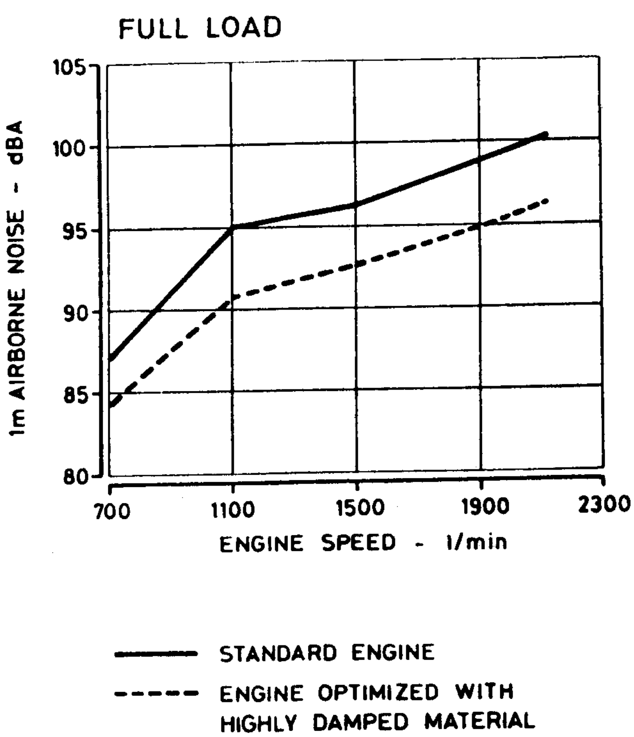
Figure 2, taken from their article, combines four figures to show the relative contribution to total sound power before (a) and after (b) the treatments, and the 1-meter sound level as a function of engine speed (c) and frequency (d). Note in (a) and (b) how the oil pan design optimization and the highly damped front cover changed those sources from being dominant to being much less so. Also, note in (c) how the 95 dBA



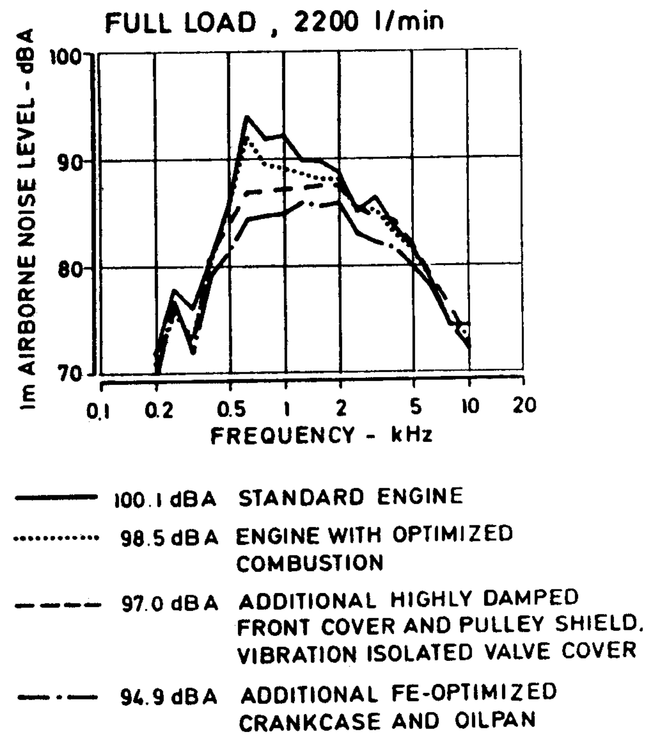
(a) - Contribution of the single engine parts to the overall sound power at 2100 rpm and full load for a 6-cyl., 11 ltr. DI-TCI diesel engine



(b) - Contribution of individual engine parts to the overall sound power at 2100 rpm and full load for a noise optimized 6-cyl., 11 ltr., DI-TCI diesel engine



(c) - 1 m airborne noise of a 6-cyl., 11 ltr., DI-TCI diesel engine - original and improved version



(d) - Different steps of noise reduction on a 11 ltr. inline 6-cylinder DI-TC diesel engine at rated speed and load

Figure 2. Engine noise sources and resultant levels from Reference (60)

goal was achieved up to an engine speed of 2100 rpm, and in (d), the significant reductions in the 500-2000 Hz frequency range.

Mitchell(58) notes that strategies to reduce engine noise include:

1. turbocharging and control of fuel injection to reduce combustion noise (slowing rate of pressure rise),
2. modifying engine structure to reduce vibration caused by forces at the main cylinder bearings,
3. reducing vibration of external engine panels (valve cover, sump, timing gear cover),
4. optimizing piston design to reduce "slap", and
5. redesigning the engine to shield noisy components (e.g., timing gears) with quieter ones.

Mitchell also noted that once engine noise is reduced, control of exhaust noise becomes more important. Issues of concern include:

1. not restricting outflowing gases,
2. desiring a small silencer volume,
3. avoiding noise generation by the gas flow and vibration of the silencer, and
4. reducing noise at exhaust manifold (timing and opening rate of exhaust valves).

Mitchell believes that the 84 dB standard can be reached using the above sets of strategies for the quieter of existing engines. For the noisy engines, some type of enclosure is needed (a "sound-absorbing tunnel or box"), which could be a fiberglass lining on the underside of the cab, or more likely, a separate fiberglass enclosure for the fan, engine and transmission. Ease of maintenance and proper cooling then become key factors, especially since the engine cooling fan can be a major noise source itself.

Other items such as the fuel pump and the transmission can be major sources; also, the quality of the diesel fuel is important in terms of engine knock (levels can increase 1-2 dB as fuel quality degrades).

Boesch has also reported on engine noise control.(61) Figure 3 presents the sound power levels of the key components for a high speed direct injection diesel engine prior to noise control. Abatement strategies included:

1. reducing combustion noise by turbocharging, injection and changing the chamber shape (these measures, in addition to reducing steady-state noise, reduced transient noise during acceleration by 8.5 dBA),
2. controlling mechanical noise such as piston slaps and "shocks" in the timing gear,

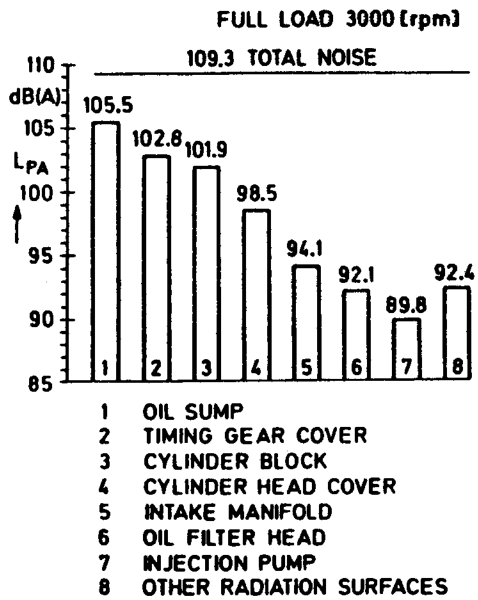


Figure 3. Noise source analysis, 3.8 litre high speed D1 diesel engine, from Reference (61)

3. acoustically optimizing the engine surface (overall shape, strategic location of ribs and stiffeners),

4. structurally isolating the oil pan from the engine block with cork or rubber washers, and

5. vibration dampening of the crank shaft pulley.

Boesch notes that full or partial encapsulation of the engine could also be effective, but was not recommended unless the other measures proved less than adequate. He claims that encapsulation has "great disadvantages" for heavy duty vehicles such as extra weight, space requirements and more difficult maintenance.

However, full encapsulation has been successfully demonstrated by Stiglmaier and Drewitz on medium duty (6-10 ton) trucks.(59) They achieved a 7.4 dBA reduction in overall vehicle noise from 86.4 to 79 dB, as measured by the newer stricter EC acceleration procedure. Figure 4 illustrates the levels of the various truck noise sources before and after encapsulation. Levels during a stationary, maximum-engine speed test decreased from 85 to 77 dBA at a distance of 25 ft. Interior levels also decreased from 79 to 76 dBA during the stationary test. They report that vehicle weight, operating temperatures and maintenance access were not affected negatively, but indicate that achieving similar all-around results on heavier trucks will be more difficult.

Another effort at developing a low-noise heavy truck engine was reported by Morrison.(62) He used design goals for engine noise of 95 dBA at 3.3 feet for the 1989 pass-by level of 84 dB at 25 ft, and 93 dBA for anticipated longer-term European limits of 80 dBA at 25 ft. Figure 5(a) shows the baseline and 95-dBA engine results in terms of sound power level for the entire engine (left) and individual components (right), in order of significance. The needed design changes were:

1. sump - 3 part, cast aluminum and damped laminated steel,
2. crankcase - additional ribbing and bracing,
3. valve covers - stiffened and isolated,
4. inlet manifold - isolated,
5. fuel injection pump - close fitting aluminum shield,
6. exhaust manifold - close fitting aluminum shield,
7. front cover - 2 part: duralumin and damped laminated steel, and
8. all other components - unmodified.

Design of the 93 dBA engine included all of the above measures (without additional modification) plus adding close-fitting aluminum shields on the right side of the crank case, the starter motor, the air compressor and the top of the engine over the injection pipe. Figures 5(b) and 5(c) show the spectral and engine speed sound pressure levels, respectively, for the baseline case, the 95 dB engine and the 93 dB engine.

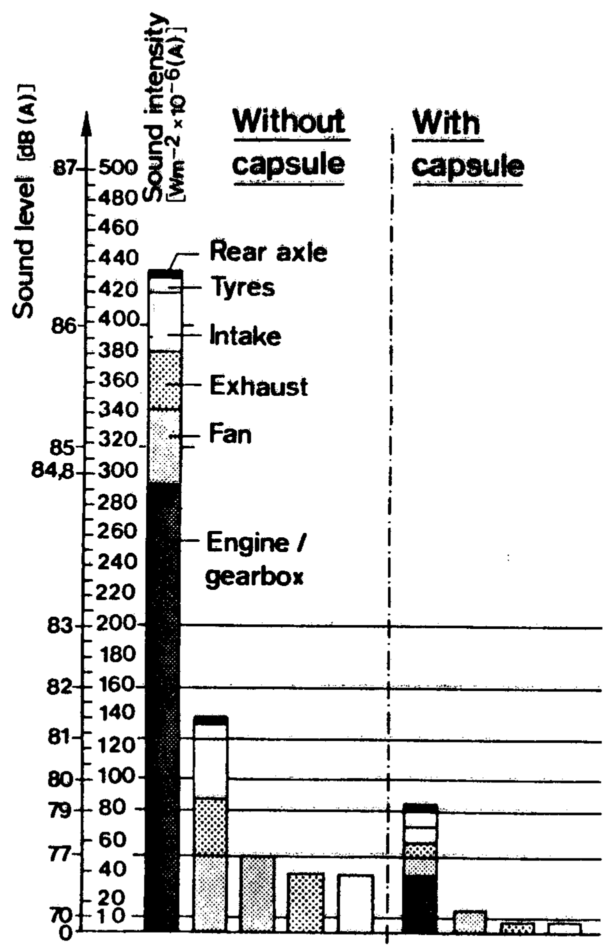
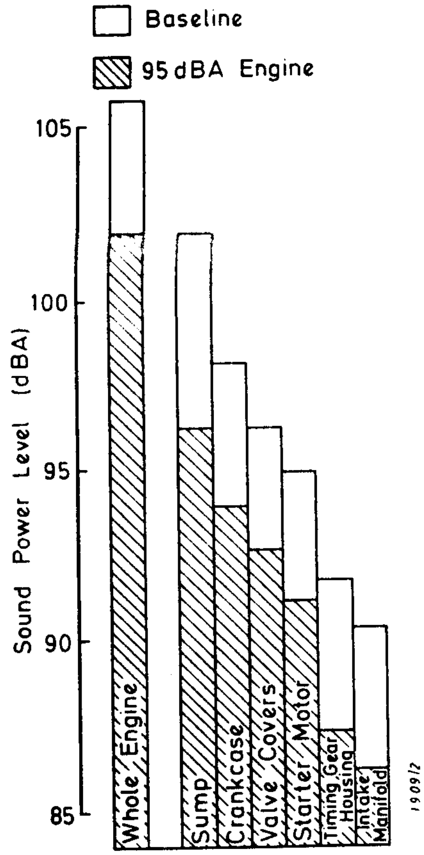
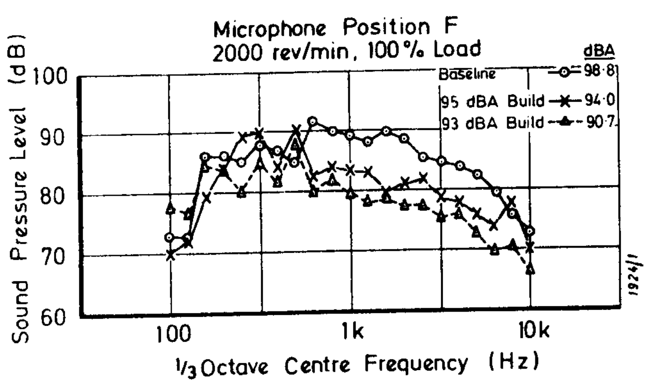


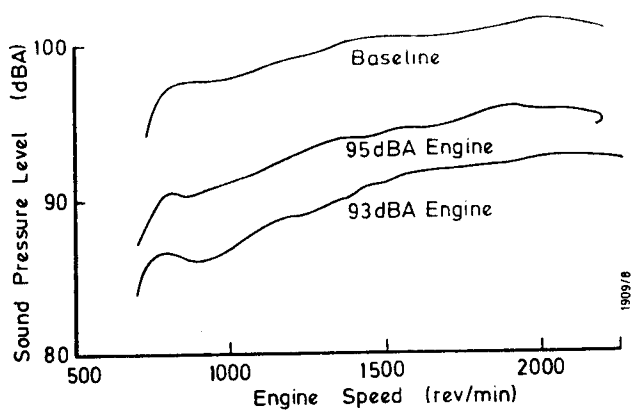
Figure 4. Individual noises and sound values on accelerated drive past; the individual values may be added to or subtracted from each other at will. (59)



(a) Sound Power Ranking of Major Noise Sources



(b) Sound Pressure Level Frequency Spectra at 2000 rev/min, Full Load



(c) Comparison of Transient Noise Level at Microphone Position F

Figure 5. Engine noise sources and levels from Reference (62)

Similar discussions on noise control for diesel-powered automobiles can also be found in recent SAE Noise and Vibration Conference Proceedings (e.g., see papers by Rust et al(63)), and Winklhofer and Thien(64), but will not be discussed here. Additional papers on gasoline-powered automobiles are also available, such as those by Oberg et al(65), and Priede and Dutkiewicz(66), (which examined engine knock). Also, DeJong(67) (among others) has studied interior levels in automobiles. Finally, Ericksson and Thawani present a good discussion on theory and practice in exhaust system design at the 1985 SAE Conference.(68)

An excellent paper on the noise characteristics of a variety of cross groove truck tire tread patterns was also presented at that same meeting by Oswald and Arambages(69) A key finding of theirs was that the primary grooves in the tread pattern must be "forward-faced at an angle approaching 45°." They describe their extensive data as the beginnings of a "tread designer's handbook."

Finally, studies on brake squeal by Schwartz et al and Liles present procedures for analyzing this annoying and complex phenomenon.(70),(71)

U.S. Vehicle Manufacturers

The major U.S. automobile manufacturers along with several truck manufacturers were surveyed regarding the state-of-the-art in traffic noise work from their point of view. The information from these surveys has been grouped under the headings that follow.

Noise Research, Design, Engineering and Testing Facilities. Manufacturers tend to divide their staffs by function into several noise related areas. One area groups duties such as providing documentation for federal and state compliance along with responsibility for implementing procedures mandated by the regulations from the government agencies. Typical staff duties include responding to federal, state, and local requests for information, monitoring test procedures to insure compliance, and maintaining updated files and information on changing regulations. Testing of new vehicles is often handled by another department in which the established test procedures are carried out on a routine basis for new vehicles. Often this can be done in a proving ground situation or a number of manufacturers have specific outdoor laboratory facilities for pass by testing. Another area of concentration involves research issues. Dedicated noise and vibration laboratories are used for interior and exterior noise research. Facilities range from large acoustical chambers to outdoor exterior test sites. Facilities to perform intensity mapping of noise sources are emerging as a major contribution to future research. Manufacturers are in various stages of implementing this concept. Intensity mapping itself is a useful method of isolating vehicle components regarding their contribution to the overall noise level.

Major Noise Sources. Most manufacturers group the vehicle noise sources under three major categories. The first category is the engine and related components. The related components included in this category are fan noise, induction air noise, accessory drives and gear drives, including the transmission. The other two major categories of vehicle noise are the exhaust and tire noise contributions.

Wayside Noise Levels. Manufacturers typically devote from 20 to 50 percent of their time and budget for noise related work, to exterior vehicle noise levels as opposed to the interior levels of vehicles. Wayside noise levels are described according to the A-weighted results of the test, SAE J 986. Typical levels for cars subjected to this test are 67 to 76 dBA. For heavy trucks the range is 75 to 80 dBA.

Meeting EPA Regulations. Efforts to reduce noise levels from exhaust systems have utilized such techniques as double wall components, increased number of baffles, and the inclusion of resonators to reduce key resonant frequencies. Computer simulations are used to optimize pipe routing patterns and muffler locations to further reduce exhaust sound levels. These resonant frequencies, which are tied to engine firing frequency, show up during acceleration through the speed range of the engine.

Reducing engine noise, on the other hand, has been a process of component-by-component investigation and application of control measures. Oil pans have been reshaped or insulated in an effort to reduce sound transmission through them. Engine block studies have produced increased use of stiffeners in the castings, and in some cases, the application of damping materials to the exterior of the block. Further application of insulation materials has been used on valve covers, plus hood blankets along with insulation on the engine side of fender surfaces. Engine noise in gasoline engines can be affected by spark calibration. Depending on the engine configuration, changing spark timing alone can produce a variation of several dB's in sound level. Corresponding level changes can be produced on diesel engines by varying the fuel injection timing.

Fan noise has been reduced through both thermostatic controlled fans and viscous clutch operated fans. Air induction noise, sometimes occurring as standing waves in the induction path itself, can be a major problem with some models. In addition, specific resonating frequencies can produce large tonal sound levels which are being reduced by adding helmholtz type resonators and/or expansion chambers. In addition, the use of damping plastics in the induction duct work is common. Accessory drive noise on engines has been reduced by the use of serpentine belts in place of multiple v-belts and a redesign of fan blades on alternators.

In some cases, manufacturers have had to resort to complete enclosure of the engine through various shielding methods. In addition, transmission noise coming from gear whine has been reduced by minimizing tolerances and reshaping gear contours. In some cases, covers or damping materials have been added to transmissions; however, these have proven to be undesirable for maintenance and are often removed at some point by the user.

Tire noise can become a dominant factor at higher speeds, such as 30-35 mph and greater under most conditions except wide-open throttle. In light of the reductions that have been achieved in the engine and exhaust areas, manufacturers are looking more and more to teaming with tire manufacturers for potential reductions in this area. The now common use of the all-season tire has increased tire noise levels. The shape of tread blocks under various conditions can create tonal noise conditions at certain frequencies. In some cases manufacturers have had to comply with the tighter standards in European countries. A common approach has involved changing tire brands to find a quieter tire that would meet the requirement. Manufacturers noted that there is a broad range in noise levels for the tires that are currently being produced.

One manufacturer has done a cost versus benefit study for vehicle noise levels for cars. As a result of the study, the "knee" on the curve of cost versus benefit occurred in the neighborhood of 80 dBA. In addition, a study in the Portland area produced less than 1 dBA drop in community noise levels (L_{eq}) when reducing the vehicle noise from 80 to 75 dBA. Typical operating levels in most of the vehicle modes are 12 to 14 dBA under the level determined by the J986 test which occurs at wide-open throttle.

Current Problems and Future Challenges. Several items surfaced as the biggest problems faced by manufacturers at this time. One issue is the benefit/cost ratio of increased efforts to reduce noise levels. Manufacturers are of the opinion that any future benefits will come at a very high cost penalty. Another issue that was named among the biggest problems is the contribution of tire noise. This is the direction that manufacturers will be looking for improvements next. Regarding future challenges, a number of issues were raised. Manufacturers are looking to the requirements of meeting international standards in the future. In the cases where these standards are more difficult to reach than U.S. standards, a large effort will be needed. One manufacturer sees a major challenge ahead in terms of customer satisfaction. Rather than the effort being expended to meet government standards, it will be driven by customer demands. There is an increasing perception among vehicle owners that a quiet vehicle is a quality vehicle. As this perception increases, more pressure is expected by the manufacturers to produce quieter vehicles. Another challenge faced by the industry is to design a simple vehicle test. Envisioned here is some kind of "test room" or other procedure that could be easily applied to vehicles taken off the assembly line.

Future Innovations. Almost every manufacturer mentioned active noise suppression devices or "negative noise" as a future innovation to reduce vehicle noise levels. In addition, the substitution of electronic engine controls in place of mechanical controls (e.g., engine speed governor for trucks), etc., would be used to reduce engine noise. Also the expectation of increased acoustic intensity techniques for studying the various contributions of vehicle components to the overall noise level was cited as a way of reducing future noise levels.

Overseas Efforts. Currently U.S. manufacturers are meeting standards for exported vehicles by carefully selecting the vehicles from their lineup or by making substitutions for components such as tires. Future increased exports will require increased efforts to reduce noise levels for some lines.

DISCUSSION

Quite a few findings have resulted from this comprehensive survey of the state-of-the-art in traffic noise abatement. This chapter will present those findings. The next chapter will focus on Washington State and the implication of these findings.

STATE DOT NOISE PROGRAMS

By the end of 1989, over 720 miles of noise barriers had been constructed by 39 states and Puerto Rico at a cost of over $635 million (in 1989 dollars). Seventy-five percent of those barriers were constructed in just ten states, with one-third of all barrier length constructed by California. A 1987 estimate for the completion of the U.S. Interstate Highway System showed a need for approximately $142 million for noise barriers on that system.

Most of the noise abatement measures used by state DOTs have involved sound-reflecting walls. The survey conducted by this study of state DOT practices focused on strategies other than sound-reflecting walls. The most commonly used of these other abatement strategies are depressing the highway, shifting the highway alignment, insulating public facilities, using sound-absorbing barriers, and prohibiting heavy trucks from a facility. The relatively high use of the last three measures was surprising, given their sometimes controversial nature. In addition, quite a few states have installed noise barriers of either the reflecting or absorbing type on non-limited access facilities. Traditionally, barriers are viewed as a unlikely solution in these situations because of the need for curb cuts for driveways and local streets.

The data showed that while 13 states have been very active in their use of these alternative measures, 20 of these states have used none or only one of these measures. Despite that finding, 60 percent of all respondents said that they would consider using sound-absorbing barriers, innovative or low-cost materials, buffer zones, shifting the highway alignment, choosing alternative corridors or modes, using pavement surface treatments, and allowing privately-funded barriers to be constructed on state right-of-way. However, there was a general unwillingness to install barriers off the right-of-way, which is often the best location acoustically for difficult to treat cites. While many other respondents indicated a willingness to try pavement surface treatments, a few had actually done so. Finally, there is general unwillingness to deck over highways, insulate private facilities, and ban all trucks from facilities. However, the willingness to try various alternative abatement measures has not fully been matched by actual implementation.

A number of findings were made on the individual abatement measures. For example, certain sound-absorbing barrier installations have been very expensive, and certain others have had maintenance problems after installation (metal, plastic, and concrete). Several states have shown a willingness to use tilted barriers as an alternative to sound-absorbing measures in parallel barrier situations.

The use of transparent barriers seems to have a role in certain situations, but problems with the few current installations have occurred.

In terms of new or innovative products, a composite material panel called Soundzero has been used as a light weight alternative on bridges. New Jersey is also looking at cutting its wind loading in its designs as a means of reducing costs. The Evergreen "planted" wall appears to have potential for application where the appearance of an earth berm is desired but right-of-way is not available, but initial installations have been very expensive.

There is interest among several states in the use of recycled plastic for noise barrier panels, and Ontario is seriously pursuing the use of recycled tire "crumb" as a barrier panel material. Ontario does have concerns over the high amount of smoke generated by these products if they burn, and has questions about the potential toxicity of the smoke. Structural issues also still need to be addressed.

It was found that homeowners have been willing to cooperate and share the cost of installing noise barriers off the state right-of-way in a number of instances. It was also found that privately funded barriers on the state right-of-way raises concerns among the DOTs, but seem feasible and a potentially good solution.

There have been no major problems with installing barriers on non-limited access facilities if there are very few curb cuts, but careful attention to sight distance is needed.

The use of decking over highways as noise abatement future is extremely expensive and has seen limited application. Washington State DOT seems to be a leader in this area with its work on I-90.

The use of depressed highways for noise reduction is common, with good effectiveness, and the shifting of highway alignments works well as a noise abatement measure if feasible. The provision of buffer zones, however, is not common.

Minnesota and Oregon developed transverse tine spacing specifications for their pavements to reduce tire/pavement noise. The use of open-grated asphalt to reduce tire/pavement noise shows promise from the field data that has been collected (although Washington State data is inconclusive), but questions still remain on the long term noise reduction capability.

Insulation of public buildings along highways is common, especially for schools, and usually involves air conditioning (or at least ventilation) and some glazing of windows. California has a major school noise abatement program that is nearing completion with 116 schools treated at a cost of $23 million, and nine more yet to be done at a projected cost of $3-4 million.

Insulation of private facilities is not popular, especially for residential property, but has been done in several instances for non-residential properties such as churches and private schools. Michigan has conducted a major residential insulation program on its I-696 project. Sixty residences have been treated through 1988, with as many as 70 more to be treated. The low cost of $3,500-$4,500 per residence is very cheap compared to noise barrier construction. Some states have legal problems with this strategy because it involves working off the right-of-way without any taking of the land (despite the common use this strategy for airport noise abatement).

In terms of traffic management schemes, banning trucks can reduce noise barrier heights on limited access facilities. However, reduced speeds are generally counter-productive to the project goal and provide marginal benefit.

Thirty-six states have indicated they have plans to install Type I (new highway construction or reconstruction) barriers over the next five years, and 14 plan to install Type II retrofit barriers on existing highways over the same time period. The projected annual expenditures of the responding states for Type I barriers were $130-$147 million per year. This amount excludes eight states that could not estimate their planned expenditures. Three of these states, Colorado, Pennsylvania and Arizona, have been active in the past. The Type II annual expenditures planned by the responding states totaled $75 million per year.

It was found that more and more states are concerned about the need for Type II programs, as citizen demands for noise abatement continue to increase. A number of states have been developing policies, priority listings, and state legislation for Type II programs over the last few years. The new National Transportation Policy calls for flexibility in the use of federal-aid funds, which, if reflected in the 1992 Surface Transportation

Act, may provide a ready mechanism for Type II barriers in those metropolitan regions desiring them. In June of 1990, California voters approved a five cents per gallon gasoline tax increase under Proposition 111, which stipulated that the Type II noise abatement program shall receive an additional $150 million over the next ten years. Coupled with existing funding, the California Type II program will be funded at a rate exceeding $20 million per year.

There were mixed responses on the seeking of funds from local governments or affected citizens by the state for noise abatement. Wisconsin will seek funds if the cost per residence for the barrier exceeds $30,000 per dwelling unit. California will allow a barrier to move up on its Type II priority list if the local government pays for the barrier, with provisions to reimburse the local government when that project is reached on the normal Type II priority list for funding.

Different states require different actions of support by local government when barriers are planned. Examples include seeking concurrence with the project and seeking or requiring land use compatibility plans for undeveloped lands elsewhere in the municipality. Colorado meets with its cities and counties on an annual basis to select the Type II barrier priorities for a five-year plan.

A number of prioritization systems for Type II projects have been developed over the years, generally considering factors such as cost, dwelling if effected, noise level, and achievable reduction. Two of the newest methods, by Wisconsin and New Jersey, have a degree of complexity not seen in previous methods.

Communication techniques used in dealing with the public typically involve public meetings. Different presentation methods used at these meetings, varying from audio recordings of traffic noise to slide presentations, artist's renderings and posters of predicted noise contours on aerial photos. Colorado used computer imaging. Some states have reported good success with individual meetings with the affected homeowners, often in the field, to discuss proposed project abatement plans. One-on-one briefings are commonly used to keep upper management and legislators informed on project and policy issues. Colorado has successfully used urban design committees consisting of representatives from state and local governments and the effected neighborhoods and a local urban planning consultant to discuss project issues of concern.

Fourteen states reported on legal decisions that had some consequence on their noise analysis or abatement program. Issues have involved the seeking of damages for noise impacts on partial takes of property, and payment of damages when there is no taking. Florida courts have held that traffic noise on individual projects has generally not caused "severe damage" relative to other traffic noise situations, and therefore has not been compensable. However, severance damages have been allowed for partial takes, representing the "cost-to-cure" to restore the remaining property to its original use and value. States have also been called upon to defend their analysis techniques and their abatement policies. In several instances, states have been directed to install noise barriers resulting from the litigation.

It was found that over half the states have either done research on noise in the last ten years or plan to do work in the next five years. However, for about half of those respondents, some or all of their research activity has been their involvement in a national pooled-fund study on parallel barrier effectiveness being conducted by the U.S. DOT Transportation Systems Center. The past and future research is focusing on improved prediction modeling, evaluating barrier performance, and studying tire/pavement noise. Several states have revised or are revising noise prediction vehicle emission levels, generally finding that heavy truck levels are lower than the national averages in the computer models. Florida has also found that the source heights used for medium and heavy trucks in the noise prediction model may be higher than in reality, which could have major consequences on barrier design.

There is a great deal of interest in the subject of multiple reflections between parallel barriers and the field results to date tend to support previous findings which indicate that degradations in barrier insertion loss tend to increase as the ratio of barrier height to width increases.

Other studies of single barrier noise reduction have found generally good comparison between predicted and measured levels. The use of open-graded asphalt pavement appears to offer noise reduction capabilities, but more data is needed on long term performance. There is a great deal of research on this subject in Europe.

State DOTs have a long list of some 50 items of needed noise research and will be active through the Transportation Research Board in helping FHWA set its environmental research agenda for the next five years.

The control of traffic noise impacts through land use compatibility is an important part of an overall noise abatement strategy. Land use compatibility is generally the responsibility of local agencies, although states such as California and Florida, as well as the province of Ontario require residential developers to consider noise as an element in their developments. California and Ontario have noise level standards that developers must meet, leading to many miles of developer-built noise barriers along their roads. Several states have reported success in working with local planning commissions on setback distances and other land development issues, and have assisted in review of subdivision plans. Virginia has developed a policy of requiring the local government to pay 50 percent of the abatement costs for non-federal aid projects and also require the jurisdiction to have a noise ordinance for abatement by developers adjacent to roads. Many states, however, do little more than provided the local governments with the predicted future noise levels near a project and information on the strategies for land use compatibility.

Some states report successes from their coordination efforts with local government indicating that noise mitigation is now being required by several municipalities for new residential developments. Additionally, two states reported that some of their communities have been making zoning changes from residential to commercial near busy roads while seven states have seen noise ordinances be developed by local governments in their states. However, the number of land use compatibility strategies throughout the country is very small compared to the extent of the problem and the potential success of proper action.

State DOT staffing for noise analysis and abatement varies considerably. All of the states had at least one person who, at a minimum, works part-time on noise. Approximately two-thirds of the states have centralized project development, while one-third rely on their district offices. Eight of the centralized states have less than one "full-time equivalent" (FTE) person and 13 more had less than two FTE staff. Eleven centralized DOTs have three or more FTE staff for noise work. The decentralized states have small main office staffs consisting of one or two FTE people. Five of the 14 decentralized states have five or more FTE staff in their districts, with California reporting a total of 48 registered engineers and technicians involved in noise studies and measurements in its district offices.

The level of training and educational background of noise staff also varies considerably. While most states have a staff with at least one four-year degree, the major fields range from civil engineering to physics to business administration and forestry. Twelve states have staff with graduate degrees in fields such as planning, environmental science and engineering.

The main sources of training for noise staff are FHWA training courses and workshops and in-house or privately-run short courses. In several states, the analysts simply have to learn on the job. Twenty of the states rarely or never use consultants in their noise analysis and research while the remainder report frequent use. Six states use consultants over half the time on their projects. The types of work upon which consultants are used varies from EIS-level analysis to preliminary engineering or final noise barrier design.

Most of the states used the FHWA STAMINA 2.0/OPTIMA traffic noise computer programs in their work. Thirty of the states do part or all of their work on microcomputers, while twelve use only mainframe systems. A few states are using digitizing systems and graphics for file creation and display. Noise measurement equipment ranges from simple sound-level meters to sophisticated sound-level analyzers.

When queried on issues of concern, by far the biggest problem or challenge is funding. Eight states listed funding as a primary problem within their noise programs, with four mentioning specifically Type II project funding. Other key issues include: inadequate training and staffing, responding to public and legislative demand for noise abatement, lack of legislation on land use compatibility (coupled with difficulties in getting local governments to consider noise in future development) and in-house resistance to noise abatement.

Respondents were asked to identify key issues in noise control at the source, along the path, and at the receiver. The key source control issue is the need for quieter heavy trucks, including the lowering of truck exhaust stack heights. Some states called for better legislation regulating vehicle noise emissions, rejuvenating the EPA noise abatement office, providing more federal support for manufacturer's noise control efforts, and improving both federal and local enforcement of vehicle noise laws. Path control issues dealt with the need for Type II funding, the need to improve barrier cost effectiveness, and barrier maintenance. For noise control at the receiver, land use compatibility planning was the key issue.

The overall sense one gets from reading many of the State DOT responses is that of frustration. The exception is in a number of the more rural states, which do not perceive themselves as having a "noise problem." For example, both Maine and Montana noted that since they have few, if any, high-volume highways there are been very few traffic noise complaints or problems. However, even these two states expressed concerns about noise becoming a problem for them. Maine noted that as traffic continues to increase on I-95 and associated interstate spurs, more complaints may be expected to surface that could require some Type II noise projects. Montana noted that the general public is beginning to become aware of traffic noise as a serious problem within the state. This awareness has put a strain and demand on an environmental staff that has responsibilities in several environmental areas unrelated to noise.

The public demand for abatement is increasing in many states while the resources--funds, staff, executive management support, legislation, regulations and technical tools--are inadequate or need improvement.

Source control is generally beyond the jurisdiction of state DOTs, yet the USEPA programs on source control and technical assistance to local government have been virtually nonexistent since funding was cut in the early 1980's. Source control through use of quiet pavements is one area, however, that offers promise to state DOTs. Control at the receiving land use is also largely beyond the jurisdiction of the state DOTs, yet effective land use compatibility planning, zoning control and physical noise mitigation techniques could prevent many future noise problems from arising. Control along the path is the main option available to state DOTs, yet work is needed on issues such as abatement cost and cost effectiveness, and analysis tools for special situations.

The challenge of funding, especially for retrofit abatement on existing highways, seemed to be the common thread throughout many of the responses. On the positive side, the public in California recently took its demand for more traffic noise abatement into its own hands passing Proposition 111, a gas tax increase that included stipulation for $150 million of the new revenue to be spent on Type II projects.

In most other states, however, traffic noise remains a minority-party issue. Its impacts can be severe, but do not affect a large enough population to muster sufficient votes for a California-like proposition. Lacking such a voice, the impacted public must rely on the various levels of government to protect and enhance the environment while carrying on their mission to provide safe, efficient, and economical transportation.

The other documents reviewed on state DOT noise abatement programs and/or FHWA policy also provided some interesting insights. Key among these was the wide variation by states and the interpretation of the Noise Abatement Criteria in the FHWA noise standards. The criteria are still interpreted by some states as desirable noise levels or design goals, rather than indicators of impact severe enough to warrant abatement. Additionally, FHWA found that states need to pay more attention to the views of the impacted residents in the decision to implement noise abatement on new construction projects and to the "will and desires" of the general public in dealing with traffic noise, particularly in implementing Type II abatement.

The states were also found to have a wide range of interpretations of items such as definition of impact, eligibility for Type I projects, insertion loss goals, and cost per residence criteria. The most common criterion for judging a "substantial increase" is an increase of 10 or more dB. The most commonly used cut off date for new developments to qualify for Type I treatment is location approval of the proposed project. While many states try to achieve 7 or more dB insertion loss during barrier design, the most commonly cited range was 5-10 dB, with two states showing goals of 3-5 dB. Cost per residence criteria ranged from $8,000 to $37,000 per dwelling unit.

It was also found that a new set of cost data for the OPTIMA noise barrier design program has been developed based on a survey of previously installed barrier costs, factored to 1988 dollars using the construction price index. While the costs are given for a height range of 1-35 feet, 96 percent of the data were between 5 and 20 feet. The data showed significant increases in the cost per linear foot for four of the surveyed materials (earth berm, concrete, masonry, steel and wood). Unit costs for steel actually are significantly lower than previous data at heights above 15 feet.

LOCAL AND NON-DOT STATE NOISE CONTROL PROGRAMS

The control of transportation noise by local governments and non-DOT state agencies fall generally into two categories: enforcement of motor vehicle emission level standards and development and implementation of land use compatibility programs. The major finding in this area of investigation is that the closing of the EPA Office of Noise Abatement and Control (ONAC) and the phase-out of the EPA noise program had a very major impact on state and local programs. These impacts were not officially anticipated by EPA when the decision to end the program was made. Only about 35 percent of the approximately 200 local noise control programs which were active during the 1970's remain active today, largely attributed to the loss in EPA funding and technical assistance. Only eight of the 20 state agencies that had active programs in the 1970's are still active today. Few individuals are still actively involved in the field at the state and local level. Over half of the municipalities with active programs felt that reinstating the federal program would be of help while one-fourth did not think so. A study commissioned by EPA to examine the impacts of the ending of its noise program concluded that these programs have not been able to do what had been expected of them after the discontinuation. The study calls for a new federal program to provide extensive technical assistance and technology transfer to state and local agencies.

These conclusions were corroborated by a General Accounting Office (GAO) investigation. The GAO concluded that the federal government needed to strongly consider expanding its efforts in several possible areas, including enforcement of current standards (although revision first is preferable) and the provision of technical assistance to local governments for land use control.

EPA had a thriving program in noise control in the 1970's in response to the Noise Control Act of 1972. Major functions included identifying "major sources of noise" and developing regulations for newly manufactured products of these major noise sources. EPA also had a very active state/local assistance program. Since the ending of its program in 1982, EPA now only has a few people in the noise area, mostly to review noise sections of environmental impact statements, as required by federal law. EPA is also not enforcing its standards on newly manufactured medium and heavy trucks, motorcycles and motorcycle exhaust kits. EPA had also promulgated in-use for motor carriers engaged in interstate commerce noise regulations that applied to trucks and buses. Enforcement of these regulations was delegated to FHWA, which is currently not enforcing them because of previously determined high compliance rates and other priorities. However, the maximum allowable noise levels were reduced 3 dB for 1986 and later model years and no compliance testing has occurred since that reduction. Recently collected independent data suggests compliance may be an issue.

The EPA new product regulations for medium and heavy duty trucks had included a 3 dB reduction in maximum allowable levels (to 80 dB at 50 feet per an SAE acceleration test) that was supposed to go into 1982. The implementation date was deferred several times and finally went into effect in 1988. A key factor is the idea of federal preemption. State and local agencies can promulgate their own regulations for newly manufactured medium and heavy trucks and in-use interstate buses and trucks, but their standards must be identical to the federal ones. Several states and municipalities have passed such regulations, but only Oregon, Florida and California require certification letters from manufacturers. Automobile and light truck noise is not regulated by EPA standards, and as a result, a number of states and cities have standards for these vehicles (typically, a value of 80 dB at 50 feet per an SAE acceleration test).

The state and local respondents who had indicated that they had a noise program in place in the late 1980's were surveyed as part of this study. Six states and 35 municipalities responded. All of the state programs began in the early 1970's by acts of their state legislatures. Annual operating costs range from $48,000 to $270,000, although there is no federal assistance currently available to them. The Illinois EPA, however, does use federal money to monitor noise emissions at Superfund hazardous materials cleanups. The FTE staff in the state programs range from 1 to 8.5 people (Hawaii). Four of the six state programs specifically exempt motor vehicles from their regulations. (The exceptions being Hawaii and California). Hawaii seems to have had the most success in surviving the EPA program's demise. While most of the state respondents wanted to see an EPA program re-established, Illinois opposed such an action because the federal preemption feature led to lax standards.

There was a wide range in diversity of program size and scope among the responding municipalities. Local agencies in California and Colorado seemed to be the most active. Over half of the programs were started in the mid-1970's. Annual operating costs to run the programs range from $130 to $214,000, with FTE staff ranging from 0.01 to 7 employees. Most of the respondents had less than one FTE person. Five respondents--two in California, two in Colorado, and Washington, D.C.--have annual operating budgets exceeding $100,000.

Twelve of the thirty-five respondents note motor vehicle noise being a regulated source. Most ordinances deal with source emission levels and properly functioning mufflers. Other ordinances deal with land-use planning by preventing a sensitive noise development in high noise areas and/or by requiring noise mitigation at noise sensitive sites. Most of the respondents indicated the ability to provide some service other than ordinance enforcement, although the extent of such service was generally limited by the limited staff.

Follow up investigations to the survey identified a number of successful efforts in California, Colorado and Canada. Key to the California success is the existence of a "noise element" that must be part of all city and county general plans. The noise element sets maximum sound levels by land use category and has led to the construction of many noise abatement features by residential developers near transportation noise sources.

In Boulder, CO, most of the current focus is on motor vehicle noise emission enforcement through both pro-active and reactive patrols. The Colorado Springs program has four full-time employees, regulates individual vehicles and has land development responsibilities.

In Canada, Calgary has had a strong program since the early 1980's, and has a noise level standard that developers must meet when developing near a roadway. Calgary uses a classification program to determine potential impact zones from traffic noise to assist in its program. Other Canadian cities, such as Saskatoon, also have traffic noise policies with residential level standards for developers. Saskatoon is currently updating its policy and inventory of impacted areas.

The province of Ontario also has had a very active program of developer-provided noise abatement since the mid-1970's. It was found that while there are a number of examples of good state and local noise control programs, they are few and far between.

In summary, the closing of the EPA Office of Noise Abatement and Control and the ending of the EPA technical assistance program has hurt the state and local noise control efforts significantly.

CONTROL OF VEHICLE NOISE AT THE SOURCE

The third part of the three-part approach to controlling transportation noise is source control. It was found that significant efforts have occurred in controlling motor vehicle noise, especially heavy trucks, since the 1970's. These efforts were driven by regulation, both in the United States and in the European community. As noted in the previous section, EPA was given duties in the 1972 Noise Control Act for identifying major sources of noise and developing "new product" regulations for them. Its regulations on medium and heavy trucks and motor cycle replacement exhaust systems are still in effect, even though the EPA program has been abolished. Likewise, the EPA in-use noise regulations for motor carriers engaged in interstate commerce remain in place, but are not being enforced. The principle of "federal preemption" prevents state and local agents from issuing strict regulations for noise from these regulated sources. The current limit on newly manufactured medium and heavy duty trucks is 80 dBA, measured at a distance of 50 feet by an SAE acceleration test procedure. Regulated levels on newly manufactured motorcycles range from 70 dB for mopeds to 82 dB for off-road motorcycles with engines over 170 cc. The in-use Interstate Motor Carrier Regulations, which apply to both trucks and buses, include separate sets of levels for pre-and post-1986 model year vehicles. Three test conditions are specified: stationary, under 35 mph, and over 35 mph.

European noise control efforts begin in the early 1970's. The allowable levels have been reduced in a staged fashion over the last 20 years. Effective October 1990, all new heavy trucks exceeding 3.5 tons with "engine power not less than 150 kW" must meet a standard of 84 dBA at 25 feet per a European acceleration test procedure. This 84 dB standard is roughly equivalent to 80 dB U.S. standard at 50 feet. A number of European researchers are working actively on controlling truck noise. The main sources of engine noise are mechanical or combustion-related. Noise level reductions are obtained by optimizing the combustion process, improving the structural response of the engine block, reducing the vibration of engine panels such as the oil pan and the valve cover and using properly designed engine shields or covers. Engine encapsulation with a cover is very effective acoustically but requires careful consideration of cooling, and poses extra concerns about weight, space and maintenance. Most European researchers believe that the new noise emission level can be met without having to go to engine covers.

U.S. vehicle manufacturers have invested heavily in control measures to successfully reduce engine and exhaust noise in both light and heavy vehicles. While gains in these areas will be made in the future, the incremental gains will be smaller and at much greater cost. As a result of engine and exhaust improvements, tire noise has emerged as the dominant source of vehicle exterior noise.

APPLICATIONS AND IMPLEMENTATION

The earlier sections of this report examined the state-of-the-art in traffic noise analysis and control. Discussion focused on noise control at the source, along the path, and at the receiver. Additionally, programs were examined at the levels of state DOTs, state environmental departments, local governments, and vehicle manufacturers.

The purpose of this section is to turn the focus to the State of Washington. How the previously reviewed material should be viewed by WSDOT will be examined in the context of WSDOT's policies, programs and structure. Recommendations are then made for the WSDOT noise mitigation programs.

There are three key factors that must be in place if a state wishes to successfully mitigate its transportation noise problems:

1. the public must demand traffic noise mitigation;
2. the legislature must respond with laws conducive to noise mitigation; and
3. the administration must be committed to implementing the laws.

Washington State is fortunate in many ways compared to other states in the sense that environmental protection has maintained a high profile and priority among these three groups--the public, the legislature and the administration. To use an analogy of building a house, the site has been prepared, foundations poured and the framing nearly complete. More framing is needed, a roof must be added, walls and utilities must be roughed in, and the interior trim finished. The addition of furnishings on the inside and landscaping on the outside would complete the project and make it habitable.

This report began by quoting Washington State Representative Nelson describing the pressure he is feeling from the public to control noise from the transportation systems. As will be described in this section, the State legislature has shown some of its concern over growth and the resultant environmental impacts with the Growth Management Act of 1990 and the subsequent Growth Strategies Act of 1991. These Acts establish a basis and a mechanism by which noise mitigation through land use planning may be accomplished, although they do not mandate such mitigation.

The third ingredient, WSDOT administration support, would require a conscientious choice among many competing initiatives to protect the environment (and specifically to control transportation noise) and then a policy to give substance to that choice. Indeed, WSDOT has demonstrated its progressiveness and leadership by making those choices for the environment and defining a transportation policy plan that gives top priority to environmental protection and that delineates action strategies to minimize noise impacts from transportation systems and facilities. A process, called Choices in Transportation for Washington's Environment, and a policy plan, the 1991 Report to the Washington State Legislature: Transportation Policy Plan for Washington State, will be discussed in detail in the following sections.

Even given a demand by the public for noise abatement, action by the legislature to lead to noise control, and a choice and policy of the WSDOT administration to abate transportation noise, two key factors must be kept in mind:

1. noise abatement must compete with other areas of environmental protection that the public, the legislature and administration also choose to be important (and in some cases, more important); and
2. demands, laws, choices and policies are useless without the resources to bring about action.

More legislation is needed and more administrative support is required, in terms of staff and funds, or else, to complete the analogy, the house will remain partially framed and will sit incomplete as a sad reminder of what could have been.

The rest of this section begins with an examination of the 1991 Transportation Policy Plan, the Choices process and the Growth Management and Strategies Acts, and their implications to the Noise Unit of WSDOT. Also discussed is the State Growth Strategies Commission final report issued after passage of the Growth Management Act. Noise unit responsibilities and duties will also be examined in the context of the organizational structure of WSDOT. Also existing WSDOT noise policies, procedures and methods will be reviewed. Then, with the material in the earlier parts of this report as a basis, recommendations will be made for the control of transportation noise in Washington State, with focus on WSDOT.

TRANSPORTATION POLICY PLAN FOR WASHINGTON STATE

The actions and focus of the Noise Unit will be driven by the Transportation Policy Plan for Washington State, which is in the 1991 Report to the Washington State Legislature. The 1991 Plan is the latest step in a policy planning process that began in 1988 and resulted in a 1990 report to the State Legislature. The 1991 Plan presents the 1990 and 1991 Policy Plan recommendations and actions and presents new state-wide policy recommendations in three areas. Two of those areas are Transportation Programming and

Transportation Finances; the third area is Environmental Protection and Energy Conservation. The 1990 Plan first stated the mission of WSDOT as being,

> "to provide safe, efficient, dependable, and environmentally responsive transportation facilities and services to:
>
> 1. promote a positive quality of life for Washington citizens,
> 2. enhance economic vitality of all areas of the state, and
> 3. protect the natural environment and improve the built environment."

The specific environmental goal was stated as the following:

> "Transportation will protect the natural environment and improve the built environment by conserving scarce resources; reducing pollutants, and other waste by-products from transportation systems; avoiding the disruption and degradation of historically and environmentally significant locations; and by including effective urban design in transportation facilities."(72)

The document groups the environmental issues into eight areas: (1) air quality, (2) water quality, (3) fish and wildlife habitat protection, (4) wetland conservation, (5) use of hazardous substances, (6) visual quality, (7) noise abatement, and (8) use of non-renewable energy resources.

The explicit inclusion of noise abatement has direct implications on the Noise Unit. However, as noted above in the discussion of the Choices process, the consequences of other environmental actions on noise need to be addressed. Also, the Noise Unit must be sensitive to the implications on its work contained in the other two broad issue areas for the 1991 Policy Plan, namely, Transportation Programming and Transportation Finance.

The 1991 Policy Plan recommends simply that WSDOT should "minimize noise impacts from transportation systems and facilities." Four action strategies are delineated:

1. require that all new transportation system facilities and structures be evaluated for adverse noise impacts; minimize adverse noise impacts if reasonable and feasible;
2. require that local land use plans identify excessive noise impacts from noise generators including transportation facilities; identify locations of needed noise mitigation measures; and avoid future excessive noise impacts by establishing a pattern of land uses and building codes that minimize the exposure of community residents to excessive noise levels;

3. develop a state transportation program to mitigate excessive noise impacts from transportation facilities as identified in local land use plans; this program will be available to local governments which have adopted land use controls which will avoid future excessive noise impacts; and
4. support research into development of alternative transportation modes which create minimal operational noise impacts within and adjacent to transportation corridors.

The first strategy is simply a restatement of current federal requirements for federal-aid projects. However, the strategy goes beyond federal-aid projects and includes projects without federal funding. The Noise Unit (and district offices) must be adequately staffed to perform this function.

The second strategy contains several essential items for a comprehensive, integrated noise abatement approach. The requirement that local and regional land use plans identify excessive noise impacts and the establishment of a pattern of land uses and building codes to minimize noise exposure are critical. WSDOT is not always the culprit for noise impacts on its neighbors, especially when lax or non-existent land use policies allow noise sensitive development along transportation facilities. The second strategy also calls for WSDOT to identify locations for needed noise abatement measures. The Noise Unit must examine its current method for identifying, ranking, and prioritizing these impacted areas for noise abatement. A funding policy must be established, a funding program phased over several years must be developed, and finally, legislative or administrative action must be taken to make available the funds to abate the noise.

The third strategy is also aimed at working with local governments to mitigate noise impacts. Developing a state transportation mitigation program that is available to those local governments who have adopted plan use controls to avoid future noise impacts will provide a tangible incentive to those local governments. However, the program must have a funding mechanism that allows abatement of problems to be done in a timely, dependable manner.

The fourth action strategy is aimed toward the noise consequences or benefits from other policy initiatives such as the improvement of air quality, the use of alternative fuels and the reduction of traffic congestion. The strategy calls for supportive research on operational noise impacts in the development of alternative transportation modes. It will be the responsibility of the Noise Unit to make sure that strategies proposed to solve one major problem (e.g., air quality) do not create a significant new problem of their own (e.g, more annoying noise conditions).

WSDOT policy in the other environmental areas can affect the work of the Noise Unit, especially in terms of alternatives to single occupant vehicles, the use of cleaner fuels, and strategies to reduce traffic congestion. For example, the Noise Unit will need to be able to quantify the noise consequences of improved traffic signal timing and coordination, conversion of private fleets to non-diesel or non-gasoline fuels, and the noise impact of busses and transit systems. The emphasis of WSDOT on "visual quality" will mean that any noise abatement measures considered by the Noise Unit will have to be aesthetically acceptable. Identification or development of new and interesting mitigation techniques such as the Evergreen noise barrier or visual graphics, texturing and coloring of noise walls, will become increasingly important. The WSDOT visual quality action strategy of identifying outstanding vistas and then protecting, restoring, and enhancing them may require the Noise Unit to address the feasibility of transparent noise barriers. The action strategy of requiring the incorporation of landscaping elements into the design of new transportation systems implies the inclusion of landscaping in noise abatement projects. The Noise Unit must continue to work with landscape architects in the department to produce integrated abatement designs.

As another example, the WSDOT policy area on the use of hazardous substances may lead to special transportation routing plans for trucks. The Noise Unit must be prepared to address the consequences of these routing strategies.

Also, the mitigation of traffic congestion could involve restriction of truck operating hours during peak traffic periods. Restricting truck hours to the evening, night or early morning for the purpose of traffic congestion relief carries a noise penalty that must be considered. The Noise Unit needs to be prepared to deal with issues regarding night-time noise impacts and appropriate criteria for assessing these impacts.

The second major policy area in the 1991 Policy Plan, Transportation Programming, calls for a continued, strong regional transportation planning process. The Noise Unit needs to be aware of this planning process in the various metropolitan planning organizations across the state to insure coordination between the Noise Unit's action strategy to minimize the noise/land use conflict in the development of region-wide transportation systems. While noise mitigation is often thought of as a "design" strategy, successful control in the planning stages may have the best long-term payback, especially for yet-to-be developed lands.

The Transportation Programming emphasis area does include three action strategies in which the Noise Unit could take a proactive role: (1) develop performance standards to measure achievements implementing the regional transportation system; (2) implement the on-going performance monitoring program for the regional transportation plan; and (3) adopt criteria for identifying regionally significant transportation projects. Noise impact and noise mitigation could become important factors in assessing components of the regional transportation system plans. Noise impact and noise mitigation could be established as part of the criteria for the identification of regionally significant projects. Region-wide noise mitigation or impact minimization could be adopted as one type of performance standard, and noise monitoring could become a component of a performance monitoring program for regional system development.

The third policy emphasis area in the 1991 Plan is Transportation Finance. The plan identified ten key financial needs. None of them dealt specifically with noise abatement, although a general statement was made that these needs must be met while protecting the environment. However, if the Noise Unit is going to be successful in responding to its own charge in the 1991 Policy Plan, then provision of funds for mitigation of existing noise problems is essential. Without explicit priority for noise abatement funding, mitigation of existing noise impacts may fall victim to limited resources in the face of higher priorities, despite noise abatement being a high priority of Washington State citizens. One of the specific needs mentioned in the Transportation Finance section of the Policy Plan was "more effective coordination of land use and transportation planning." As noted above, this need is the focus of two of the specific noise abatement action strategies dealing with compatibility of land use and noise. The Noise Unit needs to insure that noise impact identification and mitigation is an integral part of any other departmental efforts on coordinating land use and transportation planning.

The 1991 Policy Plan also delineates on-going policy planning activities and new policy research initiatives. One on-going area is with the Freight Mobility and Economic Opportunity Subcommittee and deals with Urban Congestion and Freight Mobility. The Noise Unit should investigate the preliminary policy recommendations of this subcommittee for implications on noise impact, such as the possible restriction of truck hours during peak periods and the potential forcing of trucks to make deliveries during the noise-sensitive nighttime periods.

New policy research initiatives in the 1991 Plan include a focus on transportation demand/systems management, which includes activities such as public transit, traffic signal timing, and increased vehicle speeds, all of which could have noise consequences.

A second initiative deals with privatization and joint development. The potential investment in privately funded toll roads implies the use of toll plazas and the potential for noise impact from accelerating and decelerating vehicles. Attention needs to be paid to the human reaction to the unusual characteristics of these types of noises. Also the Noise Unit, as well as, the Environmental Branch, needs to ensure that privately developed transportation facilities do not create environmental impacts on the public simply because no federal or state aid is involved. The Policy Plan calls for the need of a state policy on privatization and joint development. The Environmental Branch should have input into this policy.

The Policy Plan also calls for research and recommendations into a number of land use and transportation issues. The Noise Unit must have input into this activity as it works on its own action strategy of noise mitigation and land use. One specific land use issue mentioned was residential site design considerations. The Noise Unit should play an important role in any policy research on this subject. Issues such as building layout and location, provision of green space buffer zones, and incorporation of noise abatement features such as barriers and berms are crucial to the Noise Unit's mission of controlling noise impact through land use planning.

In summary, the 1991 Transportation Policy Plan Report to the State Legislature contains many items that impact on the Noise Unit's program and workload, either explicitly or implicitly. To be able to act on its explicit noise abatement action strategies, the Noise Unit must see that it plays an active role in other emphasis areas that could have noise consequences such as land use planning, other environmental impact mitigation areas, and consideration of alternative transportation modes or management strategies. Additionally, the Noise Unit must get noise abatement funding put on the agenda of either the WSDOT or the State Legislature if it hopes to make any significant progress in mitigating existing noise impacts along Washington State's transportation facilities.

CHOICES IN TRANSPORTATION FOR WASHINGTON'S ENVIRONMENT

WSDOT has begun a process called Choices in Transportation for Washington's Environment - 1991, including a symposium in the fall of 1991. The purpose is to help WSDOT develop strategies and programs for implementing the State Transportation Policy Plan as it relates to the environment. A document on the Choices process sums up the problem concisely and espouses a philosophy for the future:

> "As Washington's population continues to grow, greater demands would be placed on schools, housing, jobs, open spaces, air, water, and transportation. The number of vehicles registered in this state continues to grow at almost twice the rate of the population."
>
> "As more is learned about transportation's effects on the environment, additional policies and procedures will be needed to protect and enhance our State's valuable resources. Washington citizens concerned about the environment will continue to have significant influence on transportation decisions. Partnerships among federal, state and local agencies will also help to make the right choices in transportation for Washington's environment."(73)

The document on the Choices process indicates a focus on five major areas: (1) protecting air quality and conserving fuel, (2) saving water resources, (3) protecting and enhancing scenic recreational highways, (4) improving the link between land use and transportation planning, and (5) protecting, preserving and enhancing fish and wildlife habitats.

Consideration of transportation noise is a part of the discussion on land use and transportation planning. WSDOT states that it will encourage local agencies to adopt noise compatible land use plans for undeveloped areas near highways, and will continue to install noise barriers to protect noise sensitive land uses along existing highways. It also notes that it has constructed lids to minimize highway noise levels on projects such as I-90.

The Noise Unit in WSDOT must be in a position to respond to these policy initiatives.

Additionally, the Noise Unit must be prepared to address the consequences and/or benefits on the noise environment from the other policy initiatives that may result from the Choices process. Specifically, what are the noise consequences or benefits of non-SOV (single occupant vehicle) strategies, air quality improvement strategies, and congestion management and relief strategies? For example, a focus on transit will mean more buses on the road, with their higher noise emission levels than automobiles. A policy toward alternative fuels will mean power plants other than gasoline and diesel. Will the change in noise emission levels and sound frequency characteristics of these alternative power plants affect community noise levels or community perception of the noise? What are the impacts of 300 mph magnetically levitated trains on neighboring communities in terms of aerodynamic noise? The above issues serve to illustrate the types of questions that the Noise Unit must be prepared to answer as the environmental impacts of these different strategies are considered. Developing answers to these questions requires a combination of further literature review and perhaps some field work.

THE GROWTH MANAGEMENT ACT OF 1990

In April of 1990, Governor Booth Gardner approved Engrossed Substitute House Bill No. 2929, known as the Growth Management Act of 1990. In developing the Act, the state legislature found that

> "uncoordinated and unplanned growth, together with a lack of common goal expressing the public's interest in the conservation and wide use of our lands, pose a threat to the environment, sustainable economic development, and the health, safety, and high quality of life enjoyed by the residents of this state. It is in the public interest that citizens, communities, local governments and the private sector cooperate and coordinate with one another in comprehensive land use planning."

Among the planning goals adopted in the Act to guide the development and implementation of the comprehensive land use plans were to encourage efficient multimodal transportation systems that are based on regional priorities, and to protect the environment and enhance state's high quality of life. No specific mention of noise control was made in the discussion of the planning goals at the beginning of the Act.

The Act called for comprehensive land use plans to be developed by counties and cities that had experienced high growth over the last ten years. Each plan needed to include elements on Land Use, Housing, Capital Facilities, Utilities, Rural Areas, and Transportation. In addition, the cities or counties were called upon to enact development regulations that implement the comprehensive plans. The Act required cities and counties to establish procedures that provided for early and continuous public participation in the development of the plans and regulations. Noticeably absent from the Act was the need for an environmental management element or environmental protection element, despite one of the planning goals being the protection of the environment.

The Growth Management Act also called upon the Department of Community Development to establish a program of technical and financial assistance and incentives to the cities and counties to help with the adoption and implementation of the plans and regulations. The Department was called upon to utilize the staff of other state agencies, such as the Department of Transportation in providing this technical assistance. Technical assistance was defined as including model land use ordinances, regional education and training programs, and information for local and regional inventories useful in managing growth.

The Growth Management Act of 1990 designated that cities or counties could impose excise taxes on real property sales for use solely in financing capital projects in the Capital Facilities plan element of a comprehensive plan. While noise mitigation measures were not specifically included in the definition of capital facilities, the real estate excise tax might be an excellent funding mechanism for noise mitigation, especially for public open space areas or publicly owned housing.

The Act also authorized counties, cities and towns involved in comprehensive land use planning to impose impact fees on development activity as part of the financing for public facilities. The impact fees could only be imposed for assisting in improvements that would be reasonably related to the new development and that would reasonably benefit the new development. The fees could only be spent for public facilities included in the Capital Facilities plan element (public facilities were defined as public streets and roads, publicly owned parks, open space and recreation facilities, school facilities, and fire protection facilities). Additionally, the Act called for cities, towns and counties to examine if proposed subdivisions included appropriate provisions for, among other concerns, the public health, safety and general welfare, and to not approve proposed subdivisions without such provisions.

A major part of the Act established a regional transportation planning process (which, for urbanized areas, would be consistent with the USDOT metropolitan planning organization (MPO) process). Among other requirements, the regional transportation plans were required to conform with the comprehensive land use plans.

Finally, the Growth Management Act asked the State Growth Strategies Commission, which was created by the governor in 1989 by executive order, to address how state government could insure that local governments comply with the Act's goals and coordinate their planning, and how state agencies can comply with the Act and do a better job of planning and managing growth statewide.

In summary, the Growth Management Act of 1990 mandated a comprehensive land use planning process with environmental protection as a goal. It also expanded the MPO process beyond urbanized areas and required that regional transportation plans conform with land use plans. It permitted real estate excise taxes and impact fees to be imposed to help fund capital facilities improvements, and called for state agencies to provide technical assistance and grants to the cities and counties for the development of their plans and subsequent implementation regulations. The Act also called for the Growth Strategies Commission to study the state's role in growth management. Important steps were made toward managing growth, but not enough was mandated explicitly on the subject of environmental protection.

Part of the Growth Strategies Commission's early charge by the governor included recommendations on ways to preserve the state's environment and quality of life while maintaining steady economic growth for all its regions. In its final report on its work (74), the commission called for more explicit strategies for protecting the environment than had been delineated in the Growth Management Act. Specifically, the commission recommended that an Environmental Management element be added to the comprehensive plans developed by cites and counties ("to insure consistency between the plans and regional standards for air and water quality"). Also recommended, among others, were a Character and Design element and an Open Spaces and Park element.

The commission specifically recommended that "all local governments must protect environmentally sensitive areas and address identified environmental problems." It also recommended that "a process must be developed by which all communities within a region fairly share the burden of public facilities." While the commission did not specifically mention roads as one such type of burdensome public facility, one could easily extend their recommendations to include the noise impacts created by new roads, and the need for the communities in a region to share the burden of mitigating the noise problems.

The commission noted that the Environmental Management element should "insure that cumulative impacts and standards are considered and that best practice development standards and mitigation efforts are incorporated into land use, economic development, and infrastructure planning." The goal was to protect, and where needed enhance, environmental quality. Specifically, the comprehensive plans "should minimize development and growth impacts -- and if necessary have offsetting requirements -- so as not to degrade air, land and water resources below accepted standards." Also, the commission recommended "lack of attainment in the state and federal environmental standards should be addressed by instituting stricter development standards, which if not adhered to, may be cause for limiting or precluding new developments."

The commission also called for regional plans for transportation to "contribute to an improved environment" and to be consistent with state or other regional environmental plans. It recommended that if local governments desire to undertake cooperative environmental planning efforts through regional processes that the state should support such efforts. The commission also recommended all new infrastructure and off-site impacts from master planned communities should be fully considered and paid for by the developer. It called for the appointment of a permanent Growth Strategies Advisory Council that would include representatives from the appropriate state agencies, such as transportation.

Finally, the commission recommended that the state's laws for development regulations should promote efficient processes that are balanced with environmental considerations. It called for existing state laws regarding local governments' approval of development actions to be reviewed to ensure that they result in efficient and fair procedures while meeting growth strategy goals.

In summary, the work of the Washington State Growth Strategies Commission extended, refined, and further defined the provisions in the Growth Management Act of 1990. The commission was much more proactive in its call for an Environmental Management element to be a part of each comprehensive land use plan so that the planning goal of protecting the environment and quality of life would be institutionalized into the process.

The legislature responded to the work of the Growth Strategies Commission with a Growth Strategies Bill introduced in the 1991 regular session of the legislature (House Bill 1025). The initial bill was very detailed and comprehensive, and contained many provisions that could have impacted upon the noise mitigation efforts of WSDOT. These provisions will be outlined below for reference information. However, it should be noted that the final version of the resultant Growth Strategies Act of 1991, which was passed as Reengrossed Substitute House Bill 1025, removed many of the most significant provisions of its earlier version in terms of environmental protection. The implications of the Growth Strategies Act of 1991 as it could apply to WSDOT's noise program will be described at the end of this section.

THE INITIAL 1991 GROWTH STRATEGIES BILL

As noted above, the Growth Strategies Bill introduced in the 1991 regular session of the legislature was a major, detailed extension to the 1990 Growth Management Act. In the Bill, the legislature found that "the lack of common goals and the absence of effective methods and procedures to plan environmentally sound land use to accommodate new economic and population growth at the local and regional level have contributed to severe problems and conflicts." Also, "A new system of land use planning and governance is needed . . . built upon . . . local accountability and initiative and the active involvement of citizens."

Among the planning goals were protection of the environment, including critical areas (e.g., wetlands and critical fish and wildlife habitats), natural resources of state-wide significance, and air and water quality. No specific mention of noise was made in the definition of the planning goals at the beginning of the Bill.

The Bill called for the comprehensive land use plans delineated in the Growth Management Act to include the following elements (the first six being carried over from the Growth Management Act):

1. Land Use,
2. Housing,
3. Capital Facilities Plan,
4. Utilities,
5. Rural,
6. Transportation,
7. Environmental Management,
8. Open Space,
9. "Fair Share,"
10. Historic Sites and Buildings,
11. Economic Development,
12. Design, and
13. Density.

The final version of the Growth Strategies Bill did not extend the list of elements beyond the initial six. Noise mitigation was mentioned under the Land Use element (Sec. 5.1 of the Bill) and Transportation element (Sec. 5.6.b.vi as an assessment to the provisions of the Growth Management Act). Specifically, the Land Use element was required to "incorporate noise exposure standards as defined by the Department of Ecology, identification of sources, including those from transportation facilities, and noise mitigation measures." Also, the Transportation element was called to include a facilities and services needs subelement that includes "identification of noise mitigation measures needed for existing or planned transportation facilities as defined in the Land Use element."

As written, the Bill give WSDOT the opportunity to have a profound effect on control of transportation noise impact on yet-to-be developed lands within the state of Washington. The Noise Unit of WSDOT had been given the charge within the 1991 Transportation Policy Plan to require that local land use plans identify excessive noise impacts and to develop a state transportation program to mitigate those impacts.

Clearly, the most effective strategy for long-term control of traffic noise problems is through land use management and control.

The final version of the Growth Strategies Act eliminated the references to noise in the Land Use element. Nonetheless, noise is a concern to many of the cities and counties. The Noise Unit should move quickly within the next year to be able to provide the needed technical assistance to counties and cities as they develop the Land Use elements of their comprehensive plans. Further, the Noise Unit must move aggressively to insure that funding mechanisms are in place to provide noise mitigation. These funding mechanisms could take the form of development fees to be paid by developers or state legislated funds for noise mitigation along existing transportation facilities.

The Noise Unit also needs to be prepared to provide on-going technical assistance to cities and counties during the implementation stages of their plans. Specifically, the Noise Unit can serve as a technical resource to developers and as a reviewer of noise mitigation plans. It may be possible to pass the costs of these activities on to the developers. This role by the Noise Unit is essential to insure integration of developer-funded noise mitigation measures and state DOT noise control measures from points of view such as acoustical performance and integrity, and aesthetic quality. The Noise Unit also needs to ensure that it has a working relationship with the Department of Community Development, which has primary implementation responsibility of the final Act.

There were aspects of the other elements that were to be added to the comprehensive plan that are worth noting in case they resurface. For example, Section 5.2.b.iii of the Bill called for a Housing element that, for certain size cities and counties, must include "identification of zoning restrictions that unduly limit density or which unreasonably increase housing development costs." While not in the final Act, this goal could be in conflict with the goal of passing noise mitigation costs onto the developer or could encourage high density development, which might potentially be located along transportation facilities. Likewise, Section 5.2.d of the Housing element encouraged cities and counties to facilitate the siting of mobile home parks by decreasing lot size and setback requirements. While also not in the final Act, such an objective could allow mobile home parks to be located very close to the state right-of-way without proper noise mitigation.

As another example, the Capital Facilities Plan element requires a forecast of the future needs of public capital facilities and a "requirement to reassess the Land Use element if probable funding falls short of meeting existing needs." A definition of capital facilities is not given, but is needed, to determine if noise mitigation measures such as barriers are included in that definition. Given that "probable funding" typically falls short of needs, a requirement to reassess the Land Use element could lead to an assignment of low priority to noise mitigation (possibly leading to its deferral or elimination).

The Transportation element of the Bill, as a carryover from the Growth Management Act, included a demand management sub-element that would have permitted higher density development in certain areas if conducive to alternatives to single occupant vehicles, such as public transit. Such permission could lead to increased pressure for development closer to the state right-of-way than would otherwise occur, with a potential increase in the resulting noise impact.

The newly added Environmental Management element specifically focused on air, water and natural resource quality. Recognition was not given in this element to the importance of noise impact and mitigation. This element was dropped from the final Act, but if added back through subsequent amendment, noise should be officially acknowledged as an important aspect of environmental management.

The Open Space element was also not linked specifically with noise impact and mitigation. In once sense, open spaces can be noise abatement measures themselves by acting as a buffer zone between noise sensitive land uses and transportation facilities. In a second sense, open spaces may require noise mitigation for themselves if one of their intended purposes was peacefulness and tranquility.

The Bill called for a Design element for certain sized cities and counties, which "at a minimum, addresses bulk and scale of new buildings adjacent to developed areas." Additionally, an optional element of the plans would be a design element "that enables communities to harmoniously fit new development with planned or existing community character and vision." Both of these design elements, while deleted from the final Act, offered WSDOT an opportunity to influence or provide for some consistency of developer-installed noise mitigation measures along transportation facilities. The recent example of Toronto, Canada, needs to be noted carefully. Many miles of developer-built noise barriers were installed on private property along transportation facilities using an inferior concrete panel product. Within one to two years after installation, the concrete panels are crumbling and the responsibility may fall onto the Ontario government to replace these barriers at its cost. WSDOT should develop minimum materials or systems standards for noise barriers that cities and counties might include as part of their comprehensive plans. Indeed, it would probably be a wise investment for WSDOT to develop the capability to test and approve systems for use by developers, cities or counties for noise mitigation along transportation facilities.

The Bill also extended the discussion of "urban growth areas" in the Growth Management Act to note that, "new development should be designed to respect the planned and existing character of neighborhoods and to mitigate the effect on the environment . . . ." This requirement, deleted from the final Growth Strategies Act, would have provided justification for intelligent site layout for noise mitigation and for creative aesthetic treatment of barrier systems to fit character of the neighborhoods.

Beyond the specifics of the comprehensive plans, other sections of the Growth Strategies Bill were relevant to the WSDOT noise program. These sections are noted below.

Section 11 of the Bill dealt with "new, fully contained communities" and includes as one criterion for approval, that "environmental protection have been adequately addressed and provided." Kept as Section 16 of the final Act, this section provides the opportunity for intelligent, integrated development (with WSDOT technical assistance), with noise mitigation as a possible objective.

An important part of the Bill was Section 15, dealing with impact fees, which was a carryover from the Growth Management Act. Impact fees could be used to pay for public facilities needed to serve new growth and development. Noise mitigation measures such as barriers or berms were not specifically defined as public facilities. WSDOT needs to investigate if impact fees may be imposed for noise mitigation purposes. If not, some means of placing the financial burden for provision of these measures onto the developers must be established. "Open space" is specifically mentioned as a public facility, implying that a noise mitigation measure such as a buffer zone could be funded through impact fees.

Section 16 of the Bill called for an environmental impact statement to be prepared for comprehensive plans and development regulations that are considered for adoption. This section was dropped in the final Act, but would have required the Noise Unit to be prepared to provide procedures to counties and cities for addressing the noise impact and mitigation portions of the environmental impact statements on their comprehensive plans.

Section 17 of the Bill called for the Department of Ecology to establish at least four pilot projects on environmental review to determine whether the review process can be improved. Goals were more coordination and elimination of duplicative reviews. By the end of 1993, the Department must evaluate the effectiveness of the pilot projects, report to the legislature and Department of Community Development on its findings and recommendations for further legislation, consider promulgation of any further regulations or guidelines, and prepare and circulate instructional manuals or other information to assist cities and counties in preparing their plans. This section was retained in the final Act as Section 20.

WSDOT should play an active role in the development, monitoring and evaluation of these pilot projects. The Noise Unit should examine its potential role in the environmental review of comprehensive plans and needs to be prepared to develop instructional material and other information used by the cities and counties. An example of first line type of technical support is the brochure on "Highway Traffic Noise" that WSDOT is currently preparing. It would be useful to include in that brochure specific reference to the Growth Management Act and Growth Strategies Act with reference to the comprehensive land use plans. Development and provision of simplified screening, analysis and abatement design methods would also be appropriate for the Noise Unit, in coordination with the Department of Community Development.

Section 18 of the Bill dealt with building permit applications. Comprehensive noise mitigation strategies for communities could include the use of provisions in building permits as one means of securing noise mitigation by the developer. However, this section was not included in the final Act.

Section 22 of the Bill dealt with neighborhood participation in the planning process and called for "neighborhood inclusion processes" for certain size cities. Neighborhood groups would be allowed to develop "neighborhood plans," and a city would be required to provide help in the development of impact mitigation measures when a neighborhood increased its density or when state or regional public facilities were sited within it. The section was deleted from the final Act. If it had been retained, the cities would have needed guidance in providing this impact mitigation measure development assistance to the neighborhood groups. Responsibility would have probably fallen upon the Noise Unit to provide this guidance material, which could logically include training courses for city personnel.

Also of interest were Sections 43 through 48 of the Bill, which dealt with a new Committee on Natural Resources of State-wide Significance, the designation of such resources, and the preparation of open space maps. Specifically, Section 47.1.b required this committee to "develop recommendations on minimum standards to be used by counties and cities to protect natural resources of state-wide significance within their jurisdiction." The Department of Transportation was not designated as a member of this committee, despite the fact that transportation facilities (and their noise) can have a major impact on these natural resources (which were defined earlier in Section 2.17). The Noise Unit needs to be prepared to deal with the issue of what constitutes an impact in a low-noise environment, such as a pristine area. One could easily argue that the current Federal Highway Administration Noise Abatement Criteria in its Noise Standards for Activity Category A ("lands where serenity and quiet are of extraordinary significance") are much too high for natural resources of "state-wide significance". Court challenges over impact criteria could be expected. The Noise Unit should look at guidelines that have been developed for noise impacts in National Parks and Forests, written in terms of "detectability", if it wishes to be proactive. In the final Act, the committee creation was retained, but the committee was made temporary, with a report to the legislature due at the end of 1991.

Sections 54 and 55 of the Bill called for establishment of a State Agency Coordinating Council that was to include the Secretary of Transportation. Among other items, this Council was to make recommendations to the legislature and governor regarding development of a "capital investment strategy", as well as changes to state agency programs and existing funds to reprioritize them in view of the investment strategy. The Council's recommendations were required to address creating a new growth management financing account which would finance infrastructure needs based on regional economic planning under Section 52 of the Bill. The recommendations also needed to address provision of "incentives to counties and cities to comply with the growth management requirements." These sections were deleted from the final Act. Their inclusion would have given the Noise Unit the opportunity to provide input to the Secretary of Transportation so that reprioritization of programs and funds would consider noise mitigation. In addition, the Noise Unit could have investigated the use of this growth management financing account and the "incentives" to cities and counties as other means of funding noise mitigation.

Section 60 of the Bill addressed the importance issue of technical assistance to the cities and counties for preparing comprehensive plans and development regulations, which had also been a part of the Growth Management Act. As noted earlier, the Department of Community Development was charged with establishing a program of technical assistance and was told to utilize both department staff and the staff of other state agencies. The technical assistance provisions were retained in the final Act. Thus, the Noise Unit can be expected to be called upon by the Department of Community Development and needs to be properly staffed to provide that assistance without impeding on its current duties.

However, the Noise Unit needs to know that environmental areas such as water quality have been specifically mentioned in the Acts while noise has not. As a result, noise mitigation may be given a lesser priority either by design or necessity, in times of tight funding. Nonetheless, WSDOT (probably in the form of the Noise Unit) needs to be adequately staffed so that it can be diligent in seeing that the environmental protection goals of both the growth legislation and the 1991 State Transportation Policy Plan are carried out. The many activities delineated in both of these initiatives indicate that current staffing will probably need to be increased for success in meeting noise mitigation goals.

Part IX (Sections 85-98) of the Bill dealt specifically with transportation. Of particular interest were Sections 87, 88, and 96. Section 87 was an amendment to the legislative code on Priority Programming for State Highways calling for coordination with the comprehensive land use planning. The discussion involved four of the WSDOT categories for highway improvement (A, B, C and H) that focus on the existing state highway system, the interstate system, other major transportation improvements, and existing bridges on the non-interstate highway system. While this specific tie-in to the comprehensive plans was not included in the final Act, the Noise Unit and other environmental units within WSDOT may wish to consider proposing a new category of highway improvement, namely: "Environmental Mitigation and Enhancement Improvements." In principle and philosophy, such a category is precisely in line with the 1991 Transportation Policy Plan for Washington State, the 1990 Federal Highway Administration Environmental Policy Statement, and the National Transportation Policy. Establishment of such a category would be a bold action by WSDOT indicating its serious concern and commitment for environmental mitigation and enhancement. A noise barrier retrofit program for existing highways could be funded from monies in this category.

Section 88 of the Bill dealt with an amendment to the Project Criteria for the Allocation of Funds from the Transportation Improvement Account in the Motor Vehicle Fund. The amended criteria related to: relief of congestion, movement of people and goods, alternative modes of transportation, conformance with the comprehensive plans, consistency with high-capacity transportation and freight rail considerations, and partial funding by local or private contributions. While the criterion of conformance with the comprehensive plans would ensure that certain considerations of environmental impact are addressed, there was no formal statement that environmental mitigation and enhancement should be considered as project criteria (other than the requirement for consideration of environmental impact by law). Given the high priority assigned to environmental protection in 1991 Transportation Policy Plan, it is entirely appropriate that environmental mitigation and enhancement be added to the list of criteria to be considered for awarding of funding to specific transportation projects from the Transportation Improvement Account (in addition to air quality, which addressed through the state air quality implementation plan and the Clear Air Act Amendments of 1990). While this section was not part of the final Act, consideration should still be given to the concept of environmental considerations in project selection.

Section 96 of the Bill dealt with the production of a State-wide Transportation System Plan. One component would be the State Highway System Plan. The plan was to contain three elements: system preservation, capacity and operational improvements, and scenic and recreational highways. In the Bill, the second of these three elements called for conformance with the state implementation plan for air quality; however, there was no other specific mention of environmental protection. This section was not part of the final Act, but if the subject is revisited, consideration should be given to adding a fourth element to the State Highway System Plan, namely, the mitigation and enhancement of environmental impacts.

In summary, the Growth Strategies Bill was a significant proposal with respect to environmental quality related to the development and implementation of comprehensive land use plans by cities and counties. Control of noise from existing and planned transportation facilities was specifically mentioned as a component of these plans with the likely use of the Department of Transportation for assistance with transportation noise mitigation.

As will be discussed below, the final Growth Strategies Act was shortened significantly with many of the key provisions of the Bill deleted. The Noise Unit should still take a proactive role and become heavily involved in providing technical assistance for comprehensive plan development and implementation as they relate to transportation noise. Technical, physical and philosophical consistency between the various state agencies and city and county governments are essential for attacking the problem of transportation noise in a comprehensive system-wide manner. Mitigation of existing noise impacts and prevention of future noise impacts are both key components of a successful program to improve the noise environment in Washington State's communities.

THE GROWTH STRATEGIES ACT OF 1991

As noted above, the final Growth Strategies Act of 1991 that was passed by the legislature differed significantly from the earlier Growth Strategies Bill that had been initially submitted and debated. All of the detailed provisions calling for additional elements to be part of the comprehensive land use plan (beyond those in the Growth Management Act of 1990) were deleted. Of special significance were the deletion of the Environmental Management element, and the deletion of the requirements in the Land Use element regarding noise exposure standards and noise mitigation. Other potential opportunities for action as part of a comprehensive system-wide noise reduction program were also lost with deletion of the provisions on design elements, building permit applications, neighborhood inclusion processes, environmental impact statements on the plans, the state agency coordinating council, and the transportation sections dealing with priority programming for state highways, project criteria for allocation of funds in transportation improvement account, and the state-wide transportation system plan. Still included from the Growth Strategies Bill of 1991 were the sections on new fully contained communities (new Section 16), new master planned resorts (new Section 17), open space protection (new Section 19) and the environmental review pilot projects (new Section 20), and the Committee on Natural Resources of State-wide Significance (new Section 37).

Also, still valid as carryovers from the Growth Management Act of 1990, with their potential for impact on the WSDOT noise program, are the sections dealing with impact fees, the real estate excise tax (new Section 33, amending the Growth Management Act), and the program of technical financial assistance and incentives to cities and counties (new Section 3, amending the Growth Management Act).

Additionally, the Growth Strategies Act of 1991, in new Sections 5 and 6, created three geographically-based growth planning hearings boards to act on issues brought before them regarding the implementation of the comprehensive plans. WSDOT should be prepared to educate these boards, as needed, on the importance of noise mitigation through comprehensive land use planning. Finally, Section 26 of the Growth Strategies Act gives the governor the power, upon a finding that state agency, city or county is not in compliance with the Act, to withhold revenues to the city or county from the Motor Vehicle Fuel Tax, the Transportation Improvement Account, the Urban Arterial Trust Account and the Rural Arterial Trust Account, among other sources of revenue.

In summary, the Growth Strategies Act of 1991 did not fully implement the recommendations of the Washington State Growth Strategies Commission, especially as they apply towards institutionalizing environmental management as part of the comprehensive land use planning process. Also, by deleting the requirement for consideration of noise mitigation in the Land Use element of the comprehensive plan, the Growth Strategies Act of 1991 has neglected probably the best long-term measure to insure that the management of growth within the State of Washington would be done in a way to minimize noise impacts both on that growth and due to that growth.

However, the Act does not prevent or preclude WSDOT from encouraging noise mitigation as part of the Land Use element. The provisions on technical assistance and planning grants call for action by the Department of Community Development and other state agencies; WSDOT can and should take a leadership role by seeing that one focus of the technical assistance includes noise mitigation through land use strategies. Support for such a role may also be found in Section 16 on new fully contained communities, which notes that one criterion for approval of such communities is that environmental protection has been "addressed and provided for." Also, Section 17 on new master planned resorts notes that these resorts may only be authorized if on-site and off-site infrastructure impacts are fully considered and mitigated. Despite these opportunities presented in the Act, WSDOT should continue to work through the legislature to see that formal inclusion of an environmental management element and noise mitigation strategies are made part of the comprehensive land use planning process through amendments to the Growth Management Act of 1990 or the Growth Strategies Act of 1991.

WASHINGTON STATE DOT STRUCTURE

Any comprehensive system-wide noise mitigation strategy for Washington State must be considered in the context of the organization of the Department of Transportation. This section examines the organizational structure from the point of view of interaction and effects upon the Noise Unit. WSDOT has a hybrid organizational structure, being organized both by function (e.g., program development, operations, planning and research, local programs, finance and budget management) and by mode (e.g., marine transportation, aeronautics and public transportation). The hybrid structure even carries down to the Assistant Secretary level, at least in the Planning, Research and Public Transportation Division. Additionally, six district offices provide direct project planning, design and construction, and facility maintenance and operation, as well as local and regional planning representation for their jurisdictions.

The Noise Unit (which currently consists of one noise specialist) is located under an Environmental Resource Manager within the Environmental Branch of the Design Office within the Program Development Division. Additionally, environmental project managers and environmental review specialists are located within the Environmental Branch. The Design Office reviews and approves designs for all aspects of the transportation facilities including environmental systems (and therefore, noise mitigation).

At least three other offices in the Program Development Division should interact with the Noise Unit. An Architecture Office provides architectural services for transportation systems, which would include noise barriers. Secondly, the Bridges and Structures Office designs and inspects the State's bridges, and such as such, would have an important role in any proposed noise mitigation on bridges or other structures. Third, the Real Estate Services Office would play a role in right-of-way acquisition for noise mitigation, obtaining easements for barrier construction off the right-of-way, etc.

The Local Programs Division has as its mission the assistance and support of the State's thirty-nine (39) counties and two hundred sixty-eight (268) cities. That mission includes the provision of technical services for design, construction and operations, the provision of engineering and technical training, and the provision of information on new technologies, innovations and efficiencies. The division conducts technical training, provides assistance to local government and manages a technology transfer center for local agencies. Logically, the division could play a major roll in the implementation of the Growth Strategies Bill in the development of comprehensive plans by the cities and counties (which will include noise mitigation subelements).

Likewise, the Planning, Research and Public Transportation Division will have a major, if not the lead roll in the city/county comprehensive plan implementation process. It is the mission of this division to provide planning and technical support to transportation and local regional transportation planning organizations. It administers a regional transportation planning program which provides a link between land use and transportation planning, and assists local and regional government agencies with technical and financial assistance. It also conducts or manages the conduct of research on topics that include environmental impact mitigation.

Also, the Aeronautics Division is responsible for supporting the State's four hundred and sixty-one (461) airports and one hundred twenty-eight (128) heliports through planning for future aviation needs and through provision of assistance to cities, counties and port districts for local airport construction and improvement. Aviation noise impacts have been described by the Federal Aviation Administration (FAA) as the single, largest problem affecting the operation, capacity and growth potential of our nation's airports. Departmental expertise in aviation noise is important, especially as the FAA develops regulations to implement the new National Aviation Noise Policy passed by the U.S. Congress in October of 1990.

The Noise Unit provides numerous functions to the department. These include:

1. development of noise analysis and mitigation policies, rules, procedures and methods,
2. district noise specialist training,
3. district noise analysis review and advice, and
4. research project planning and monitoring.

The Noise Unit represents the department in dealing with the public, the legislature, and other state and local agencies. These agencies include the Attorney General's office, and the departments of ecology and community development. As such, the Noise Unit must play a liaison roll within the department beyond its division in dealing with offices such as operations, public transportation, aeronautics, research, transportation planning, local programs (especially technology transfer), and legal affairs.

The role that the main office Noise Unit will play with each of the district offices will vary from district to district. Factors such as the number of projects requiring noise analysis, the number of available people to do this available work, and the experience and expertise of the staff will affect the nature and extent of interaction with each district. District 1, for example, with cities such as Seattle, Everett, and Bellingham will have a much different workload than Districts 2 and 5 (in terms of the number and complexity of the projects requiring noise analysis studies). District 1 currently has an Air and Noise Unit that consists of four personnel and the unit supervisor. Three of the four personnel are full-time noise specialists.

Currently, the noise experts within the District 1 and 4 offices are able to function with minimal main office assistance, and actually serve as advisors to the main office staff. Having this advisory feedback is important for the main office staff in terms of formulating policies, procedures and research needs statements.

Involving the people charged with noise responsibilities in the other districts is also important. If not already done, a meeting of the noise engineers from each district with the main office staff should be held at least annually. These meetings could be conducted in conjunction with advanced or refresher training and briefings on new policies and procedures. The meetings could be rotated between the main office and the districts to give all involved a chance to see each other's abatement projects.

Thus, while the main office noise specialist function is located organizationally within the Design Office of the Program Development Division, the Noise Unit must provide technical support across organizational lines within its own division, across other main office divisions, and in the districts. Knowledge that a noise specialist exists within the Design Office of the Program Development Division, if such information is known, neither requires nor guarantees that the specialist will be consulted on issues that need expertise in noise for proper input to decision making.

While formal organizational changes may not be warranted, some consideration is needed. First, the department has described noise abatement as an important goal in the State Transportation Policy Plan. Second, the department has defined specific action strategies: noise mitigation through land use control; highway project mitigation; and examination of alternative modes. Third, the Growth Management and Strategies Acts call for comprehensive land use planning by cities and counties that could lead to noise mitigation measures for existing and planned transportation facilities. Finally, the new National Aviation Noise Policy passed by Congress will necessitate in-house WSDOT expertise to assist airport and heliport operators in the implementation of the Policy. No doubt, the duties, responsibilities and work load of the Noise Unit and the district offices will increase if the State wants to successfully mitigate transportation noise on a system-wide basis.

WSDOT TRAFFIC NOISE PROGRAM DOCUMENTS

Four documents on the traffic noise program provided by WSDOT were reviewed for this study:

1. Position Paper: Criteria for Programming of Noise Attenuation Work, August 24, 1983,
2. Noise Evaluation Procedures for Existing State Highways, Directive D22-22, November 2, 1987,
3. WSDOT Noise Abatement Program, with a January 4, 1989 cover letter from C.L. Slemmer, and
4. Partial Draft of a Proposed Directive on Noise Abatement, WSDOT Environmental Branch, 1991.

The first document presented four criteria for accomplishing noise attenuation in construction programs. The four criteria were: (1) defined need; (2) priority order; (3) uniform rate of correction across the state; and (4) modest, reasonable cost. Responsibility was given to the district offices to establish and maintain a list of priorities. Each district was also asked to begin to address its problems with a level of effort commensurate with the noise needs relative to the other needs in the district.

The second document, which superseded a 1975 document of the same name, presented a Type II noise barrier priority listing of 28 projects. This directive gave a procedure for inventorying and prioritizing the noise abatement sites. The inventory procedure first identified all highway sections where an Leq of 67 dB or greater occurred at the right-of-way line. A second-level screening eliminated highway sections without residential development, with physical restrictions on practical solutions, or where roadside development, including access driveways, precluded noise barriers. An on-site inspection then preceded a second, more detailed prediction phase to determine a benefit/cost computation, which led to an expression of a noise impact and a noise barrier priority number. Several comments are in order on the procedures. First, the procedures make a point to carefully note that sections excluded from the priority listing be documented with reasons for their exclusion. Such documentation is essential when responding to requests for abatement measures. Second, the procedures use the philosophy of only listing those areas exceeding an L_{eq} of 67 dB. A second philosophy is to prioritize down below the 67 dB level (to a value of 55 dB, for example). This ranking establishes impacts without regard to feasibility of abatement. The advantage is that many more sites are listed, providing visible evidence as to why certain sites are unlikely to receive abatement. Once this ranking of impacts is available, then the consideration of feasibility, effectiveness and cost of abatement can be introduced to produce the barrier construction priority list.

The procedure properly groups the number of people exposed to different noise levels at a site, rather than counting all people who receive some benefit equally. Finally, the procedure does not seem to make provision for special noise-sensitive land uses, such as in FHWA Activity Category A, which should be included.

The third document, on WSDOT's Noise Abatement Program, builds upon the procedures in Directive D 22-22. Seventy-seven sites were listed in the priority ranking for noise abatement. The document did a very good analysis of the types of funding sources available for highway noise abatement under current state and federal legislation. It also analyzed the costs for each priority site in terms of these various funding mechanisms.

Both the document and its accompanying cover letter acknowledged the Department's concern for traffic noise impact but also described the funding reality. In fact, noise mitigation receives a low priority relative to other departmental needs such as maintaining and improving the existing highway system. The document notes that "demand for funds in other critical areas absorb funding allocations, especially state funds." It further notes that while most of the high priority sites are on the interstate systems, "noise projects must compete with other environmental mitigation projects which the Department is committed to construct."

From a list of seventy-seven (77) priority sites, only two projects were funded and built between 1986 and January, 1989. At the rate of two projects per three years, it would take over 100 years to complete the projects on the priority list. It must be noted that this list only contains sites where the Leq exceeds 67 dB. The FHWA Noise Standards say that when the level approaches or exceeds 67 dB, the impact is serious enough to warrant mitigation. Using a 2 decibel cushion for defining the word "approach", which WSDOT is proposing in the fourth document, the number of priority sites would grow well beyond 77.

Clearly, if the State of Washington wants to be able to act on its policy statements to abate traffic noise, funding must be made a priority. With an accumulated cost of nearly $15 million dollars (in 1985 dollars) for only these 77 sites, a Type II funding level of $3-4 million dollars a year would seem appropriate. With that level of funding, the effects of inflation, and the inclusion of sites between 65 and 67 dB, WSDOT could probably complete its noise barrier retrofit program in six to eight years. With proper staffing (or use of consultants), such an abatement schedule is feasible and certainly much more realistic than the current situation.

One other item of consideration is the State's use of a value of $8,000 per residence protected as a measure for determining cost effectiveness of a barrier. This value appears to be quite low relative to those used by other states, although WSDOT does consider more than just the front row receivers, while some other state DOTS do not. Nevertheless, value on the order of $20,000-25,000 per residence is suggested.

The fourth document was a partial draft or actually an outline of a proposed new directive on noise abatement. The directive would apply to both state-funded and federal-aid projects both for new construction and retrofit noise abatement. The development of this directive is an excellent idea and its periodic review and update would be appropriate. The document quantifies some of the qualitative terminology in the FHWA Noise Standards defining noise impact. Use of a 2 dB value to define "approaching" the noise abatement criteria is an appropriate value. Also, defining a "substantial increase over the existing noise level" as being 10 dBA is consistent with the value used by half of the respondents to the Maryland DOT Survey on noise abatement program issues discussed earlier in this report. When completed, the WSDOT directive should be a useful document for applying the FHWA traffic noise standards to WSDOT highway projects.

RECOMMENDATIONS FOR WSDOT IMPLEMENTATION AND RESEARCH

This study was conducted with six areas of interest to WSDOT in mind:

1. noise abatement strategies at the source, at the receiving property, and along the path between them,
2. state and local noise ordinances, legislation and regulations,
3. traffic noise research,
4. successful noise program communications techniques,
5. legal decisions, and
6. state DOT administrative and programmatic issues such as staffing, funding, and prioritizing abatement, and funding research.

The findings of this study, both in terms of the state of the art review and the reviewed Washington State legislation, regulation and policy, have led to a series of recommendations, presented below, addressing these various areas of interest. There is some duplication among those recommendations that fit in one or more of the above areas.

Noise Abatement Strategies Available to WSDOT

The following recommendations are rather specific, based on the information collected from other states DOTs on various abatement measures:

1. WSDOT should develop specifications for sound-absorbing barriers to avoid previous problems that some states have had with certain materials and systems;

2. WSDOT should consider the use of transparent barriers in situations where the view of the receivers is important, but should avoid locating these barriers along the roadway shoulder due to maintenance problems;

3. WSDOT should investigate the use of the Evergreen Noise Barrier System where the appearance of a berm is needed but space is not available; the Noise Unit may wish to monitor the progress of the Pennsylvania DOT project on I-476;

4. WSDOT should look to the strategy of depressed highways where feasible but should be careful to analyze the potential multiple reflections effect; further study of its own tilted noise barriers as an alternative to sound absorbing barriers is warranted;

5. WSDOT should continue to consider the use of noise barriers on non-limited access highways where curb cuts are not present and sight distance problems with cross streets can be avoided;

6. WSDOT should be open to the placement of noise barriers off of the state's right-of-way where such location could be the most effective acoustically; legal issues regarding easements needs to be investigated;

7. WSDOT should monitor the experiences of the Ontario Ministry of Transportation in its use of recycled tire crumb as a possible material for noise barrier panels; the state should also coordinate with other states investigating the use of recycled plastics and noise barrier materials;

8. WSDOT should develop a policy regarding the contribution of private funds toward the construction of a Type II noise barrier where such a contribution would move the project up on the State's priority list; the issue of discrimination against poor people must be addressed;

9. WSDOT should initiate a study on the extent of noise impacts on schools located near highway projects, using the California DOT program as a model; WSDOT should then look to develop a school noise abatement program and seek special funding from the State Legislature to fund it;

10. WSDOT should investigate the legal issues regarding the noise insulation for Type I and possibly for Type II projects; the noise insulation of private schools and churches has been done successfully elsewhere in the country as long as attention is paid to issues such as maintenance and repair responsibilities and effects on utility costs;

11. WSDOT should also be open to the sound insulation of private residences in unusual circumstances; simply because a noise barrier is not feasible, a severely impacted residence should not automatically be disqualified from consideration for abatement by an alternative measure; the experience of the Seattle-Tacoma International Airport in its sound insulation program would be of great benefit to the Noise Unit;

12. WSDOT should continue with its research on the noise properties of open-graded asphalt especially as it relates to roadside levels;

13. WSDOT should consider the use of truck restrictions, either in terms of hours or routes (or both), in cases where there will not be interference with interstate commerce; truck restrictions have allowed states to reduce the height of noise barriers in severe impact situations; the Noise Unit should be aware of efforts elsewhere in the Department to possibly shift truck deliveries to night time hours to avoid daytime traffic congestion; and

14. The use of reduced speeds as a means of noise abatement should generally not be considered; the effects are marginal for the possible costs incurred in terms of traffic capacity.

State and Local Ordinances, Legislation, and Regulations

Some of the most effective noise mitigation measures are out of the direct control of the Department of Transportation but require its guidance and assistance to be successful. Most of the following recommendations are summarized from the earlier discussions on the Growth Management and Strategies Acts:

1. WSDOT should have an active involvement in the implementation of the Growth Management and Strategies Acts;

2. The Noise Unit of WSDOT should play a major role in providing technical assistance to cities and counties in the development of noise mitigation components of the comprehensive land use plans, and the implementation of those components (e.g., review of residential developer noise barrier designs).

3. WSDOT should help the Department of Community Development with the preparation of instructional materials and courses to assist in comprehensive plan development and implementation; these materials include model ordinances and simple analysis techniques;

4. WSDOT should seek amendments to the growth legislation to permit the use of impact fees, capital facilities money and real estate excise taxes for noise abatement.

5. WSDOT should become the lead agency for the development of noise barrier design specifications for residential developers; the Department should take a lead role in the testing and approval of proposed barrier materials and systems;

6. WSDOT should support the revival of a noise program in the U.S. Environmental Protection Agency, and should support an expanded program in noise control within the appropriate state agency; emphasis of the EPA Program should be on:

   a. technical assistance,

   b. funding assistance,

   c. training,

   d. investigation of a need for noise standards for newly manufactured automobiles and buses,

   e. investigation of the need for noise standards for tires, and

   f. examination of the degree of compliance with the noise regulations for motor carriers engaged in interstate commerce.

Administrative and Programmatic Issues

All of the above material has pointed to the facts that the duties and responsibilities of the Noise Unit are already quite extensive, and will certainly grow in the future if WSDOT wants to be successful in mitigating of traffic noise through source control, path control and receiver control. This section addresses recommendations dealing with the administration of the WSDOT noise program. Part of these recommendations are summarized from the earlier material in this section on the WSDOT Choices in Transportation for Washington's Environment process and the 1991 State Transportation Policy Plan.

1. The Noise Unit must be in position to respond to the specific noise initiatives being considered in the Choices process:

   a. encourage local agencies to adopt noise compatible land use plans for undeveloped areas near highways,

   b. continue to install noise barriers to protect noise sensitive land uses along existing highways, and

c. consider alternative abatement measures such as the I-90 lids,

Also, the Unit must be in a position to address the consequences and/or benefits on the noise environment from other environmental policy initiatives (e.g. congestion management and relief, air quality improvement, transit, alternative fuels, alternative modes, hazardous materials truck routing, visual quality).

2. The Noise Unit must be in a position to respond to the four action strategies in the 1991 Policy Plan:

   a. evaluate and minimize noise impacts on new facilities,

   b. interact with local officials to require land use plans to identify excessive noise impacts, identify where mitigation is needed and establish patterns of land uses and building codes to minimize future noise impacts,

   c. develop a noise mitigation program for impacts identified in the local plans,

   d. support research of low noise alternative transportation modes.

3. The Noise Unit needs to examine its current prioritization method for existing highway noise abatement; the priority listing should include areas with levels as low as 55 dB (for impact identification) and seek to mitigate areas with levels of 65 dB or greater; funding policies and programs must be developed; legislative or administrative action must be taken to make funds available to abate the noise; a Type II noise barrier retrofit funding level of $3-4 million per year (current dollars) appears to be needed to complete the noise barrier retrofit program in six to eight years; increased staffing (or use of consultants) is essential to complete this program.

4. WSDOT should consider an increase in staff to adequately deal with the local comprehensive land use plan initiatives especially if WSDOT decides to act on the opportunities in the legislation for noise mitigation; this staffing could logically be in the Local Programs Division, the Planning, Research and Public Transportation Division, or for consolidation of expertise, the Design Office Noise Unit.

5. WSDOT should take full advantage of current district office noise expertise, such as the Air and Noise Unit personnel in District. 1.

6. WSDOT should consider formally including a departmental noise expert in the regional transportation planning process; consideration should be given to establishing a Noise Mitigation Technical Coordinating Committee much along the lines of the Air Quality Technical Coordinating Committees

common in many MPOs; the WSDOT representative could come from the Design Office Noise Unit or expertise could be developed within the Planning, Research and Public Transportation Division; attention should be given to the action strategies in the Transportation Programming emphasis area of the policy plan regarding performance standards, monitoring and criteria for regionally significant projects;

7. The Noise Unit should interact with the Freight Mobility and Economic Opportunity Subcommittee in case that subcommittee is considering the potential shifting of truck deliveries to noise-sensitive night time periods;

8. The Noise Unit should be involved in assessing potential noise impacts of initiatives related to privatization, such as the noise from toll road plazas; the Environmental Branch should have input into the State policy on privatization;

9. The Noise Unit should play a role in land use policy research on residential site design considerations;

10. WSDOT and its Noise Unit need to seize the opportunity provided in the Growth Management and Strategies Acts to control transportation noise through comprehensive land use planning:

    a. WSDOT should provide technical assistance to counties and cities during comprehensive plan development and encourage them to develop noise mitigation components in their plans;

    b. WSDOT should be active in helping establish a funding mechanism for this noise mitigation (development fees, impact fees, state legislative funds, real estate excise taxes, etc.);

    c. The Noise Unit should be a technical resource to cities, counties and their developers regarding noise mitigation in the implementation of the comprehensive plans and development of subsequent local regulations; WSDOT should consider establishing itself as the review and approval authority both of noise barrier materials and systems and noise barrier plans proposed through the comprehensive plan implementation (the unit needs to have a strong working relationship with Department of Community Development);

    d. WSDOT should seek amendments for noise mitigation measures to be defined as "capital facilities" and "public facilities" to open up funding opportunities for mitigation;

    e. WSDOT should seek amendments for the inclusion of noise mitigation as a subelement of the Land Use element and for the inclusion of an Environmental Management element in the comprehensive plans;

    f. WSDOT should have input into the "open space protection" aspects of the legislation in terms of open spaces either being noise mitigation measures or themselves requiring noise mitigation;

    g. WSDOT should develop minimum noise barrier materials and systems standards for developer-installed barriers along transportation facilities,

h. WSDOT should have input into the parts of the growth legislation on urban growth development areas, new, fully-contained communities and new master-planned resorts, in terms of the design of new developments to minimize environmental impacts;

11. WSDOT should play an active role in the development, monitoring and evaluation of the "environmental review pilot projects" called for in the growth legislation;

12. WSDOT should be prepared to be called upon by the Department of Community Development to develop instructional material and other information (and possibly training) useful to cities and counties for the preparation and implementation of their comprehensive plans and their neighborhood inclusion processes;

13. WSDOT should develop a technical assistance role in the review and approval of noise mitigation measures on subdivision plats;

14. The WSDOT secretary needs to be designated as a member of the Committee on Natural Resources of State-wide Significance. The Noise Unit needs to be prepared to address noise impacts in the low-noise environments that can be anticipated in these significant resources;

15. WSDOT should seek amendments to the growth legislation restoring the sections of initial Growth Strategies Bill regarding development of a "capital investment strategy," a new "growth management financing account," and "incentives to counties and cities to comply with the growth management requirements," with emphasis on noise mitigation;

16. WSDOT should consider the designation of a new category of highway improvement projects called "Environmental Mitigation and Enhancement Improvements;" this action would provide a formal mechanism to act on the WSDOT commitment toward the environment; a noise barrier retrofit program could be funded from this category;

17. WSDOT should consider adding environmental mitigation and enhancement as a criterion in its Project Criteria for Allocation of Funds from the Transportation Improvement Account;

Staffing

The Noise Unit, which currently consists of one noise specialist, performs a line function within the Design Office of the Program Development Division. As such, the Noise Unit interacts with other Division offices, such as architecture, bridges and structures, and real estate services. Additionally, the specialist serves as a resource of noise expertise to other divisions in the department (local programs; planning, research and public transportation; aeronautics; legal affairs) and to the six district offices. Notable among district office staffing is District 1, where the Air and Noise Unit consists of personnel and a supervisor; three of the four personnel are noise specialists. The main office and districts noise specialists are also a resource to the Department in its dealing with the public, the legislature, and local and other state agencies.

The following recommendations are made:

1. WSDOT should carefully examine its level of staffing to be able to adequately deal with the noise abatement action strategies in its the State Transportation Policy Plan and to be proactive in responding to the interest generated across the state during the debate over the Growth Management and Growth Strategies Acts. This staff expansion could be kept within the Noise Unit if there is formal departmental recognition of the Unit's role beyond its normal line function; based on the experiences of other state DOTs, a two-to-three person main office staff would be needed for an ambitious noise analysis and mitigation program that includes:

    a. working with the cities and counties and the other state agencies on the comprehensive land use plans,

    b. coordinating a Type II Noise Barrier Retrofit Program and providing technical assistance and review for district noise studies (both on Type I and Type II projects), and

    c. policy and procedure issues as well as methods development, training and research project monitoring.

2. Expertise is needed within the Architecture Office and the Design Standards Branch of the Design Office to develop noise barrier systems specifications, as well as a program for the review and approval of barrier materials and systems for use by developers in meeting the goals of the comprehensive land use plans, and

3. Expertise is needed on the subject of aviation noise to serve as a resource to the state's airports and heliports as they respond to the new National Aviation Noise Policy.

4. Increases in district office staffing (or their use of consultants) will probably be required if a Type II Retrofit Program is implemented (fifty percent of the currently listed Type II projects are in District 1 (38 of 77); Districts 5 and 2 have seventeen and fourteen projects, respectively, while Districts 3 and 4 each have four projects on the priority list). A six to eight year Type II Program would mean

about ten projects per year state-wide, or approximately five in District 1 and two each in Districts 2 and 5. While one noise expert in Districts 3 and 4 would appear to be sufficient for the workloads for both Type I and Type II projects, district staffing and workloads should be assessed if a major Type II program is initiated.

Traffic Noise Research

WSDOT has taken an active role in the last several years defining and conducting a traffic noise research program. For example, it initiated the NCHRP Project several years ago that resulted in NCHRP Report 311, Predicting Stop and Go Traffic Noise Levels. Currently, WSDOT has HP&R projects dealing with noise as follows:

1. Comprehensive System-level Noise Reduction Strategies, Vanderbilt University (this project),
2. Effects of Roadway Wear on Tire Noise Phases I and II, University of Washington, and
3. Alaskan Way Viaduct Traffic Noise Abatement Plan, University of Washington.

A Phase II effort for the first project is planned with eight anticipated emphasis areas:

1. motor vehicle noise reduction strategies,
2. estimating noise abatement potential and costs for vehicles,
3. evaluate new computerized noise models,
4. compare models with others in the U.S. and abroad,
5. review effects of laws and ordinances on vehicle noise and development of new technology,
6. evaluate successful community noise reduction programs,
7. develop guidelines for innovative barrier types, analyze cost data, and
8. develop a matrix of system-level abatement strategies comparing costs and benefits.

Additionally, research was proposed in the following areas:

1. measurement of the effect of highway noise barriers on air pollutant concentrations,
2. state-wide airport noise mediation plan,
3. CAD/noise analysis integration,
4. updated constant speed and varying speed vehicle noise emission levels,
5. tire/pavement noise, phase III,

6. special noise barrier applications,

7. departmental Type II noise abatement program evaluation,

8. free-field performance of absorptive materials used in noise barriers,

9. roadside tire noise prediction using transfer functions, and

10. field evaluation of noise barrier effectiveness.

Decisions were made to move forward on item 5 of the above list and Phase II of the comprehensive review for the 1991-1993 Biennium WSDOT Transportation Research Program. The State has also proceeded to elevate the fourth and eighth items in the above list to an NCHRP problem submittal for the FY 1993 NCHRP Program. The first stage problem statements received favorable reviews and second stage submittals were prepared in April, 1991.

The above research items seem to cover most of the aspects of what is needed in traffic noise research for WSDOT. Some specific items that would fall within one or more of those proposed research projects include: (1) effectiveness of titled walls, (2) durability of transparent walls (especially re: ultraviolet radiation), (3) the potential use of recycled rubber tire crumb and recycled plastics as barrier materials, (4) multiple reflections between parallel, vertical barriers, and (5) specifications for sound absorbing barriers. Also, the emissions levels measurements should look for compliance with the EPA Noise Regulations for Motor Carriers Engaged in Interstate Commerce.

While the proposed projects on CAD/Noise Analysis Integration was not carried forth in the HP&R research program, the improvement of the methods, analysis techniques and tools available to the district engineers and main office specialists should be a priority. Noise analysts cannot afford to work inefficiently using outdated tools given the use of modern computer technology by their design office colleagues.

One other item of possible research deals with noise impact criteria in areas of low-existing noise where quiet is essential. In particular, with the call in the Growth Management and Strategies Acts to designate natural resources of state-wide resources, WSDOT may have to consider impacts from transportation facilities from pristine environments.

Because of its strong in-house sponsored noise research program, WSDOT should take an increasingly active role within the Transportation Research Board, NCHRP, and FHWA Pooled-Fund Studies. WSDOT is becoming a leader in traffic noise research in the country with its current and proposed levels of effort and has an opportunity to play a national leadership role.

Communications Techniques

Good communications techniques are needed for dealing with the public, legislators, departmental upper administration and fellow engineers for answering questions and complaints, seeking information, and conveying proposed solutions. The following recommendations should help to improve this communication with the various parties.

1. The Noise Unit should develop a video tape for use at public meetings that describes the basic terminology of environmental noise and traffic noise predictions, demonstrates the change in sound levels before and after installation of a barrier (or at equivalent sites with and without a barrier), and illustrates various noise barrier concepts that WSDOT has implemented or would consider; WSDOT may wish to go outside the State to collect the appropriate video footage;
2. WSDOT should develop a video that focuses on the noise control efforts that went into the I-90 Project; this project is a national showcase and deserves specific recognition for its noise control measures;
3. WSDOT should continue to pursue video technology in its field reviews and as a means of noise measurement site documentation and should consider using some of the field review footage at public meetings;
4. WSDOT should continue to pursue the latest CAD technology to allow computer-generated displays of noise barriers; the Noise Unit should investigate the combined use of video and computer graphics to superimpose barriers and proposed highways onto existing terrain;
5. WSDOT should develop improved computer modeling and display techniques for the conveyance of design ideas and solutions to roadway designers; WSDOT should also use artists' renderings (including noise barrier overlays on photos) and posters of predicted noise contours on aerial photos in its public meetings;
6. WSDOT should continue with its preparation of the reprint of the FHWA brochure on "Highway Noise," but should customize it to be specific to the Washington State situation, including the

potential implications and opportunities in the Growth Management and Strategies Acts and the resultant comprehensive land use plans;

7. WSDOT should use informal discussions, open-house workshops and small group meetings to supplement more public meetings or public hearings;

8. The Noise Unit should consider the development of a periodic informal seminar series on the subject of traffic noise; the format could revolve around a lunch time gathering of noise experts in other state agencies and local agencies as well as elsewhere in the department; each seminar (perhaps on a monthly or bi-monthly basis) could feature a brief presentation from one of the participants on some aspect of their noise activities; upper management could be invited to these seminars, or asked to be featured speakers;

9. When specific noise problems arise that warrant a decision by upper management, the Noise Unit should make every effort to get upper management to visit the site with them in the field; there is no substitute for trying to carry out a conversation describing the problem over the roar of traffic to give an appreciation for the problem;

10. WSDOT should work with the Department of Community Development to develop Noise Technical Coordinating Committees within each regional planning organization, with a representative from WSDOT serving on committees; the Noise Unit should investigate the Colorado Highway Department use of "urban design committees" to involve the various agencies;

11. WSDOT should take an active role in the preparation of information and materials for use by local cities and counties in the development and implementation of their comprehensive land use plans; WSDOT should consider developing a training course or seminar for local officials who will need to deal with noise mitigation in their plans;

12. The Noise Unit should institute periodic meetings (at least annually) of the noise experts from each district office, to discuss new policies and procedures, to review projects of interest, and perhaps to provide some refresher or advanced training.

Legal Issues

The most commonly raised legal issue in the area of traffic noise deals with damages due to noise and whether or not they should be compensable (as a function of any taking of the impacted property). Additionally, there are a number of issues involving potential abatement measures that warrant some legal study.

1. The Noise Unit should work through the state attorney general office to develop a series of case histories on projects that have involved noise issues; in many instances, the environmental units often do not learn of all of the cases that a state is involved in defending;
2. WSDOT should investigate the legal aspects of obtaining easements to construct noise barriers off the state right-of-way; standardized easement agreements should be drawn up as a result of this investigation;
3. WSDOT should investigate the sound insulation of private facilities including schools, churches and residences; again, standardized agreements should be drawn up;
4. WSDOT should develop an agreement for a local government to sign endorsing the installation of retrofit noise barriers in its jurisdiction or agreeing to not install them. WSDOT should also consider agreements for the affected homeowners to sign, using the Connecticut DOT Model in Appendix D of the Technical Report as an example;
5. WSDOT should investigate the legal ramifications of allowing privately contributed funds to move a Type II barrier up on the State's priority list;
6. WSDOT should investigate if impact fees, development fees, real estate excise taxes, and the newly proposed growth management financing accounts and local growth management incentives may be used for the purposes of noise mitigation by cities and counties to mitigate existing noise impacts from transportation facilities;
7. WSDOT legal staff should follow the developments of the Federal Aviation Administration regarding its regulations in response to the new National Aviation Noise Policy.

Funding Issues

Adequate funding is required for WSDOT to be able to follow through on its commitments toward noise abatement in the 1991 State Transportation Policy Plan and to meet the opportunities and duties presented in the Growth Strategies Bill. Of top priority is funding for a Type II Noise Barrier Retrofit Program for existing highways. The following recommendations are made:

1. WSDOT should consider adding a new category of funding for highway improvements called Environmental Mitigation and Enhancement Improvements in addition to the current categories, such as A, B C, and H;
2 WSDOT should seek special legislation to fund the Type II program, which could be eligible in the above-noted new highway improvement category;
3. WSDOT should consider using a dedicated percent of the state gasoline tax (the amount depending on the adopted program) to fund its Type II noise barriers;
4. A funding level of $3-4 million per year in current dollars should allow the retrofit program to be completed in six to eight years;
5. WSDOT should be prepared to provide funding for an increase in noise specialists staff, both in the main office and those districts with large needs for Type I and Type II studies; as an example, a major Type II effort would seriously impact workloads in Districts 1, 2 and 5;
6. WSDOT should provide the Noise Unit with adequate line item funding to accomplish its many tasks;
7. WSDOT should look toward any new flexibility in the use of federal-aid funds in the new national Surface Transportation Bill for FY 1992;
8. WSDOT should provide adequate funding for staff in the Architecture and Design Standards offices for developing standard noise barrier specifications and for developing a testing and approval program for new barrier materials and systems, and in the Local Programs Division or the Noise Unit of the Design Office for providing for local assistance in response to the Growth Management and Strategies Acts;
9. External to the department, WSDOT should look to see that noise abatement of transportation facilities may be eligible for funding from impact fees or real estate excise taxes as related to the growth legislation;

10. WSDOT should develop a policy for private or local contributions to the cost of a Type II noise barrier (and the resultant potential change in the project priority).

Noise Policies, Programs and Procedures

The review of current WSDOT traffic noise analysis methods, policies and procedures was positive. WSDOT seems to be interpreting correctly the FHWA noise standards and requirements. The following recommendations are made:

1. The Noise Unit should complete the development of its new directive on noise abatement;
2. The Noise Unit should complete its brochure on Highway Traffic Noise, incorporating information relative to the Growth Management and Strategies Acts and other items specific to Washington State;
3. WSDOT should continue with its training efforts of its district staff, and should consider suggesting that its noise consultants attend these courses as well;
4. WSDOT should insure that the districts are outfitted with the latest traffic noise prediction models, including digitizing and graphics capabilities;
5. The Noise Unit should seek to update the emission levels in its traffic noise prediction model (as planned in its research agenda);
6. The Noise Unit should examine its procedures on the calibration of the FHWA traffic noise model;
7. The Noise Unit should reconsider its prioritization method for Type II noise abatement projects to include all areas exceeding 55 dB in its definition of impact and should try to include in the listing of its rankings the approximate height and length of the barrier, and number of people impacted (and protected) at each site; the newer prioritization methods of New Jersey and Wisconsin DOT should be considered (see the Appendices in the Final Technical Report);
8. The Noise Unit should study the costs and benefits of the various noise abatement measures;
9. WSDOT should develop specifications for sound-absorbing noise barriers;
10. WSDOT should develop a noise barrier materials and systems testing and certification program, especially for barriers proposed by developers as part of the city and county comprehensive plan implementation;

11. The Noise Unit should implement a six to eight year Type II noise barrier retrofit program at a funding level of $3-4 million dollars a year;

12. The Noise Unit should raise its cost per residence from $8,000 to $20,000-$25,000 for assessing the reasonableness of noise abatement measures;

13. WSDOT should consider developing a school noise abatement program patterned after that in California;

14. WSDOT should develop policies for the sound insulation of private facilities, for installing state noise barriers off the right-of-way, and for private funding contributions to Type II barriers;

15. WSDOT should entertain the placing of privately funded noise barriers on the state right-of-way, but should require the requestor to pay the state all costs to review and approve both the acoustical and structural design (as well as the appearance of the wall) and to inspect the construction;

16. WSDOT should play an active role in all aspects of the implementation of the Growth Management and Strategies Acts that could lead to improved mitigation of transportation noise in the State of Washington.

In summary, WSDOT is in a unique position to have a major, long-term effect on transportation noise in the State of Washington. The State Transportation Policy Plan delineates noise mitigation action strategies, and state growth legislation requires comprehensive land use planning by cities and counties experiencing rapid growth. While specific requirements for noise mitigation were deleted from the final Growth Strategies Act, the intents of the State Growth Strategies Commission and at least some members of the legislature were clear to make environmental protection an integral part of growth management. The opportunities are there in the current legislation, perhaps with some amendment regarding use of fees and taxes, to address transportation noise control at the local level through land use planning. Controlling transportation noise along existing state and federal-aid roads, which should be done at the state level, will require additional funding. Together, these two aspects of noise control at the receiver and along the path of the noise will require additional staffing if efforts are to be increased successfully over current levels of activity.

ACKNOWLEDGMENT

The principal investigator on this study was Dr. William Bowlby, P.E. However, the project could not have been done without the teamwork of a group of graduate and undergraduate researchers and dedicated staff. Assisting in the information gathering and analysis were: Dr. Roger L. Wayson, now Assistant Professor of Civil and Environmental Engineering at the University of Central Florida; Mr. Thomas O'Grady, graduate research assistant; Mr. Cong Chen, graduate research assistant; Mr. Jinsheng Li, graduate research assistant; Mr. Lloyd Herman, graduate research assistant; and Mr. Clay Patton, senior civil engineering student. Assisting in the writing of the interim and final reports were Mr. O'Grady, Mr. Herman and Mr. Patton.

Long and tireless hours in compiling questionnaire results and typing the manuscript were put in by Mrs. Carol Soren, whose continued patience and outstanding efforts are greatly appreciated. Also, special thanks go to Administrative Assistant Cindy Wade for all of her assistance in preparing the interim documents and to John Malone and Bernadette McMaken for additional assistance with typing.

Finally, appreciation is expressed to Mr. Ron Rolfer, Mr. Bernie Chaplin, Mr. Don Anderson, Mr. Walt Aldrich, Mr. Bill Carr and Mr. Pat LaViollette of WSDOT for their direction and guidance in the conduct of this work, and to WSDOT and FHWA for sponsoring the project.

REFERENCES

1. Weiss, M., "Summary of Highway Noise Barrier Construction in the United States", Transportation Research Record 1176, Transportation Research Board, Washington, D.C., 1988.

2. "Unusual Features of Noise Barriers and Other (Non-Barrier) Abatement Measures Implemented by December 31, 1988", U.S. Department of Transportation, Federal Highway Administration, Washington, D.C., June 1989.

3. Hendriks, R. and Hecker, J., "Parallel Noise Barrier Report: A Noise Absorptive Demonstration Project", California Department of Transportation (District 7), Los Angeles, California, July 1989.

4. Cebrick, R.C., "Overview of NJDOT's Noise Mitigation Program", Transportation Research Record 1176, Transportation Research Board, Washington, D.C., 1988.

5. Bowlby, W., Cohn, L.F. and Harris, R.A., "Design Method for Parallel Traffic Noise Barriers," Journal of Transportation Engineering, Vol. 113, No. 6, pp. 672-685, American Society of Civil Engineers, New York, November 1987.

6. Rocchi, S.E. and Pedersen, S., "Feasibility of Transparent Noise Barriers", Transportation Research Record 1255, Transportation Research Board, Washington, D.C., 1990.

7. Recommendations Techniques pour les Ouvrages de Protection contre le Bruit, Ministere de l'Environnement et du Cadre de Vie, Ministere des Transports, Bagneux, France, May 1978.

8. Sollenberger, D.A., "Evaluation of Compost and Co-Compost Materials for Highway Construction -- Phase I", Final Report, California DOT, Office of Transportation Laboratory, Sacramento, California, June 1987.

9. Beyer, E., Konstruktiver Larmschutz -- Forschung und Praxis fur Verkehrsbauten, Beton-Verlag GmbH, Dusseldorf, 1982.

10. Barrass, A.N. and Cohn, L.F., "Noise Abatement and Public Policy Decisions: A Case Study -- I-440 in Nashville", Transportation Research Record 789, Transportation Research Board, Washington, D.C., 1981.

11. State of California, Section 216 of the Streets and Highways Code, School Noise Abatement, 1983.

12. Hatano, M. and Hendriks, R.W., "Noise Insulation of Residences Near Freeways", Final Report, California DOT, Office of Transportation Laboratory, Sacramento, California, August 1985.

13. "Report on the Reevaluation of the Connecticut Department of Transportation Retrofit Noise Abatement Program", The Office of Environmental Planning, Connecticut Department of Transportation.

14. State of California, Section 215.5 of the Streets and Highways Code, Priority System for Noise Barriers.

15. Federal Highway Administration (FHWA), Procedures for Abatement of Highway Traffic Noise and Construction Noise. 23 C.F.R. Part 772, Washington,D.C., 1982.

16. California Department of Transportation, Highway Design Manual, Chapter 1100, Highway Traffic Noise Abatement, January 1987.

17. Howard, Needles, Tammen & Bergendoff, "Wisconsin Noise Barrier Study Summary Report", Wisconsin Department of Transportation, Division of Highways and Transportation Services, Milwaukee, Wisconsin, May 1990.

18. Lindeman, W., "Traffic-Related Noise as a Factor in Eminent Domain Proceedings in Florida", Transportation Research Record 1058, Transportation Research Board, Washington, D.C., December 1989.

19. Fleming, Greg G. and Rickley, E.J., "Parallel Barrier Effectiveness -- Dulles Noise Barrier Project", Final Report, U.S. Department of Transportation, Cambridge, Massachusetts, May 1990.

20. Hendriks, R.W., "California Vehicle Noise Emission Levels." Report FHWA/CA/TL-87/03, Office of Transportation Laboratory, California DOT, Sacramento, California, 1987, 286 pp.

21. Harris, R.A., "Determination of Reference Energy Mean Emission Level in Georgia", Transportation Research Record 983, Transportation Research Board, Washington, D.C., 1984.

22. Dunn, S.E., and Smart, R.C., "Determination of Vehicle Noise Levels for Highway Noise Computer Models," State Project 99700-7367, Florida Atlantic University for Florida Department of Transportation, June 1986, 196 pp.

23. Menge, C.W., "User's Manual: Barrier Cost Reduction Procedure, Stamina 2.0 and Optima", Interim Report, Federal Highway Administration, Washington, D.C., June 1981.

24. Bowlby, W., Higgins, J., and Reagan, J.A., eds., "Noise Barrier Cost Reduction Procedure, STAMINA 2.0/OPTIMA: User's Manual." Federal Highway Administration, Report No. FHWA-DP-58-1, Arlington, Virginia, 1982, 102 pp.

25. Bowlby, W., Wayson, R.L. and Stammer, Jr., R.E., Predicting Stop-and-Go Traffic Noise Levels, NCHRP Report 311, Transportation Research Board, Washington, D.C., 1989.

26. Bowlby, W., Wayson, R.L. and Li, J., User Instructions for SOUND32 PC, California Dept. of Transportation, Office of Transportation Materials and Research, October 1989.

27. Glegg, S.A.L., "Determination of Noise Source Height of Vehicles on Florida Roads", Florida Atlantic University, October 1989.

28. Bowlby, W. and Cohn, L.F., "A Model for Insertion Loss Degradation for Parallel Highway Noise

Barriers," Journal of the Acoustical Society of America, Vol. 80, No. 3, pp. 855-868, New York, September 1986.

29. "Effectiveness of Parallel Noise Barriers -- An Iowa Study", Final Report, Federal Highway Administration Work Order DTFH71-83-3610-IA-12, Iowa Department of Transportation, Planning and Research Division, August 1987.

30. Lee, V.M., Michalove, R.A. and Slutsky, S., "Tilted Parallel Barrier Program: Application and Verification", Transportation Research Record 1176, Transportation Research Board, Washington, D.C., 1988.

31. "American National Standard -- Methods for Determination of Insertion Loss of Outdoor Noise Barriers", Acoustical Society of America, ANSI S12.8-1987, New York, 1987.

32. Creasey, F.T. and Agent, K.R., "Effectiveness of Traffic Noise Barrier on I-471 in Campbell County, Kentucky", Transportation Research Record 1176, Transportation Research Board, Washington, D.C., 1988.

33. Dunn, S.E., "Investigation of the Effectiveness of Noise Barriers along I-275 and I-95", Florida Atlantic University, October 1989.

34. Hendriks, R.W. and Hatano, M.M., "Evaluation of Noise Barriers", Final Report, California Department of Transportation, Sacramento, California, June 1981.

35. "An Iowa Noise Barrier: Sound Levels, Air Quality and Public Acceptance", Project No. I-235-2(158), Iowa Department of Transportation, Office of Project Planning, Des Moines, Iowa, February 1983.

36. Hendriks, R.W., "Traffic Noise Attenuation as a Function of Ground and Vegetation", Interim Report, California DOT, Office of Transportation Materials and Research, Sacramento, California, September 1989.

37. Polcak, K.D., "Field Testing of the Effectiveness of Open-Graded Asphalt Pavement in Reducing Tire Noise from Highway Vehicles", Transportation Research Record 1255, Transportation Research Board, Washington, D.C., 1990.

38. Bowlby, W., Lindeman, W., Knauer, H. and Wayson, R., "Traffic Noise Research Needs of State Highway Agencies," Transportation Research Circular, No. 313, National Academy of Sciences, Transportation Research Board, Washington, D.C., February 1987.

39. Anderson, G.S. and Menge, C.W., "Barrier Cost Reduction Program: A Supplement to FHWA's Stamina Program", Transportation Research Record 740, Transportation Research Board, Washington, D.C., 1980.

40. Bowlby, W., Agent, K.R., Fuca, T.A., Noble, D.F. and O'Connor, J.R., "Synthesis of Highway Practice: Environmental Noise Measurements," Transportation Research Circular, No. 288, National Academy of Sciences, Transportation Research Board, Washington, D.C., February 1985.

41. "Highway Traffic Noise in the United States", U.S. Department of Transportation, Federal Highway Administration, Washington, D.C., April 1986.

42. "Type II Projects for Highway Traffic Noise Abatement", Federal Highway Administration, Office of Environmental Policy, Washington, D.C., June 1988.

43. Summary of Noise Barriers Constructed by December 31, 1989, U.S. Department of Transportation, Federal Highway Administration, Office of Environmental Policy, Noise and Air Quality Division, Washington, DC, July 1990.

44. Cohn, L.F. and Harris, R.A., "Cost of Noise Barrier Construction in the United States", Transportation Research Record 1255, Transportation Research Board, Washington, D.C., 1990.

45. "Appropriate Level of Highway Traffic Noise Analysis for CE, EA/FONSI, and EIS", Discussion Paper, Federal Highway Administration, Office of Environmental Policy, Washington, D.C., June 1989.

46. "Highway Traffic Noise Impact Identification and Mitigation Decisionmaking", Field Review Report, Federal Highway Administration, Office of Environmental Policy, Washington, D.C., June 1989.

47. "Summary Report for Survey of State Noise Policies", Maryland Department of Transportation, Greiner Engineering Sciences, Inc., Timonium, Maryland, December 1986.

48. "Summary Report for Supplemental Survey of State Noise Policies", Maryland Department of Transportation, Greiner Engineering Sciences, Inc., Timonium, Maryland, January 1987.

49. Soporowski, J.J., III, The Status of Key State and Local Noise Control Programs That Served as a Basis for Discontinuing a Federal Program in 1982, A National Network for Environmental Management Studies Project, report prepared for U.S. Environmental Protection Agency, January 1990.

50. "Transportation Noise -- Federal Control and Abatement Responsibilities May Need To Be Revised", United States General Accounting Office, Washington, D.C., October 1989.

51. Parsons, D.L., Noise Control Through Land Use Planning: The Calgary Case, Report for Transportation Department, City of Calgary, Calgary, Alberta, December 1981.

52. City of Saskatoon Traffic Noise Study, Prepared by Sparks & Associates, Ltd., in association with the Vanderbilt Engineering Center for Transportation Operations and Research (VECTOR), Prepared for Engineering Department, Transportation Section, City of Saskatoon, April 1990.

53. Model Community Noise Control Ordinance, National Environmental Health Association, Developed by the Noise Committee, Preprinted from Journal of Environmental Health, July/August 1977.

54. USEPA, "New Product Noise Regulations, Subpart B, Medium and Heavy Trucks", 40 Code of Federal Regulations Part 205, July 1, 1987.

55. Standard SAE J366b, "Exterior Sound Level for Heavy Trucks and Buses," SAE, Warrendale, PA.

56. USEPA, "Noise Regulations for Motor Carriers Engaged in Interstate Commerce", 40 Code of Federal Regulations 202, July 1, 1987.

57. International Standard ISO 362-1981 (E), "Acoustics-Measurement of Noise Emitted by Accelerating Road Vehicles-Engineering Method," American National Standards Institute, New York, NY.

58. Mitchell, C.G.B., "Quiet Heavy Vehicles for 1990 -- The QHV 90 Programme," Surface Vehicle Noise and Vibration Conference Proceedings P-161, Society of Automotive Engineers, Warrendale, PA, May 1985.

59. Stiglmaier, M. and Drewitz, H., "Engine Encapsulation on 6-10 Ton Trucks", Surface Vehicle Noise and Vibration Conference Proceedings P-161, Society of Automotive Engineers, Warrendale, Pennsylvania, May 1985.

60. Brandl, F.K., J. Affenzeller and G.E. Thien, "Some Strategies to Meet Future Noise Regulations for Truck Engines," Proceedings of the 1987 Noise and Vibration Conference P-195, Society of Automotive Engineers, Inc., Warrendale, PA, April 1987.

61. Boesch, N.J.W., "The Development of Low-Noise DI Diesel Engines," Proceedings of the 1987 Noise and Vibration Conference P-195, Society of Automotive Engineers, Inc., Warrendale, PA, April 1987.

62. Morrison, D., "The Practical Development of a Heavy Duty Truck Engine for Low Noise," Proceedings of the 1987 Noise and Vibration Conference P-195, Society of Automotive Engineers, Inc., Warrendale, PA, April 1987.

63. Rust, A., H. Schiffbaenker and F.K. Brandl, "Complete NVH Optimisation of a Passenger Vehicle with a D.I. Diesel Engine to Meet Subjective Market Demands and Future Legislative Requirements," Proceedings of the 1989 Noise and Vibration Conference P-222, Society of Automotive Engineers, Inc., Warrendale, PA, May 1989.

64. Winklhoger, E. and Thien, G.E., "A Review of Parameters Affecting the Noise and Vibration in Diesel Powered Passengers Cars", Surface Vehicle Noise and Vibration Conference Proceedings P-161, Society of Automotive Engineers, Warrendale, Pennsylvania, May 1985.

65. Oberg, H.J., D. Pundt and H.A. Fachbach, "Decoupled Engine for Exterior-Noise Reduction in a Lower-Mid-Class Front-Wheel-Drive Passenger Car," Proceedings of the 1987 Noise and Vibration Conference P-195, Society of Automotive Engineers, Inc., Warrendale, PA, April 1987.

66. Priede, T. and R.K. Dutkiewicz, "The Effect of Normal Combustion and Knock on Gasoline Engine Noise," Proceedings of the 1989 Noise and Vibration Conference P-222, Society of Automotive Engineers, Inc., Warrendale, PA, May 1989.

67. DeJong, R.G., "A Study of Vehicle Interior Noise Using Statistical Energy Analysis", Surface Vehicle Noise and Vibration Conference Proceedings P-161, Society of Automotive Engineers, Warrendale, Pennsylvania, May 1985.

68. Ericksson, L.J. and P.T. Thawani, "Theory and Practice in Exhaust System Design," Surface Vehicle Noise and Vibration Conference Proceedings P-161, Society of Automotive Engineers, Inc., Warrendale, PA, May 1985.

69. Oswald, L.J. and A. Arambages, "The Noise of Cross Groove Tire Tread Pattern Elements," Surface Vehicle Noise and Vibration Conference Proceedings P-161, Society of Automotive Engineers, Warrendale, PA, May 1985.

70. Schwartz, H.W., W.D. Hays, Jr. and J.H. Tarter, "A Systematic Approach to the Analysis of Brake Noise," Surface Vehicle Noise and Vibration Conference Proceedings P-161, Society of Automotive Engineers, Warrendale, PA, May 1985.

71. Liles, G.D., "Analysis of Disc Brake Squeal Using Finite Element Methods," Proceedings of the 1989 Noise and Vibration Conference P-222, Society of Automotive Engineers, Inc., Warrendale, PA, May 1989.

72. State Transportation Policy Plans Committee, "1991 Report to the Washington State Legislature, Transportation Policy Plan for Washington State," T-91-01, Olympia, WA, March, 1991.

73. Washington State Department of Transportation, Choices in Transportation for Washington's Environment, Olympia, Washington, 1991.

74. Washington State Growth Strategies Commission, A Growth Strategy for Washington State, Seattle, WA, September 1990.

Appendix A -- List of Unusual Noise Barrier or Non-Barrier Abatement Projects Implemented by State DOTS

UNUSUAL FEATURES OF NOISE BARRIERS AND OTHER (NON BARRIER) ABATEMENT MEASURES

STATE	LOCATION	TYPE	YEAR	DESCRIPTION	ADDITIONAL INFORMATION	PHYSICAL DIMENSIONS	COST
Arizona	I-10, Phoenix	Noise Insulation	1986	Central air conditioning and sealed windows (on side facing freeway) were added to an existing historic school building.		NA	$744,000
Arizona	I-10, Phoenix	Unusual design	1986	Symbolic Indian artwork was cast into surface of curved walls along a noise barrier.	The undecorated portion of the wall is straight.	NA	cost 55% more than plain straight wall
California	Rt. 405, Los Angeles	Absorbing Barrier	1988	Sound absorbing panels were added to barrier as result of complaints.	Lawsuit pending.	NA	$144,866
California	Rt. 8, San Diego	Barrier outside SHA ROW	1986	Construction done on private property under permits from owners.	No practical location within SHA ROW.	6-8' x 334'	$49,000
California	Rt. 52, San Diego	Barrier outside SHA ROW	1987	Construction done on private property under permits from 12 property owners.	No practical location within SHA ROW.	6-8' x 1200'	$158,641 ($18/sqft)
California	Rt. 805, San Diego	Barrier outside SHA ROW	1983	Construction done on private property under permits from owners.	No practical location within SHA ROW.	6-9' x 385'	$38,200
California	Rt. 7, Camrillo Rt. 101 San Francisco	Noise Insulation	1983	4 Private residences with treatment such as: treated windows and doors and heat pump, central A/C, ventilation	As part of National Experimental Evaluation Project 21. One owner paid for electric upgrade to be compatible with central A/C.	NA	$6,000 to $18,000
California	Statewide (25% San Francisco, 60% Los Angeles)	Noise Insulation	1973-88	Schools were treated (usually replacing/sealing windows and providing ventilation or air conditioning).	Mandated by state legislation. Sometimes schools were treated by a combination of insulation and a noise barrier.	NA	$8,000 to $1,499,000 (about $22,000,000 through 1988)
Colorado	I-25,70, Denver	Barrier on Structure	1983-88	Enamelized metal panels mounted on structure connect with ground mounted wood barriers on 8 bridges.	Typically the panels are 3' to 4' high and are placed on top of 2' to 4' high solid prapets. Typically 150' long.	5' to 8' x 150'	$15/sqft
Connecticut	I-84, E. Hartford	Absorbing Barrier	1988	2' x 4' polyethylene shell with rockwool filler. Parallel barriers are about 80-100' apart.	Quoted at $10/sqft before PS&E but escalated in contractor's bid.	15' x 1265'	$27/sqft
Illinois	I-255, E. St. Louis	Absorbing Barrier	1984-85	Four inch thick layer of rockwool sandwiched between tedlar and stainless steel.	After 2 years, coating began to peel off. Becoming unsightly. Remedial work under study.	6' to 10' x 4000'	$20/sqft

UNUSUAL FEATURES OF NOISE BARRIERS
AND
OTHER (NON BARRIER) ABATEMENT
MEASURES

STATE	LOCATION	TYPE	YEAR	DESCRIPTION	ADDITIONAL INFORMATION	PHYSICAL DIMENSIONS	COST
Iowa	I-80, Johnson County	Noise Insulation	1981	A private residence was insulated as part of an experimental project. It included A/C, sealing and replacing patio door.		NA	$3800
Kentucky	US 31W, Dixie Highway, Jefferson County	Noise Insulation	1985	The Medora Elementary School was soundproofed.	Entire bldg soundproofed. Fed + State funding only for portion of bldg directed affected by traffic noise of project.	NA	$361,950 (FA+SHA=$123,000:: School Funds=$238,950)
Maryland	I-695, Baltimore County	Absorbing Barrier	1986	Concrete with one side treated to create sound absorbing texture.	Soundlock.	15' x 500'	$17/sqft
Maryland	I-695, Ann Arundal County	Absorbing Barrier	1988	Concrete with one side treated to create sound absorbing texture.	Soundlock.	20' x 480'	$21/sqft
Maryland	Rt. 702, Baltimore County	Non-Barrier abatement	1983	Trucks prohibited. Noise walls designed at lower heights as a consequence.		NA	NA
Maryland	I-95, Baltimore City	Translucent Barrier	1982	Transluscent panels between metal posts.	Was transparent when first installed. Opacity increasing with time.	10' x 435'	$40/sqft
Massachusetts	I-93, Somerville	Transparent Barrier	1986	10' x 7.5' polycarbonate panels between metal posts.	Washing of panels covered by extending standard maintenance contract. Cracks in panel corners visible by early 88.	10' x 1200'	$25/sqft materials, $25/sqft for installation
Michigan	I-696, Warren	Noise Insulation	1987-88	Noise insulation (A/C, some attic work), of private residences as part of negotiations/litigation dating to 1960's.	About 60 residences were treated through 88. As many as 70 more may be treated.	NA	$3500 to $4500 per residence.
Minnesota	HWY 60, Wabasha	Barrier on Structure	1988	Concrete panels were bolted to superstructure.	Graphics were embossed on the concrete.	8' x 1600'	$130,000
Minnesota	I-94, Minneapolis	Barrier on Structure	1979	Timber barrier on bridge.	Barrier was limited to 6' in height based on calculated wind loadings on the bridge.	100' x 6'	Minimal
Minnesota	I-35E, St.Paul,Maplewood	Non-Barrier abatement	1984-86	Trucks banned, speed limit reduced to 45mph, bituminous surface used.	Relatively low combination berm/wall also included for 2.7 mi. Traffic noise is quite limited near protected residences.	7 miles.	Minimal to SHA. Affects user costs.
Minnesota	I-94, Minneapolis	Unusual Material	1978	Used wood from dutch elm trees that were dying to face a barrier.	Done as a demonstration by a college to find a use for the wood.	500' x 17'	Minimal

UNUSUAL FEATURES OF NOISE BARRIERS AND OTHER (NON BARRIER) ABATEMENT MEASURES

STATE	LOCATION	TYPE	YEAR	DESCRIPTION	ADDITIONAL INFORMATION	PHYSICAL DIMENSIONS	COST
Minnesota	I-94, St. Paul	Unusual Material	1975	Used pressed/treated paper to get a sound absorbing surface.	Done as a demonstration ad hoc to see if the concept worked. No problem noticed in the first 13 years of service.	500' x 8'	NA
Minnesota	US 12, St. Louis Pk.	Unusual design	NA	H piles were driven into the ground to save a natural hill that was acting as a noise barrier.		300' x 2'to10'	Minimal
Minnesota	I-94, Minneapolis	Unusual design	1978	Barrier height was decreased at the request of a business so that business's logo could be just visible from highway.		150' x -4'	Negative cost.
Nevada	US 95, Las Vegas	Tilted Barrier	1986	22-gage formed metal wall mounted on a concrete safety shape barrier at an angle of 10 degrees away from road.		11' x 4002'	$275,000 (about $6/sqft)
New Jersey	I-78, Springfield	Absorbing Barrier	1985	Concrete sound absorbing material on hwy side. Parallel barriers are about 120' to 200' apart.	Includes interchange. Reflecting portion of barrier is about 12,350' long.	5'-24' x 7600'	$3.75/sqft for sound absorbing material
New Jersey	Rt 18, New Brunswick	Deck over freeway	1985	Landscaped deck cantilevered over freeway. The deck was a combination noise mitigation measure and parkland replacement.	Deck is open on one side. On other side, a modular wall/ventilation room was affixed to the exterior of Rutgers U.	1530' x 120'	$12,000,000 (all but $340,000 for deck)
New Jersey	I-280, Harrison	Noise Insulation	1981	Central Air Conditioning and double glazing of windows at Our Lady of Czestochowa School.		NA	$267,000
New Jersey	I-295, Hamilton Township	Noise Insulation	1983	Air Conditioning window units installed in several classrooms.		NA	$3,400
New Jersey	Rt 24, Morris Co.	Tilted Barrier	1986	Concrete post&panel barriers tilted 10 degrees away from road. Parallel barriers are about 150' apart.	Untilted portion of barrier is about 8700' long.	9'-18' x 1000'	$19/sqft (entire barrier), tilting costs UNKNOWN
New Jersey	I-78, Springfield, Mountainside	Tilted Barrier	1985	Concrete post&panel barriers tilted 10 degrees away from road. Parallel barriers are about 150' apart.	Untilted portion of barrier is about 15,400' long.	4'-20' x 2600'	$12/sqft (entire barrier), tilting costs UNKNOWN

UNUSUAL FEATURES OF NOISE BARRIERS
AND
OTHER (NON BARRIER) ABATEMENT
MEASURES

STATE	LOCATION	TYPE	YEAR	DESCRIPTION	ADDITIONAL INFORMATION	PHYSICAL DIMENSIONS	COST
New Jersey	Rt 17, Bergen Co. (3 Townships)	Tilted Barrier	1986	Concrete post&panel barriers tilted 6 degrees away from road. Parallel barriers are about 130' apart.	Untilted portion of barrier is about 7000' long.	10'-18' x 4100'	$16/sqft (entire barrier), tilting costs UNKNOWN
New Jersey	I-287, Riverdale	Unusual Material	1986	Gabions were used on top of a berm.		10'-12' x 2300'	$19.40/cubic yard was combined cost of material
New York	Rt. 7, Albany Co.	Noise Insulation	1986	Air Conditioning of Maplewood Elementary School.	Insulation was in lieu of $800,000 barrier.	NA	$320,000
Oregon	I-205, Portland	Barrier on Structure	1980	Metal noise wall on overpass structure joining concrete post and panel ground mounted barriers.	Included two expansion joints. Oregon Inventory #37	10' x 402'	NA
Oregon	I-84, Portland	Barrier outside SHA ROW	1979-81	Noise walls located on a city street ROW. Wall protects against freeway, street noise and RR noise.	Oregon Inventory #s 87 and 119	9' to 14' x 2180' (both)	$495,000
Oregon	I-84, Portland	Barrier outside SHA ROW	1986	Noise wall located on 7 5' easements and city ROW. Wall protects against both traffic and RR noise.	Residences donated easements to allow construction. Barrier is up to 100' from SHA ROW. Oregon Inventory #145	10 to 14' x 970'	$112,000
Oregon	I-84, Portland	Barrier outside SHA ROW	1987	Earth berm and wall constructed on dedicated city street ROW.	Oregon Inventory #166	10' x 270' wall on 10' x 940' berm	$70,000
Oregon	Hwy 26, Portland	Noise Insulation	1981	School had ventilation system installed and had single glazed windows replaced with double glazed windows.	Portland Cleveland High School. Oregon Inventory #42	NA	$30,000
Oregon	Hwy. 26, Portland	Noise Insulation	1981	School had ventilation system installed.	Portland Parry School. Oregon Inventory #43	NA	$22,000
Oregon	Hwy 2W, Scappoose	Noise Insulation	1988	School had ventilation system and storm windows installed in 3 classrooms.	Scappoose Grade School. Oregon Inventory #62	NA	$45,000
Oregon	Hwy. 91, Tigard	Noise Insulation	1981	School had ventilation system installed.	Tigard St. Anthony School. Oregon Inventory #44	NA	$46,000
Oregon	Hwy 2W, Scappoose	Noise Insulation	1988	School had ventilation system and storm windows installed in 12 classrooms.	Scappoose Middle School. Oregon Inventory #63	NA	$75,000

UNUSUAL FEATURES OF NOISE BARRIERS
AND
OTHER (NON BARRIER) ABATEMENT
MEASURES

STATE	LOCATION	TYPE	YEAR	DESCRIPTION	ADDITIONAL INFORMATION	PHYSICAL DIMENSIONS	COST
Oregon	Hwy. 72, Salem	Noise Insulation	1985	Church had ventilation system installed.	Salem Foursquare Gospel Church. Oregon Inventory #187	NA	NA
Oregon	I-84, Portland	Noise Insulation	1984	Church had 3 window type air conditioners installed.	Portland Bethlehem Lutheran Church. Oregon Inventory #71	NA	$5,500
Oregon	Route 213, Salem	Noise Insulation	1987	School had ventilation system and storm windows installed in 2 classrooms.	Salem Middle Grove School. Oregon Inventory #186	NA	$37,500
Oregon	Circle Blvd., Corvallis	Non-Barrier abatement	1982	24-hour ban on all trucks except emergency and delivery vehicles.	Cities in Oregon have 'no truck networks' and the ban was just an extention of the existing network. Oregon Inventory #47	NA	NA
Oregon	Allen Blvd., Beaverton	Non-Barrier abatement	1980	24 hour ban on all trucks except emergency and delivery vehicles.	Cities in Oregon have 'no truck networks' and the ban was just an extention of the existing network. Oregon Inventory #64	NA	NA
Oregon	NW 3rd Ave., John Day	Non-Barrier abatement	1982	24-hour ban on all trucks except emergency and delivery vehicles.	Cities in Oregon have 'no truck networks' and the ban was just an extention of the existing network. Oregon Inventory #45	NA	NA
Oregon	Walnut Blvd., Corvallis	Non-Barrier abatement	1982	24-hour ban on all but emergency and delivery vehicles.	Cities in Oregon have 'no truck networks' and the ban was just an extention of the existing network. Oregon Inventory #46	NA	NA
Oregon	I-84, Portland	Unusual design	1980	Recessed pictures of flowers and animals were cast in a concrete wall next to a child care center/chidren's hospital.	Concrete designs were painted in various colors. Oregon Inventory #73	NA	NA
Pennsylvania	Blue Route, Phil. County	Absorbing Barrier	1988	Noise wall incorporating mineralized wood chips cemented to precast concrete. Some on structure.	Durosol.	14' x 2400 ground mounted, 12' x 1600 on structure	$30/sqft
Pennsylvania	I-78, Allentown	Absorbing Barrier	1988	Noise wall incorporating mineralized wood chips cemented to precast concrete.	Durosol.	12' x 1600'	$16/sqft
Pennsylvania	I-78, N. Hampton	Barrier on Structure	1987	Wood barrier on structure.		6' x 100'	$25/sqft
Pennsylvania	Vine St., Philadelphia	Noise Insulation	1985	Old historic school/rectory was provided with air conditioning plus some window work.	Cost was high to preverve historic features while doing insulation work.	NA	$1,000,000

UNUSUAL FEATURES OF NOISE BARRIERS
AND
OTHER (NON BARRIER) ABATEMENT
MEASURES

STATE	LOCATION	TYPE	YEAR	DESCRIPTION	ADDITIONAL INFORMATION	PHYSICAL DIMENSIONS	COST
Pennsylvania	Blue Route, Phil. County	Unusual design	1987	Noise wall made of concrete cribbing filled with earth and planted with vegetation (Evergreen Wall)	Quoted at $300/linear foot before PS&E but cost went up in bid. Establishment of desirable vegetation has been slow.	16' x 800'	$50/sqft
Puerto Rico	PR-2, Isapela	Non-Barrier abatement	1986	Classrooms were added on the 'quiet' side of the building.		NA	$50,000
Tennesse	I-440, Nashville	Absorbing Barrier	1984	Acoustical block facing on highway side where barriers are parallel. The cost penalty was $0.05/sqft.	Facing is occasionally not used on the bottom 2' of the barrier.	8' x 5000'	$12/sqft
Tennesse	I-440, Nashville	Barrier on Structure	1984	Metal barrier over structure connects with ground mounted masonry barriers.	3 barriers each of which is about the same dimensions (5' x 250')	3 x (5' x 250')	$22/sqft
Utah	I-215, Salt Lake County	Barrier on Structure	1988	Exposed aggregate precast panels between steel posts behind parapet.	Bridge required structural augmentation.	12' x 200'	$13/sqft plus $40,000 for structural augmentation
Virginia	La Prado Ave., Hopewell	Noise Insulation	1979	Church school/convent air conditioned, wall and door were insulated and the entrance was relocated.		NA	$136,000
Virginia	Rt. 11, Merion	Noise Insulation	1980	Church was air conditioned.		NA	$10,000
Virginia	Rt. 17, Newport News	Noise Insulation	1981	School was air conditioned.		NA	$22,000
Virginia	Rt. 250, Fisherville	Noise Insulation	1984	Church was air conditioned.		NA	$22,000
Washington	I-90, Mercer Island	Deck over freeway	1986-88	Freeway in deep cut. Deck over freeway was jointly for noise, visual, community cohesion and other reasons.		210' x 2900'	$160,000,000
Washington	I-90, Seattle	Deck over freeway	1986	Freeway in deep cut. Deck over freeway was jointly for noise, visual, community cohesion and other reasons.		200' x 2200'	$145,000,000
Washington	I-90, Seattle	Tilted Barrier	1986-88	Walls tilted 1:10 away from highway. Mostly parallel walls.		6' x 10300' some are extention of retaining wall	NA

UNUSUAL FEATURES OF NOISE BARRIERS
AND
OTHER (NON BARRIER) ABATEMENT
MEASURES

STATE	LOCATION	TYPE	YEAR	DESCRIPTION	ADDITIONAL INFORMATION	PHYSICAL DIMENSIONS	COST
Washington	SR-14, Kennewick Vicinity	Tilted Barrier	1980	Wall tilted 1:10 away from highway to prevent any single wall reflection.		12' x 1440'	$252,000
Washington	I-90, North Bend	Unusual design	1976	Natural rock wall (about 4') on top of berm (about 6')		10' x 1100'	$50,000
Washington	SR 520, Seattle	Unusual funding/placement	1986	Cast-in-place concrete wall with concrete cap on SHA ROW built by private funds.		12' x 410'	$100,000

Appendix B -- Summaries of HP&R and Other Research Projects

DATE: 09/12/90
TIME: 07:54:49

HIGHWAY TECHNOLOGY
INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

SCREEN: LR28M425

UNIQUE ID: 41300596 STUDY NO: FL 0362 NCP CODE: 4E7B1462

STUDY
TITLE: DETERMINATION OF NOISE SOURCE HEIGHT OF VEHICLES ON FLORIDA ROADS AND HIGHWAYS

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2085 STATUS: S
DATE STARTED: 07/01/86 DATE COMPLETED: 04/10/89 TYPE A OR B: A
PERFORMING ORGANIZATION(PO): FLORIDA ATLANTIC UNIVERSITY
CITY: BOCA RATON STATE: FL ZIP: 33431
PRINCIPAL INVESTIGATOR: CLEGG. S.
FTC: FPA: HUMESTON. J.
SPONSORING ORGANIZATION: FL

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
SOCALIZATION TECHNIQUES TO IDENTIFY NOISE SOURCES HAVE BEEN USED IN EURO PE FOR 12 YEARS FOR AIRPLANE RAIL AND INDUSTRIAL NOISE SOURCES. P.I. HAS BEEN INVOLVED. OBJECTIVE IS THE APPLICATION OF THIS TECHNOLOGY TO HIGHWAY VEHICLE SOURCE HEIGHTS AND THUS IMPROVE CRITERIA FOR HIGHWAY NOISE BARRIERS. SEVEN ELEMENT MICROPHONE ARRAY AND SEVEN CHANNEL TAPE RECORDERS TO BE USED TO MEASURE NOISE OF PASSING VEHICLES. ANALYSES OF NOISE SIGNALS. SOURCE HEIGHTS OF INDIVIDUAL VEHICLES ON ISOLATED ROADS. THREE ROADS WITH VARIOUS TYPES OF TRUCK TRAFFIC AND TYPICAL HIGHWAYS WITH HEAVY TRAFFIC WILL: BE MEASURED. SOURCE HEIGHTS FOR VEHICLE TYPE. SPEED. AND SOUND FREQUENCY WILL BE DEVELOPED. REMARKS EARLIER ATTEMPT PSU 1978-81. KNOWN SOURCE HEIGHTS -COULD REDUCE NOISE BA. CO

NCP CATEGORY/PROGRAM: E7 FUNDING SOURCE: FL

FY	PROGRAMMED
88	55.191
87	76.920

DATE: 09/12/90
TIME: 07:56:34

HIGHWAY TECHNOLOGY
INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

SCREEN: LR28M425

UNIQUE ID: 41300622 STUDY NO: NJ-7789 NCP CODE: 4E7B1612
STUDY
TITLE: PUBLIC RESPONSE TO NOISE BARRIERS

HQ CONTACT: JONGEDYK. PHONE: 703-285-2085 STATUS: N
DATE STARTED: 03/04/87 DATE COMPLETED: 02/28/89 TYPE A OR B: A
PERFORMING ORGANIZATION(PO): NEW JERSEY DOT
CITY: TRENTON STATE: NJ ZIP: 08623
PRINCIPAL INVESTIGATOR: MARSELLA. M.
FTC: FPA: GOWNEY. J.
SPONSORING ORGANIZATION: NJ

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
EVALUATE THROUGH LITERATURE AND CONTACTS RELATED STUDIES DEALING WITH PUBLIC RESPONSES TO HIGHWAY NOISE AND BARRIERS. INVESTIGATE THEORY AND PRACTICE OF DESIGNING QUESTIONAIRES. DETERMINE CONTENT OF QUESTIONAIRE. DESIGN QUESTIONAIRE. AND DECIDE ON METHOD OF ITS PRESENTATION. IDENTIFY RESIDENTIAL POPULATION TO BE SURVEYED. PRESENT AND RECEIVE RESULTS OF QUESTIONAIRES. RECORD AND AND ANALYZE DATA. PREPARE A REPORT ON STUDY RESULTS INCLUDING TASKS. METHODS.AND RECOMMENDATIONS.

NCP CATEGORY/PROGRAM: FUNDING SOURCE: NJ

FY	PROGRAMMED
87	18.100
88	45.400
89	27.900

SCREEN TOTAL: 91.400

-----------------------------------MESSAGES-----------------------------------

DATE: 09/12/90
TIME: 08:14:55

HIGHWAY TECHNOLOGY
INFORMATION MANAGEMENT SYSTEM
PERFORMING ORGANIZATION

SCREEN: LR28M430

UNIQUE ID: 43100155 CONTR. NO: CA-E82TL06 REQ NO: RFP NO:
STUDY TITLE:
PROGRAM COMPUTER TO OPTIMIZE NOISE BARRIER DESIGN

COTR: SMITH. D. PHONE: 703-285-2069 STUDY STATUS: S
DATE AWARDED: 06/09/81 COMPLETED: 06/30/82 NCP CODE: 4E7B1983
PERFORMING ORGANIZATION(PO): CALTRANS/TRANSLAB
CITY: SACRAMENTO STATE: CA ZIP: 95819
PRINCIPAL INVESTIGATOR: HATANO ORIGINATING STATE:
TASK ORDER:

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
THIS IMPLEMENTATION EFFORT WILL ADAPT THE FHWA 'OPTIMA' NOISE BARRIER DESIGN OPTIMIZATION COMPUTER PROGRAM TO THE CALTRANS VERSION OF FHWA 'STAMINA' HIGHWAY TRAFFIC NOISE PREDICTION MODEL.

UNIQUE ID: 43100155 CONTRACT NO: CA-E82TL06 NCP CODE: 4E7B1983

ACT CODE	FIS YEAR	FUND GROUP	ACTV CODE	CAT/ PROG	FUND SRCE	+ COMMITTED AMOUNT	+ OBLIGATED/ AWARDED AMOUNT	REQ NUMBER	MOD NUMBER
.	82	4310		3F	CA		30.000		00
.									

DATE: 09/12/90 HIGHWAY TECHNOLOGY SCREEN: LR28M425
TIME: 08:17:44 INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

UNIQUE ID: 41300887 STUDY NO: NJ 7270 NCP CODE: 4E7B1613

STUDY
TITLE: **SPECIALIZED NOISE BARRIERS FOR USE ON BRIDGES**

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2085 STATUS: N
DATE STARTED: 11/01/89 DATE COMPLETED: 09/30/91 TYPE A OR B: B
PERFORMING ORGANIZATION(PO): **NEW JERSEY DOT**
CITY: TRENTON STATE: NJ ZIP: 08623
PRINCIPAL INVESTIGATOR: MARSELLA. M.
FTC: FPA: GOWNEY. J.
SPONSORING ORGANIZATION: NJ

~~BRIEFLY DESCRIBE~~ THE WORK TO BE PERFORMED:
TRAFFIC NOISE BARRIERS ARE BEING RETROFITTED UNTO NUMEROUS HIGHWAY BRIDGES. BRIDGES ARE NOT DESIGNED TO WITHSTAND ADDED LOAD FROM NOISE BARRIERS PLACED UNTO BRIDGE SUPERSTRUCTURES. CONSEQUENTLY NOISE WALLS ARE PLACED ON ADJACENT SIGN BRIDGES. THE OBJECTIVE OF THIS STUDY IS THE EVALUATION OF LESS EXPENSIVE ALTERNATIVES INCLUDING BETTER BRIDGE SUPPORTS AND MEANS TO RELIEVE WIND LOADS. CONSTRUCTION AND MAINTENANCE COSTS AND NOISE ABATEMENT OF SUCH ALTERNATE BRIDGE BARRIER COMBINATIONS SHALL BE CONSIDERED. A LITERATURE SEARCH AND APPROPRIATE ANALYSES WILL BE INCLUDED. FINAL REPORT WILL INCLUDE FINDINGS AND RECOMMENDATIONS.

NCP CATEGORY/PROGRAM: E7 FUNDING SOURCE: NJ

FY	PROGRAMMED
90	27.400
91	20.300

SCREEN TOTAL: 47.700

DATE: 09/12/90
TIME: 08:38:21

HIGHWAY TECHNOLOGY
INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

SCREEN: LR28M425

UNIQUE ID: 41300877 STUDY NO: WA-GC-8719 NCP CODE: cE7B1952

STUDY
TITLE: **TIRE NOISE-EFFECTS OF ROADWAY WEAR II**

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2085 STATUS: N
DATE STARTED: 09/01/89 DATE COMPLETED: 09/03/91 TYPE A OR B: B
PERFORMING ORGANIZATION(PO): TRAC/UNIVERSITY OF WASHINGTON
CITY: OLYMPIA STATE: WA ZIP: 98195
PRINCIPAL INVESTIGATOR: CHALUPNIK. J.D.
FTC: GLOVER. W. FPA: LLOYD.I.
SPONSORING ORGANIZATION: WA

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
THIS IS SUPPLEMENT AN EARLIER AND A CURRENT STUDY ON TIRE-PAVEMENT NOISE BY THE STATE OF WASHINGTON.THIS PROBLEM IS THE DETERMNINATION OF NOISE CHNAGES WITH TIME AND HOW THIS CHANGE IS RELATED TO MEASUREABLE OR OBSERVED CHARACTERISTICS OF THE ROADWAY SURFACE. TIRE NOISE FROM SELECTED PAVEMENTS OF VARIOUS AGES TO 21 YEARS WILL BE MEASURED OVER STUDY PERIOD. SECTIONS TO BE TESTED WILL INCLUDE THOSE TESTED EARLIER AND ADDED SECTIONS OF PCCP. LMPCCP. OGACP. CLASS B ACP. PLUS RIDE. ETC. EFFECTS OF SURFACE COMPOSITION. WEAR. AND ROUGHNESS OF PAVEMENTS ON TIRE NOISE WILL BE COMPARED. FOR THE FOREGOING CONDITIONS. THE SPECTRA OF TIRE NOISE WILL BE MEASURED AND EVALUATED TO DETERMINE HOW TO CONTROL NOISE LEVELS AND LEARN TEMPORAL CHANGES OF TIRE NOISE WITH PAVEMENTS.

NCP CATEGORY/PROGRAM: E7 FUNDING SOURCE: WA

FY	PROGRAMMED
90	12.190
91	6.972
92	838

SCREEN TOTAL: 20.000

DATE: 09/12/90 HIGHWAY TECHNOLOGY SCREEN: LR28M425
TIME: 08:36:43 INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

UNIQUE ID: 41300414 STUDY NO: E82TL04 NCP CODE: 4E761972

STUDY
TITLE: **UPDATE VEHICLE NOISE EMISSION LEVELS**

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2085 STATUS: S
DATE STARTED: 06/29/81 DATE COMPLETED: 09/28/87 TYPE A OR B: A
PERFORMING ORGANIZATION(PO): **CAL DOT DIV OF HIGHWAYS**
CITY: SACRAMENTO STATE: CA ZIP: 95807
PRINCIPAL INVESTIGATOR: HATANO
FTC: FPA:
SPONSORING ORGANIZATION: CA

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
DETERMINE AVERAGE EMISSION LEVELS OF CARS AND MEDIUM AND HEAVY TRUCKS AND MAKE ANY NECESSARY CHANGES IN THE PREDICTION MODEL FOR NOISE ASSESSMENT AND BARRIER DESIGN.

NCP CATEGORY/PROGRAM: E7 FUNDING SOURCE: CA

FY	PROGRAMMED
83	61.666
84	57.834
85	35.000
86	12.000
87	2.000

SCREEN TOTAL: 168.500

DATE: 09/09/90
TIME: 09:40:26

HIGHWAY TECHNOLOGY
INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

SCREEN: LR28M425

UNIQUE ID: 41300861 STUDY NO: CA-E89TL11 NCP CODE: 4E7B1702

STUDY TITLE: **DESIGN OF NOISE BARRIERS USING ARTIFICIAL INTELLIGENCE**

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2085 STATUS: N
DATE STARTED: 05/23/89 DATE COMPLETED: 06/30/91 TYPE A OR B: A
PERFORMING ORGANIZATION(PO): **CALTRANS**
CITY: SACRAMENTO STATE: CA ZIP: 95807
PRINCIPAL INVESTIGATOR: HENDRIKS. R.

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
WITH THE AID OF A CONTRACTOR DEVELOP AN ARTIFICIAL INTELLIGENCE DESIGN PROCEDURE FOR NOISE BARRIERS. THIS STUDY SHALL ESTABLISH ALL BACKGROUND MATERIALS . NOISE PROPAGATION MODELS. AND OTHER REQUIREMENTS OF NOISE BARRIERS SUCH AS STRUCTURAL REQUIREMENTS. MATERIALS. IMPACTS. LOCATIONS. AND NOISE REFLECTANCE AND ABSORPTIVE FEATURES. DEVELOP AN INTELLIGENT COMPUTER PROGRAM (EXPERT SYSTEM) THAT USES KNOWLEDGE AND INFERENCE PROCEDURES TO PROVIDE COMPLEX NOISE ANALYSIS AND NOISE BARRIER DESIGNS. DEVELOP A USERS MANUAL. DEVELOP A PILOT TWO DAY TRAINING COURSE AND PRESENT THIS COURSE TO CALTRANS PERSONNEL.

NCP CATEGORY/PROGRAM: E7 FUNDING SOURCE: CA

FY	PROGRAMMED
89	10.000
90	66.000
91	66.000

SCREEN TOTAL: 142.000

DATE: 09/09/90
TIME: 09:45:01

HIGHWAY TECHNOLOGY
INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

SCREEN: LR28M425

UNIQUE ID: 41300776 STUDY NO: WAGC8286 NCP CODE: 4E7B1902

STUDY
TITLE: **THE EFFECT OF ROADWAY WEAR ON TIRE NOISE**

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2085 STATUS: N
DATE STARTED: 09/01/87 DATE COMPLETED: 08/31/89 TYPE A OR B: B
PERFORMING ORGANIZATION(PO): **UNIVERSITY OF WASHINGTON**
CITY: OLYMPIA STATE: WA ZIP: 98501
PRINCIPAL INVESTIGATOR: CHALUPNIK. J.D.
FTC: FPA:
SPONSORING ORGANIZATION: WA

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
THIS STUDY IS EVALUATING THE CHARACTERISTICS OF HIGHWAY NOISE AND ITS CHANGES WITH AGING EFFECTS ON 6 TYPES OF HIGHWAY PAVEMENT. MEASUREMENTS ARE BEING MADE BIANNUALLY ON 41 ROAD SECTIONS WHICH INCLUDE TWO TYPES OF PORTLAND CEMENT CONCRETE AND FOUR TYPES OF ASPHALT. PAVEMENT SURFACE COMPOSITION. SURFACE WEAR. AND SURFACE ROUGHNESS ARE EXAMINED AS FACTORS DETERMINING SPECTRA OF TIRE NOISE. NOISE IS TO BE REPRESENTED AS A-WEIG HTED SOUND PRESSURE LEVELS. A MICROPHONE FOR MONITORING THE TIRE NOISE NEAR THE WHEEL-ROAD CONTACT POSITION WILL BE MOUNTED ON A UTILITY TRAILER WEIGHTED TO RESEMBLE A CAR. STUDY WILL PROVIDE GUIDANCE ON NOISE IMPACTS FROM REESURFACING PROJECTS (LONG/SHORT TERM). ESPECIALLY AS NEARBY LOCATIONS ARE IMPACTED.

NCP CATEGORY/PROGRAM: E7 FUNDING SOURCE: WA

FY	PROGRAMMED
88	12.566
89	13.283

SCREEN TOTAL: 25.849

DATE: 09/09/90
TIME: 09:25:01

HIGHWAY TECHNOLOGY
INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

SCREEN: LR28M425

UNIQUE ID: 41300859   STUDY NO: NJ.-7950   NCP CODE: 4E7B1292
STUDY
TITLE: **UPDATE OF N.J. TRUCK NOISE LEVELS**

HQ CONTACT: JONGEDYK. H.   PHONE: 703-285-2085 STATUS: N
DATE STARTED: 05/22/89 DATE COMPLETED: 03/01/92 TYPE A OR B: A
PERFORMING ORGANIZATION(PO): **NEW JERSEY DOT**
CITY: TRENTON   STATE: NJ ZIP: 08623
PRINCIPAL INVESTIGATOR: SASOR. S.
FTC: FPA: GROWNEY. J.
SPONSORING ORGANIZATION: NJ

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
DDATE THE TREUCK NOISE EMISSION LEVELS IN NEW JERSEY BY TAKING PRESENT DAY MEASUREMENTS ON VARIOUS TYPES OF NEW JERSEY HIGHWAYS. NOISE LEVELS OF INDIVIDUAL MEDIUM AND HEAVY TRUCKS WILL BE MEASURED AT VARIOUS GRADES AND CONTOLLED AND NON-CONTROLLEDACCESS HIGHWAYS USING THE SAME OR SIMILAR 13 VEHICLE CLASSES.ROADWAY TYPES. AND MEASUREMENT TECHNOLOGY IN THE TRUCK NOOISE ASSESMENTS . 12 YEARS AGO. NOISE LEVEL.SPEED. AND WEATHER DATA WILL COLLECTED AT SELECTED SITES. DATA REDUCED AND ANALYZED. PAST AND PRESENT NOISE LEVELS COMPARED. AND TRUCK NOISE EMISSION LEVEL EQUATIONS DEVELOPED. SAMPLING OF TRUCK NOISE WILL INCLUDE AN ADEQUATE NUMBER ANS BE REPRESENTATIVE OF LOCATIONS AND SITE TUPES IN THE STATE. A WEIGHTED NOISE LEVELS AND INDIVIDUAL TRUCK FREQ. SPECTRUMS TO BE USED.

NCP CATEGORY/PROGRAM: E7   FUNDING SOURCE: NJ

FY	PROGRAMMED
90	65.970
91	46.261
92	34.409

SCREEN TOTAL: 146.640

DATE: 09/09/90 HIGHWAY TECHNOLOGY SCREEN: LR2BM425
TIME: 09:26:12 INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

UNIQUE ID: 41300631 STUDY NO: WA-GC8286 NCP CODE: 4E7B1902
STUDY
TITLE: ALASKAN WAY VIADUCT TRAFFIC NOISE ABATEMENT PLAN

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2065 STATUS: N
DATE STARTED: 11/01/88 DATE COMPLETED: 11/01/90 TYPE A OR B: B
PERFORMING ORGANIZATION(PO): UNIVERSITY OF WASHINGTON
CITY: OLYMPIA STATE: WA ZIP: 98501
PRINCIPAL INVESTIGATOR: CHALUPNIK. J.D.
FTC: GLOVER. W. FPA: LLOYD. I.
SPONSORING ORGANIZATION: WA

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
EVALUATION OF THE ABATEMENT OF NOISE TO A LOW WATERFRONT PARK - ELLIOT BAY IN SEATTLE FROM ALL SOURCES WITH SPECIAL CONSIDERATION OF NOISE FROM A TWO LEVEL EXPRESSWAY PASSING OVER THE PROPOSED PARK AREA AND WATERWAY INLET. A BACKGROUND SURVEY OF RELATED EARLIER WORK AND NOISE CONTROL MATERIALS WILL BE CONDUCTED. NOISE MEASUREMENTS WILL BE MADE AT STRATEGIC LOCATIONS TO QUANTIFY EXISTING CONDITIONS. HIGHWAY AND NON-HIGHWAY SOURCE COMPONENTS OF NOISE WILL BE EVALUATED WITH SPECIAL CON CERN FOR NOISE REFLECTED FROM UNDERSIDE OF TOP ROAD OF 2 LEVEL VIADUCT. NOISE ABATEMENT EFFORTS WILL BE EVALUATED. STUDY RESULTS WILL BE MADE AVAILABLE TO OFFICIALS TO REDUCE HIGHWAY NOISE IMPACTS.

NCP CATEGORY/PROGRAM: E7 FUNDING SOURCE: WA

FY	PROGRAMMED
89	28.175
90	20.395
91	4.430

SCREEN TOTAL: 53.000

-----MESSAGES-----

DATE: 09/09/90
TIME: 09:30:20

HIGHWAY TECHNOLOGY
INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

SCREEN: LR28M425

UNIQUE ID: 41300860 STUDY NO: CA-E89TL08 NCP CODE: 4E7B1932

STUDY
TITLE: FIELD EVALUATION OF REDUCTION IN ACOUSTIC PERFORMANCE OF PARALLEL NOISE BARRIERS

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2085 STATUS: N
DATE STARTED: 03/17/89 DATE COMPLETED: 06/30/90 TYPE A OR B: B
PERFORMING ORGANIZATION(PO): CALTRANS
CITY: SACRAMENTO STATE: CA ZIP: 95807
PRINCIPAL INVESTIGATOR: HENDRIKS. R.
FTC: FPA: BATES. J.
SPONSORING ORGANIZATION: CA

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
THE EFFECTS OF ONE AND TWO WALLS ALONG ROUTE 99 IN SOUTH SACRAMENTO WILL BE EXPLORED FOR ONE RELECTION PFF OF ONE WALL. SINGLE REFLECTIONS AFFECTING THE PERFORMANCE OF ONE BARRIER. AND MULTIPLE REFLCTIONS OFF OF BOTH WALLS WHICH COULD DEGRADE THE PERFORMANCES OF EACH WALL 6 TO 8 DB A. FIELD SITE CONDITIONS. MICROPHONE LOCATIONS. AND ROADWAY CROSS SECTIONS INCLUDING PROPOSED BARRIERS WILL BE EVALUATED. MEASUREMENTS OF SOUND PROPAGATION WILL BE MADE BEFORE BOTH BARRIERS ARE CONSTRUCTED. AFTER BTOH BARRIERS ARE BUILT. AND DURING A SHORT PERIOD AFTER THE FIRST BARRIER IS COMPLETED AND BEFORE THE SECOND BARRIER CONSTRUCTION HAS STARTED. CONDTIONS SUCH AS NOISE SOURCES AND WIND SPEED AND DIRECTION WILL BE EVALUATED SINCE SUCH FACTROS INFLUENMCE NOISE PROPAGATION.

NCP CATEGORY/PROGRAM: E7 FUNDING SOURCE: CA

FY	PROGRAMMED
89	15.000
90	35.000

SCREEN TOTAL: 50.000

------------------------------------MESSAGES--

DATE: 09/09/90 TIME: 09:32:43

HIGHWAY TECHNOLOGY
INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

SCREEN: LR28M425

UNIQUE ID: 41300921 STUDY NO: FL-0555 NCP CODE: 4E7B1982

STUDY TITLE: **EXTENSION OF REFERENCE EMISSION FACTORS FOR STAMINA MODEL TO INCLUDE 55-65 MPH RANGE**

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2085 STATUS: N
DATE STARTED: 07/05/90 DATE COMPLETED: 12/31/91 TYPE A OR B: B
PERFORMING ORGANIZATION(PO): UNIVERSITY OF CENTRAL FLORIDA
CITY: ORLANDO STATE: FL ZIP: 32816
PRINCIPAL INVESTIGATOR: WAYSON. R.
FTC: FLORENCE. R. FPA: CORINO. G.
SPONSORING ORGANIZATION: FL

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
STAMINA MODELS PREDICT TRAFFIC NOISE LEVELS AFTER CONSIDERATIONS OF SPEEDS OF CARS. MEDIUM TRUCKS. AND HEAVY DUTY TRUCKS USING THE REFERENCE EMISSION LEVELS. ONLY TRAFFIC SPEEDS UP TO 55 MPH WERE CONSIDERED THUS FAR. THIS STUDY WILL CONSIDER SPEEDS TO 65 MPH. EARLIER PERTINENT DATA AND COMPUTER PROGRAM CHANGES WILL BE EVALUATED. NOISE REFERENCE LEVELS WILL BE MEASURED AT WELL SELECTED FLORIDA HIGHWAYS WITH CONSIDERATIONS OF BACKGROUND NOISE. WEATHER. AND ABILITY TO MEASURE INDIVIDUAL VEHICLES PASSING BY DISTINCTLY. SITES WILL HAVE APPROPRIATE PAVEMENTS AND FIELD CONDITIONS FOR MICROPHONE PLACEMENTS. DATA WILL BE ANALYZED AND EVALUATED. THE STAMINA COMPUTED PROGRM WOULD THEN BE ALTERED TO CHANGE SPEED LIMIT STATEMENTS AND ADD FLEXIBILITY. CONDUCT TESTS AND PREPARE REPORT.

NCP CATEGORY/PROGRAM: E7 FUNDING SOURCE: FL

FY	PROGRAMMED
91	24.000

SCREEN TOTAL: 24.000

DATE: 09/09/90 HIGHWAY TECHNOLOGY SCREEN: LR28M40B
TIME: 09:16:36 INFORMATION MANAGEMENT SYSTEM
PREAWARD

UNIQUE ID: 41300442 CONTR. NO: 85-P-00290 REQ NO: 41305054 RFP NO: 85-R-00020
COTR: PHONE: 703-285-2085
CONTRACT NEGOTIATOR: STUDY STATUS: S

DATE: REQ: 09/04/84 TO PAC EST: 09/04/84 TO CP: 09/06/84
ACC CP EST: 09/18/84 ACCEPTED BY CP: / / RFP ISSUED: / /
AWARD EST: 04/04/85 FORM 17 REC'D: / / AWARD: 01/23/85

REVIEW BOARD STATUS: FISCAL YEAR: 85
TECHNICAL EVALUATION: / / COST EVALUATION: 11/27/84

REMARKS:

UNIQUE ID: 41300442 CONTR. NO: 85-P-00290 REQ NO: 41305054 RFP NO: 85-R-00020
STUDY TITLE:
PARALLEL NOISE BARRIER PREDICTION PROCEDURE

COTR: JONGEDYK. H. PHONE: 703-285-2085 STUDY STATUS: S
DATE AWARDED: 01/23/85 COMPLETED: 05/06/87 NCP CODE: 3E7B1852
PERFORMING ORGANIZATION(PO): DR. SIMON SLUTSKY
CITY: NORTH BELLMORE STATE: NY ZIP: 11740
PRINCIPAL INVESTIGATOR: ORIGINATING STATE:
TASK ORDER:

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
TO EVALUATE THE COST EFFECTIVENESS OF ALTERNATIVE NOISE BARRIER DESIGNS WHICH SPECIFICALLY INCLUDED: 1) ABSORPTIVE MATERIAL ON BOTH SINGLE AND PARALLEL BARRIERS: AND 2) GEOMETRIC SHAPE. AN EVALUATION PROGRAM BASED ON EXPERIMENTAL AND TEMPORARY RETROFITS OF HARD WALL BARRIERS WILL PROVIDE STATE AGENCIES INFORMATION. DESIGN CRITERIA. AND COST EFFECTIVENESS OF ABSORPTIVE TREATMENTS FOR SINGLE AND PARALLEL NOISE BARRIERS HAVING VARIOUS ALTERNATIVE DESIGNS.

UNIQUE ID: 41300442 CONTRACT NO: 85-P-00290 NCP CODE: 3E7B1852

ACT CODE	FIS YEAR	FUND GROUP	ACTV CODE	CAT/ PROG	FUND SRCE	+ COMMITTED AMOUNT	+ OBLIGATED/ AWARDED AMOUNT	REQ NUMBER	MOD NUMBER
.	85	4130	13	3B	30	20.000	17.873	41305054	00
.									
.									
.									
.									
.									
.									
				TOTALS:		20.000	17.873		

DATE: 09/09/90 HIGHWAY TECHNOLOGY SCREEN: LR28M400
TIME: 09:13:02 INFORMATION MANAGEMENT SYSTEM
PREAWARD

UNIQUE ID: 41100549 CONTR. NO: 84-C-00060 REQ NO: 41304616 RFP NO: 84-R-00120
COTR: BOSCH. H. PHONE: 703-285-2446
CONTRACT NEGOTIATOR: SCOTT. V. STUDY STATUS: S

DATE: REQ: 09/29/83 TO PAC EST: 09/29/83 TO CP: 09/29/83
ACC CP EST: / / ACCEPTED BY CP: 03/19/84 RFP ISSUED: 03/14/84
AWARD EST: 07/24/84 FORM 17 REC'D: / / AWARD: 08/28/84

REVIEW BOARD STATUS: E FISCAL YEAR: 84
TECHNICAL EVALUATION: 05/11/84 COST EVALUATION: 05/16/84

REMARKS:

UNIQUE ID: 41100549 CONTR. NO: 84-C-00060 REQ NO: 41304616 RFP NO: 84-R-00120
STUDY TITLE:
INVESTIGATION OF STRUCTURAL DESIGN CRITERIA FOR NOISE WALLS

COTR: BOSCH. H. PHONE: 703-285-2446 STUDY STATUS: S
DATE AWARDED: 08/28/84 COMPLETED: 05/23/86 NCP CODE: 3E7B1042
PERFORMING ORGANIZATION(PO): ANALYSIS GROUP. INC.
CITY: WASHINGTON STATE: DC ZIP: 20006
PRINCIPAL INVESTIGATOR: BASU. S. ORIGINATING STATE:
TASK ORDER:

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
THE DESIGN OF NOISE WALLS BY SHA'S IS BASED PRIMARILY ON CRITERIA DEVELOPED FOR SIGN SUPPORT STRUCTURES. IT IS BELIEVED THAT THE CONSERVATIVE NATURE OF THESE CRITERIA. ALONG WITH THE INHERENTLY MORE STABLE NATURE OF WALLS (LINEAR. CONTINUOUS FOUNDATION VS. INTERUPTED. NARROW SUPPORTS): HAS LEAD TO OVERDESIGN OF NOISE WALLS. PARTICULARLY FOUNDATIONS. THIS RESEARCH WOULD EVALUATE THE CURRENT PARAMETERS USED FOR STRUCTURAL DESIGN. ESPECIALLY WIND LOADINGS. DETERMINE THE EXTENT OF THEIR ACTUAL APPLICABILITY. AND DEVELOP RECOMMENDED WIND LOADING PARAMETERS FOR MORE COST EFFECTIVE DESIGNS.

UNIQUE ID: 41100549 CONTRACT NO: 84-C-00060 NCP CODE: 3E7B1042

ACT CODE	FIS YEAR	FUND GROUP	ACTV CODE	CAT/ PROG	FUND SRCE	+ COMMITTED AMOUNT	+	OBLIGATED/ AWARDED AMOUNT	REQ NUMBER	MOD NUMBER
.	84	4130	13	E7 B	30	50.000		50.000	41304616	00
.	84	4130	13	E7 B	30	5.850		5.850	41304616	00
.	88	4130	13	E7 B	30	5.055		3.723	41308039	01
.										

TOTALS: 60.905 59.573

DATE: 09/09/90
TIME: 06:42:32

HIGHWAY TECHNOLOGY
INFORMATION MANAGEMENT SYSTEM
STUDIES BY NCP CODE

SCREEN: LR28M557
PAGE: 0001

NCP CODE (SEARCH ARGUMENT): 5E7B****

UNIQUE ID	STUDY TITLE
41300779	PREDICTING STOP-AND-GO TRAFFIC NOISE LEVELS

DATE: 09/09/90 HIGHWAY TECHNOLOGY SCREEN: LR28M426
TIME: 08:46:29 INFORMATION MANAGEMENT SYSTEM
POOLED-FUND STUDIES

UNIQUE ID: 41300750 CONTRACT NO: PPA727 NCP CODE: 4E7B1112
STUDY
TITLE: **EVALUATION OF PERFORMANCE OF EXPERIMENTAL HIGHWAY NOISE BARRIER**

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2085 STATUS: N
DATE AWARDED: 01/11/87 DATE COMPLETED: 09/30/91
PERFORMING ORGANIZATION(PO): **TRANSPORTATION SYSTEMS CENTER**
CITY: CAMBRIDGE STATE: MA ZIP: 02142
PRINCIPAL INVESTIGATOR: RICKLEY. E.
POOLED-FUND/PROJECT NO: HPR-2(136)

UNIQUE ID: 41300750 STUDY NO: PPA727 NCP CODE: 4E7B1112

FUNDING GROUP: 0000 NCP CATEGORY/PROGRAM: FUNDING SOURCE:

FY

DATE: 09/09/90 HIGHWAY TECHNOLOGY SCREEN: LR28M430
TIME: 09:05:49 INFORMATION MANAGEMENT SYSTEM
PERFORMING ORGANIZATION

UNIQUE ID: 41300297 CONTR. NO: 84-Y-30020 REQ NO: 41304619 RFP NO:
STUDY TITLE:
INVESTIGATION OF TIRE/PAVEMENT INTERACTION NOISE MECHANISMS: PHASE I
MITIGATION OF TIRE/PAVEMENT NOISE THROUGH OPTIMIZED PAVEMENT DESIGN:
PHASE II
COTR: JONGEDYK. H. PHONE: 703-285-2085 STUDY STATUS: s
DATE AWARDED: 03/02/84 COMPLETED: 09/30/90 NCP CODE: 3E7B1822
PERFORMING ORGANIZATION(PO): RSPA
CITY: WASHINGTON STATE: DC ZIP: 20590
PRINCIPAL INVESTIGATOR: eberhardt. a. ORIGINATING STATE:
TASK ORDER:

DATE: 09/09/90 HIGHWAY TECHNOLOGY SCREEN: LR28M400
TIME: 08:53:55 INFORMATION MANAGEMENT SYSTEM
PREAWARD

UNIQUE ID: 41300297 CONTR. NO: 84-Y-30020 REQ NO: 41304619 RFP NO:
COTR: JONGEDYK. H. PHONE: 703-285-2085
CONTRACT NEGOTIATOR: BAVISOTTO. C. STUDY STATUS: N S

DATE: REQ: 12/12/83 TO PAC EST: 12/12/83 TO CP: 12/12/83
ACC CP EST: / / ACCEPTED BY CP: / / RFP ISSUED: / /
AWARD EST: / / FORM 17 REC'D: / / AWARD: 03/02/84

REVIEW BOARD STATUS: E FISCAL YEAR: 84
TECHNICAL EVALUATION: / / COST EVALUATION: / /

REMARKS: 1513 SUBMITTED THE PHASE I REPORT HAS BEEN DELIVERED IN DRAFT FORM.
FINAL VERSION WILL BE DELIVERED MAY 85.

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
REDUCTION OF HIGHWAY TRAFFIC NOISE AT THE SOURCE CAN BE ACHIEVED BY REDUCING ONE OF THE DOMINANT CONTRIBUTORS: TIRE/PAVEMENT NOISE. THEREFORE. THE BASIC MECHANICS OF PAVEMENT INDUCED TIRE VIBRATIONS AND NOISE ARE BEING STUDIED UNDER PHASE I TO PROVIDE FIRST GENERATION COMPUTER SIMULATIONS FOR ANALYSES LEADING TO OPTIMUM PAVEMENT MACRO-TEXTURE. PHASE II WILL SIGNIFICANTLY REFINE AND COMPLETE AN ANALYTIC MODEL. WHICH USES MACROTEXTURE DATA FROM PHASE I. TO DETERMINE TIRE VIBRATION RESPONSES DUE TO NORMAL AND TANGENTIAL (TRACTION) FORCES AS DICTATED BY THE CONTROLLING PAVEMENT MACROTEXTURE.
(NON-COMPETITIVE PROCUREMENT FOR PHASE II).

UNIQUE ID: 41300297 CONTRACT NO: 84-Y-30020 NCP CODE: 3E7B1822

ACT CODE	FIS YEAR	FUND GROUP	ACTV CODE	CAT/ PROG	FUND SRCE	+ COMMITTED AMOUNT	+	OBLIGATED/ AWARDED AMOUNT	REQ NUMBER	MOD NUMBER
.	84	4130	13	3B	30	100.000		100.000	41304619	00
.	85	4130	13	3B	30	100.000		100.000	41305094	01
.	86	4130	13	3B	30	60.000		60.000	41306067	02
.										
.										
.										
.										
					TOTALS:	260.000		260.000		

DATE: 09/12/90 HIGHWAY TECHNOLOGY SCREEN: LR28M430
TIME: 08:12:34 INFORMATION MANAGEMENT SYSTEM
PERFORMING ORGANIZATION

UNIQUE ID: 41300155 CONTR. NO: 80-C-00034 REQ NO: RFP NO:
STUDY TITLE:
STOP AND GO TRAFFIC NOISE PREDICTION PROCEDURE

COTR: ROMANO. F. PHONE: 0- 0- 0 STUDY STATUS: 5
DATE AWARDED: 02/21/80 COMPLETED: 08/31/82 NCP CODE: 33B 2412
PERFORMING ORGANIZATION(PO): **POLYTECHNIC INSTITUTE OF N.Y.**
CITY: BROOKLYN STATE: NY ZIP: 11201
PRINCIPAL INVESTIGATOR: SLUTSKY. S. DR. ORIGINATING STATE:
TASK ORDER:

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
THE COMPLEX GEOMETRY OF THE URBAN THOROUGH FARE REQUIRES A DETAILED ANALYSIS WHICH ACCOUNTS FOR MULTIPLE REFLECTIONS AND SOURCE EMISSIONS WHICH ARE NOT STEADY STATE. THIS RESEARCH WILL PROVIDE HIGHWAY ENGINEERS/PLANNERS WITH THE TECHNIQUES FOR PERFORMING NOISE IMPACT ANALYSES IN THE URBAN ENVIRONMENT. AN URBAN NOISE PREDICTION MODEL IS BEING DEVELOPED TO ACCOUNT FOR THE EFFECTS OF STOP AND GO TRAFFIC ON CITY STREETS. CONSIDERATION IS GIVEN TO VEHICLE TYPE. OPERATING MODE (ACCELERATION DECELERATION. CRUISE AND IDLE0. TRAFFIC FLOW CHARACTERISTIC AND URBAN PROPAGATION. NOISE PROPAGATION WILL BE CONSIDERED IN TERMS OF DIRECT RADIATION. SINGLE AND REFLECTIONS. AND DIFFUSE SCATTERING.

UNIQUE ID: 41300155 CONTRACT NO: 80-C-00034 NCP CODE: 33B 2412

ACT CODE	FIS YEAR	FUND GROUP	ACTV CODE	CAT/ PROG	FUND SRCE	+ COMMITTED AMOUNT	+	OBLIGATED/ AWARDED AMOUNT	REQ NUMBER	MOD NUMBER
.	81	4130	13	3F	30					00
.										
.										
.										
.										
.										
.										

DATE: 09/09/90
TIME: 09:20:30

HIGHWAY TECHNOLOGY
INFORMATION MANAGEMENT SYSTEM
PREAWARD

SCREEN: LR26M400

UNIQUE ID: 41300156 CONTR. NO: PPA. HW-125 REQ NO:
COTR: JONGEDYK. H.
CONTRACT NEGOTIATOR:

RFP NO:
PHONE: 703-285-2085
STUDY STATUS: N

DATE: REQ: / /
ACC CP EST: / /
AWARD EST: / /

TO PAC EST: / /
ACCEPTED BY CP: / /
FORM 17 REC'D: / /

TO CP: / /
RFP ISSUED: / /
AWARD: 06/01/81

REVIEW BOARD STATUS: FISCAL YEAR: 81
TECHNICAL EVALUATION: / / COST EVALUATION: / /

REMARKS:

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
A STANDARD TEST PROCEDURE FOR DETERMINING NOISE BARRIER PERFORMANCE IS BEING DEVELOPED IN COORDINATION WITH A VOLUNTARY STANDARDS COMMITTEES OF THE ACOUSTICAL SOCIETY OF AMERICA AND THE AMERICAN NATIONAL STANDARDS INSTITUTE AND WILL BE SUITABLE FOR ADOPTION BY THESE GROUPS. EXPERIMENTAL INVESTIGATIONS FOR DEVELOPMENT OF THE STANDARD ARE BEING CONDUCTED BY THE TRANSPORTATION SYSTEMS CENTER. SPECIFIC TASKS WILL INCLUDE THE DEVELOPMENT OF A PRELIMINARY STANDARD. A REVISED STANDARD AND A FINAL STANDARD. THIS DEVELOPMENT WILL BE BASED ON CURRENT PRACTICE. IDENTIFICATION OF GAPS AND DEFICIENCIES THEREOF. DEVELOPMENT OF A PLAN FOR ANALYTICAL AND THEORETICAL STUDIES AND PERFORMANCE OF THESE STUDIES. AND VALIDATION TO ASSESS THE FEASIBILITY OF THE

UNIQUE ID: 41300156 CONTRACT NO: PPA. HW-125 NCP CODE: 3E7B1082

ACT CODE	FIS YEAR	FUND GROUP	ACTV CODE	CAT/ PROG	FUND SRCE	+ COMMITTED AMOUNT	+ OBLIGATED/ AWARDED AMOUNT	REQ NUMBER	MOD NUMBER
.	81	4130	13	3F	30	73.000	73.000		00
.									
.									
.									
.									
.									
.									
					TOTALS:	73.000	73.000		

DATE: 09/12/90
TIME: 10:00:53

HIGHWAY TECHNOLOGY
INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

SCREEN: LR28M425

UNIQUE ID: 41300799 STUDY NO: FL-86-31 NCP CODE: 4E7B1302

STUDY
TITLE: **AN INVESTIGATION OF THE EFFECTIVENESS OF NOISE BARRIERS ALONG I-275 AND I-95**

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2085 STATUS: S
DATE STARTED: 03/03/87 DATE COMPLETED: / / TYPE A OR B: B
PERFORMING ORGANIZATION(PO): FLORIDA ATLANTIC UNIVERSITY
CITY: BOCA RATON STATE: FL ZIP: 33431
PRINCIPAL INVESTIGATOR: DUNN. S.
FTC: FPA: HUNESTON. J.
SPONSORING ORGANIZATION: FL

BRIEFLY DESCRIBE THE WORK TO BE PERFORMED:
THE EFFECTIVENESS OF I-275 NOISE BARRIER IN PINELLAS COUNTY AND THREE NOISE BARRIERS IN DADE COUNTY IS TO BE MEASURED. TWO THREE ELEMENT ARRAYS OF MICROPHONES WILL BE LOCATED AT VARIOUS LOCATIONS BEYOND THE NOISE WALLS AND A MEASUREMENT WILL BE MADE ABOVE THE WALLS AT THE SAME TIMES THAT TRAFFIC AND METEOROLOGICAL FACTGORS ARE MEASURED. RECEPTOR CONDITONS ARE NOTED AND MEASUREMENTS ARE TO BE MADE BOTH BEFORE AND AFTER THE CONSTRUCTION OF NOISE BARRIERS. MEASURED RESULTS ARE TO BE COMPARED TO PREDICTED RESULTS AND STAMINA 2.0 USED TO ADJUST MEASURED RESULTS TO TRAFFIC FLOWS. PROPOSED ANSI PROCEDURE FOR EVALUATING BARRIER EFFECTIVENESS WILL BE EMPLOYED IN THE STUDY. A-WEIGHTED SOUND LEVELS USING EQUIV. ENERGY LEVELS CHARACTERIZE NOISE.

UNIQUE ID: 41300799 STUDY NO: FL-86-31 NCP CODE: 4E7B1302

NCP CATEGORY/PROGRAM: E7 FUNDING SOURCE: FL

FY	PROGRAMMED
87	39.250

SCREEN TOTAL: 39.250

DATE: 09/12/90 HIGHWAY TECHNOLOGY SCREEN: LR28M428
TIME: 10:03:25 INFORMATION MANAGEMENT SYSTEM
POOLED-FUND STUDIES

UNIQUE ID: 41300750 CONTRACT NO: PPA727 NCP CODE: 4E7B1112
STUDY
TITLE: **EVALUATION OF PERFORMANCE OF EXPERIMENTAL HIGHWAY NOISE BARRIER**

HQ CONTACT: JONGEDYK, H. PHONE: 703-285-2085 STATUS: N
DATE AWARDED: 01/11/87 DATE COMPLETED: 09/30/91
PERFORMING ORGANIZATION(PO): TRANSPORTATION SYSTEMS CENTER
CITY: CAMBRIDGE STATE: MA ZIP: 02142
PRINCIPAL INVESTIGATOR: RICKLEY, E.
POOLED-FUND/PROJECT NO: HPR-2(136)

DATE: 09/12/90 HIGHWAY TECHNOLOGY SCREEN: LR28M425
TIME: 10:05:43 INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

UNIQUE ID: 41300747 STUDY NO: CA-E85TL18 NCP CODE: 4E7B1052
STUDY
TITLE: TRAFFIC NOISE ATTENUATION AS A FUNCTION OF GROUND AND VEGETATION

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2085 STATUS: N
DATE STARTED: 08/01/85 DATE COMPLETED: / / TYPE A OR B: A
PERFORMING ORGANIZATION(PO): CALTRANS
CITY: SACRAMENTO STATE: CA ZIP: 95807
PRINCIPAL INVESTIGATOR: BENSON. P.
FTC: FPA:
SPONSORING ORGANIZATION: CA

DATE: 09/12/90 HIGHWAY TECHNOLOGY SCREEN: LR28M425
TIME: 09:53:41 INFORMATION MANAGEMENT SYSTEM
HP&R STUDIES

UNIQUE ID: 41300752 STUDY NO: NJ 85-01 NCP CODE: 4E7B1252
STUDY
TITLE: **EVALUATION OF INNOVATIVE NOISE BARRIERS**

HQ CONTACT: JONGEDYK. H. PHONE: 703-285-2085 STATUS: N
DATE STARTED: 05/09/85 DATE COMPLETED: / / TYPE A OR B: A
PERFORMING ORGANIZATION(PO): **NEW JERSEY DOT**
CITY: TRENTON STATE: NJ ZIP: 08623
PRINCIPAL INVESTIGATOR: MARSELLA. M.
FTC: FPA:
SPONSORING ORGANIZATION: NJ

Appendix C -- Legislation and Guidelines for Traffic Noise Abatement in California

Senate Bill No. 290

CHAPTER 707

An act to amend Section 216 of the Streets and Highways Code, relating to state highways.

[Approved by Governor September 9, 1983. Filed with Secretary of State September 11, 1983.]

LEGISLATIVE COUNSEL'S DIGEST

SB 290, Ellis. State highways: noise abatement programs.

Under existing law, the Department of Transportation is required to measure noise levels and undertake noise abatement programs in specified schools along state freeways.

This bill would revise the decibel scale to be used by the department for measurement of noise levels in the schools and for qualification for the noise abatement programs.

The people of the State of California do enact as follows:

SECTION 1. Section 216 of the Streets and Highways Code is amended to read:

216. The noise level produced by the traffic on, or by the construction of, a state freeway shall be measured in the classrooms, libraries, multipurpose rooms, and spaces used for pupil personnel services of a public or private elementary or secondary school if the rooms or spaces (a) were constructed prior to the award of the initial construction contract for the freeway route and prior to January 1, 1974, or (b) were constructed after December 31, 1973, and were constructed prior to the issuance of a statement of present and projected noise levels of the freeway route by the department pursuant to subdivision (g) of Section 65302 of the Government Code, and (c) are being used for the purpose for which they were constructed.

The measurements shall be made at appropriate times during regular school hours and shall not include noise from sources that exceed the maximum permitted by law.

If the noise level produced from the freeway traffic, or the construction of the freeway, exceeds 55dBA, L10, or 52dBA, Leq., the department shall undertake a noise abatement program in any such classroom, library, multipurpose room, or space used for pupil personnel services to reduce the freeway traffic noise level therein to 55dBA, L10, or 52dBA, Leq., or less, by, but not limited to, installing acoustical materials, eliminating windows, installing air conditioning, or constructing sound baffle structures.

If the department determines that the construction of the freeway will result in a noise level exceeding 55dBA, L10, or 52dBA, Leq., the department shall complete the temporary or permanent noise abatement program prior to commencing such construction, or as soon as practicable thereafter.

If it becomes necessary to convert the classrooms, libraries, multipurpose rooms, or spaces used for pupil personnel services to other school-related purposes because the freeway traffic noise level therein exceeds 55dBA, L10, or 52dBA, Leq., the department shall pay the cost of the conversions.

If the noise level generated from sources within and without the classrooms, libraries, multipurpose rooms, or spaces used for pupil personnel services exceeds 55dBA, L10, or 52dBA, Leq. prior to construction of the freeway and the noise from the freeway, or the construction thereof, also exceeds 55dBA, L10, or 52dBA, Leq., the department shall be required to undertake a noise abatement program that will reduce the noise to its preconstruction level.

Priority for noise abatement programs shall be given to those public and private elementary and secondary classrooms, libraries, multipurpose rooms, and spaces used for pupil personnel services constructed in conformance with Article 3 (commencing with Section 39140) of Chapter 2 of Part 23 of Division 3 of Title 2 of the Education Code.

As used in this section, dBA means decibels measured by the "A" weighting described in Section 3.1 of the American National Standard specification for sound level meters, S1.4-1971, approved April 27, 1971, and published by the American National Standards Institute. L10 is the sound level that is exceeded 10 percent of the time for the period under consideration and is a value which is an indicator of both the magnitude and frequency of occurrence of the loudest noise events. Leq. is the equivalent steady state sound which in a stated period of time would contain the same acoustic energy as the time-varying sound level during the same time period.

O

State of California, Section 215.5 of the Streets and Highways Code

Priority System for Noise Barriers

215.5. (a) The department shall develop and implement a system of priorities for ranking the need for installation of noise attenuation barriers along freeways in the California freeway and expressway system. In establishing a priority system, the department shall give the highest consideration to residential areas which were developed prior to the opening of the freeway. If alterations have been made to the freeway since its original opening which result in a significant and measurable increase in ambient noise levels, the opening date for that segment of the freeway, for the purposes of determining priorities under this section, is the completion date of that alteration project. Other criteria for determining priorities shall include the existing and future intensity of sound generated by the freeway, the increase in traffic flow since the original construction of the freeway, the cost of building the sound wall in relation to the expected noise reduction, the number of persons living in close proximity to the freeway, and whether a majority of the occupants in close proximity to the freeway resided there prior to the time the freeway routing was adopted by the commission. The city or county in which the residential area is located shall be responsible for providing documentation to the department on the percentage of original occupants still residing along the freeway.

The actual cost of construction shall be used in determining the relative priority ranking of projects funded and constructed pursuant to subdivision (d).

(b) When all freeways have been ranked in priority order, the department shall, consistent with available funding, include in its proposed state transportation improvement program, a program of construction of noise attenuation barriers beginning with the highest priority.

In preparing the annual priority list, the department shall not add any new project to the list ahead of a project that has been funded by a city or county and is awaiting state reimbursement pursuant to subdivision (d).

(c) The commission shall include in the estimate adopted pursuant to Section 14525 of the Government Code an annual and five-year estimate of funds estimated to be available for noise attenuation barriers along freeways. If any city or county constructs a noise attenuation barrier along a freeway pursuant to subdivision (d), the commission shall allocate funds for the project in the fiscal year the project would have been eligible for funding based on the department's priority list and the commission's fund estimate at the time of approval of the project pursuant to subdivision (d).

(d) If any city or county constructs a noise attenuation barrier along a freeway using public funds prior to the time that the barrier reaches a high enough priority for state funding, then, when the funding priority is reached, the department shall reimburse the city or county without interest for the cost of construction, but the reimbursement may not exceed the cost of the department to construct the barriers. Reimbursement shall be made only if the city or county constructs the noise attenuation barrier to the standards approved by department, follows bidding and contracting procedures approved by the department, and the project is approved by the commission.

CHAPTER 1100 HIGHWAY TRAFFIC NOISE ABATEMENT

Topic 1101 - General Requirements

Index 1101.1 - Introduction

The abatement of highway traffic noise is a design consideration that is required by State and Federal Statutes and regulations and by Caltrans' policy. This chapter provides the basic guidelines that are to be followed to determine when noise abatement is required and to design abatement features in major projects. Specific structural, architectural, and noise design procedures are covered in other manuals, guides, and in Standard Plans as mentioned below.

Because of the sensitivity of the public to the highway noise issue and the relatively high cost of abatement, it is imperative that the Districts carefully follow the guidelines, reference procedures, and standards.

The three basic types of projects include:

(a) The construction of new highways or the reconstruction or widening of existing highways.

(b) The retrofitting of noise abatement features on existing freeways through residential areas.

(c) The retrofitting of noise abatement features to reduce the level of freeway traffic noise that intrude public and privately-owned primary and secondary schools.

1101.2 Objective

The objective is to limit the intrusion of highway traffic noise into adjacent areas to specified levels or standards on new construction or reconstruction of highways, to achievable levels within practical and financial limits on existing freeways, and to specified levels by statute on freeways adjacent to qualifying schools. To achieve these objectives the Department supports the following three approaches to alleviate traffic noise impacts:

(1) Reduction at the Source. Reduction of traffic noise at the source is the most effective control. Therefore, Caltrans encourages and supports legislation to require reduction in motor vehicle noise as advances in the state-of-the-art of motor vehicle engineering permit.

(2) Encouraging Compatible Adjacent Land Use. Caltrans encourages those who plan and develop land and local governments controlling development or planning land use near known highway locations to exercise their powers and responsibility to minimize the effect of highway vehicle noise through appropriate land use control. For example, cities and counties have the power to control development by the adoption of land use plans and zoning, subdivision, building and housing regulations.

(3) Noise Abatement. Caltrans will attempt to locate, design, construct, and operate highways to minimize the intrusion of traffic noise into adjacent areas. When this is not possible, noise impacts may be attenuated by the construction of noise barriers.

1101.3 Procedures for Assessing Noise Impacts

Highway traffic noise impacts are identified in the project noise study report and are listed in the environmental document. The procedures for assessing noise impacts for new highway construction or reconstruction projects, retrofit projects (Community Noise Abatement Program - HB311) along existing freeways, and School Noise Abatement Projects (HB312), are included in FHPM 7-7-3, the Caltrans Noise Manual developed by the TM&R, and Sections 215.5 and 216 of the Streets and Highways Code relating to the California Department of Transportation.

Topic 1102 - Design Criteria

1102.1 General

This section covers the noise level criteria for the various types of noise abatement projects, and gives guidelines on noise reduction, noise barrier location, and various design aspects such as height and length of noise barriers. Alternate designs, maintenance considerations, and aesthetic aspects are also discussed. Various types of Caltrans' standard noise barrier designs are referenced. Noise barrier design procedures, from the acoustical standpoint, are included in the Caltrans' Noise Manual.

1102.2 Noise Abatement Criteria Levels

(1) General. The noise abatement criteria levels in Table 1102.2 represents a balancing of that which may be desirable for the various land use activities and that which may be achievable. In many cases the achievement of lower noise levels would result in even greater benefits to the community and should be considered. The additional cost should, of course, be compared to the added benefits.

(2) New Highway Construction or Reconstruction. For new highway construction or reconstruction which meets the definition of a Type I Project as defined in Index 1106.7, noise abatement measures which are reasonable and feasible should be incorporated into the plans and specifications to reduce or eliminate the traffic noise impacts on existing or design year activities. Traffic noise impacts occur when the predicted traffic noise levels approach or exceed the noise abatement criteria shown in Table 1102.2 or when the predicted traffic noise levels substantially exceed the existing noise levels.

(3) Existing Freeways. On existing freeways, the construction of noise barriers is limited to residential areas meeting the criteria outlined in Index 1104.2 when the existing noise levels exceed the noise abatement criteria level for land use activity Category B shown on Table 1102.2.

(4) School Noise Abatement. Section 216 of the Streets and Highway Code requires the Department to reduce the freeway noise levels to 55 dBA, L_{10}, or 52 dBA L_{eq}, within the interior of public and private elementary and secondary schools if the school was constructed within the time frame specified in the Code.

Table 1102.2
Noise Abatement Criteria

Hourly A-Weighted Sound Level(1) (dBA)

Activity Category	L_{eq} (h)	L_{10} (h)
A	57 (Exterior)	60 (Exterior)
B	67 (Exterior)	70 (Exterior)
C	72 (Exterior)	75 (Exterior)
D	--	--
E	52 (Interior)	55 (Interior)

(1) Either L_{10} (h) or L_{eq} (h) (but not both) may be used on a project.

Description of Activity Categories

A Lands of which serenity and quiet are of extraordinary significance and serve an important public need, and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.

B Picnic areas, recreation areas, playgrounds, active sport areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.

C Developed lands, properties, or activities not included in Categories A or B above.

D Undeveloped lands.

E Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

1102.3 Noise Reduction

(1) Minimum Attenuation. The noise abatement criteria levels of Table 1102.2 should not automatically be considered the lower limit of attenuation if it is reasonable and feasible to achieve a lower noise level. Whenever a noise barrier is proposed it should achieve a minimum attenuation of 5 decibels, except under certain conditions such as where a gap between two noise barriers is closed to provide continuity.

(2) Substantial Increase. On new construction and reconstruction projects, noise abatement facilities should be provided if the predicted traffic noise levels substantially exceed the existing traffic noise levels even though the predicted levels are below the noise abatement criteria shown on Table 1102.2. In order to provide a uniform approach for substantial increases, noise abatement must be considered on all construction or reconstruction projects where the predicted design year noise level increases by 12 decibels over the ambient and the design year level equals or exceeds 65 dBA, Leq. However, attenuation for lesser increases in noise levels above the ambient and lesser design year levels should be considered when a lower noise level is a clear and special need.

1102.4 Noise Barrier Location

(1) Lateral Clearances. **Minimum lateral clearance to noise barriers shall be as provided in Topic 309.1, Horizontal Clearances, of this manual.** Lateral clearances greater than the minimums should be used whenever feasible. Where terrain permits, the most desirable location for a noise barrier is just inside the right of way or, alternatively, 30 feet or more from the traveled way.

When clearance is 15 feet or less, the noise barrier shall be placed on a safety shape concrete barrier. Guardrail or safety shape barrier protection should be considered when the noise barrier is located between 15 feet and 29 feet from the edge of the traveled way.

(2) Sight Distance Requirements. The stopping sight distance is of prime importance for noise barriers located on the edge of shoulder along the inside of a curve. Horizontal clearances which reduce the stopping sight distance should be avoided. Noise barriers in gore areas should begin or end at least 200 feet from the theoretical curb nose location.

1102.5 Noise Barrier Heights

(1) Minimum Height. Noise barriers should have a minimum height of 6 feet (measured from the top of the barrier to the top of the foundation).

(2) Maximum Height. Noise barriers should not exceed 14 feet in height (measured from the pavement surface at the face of the safety-shape barrier) when located within 15 feet of the traveled way, and should not exceed 16 feet in height above the ground line when located more than 15 feet from the traveled way.

(3) Truck Exhaust Intercept. Current FHWA noise barrier design procedures result in noise barrier heights which often do not intercept noise emitted from the exhaust stack of trucks. For design purposes, the noise barrier should intercept the line of sight from the exhaust stack of a truck to the receptor. The truck stack height is assumed to be 11.5 feet above the pavement. The receptor is assumed to be 5 feet above the ground and located 5 feet from the living unit nearest the roadway. If this location is not representative of potential outdoor activities, then another appropriate location should be justified in the noise study report.

(4) Two-story Development. The noise barrier should not be designed to shield the second story of two-story residences unless it provides attenuation for a substantial number of residences at a reasonable increase in cost. If the noise barrier is extended in height to provide second story attenuation, this attenuation is to be at least 5 decibels.

1102.6 Noise Barrier Length

(1) General. Careful attention should be given to the length of a noise barrier to assure that it provides adequate attenuation for the end dwelling. Where there is no residential area beyond the end dwelling, consideration should be given to terminating the noise barrier with a section of the barrier perpendicular to the freeway

which could reduce the overall barrier length. This could require an easement from the property owner to permit construction of the noise barrier off the right of way.

(2) Gap Closures. In some cases, short gaps may exist between areas qualifying for a noise barrier. The closure of these gaps should be considered on a project by project basis and be justified in the Project Report.

(3) Local Street Connections. At on- and off-ramp connections to local streets, the Department's responsibility for noise abatement should be limited to areas where the traffic noise level from the State highway is the predominant noise source.

1102.7 Alternate Noise Barrier Design

(1) General. Every noise barrier that is constructed as a part of new highway construction or reconstruction, or along freeways as a part of the Community and School Noise Abatement Programs, should include at least two alternate designs. Standard sheets for noise barriers (sound walls) developed by the of Structure Design have been furnished to the Districts. These standard designs include the following materials:

- o Masonry block.
- o Precast concrete panel (with post or mounted on safety shaped barrier).
- o Wood (post and plank or framed plywood).
- o Metal (ribbed steel).
- o Composite beam (Styro-foam and wire mesh core with stucco exterior).
- o Other design alternates maybe considered provided they meet the structural and noise attenuation criteria.

(2) Design Procedures. The plans for alternate noise barriers are to be prepared using the standard sound wall sheets and the appropriate Standard Special Provisions. As a minimum, the sound wall plans are to show the horizontal alignment, the wall profile made up of a top elevation line and a bottom elevation line, the applicable standard sound wall detail sheets, and aesthetic features sheet. The top elevation line is defined as the profile line of the minimum wall height required for the design insertion loss, and the bottom elevation line is defined as the finished grade ground line. If a concrete safety-shape barrier is involved, the top of barrier is to be designated as the bottom elevation line of the sound wall. For alternate sound walls not on a barrier, the footing design does not have to be detailed on the plans. If a barrier is required, the pile layout should be detailed for only one of the alternate designs. Although this method does not require the detailing of one complete sound wall alternate, it does not remove the necessity to solve drainage, utility, foundation, or any other problems which are unique to each project.

(3) Pay Quantities. The pay item for alternate sound walls without a barrier is square foot of sound wall and is measured between the top elevation line and the bottom elevation line. The pay item will be in three groups; H = 6' to 8', H = 10' to 12', H = 14' to 16'. The square foot cost includes all types of supports (footings, piles and pile caps).

Since the elevation lines define the pay item they must be clearly noted on the typical sections and profile plans, and the limits of each wall height group must be designated for pay purposes. All reference to "pile length for payment" should be removed from the Standard Plan sheets if there is no safety shape barrier involved. If the sound wall is on a barrier the sound wall pay item is measured from top elevation line to top of barrier, and the supporting piles or footings and barrier will be separate pay items.

The aesthetic features affect the amount of footing for the masonry block design, and these features must be shown clearly on the plans. The "Typical Sections" sheet is the recommended location to show the aesthetic treatment.

(4) Shop Plans. The Special Provisions should require the successful bidder to submit two sets of shop plans of the alternate selected for approval. These shop drawings must show pile spacing, pile lengths, expansion joints location, and aesthetic treatment.

(5) Preliminary Site Data. In using the "Top Line/Bottom Line" concept, it is important that the preliminary site data be complete as possible. To eliminate or minimize construction change orders the following guidelines are suggested.

- o Provide accurate ground line profiles.

- Select only standard design alternative sound wall types. Determine locations where these are acceptable and describe in the Special Provisions or show on the plans.
- Provide adequate foundation investigation.
- Locate overhead and underground utilities.
- Review drainage and show any modifications on the plans.
- Determine and specify architectural treatment.
- Determine the need for special design, and coordinate with the Division of Structures during the early stages of design.

1102.8 Noise Barrier Aesthetics

(1) General. A landscaped earth berm or a combination wall and berm tend to minimize the apparent noise barrier height and are probably the most aesthetically acceptable alternative, but unfortunately these alternatives are not suitable for many sites due to limited space.

Some moderate additional cost to enhance the noise barrier's aesthetic quality is warranted. However, elaborate or costly individualized designs which significantly increase the cost of the noise barrier should be avoided. When landscaping is to be placed adjacent to the sound wall which will eventually screen a substantial portion of the wall, only a minimal aesthetic treatment is justified. Sound walls should not be designed with abrupt beginnings or ends. Generally, the ends of the sound wall should be tapered or stepped if the height of the sound wall exceeds 6 feet.

(2) Standard Aesthetic Treatment. Only the standard aesthetic treatments for the various alternative materials developed by the Division of Structures should be used. A description of the different types of aesthetics treatments developed are included in the "Instructions for Using the Standard Aesthetics Features Sheets" which are available from the Aesthetics and Models unit of the Division of Structures.

1102.9 Maintenance Consideration in Noise Barrier Design

(1) General. Noise barriers placed within the area between the shoulder and right of way line complicate the ongoing maintenance and landscaping operations and lead to substantially increased costs, especially if landscaping is placed on both sides of the noise barrier. The area behind noise barriers adjacent to the right of way line require special consideration. If the adjoining land is occupied with streets, roads, parks, or other large parcels, an effort should be made during the right of way negotiations to have the abutting property owners maintain the area. In this case, the chain link fence at the right of way line would not be required. Maintenance by others may not be practical if a number of small individual properties abut the noise barrier.

(2) Access Requirements. Access to the back side of the noise barrier must be provided if the area is to be maintained by Caltrans. In subdivided areas, access can be via local streets, when available. If access is not available via local streets, access gates or openings are essential at intervals along the noise barrier. Offset barriers concealing the access opening must be overlapped a minimum of 2.5 to 3 times the offset distance in order to maintain the integrity of the sound attenuation of the main barrier. Location of the access openings must be coordinated with the District maintenance office.

(3) Sound Wall Material. The alternate materials selected for the noise barrier should be appropriate for the environment in which it is placed. For walls that are located at or near the edge of shoulder, the portion of the noise barrier located above the safety-shape concrete barrier should be capable of withstanding the force of an occasional vehicle which may ride up above the top of the safety barrier. At this location, concrete block, cast-in-place concrete, or precast concrete panels are the recommended alternative sound wall materials. In locations which are susceptible to fires, use of the wood noise barrier option should be avoided.

Topic 1103 - Procedures for Designing Noise Barriers

1103.1 General

The procedures for predicting highway noise levels and calculating the insertion loss of a noise barrier are included in the Caltrans' Noise Manual and are based on the FHWA Highway

Traffic Noise Prediction Model (Report No. FHWA-RD-77-108). As the result of a research project conducted by the TM&R, the national (FHWA) reference energy mean emission levels reported in the FHWA Report No. FHWA-RD-77-108 are to be replaced by the California Vehicle Noise (Calveno) reference energy mean emission level curves related to vehicle speeds and vehicle type (autos, medium and heavy trucks).

The Calveno curves have been programmed as an option in the following computer programs for predicting noise levels and calculating the noise insertion losses of a barrier:

LEQV2, SOUND3, and SOUND32

All traffic noise predictions and noise barrier insertion loss calculations for noise studies started on March 26, 1985, or later must use the Calveno curve option.

Topic 1104 - Community Noise Abatement Projects

1104.1 General

This topic covers the procedures to follow in order to identify and prioritize residential areas adjacent to existing freeways which qualify for noise abatement pursuant to Section 215.5 of the Streets and Highway Code.

1104.2 Section 215.5 Requirements

(1) General. Section 215.5 of the Streets and Highways Code requires Caltrans to develop and implement a system of priorities for ranking the need for installation of noise attenuation barriers along the California Freeway and Expressway System and, consistent with available funding, recommend in the STIP, a program for construction of noise attenuation barriers beginning with the highest priority.

(2) Qualifying Areas. In order for a residential area to qualify for this program it must meet one of the following conditions:

(a) Developed prior to the opening of the freeway, or

(b) Developed after opening of the freeway, but before the completion of an alteration to the freeway which caused at least a 3 dBA increase in noise levels.

In determining the time relationship between residential development and freeway opening, the date of residential development means the date of the issuance of a building permit and the opening date of the freeway means the date that the adjacent freeway was opened to traffic.

1104.3 Inventory of Qualifying Areas

The Districts must maintain an inventory of residential areas adjacent to freeways on the California Freeway and Expressway System that meet the criteria stipulated in Index 1104.2(2). This inventory should be segregated into logical construction project limits.

1104.4 District Priority List

From the inventory of qualifying projects, a priority index is to be calculated for each project where the measured or adjusted noise levels exceed the noise level criteria for Activity Category B, shown on Table 1102.2 (67 dBA, L_{eq}). This priority index is to be calculated using the following formula:

$$PI = \frac{AR \times (NL-67)^2 \times LU}{\text{Cost } (\$1000)}$$

Where:

PI = Priority Index

AR = Achievable Reduction

NL = Measured Noise Levels, L_{eq}

LU = Number of Living Units

In the above formula, the achievable reduction should be the average reduction in noise levels that the proposed noise barrier will achieve. The noise abatement criteria level (or lower) shown for activity category B on Table 1102.2 is a goal for achievement, but is not mandatory. However, any noise barrier considered under this program, in order to provide a significant benefit in noise reduction, must provide a minimum of 5 decibels reduction.

The noise level used in the formula should be the average of the actual field measured design hour levels for the project in L_{eq}. These measured levels should be adjusted as follows to account for future increases in noise levels, unless unique conditions dictate otherwise:

Present Design Hour Level of Service(1)	Adjustment
A	+ 2 dBA
B	+ 1 dBA
C	0
D,E,F	(2)

(1) As defined in 1985 Highway Capacity Manual.
(2) Noise measurements not recommended during this level of service.

The number of living units should be limited to the residences immediately adjacent to the freeway. Residences located above the first floor in multi-story units should be included in the residential count if the proposed barrier provides a 5 dBA reduction for these units.

1104.5 Priority Adjustments

Section 215.5 stipulates that one of the factors in determining the priority shall be whether a majority of the occupants in close proximity of the freeway resided there prior to the time the freeway routing was adopted by the CTC. The city or county in which the residential area is located is responsible for providing documentation to the department on the percentage of original occupants still residing along the freeway.

If a city or county submits documentation which shows that for a specific project the majority (over 50%) of the current occupants in close proximity of the freeway resided there prior to the adoption of the freeway, the Priority Index, as calculated by the above formula, is to be enhanced in an amount equal to the actual "current residing percentage". For example, if the priority index for a project is calculated to be 10.00 and the documentation furnished by the local agency indicates that the "current residing percentage" is 52.5%, then the priority index is adjusted to 62.5.

When verifying the documentation submitted by a city or county, the following definitions shall apply:

(a) Majority - Over 50% of total persons in dwelling units that are living in close proximity or immediately adjacent to the freeway.

(b) Occupants - Person or persons who are currently occupying the dwelling units under consideration.

(c) In Close Proximity - the area encompassed by residential units immediately adjacent to the freeway. (Same first line receptors used in above Priority Index formula).

If the current occupant or occupants are the owners, than the date of purchase should be submitted as documentation. For renter/occupants, a statement should be obtained from the renter as to date occupancy commenced. For occupants other than the principal occupants, a statement which shows the date these occupants first began to reside in the residence should be obtained from the principal occupants.

1104.6 Cost-effectiveness

Projects on the priority list must be "cost effective projects". Projects costing no more than $30,000 per residential unit protected by the barrier are considered to be cost-effective. In calculating the cost-effectiveness, include all living units (houses, apartments, and condominiums, etc.) that will benefit by a 5 decibel or more reduction in noise levels by reason of the noise barrier construction. This could include some of the second line receptors which are not included in the priority index calculations.

Topic 1105 - School Noise Abatement Projects

1105.1 General

Section 216 of the Streets and Highways Code requires the Department to measure and to attenuate the noise from a freeway in specified areas within public and private elementary or secondary schools when the noise levels from the freeway within the school exceeds 55 dBA, L_{10}, or 52 dBA, L_{eq}. In addition, the time of school construction and the current use must meet the requirements of the Code.

The options available for reducing the noise levels within the school include construction of a noise barrier, acoustical treatment of the school structure, or a combination of both. A preliminary investigation should be made to determine which method of attenuation is the most appropriate. If it is determined that the construction of a noise barrier is the appropriate solution, then a noise barrier would be designed and constructed similar to those constructed for the Community Noise Abatement Program. If it is determined that it would be more appropriate to perform acoustical treatment on the school,then a cooperative agreement should be entered into with the School District. This allows the School District to prepare the plans and specifications for the proposed acoustical work and to administer the construction contract using the Preapproved Agreements in Appendix 3, Volume 2A of the Cooperative Agreement Manual.

The school district generally engages an architect to do the design and prepare the PS&E. When Federal-aid funds are used for the project, the PS&E are to be submitted to the Office of Project Planning and Design to obtain FHWA approval before the District authorizes the school district to advertise the project.

Topic 1106 - Definitions

1106.1 Noise

(1) Existing Noise Levels. The noise resulting from the natural and mechanical sources, and human activity considered to be usually present in a particular area.

(2) Insertion Loss. The net reduction in noise levels resulting from the installation of a noise barrier.

(3) L_{10}. The sound level that is exceeded 10 percent of the time (the 90th percentile) for the period under consideration.

(4) $L_{10}(h)$. The hourly value of L_{10}.

(5) L_{eq}. The equivalent steady-state sound level which in a stated period of time contains the same acoustic energy as the time-varying sound level during the same period.

(6) Traffic Noise Impacts. Impacts which occur when the predicted traffic noise levels approach or exceed the noise abatement criteria (see Table 1102.2), or when the predicted traffic noise levels substantially exceed the existing noise levels.

(7) Type I Projects. A proposed Federal or Federal-aid highway project for the construction of a highway on new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment or increases the number of through-traffic lanes. This definition also applies to State only funded highway projects.

(8) Type II Projects. A proposed Federal or Federal-aid highway for noise abatement on an existing highway. This definition also applies to State only funded highway projects.

For a more complete list of definitions commonly found in environmental noise literature, refer to Appendix IA of the Caltrans' Noise Manual.

Appendix D -- Report on Reevaluation of Retrofit Barrier Program, and Sample Letter and Property Owner Agreement Required by ConnDOT to Delete or Modify a Planned Barrier

CONNECTICUT DEPARTMENT OF TRANSPORTATION
OFFICE OF ENVIRONMENTAL PLANNING

GUIDELINES FOR ESTABLISHING PRIORITIES FOR TYPE II NOISE ABATEMENT PROJECTS (REVISED FEBRUARY 1986)

These guidelines will be used to provide the primary input to an evaluation process for determining priorities for Type II Noise Abatement projects as defined by Federal Aid Highway Program Manual 7-7-3, "Procedures for Abatement of Highway Traffic Noise and Construction Noise" (FHPM 7-7-3).

1. The first step in the process is to determine if the area qualifies for consideration as a Type II project as defined in FHPM 7-7-3. Also, the existing outdoor noise levels should equal or exceed 60 dBA and the receptors under consideration must have been in existence on May 14, 1976, the date of issuance of FHPM 7-7-3. Receptors that come into existence after the issuance of FHPM 7-7-3 will not normally qualify for a noise abatement project.

   The existing outdoor L_{10} noise level will be determined by measurements made at a time when the highest noise levels are experienced.

   For residences and other buildings described in FHPM 7-7-3, Land Use Category "B", the measurements will be made at the building. For other open areas in this category and for all areas in FHPM 7-7-3, Land Use Category "A", the measurement will be made at the portion where activities devoted to frequent human use occur.

2. If the area qualifies under Step 1 and area residents desire a noise abatement project, the second step is to determine a Project Priority Ranking Number (PPRN).

   The PPRN is determined in the following manner:

   A. Calculate the Benefits Factor (BF)

   $$BF = (PI \times N_b \times SF) + (PI \times N_a \times SF)\ 1/3$$

   Where

   PI = Project effectiveness index

   N_b = Number of receptor units in existence before the highway was built

N_a = Number of receptor units in existence after the highway was built

SF = Sensitivity Factor

Project Effectiveness Index (PI)

This is determined from Figure 1 as follows:

Plot the L_{10} noise level measured at the receptor on y axis and then read the corresponding project effectiveness index (PI) on the x axis.

Number of Receptor Units (N_b and N_a)

Each family living in a house or residence is considered a receptor unit. For other land uses, as described in land use categories A and B, the equivalent number of receptor units is determined by the formula:

Number of Receptor Units = a x b x c x d

Where

a = Number of families using facility

$$b = \frac{\text{Number of days of use per week}}{7}$$

$$c = \frac{\text{Number of hours of use per day}}{24}$$

$$d = \frac{\text{Number of months of use per year}}{12}$$

Sensitivity Factor (SF)

A factor giving consideration to the sensitivity of the land use to noise is provided as indicated below.

Land Use Category (FHPM 7-7-3)	Factor
A	1.5
B	1.0

This equation gives consideration to the three cases that could arise. One, where all the receptors were in existence before the highway was built; two, where all the receptors were in existence after the highway was built, but before the issuance of FHPM 7-7-3; and three, where there is a combination of one and two. In case one, the second half of the equation becomes zero; in case two, the first half of the equation becomes zero; and in case three, the whole equation applies. The second half of the equation is reduced by a factor of one-third to give more weight to receptors in existence before the highway was built.

B. Estimate Total Project Costs

The total project cost includes all items contributing to the cost of the project expressed as a cost per foot x length of barrier.

C. Calculate the Project Priority Ranking Number (PPRN)

$$PPRN = \frac{\text{Benefits Factor}}{\text{Total Project Cost}} \times 1000$$

The PPRN's for all projects are then listed with high priority projects being represented by high Project Priority Ranking Numbers.

Once a preliminary list has been established, a more detailed analysis will be done for the higher rated projects. Assumptions to be used for calculating preliminary PPRN's include:

1. The average height of all barriers will equal 15' above the highway pavement.

2. The cost of the noise barrier per foot of length will equal $243.75 (where crash barrier protection is required, an extra cost of $58.50 per foot of length will be added). The cost of noise barrier on structure will equal $487.50. All costs include preliminary engineering and incidentals to construction.

3. Noise barriers will be designed to reduce the noise level at receptors located behind the center of the barrier by 10 dBA. Those receptors located at either end can anticipate a 7-10 dBA reduction. Noise abatement is not normally recommended for residential areas greater than 300 feet from an expressway due to technical infeasibility of abatement.

4. The Benefits Factor will be based on the total number of families affected.

SUMMARY

Pursuant to SA 85-107, the Department of Transportation Retrofit Noise Abatement Program was reevaluated. Noise investigations were undertaken at 196 residential areas along the State's expressways. It was determined that noise abatement was warranted and feasible at 189 areas. Implementation of a ten year program to construct noise barriers at these locations would approach $125 million over that period with implementation of 19 barriers per year. These costs are based on preliminary average estimates for engineering, construction, and inspection and have been inflated at an average annual rate of 5% over the ten year period. It should be noted that these costs can change as the result of detailed engineering for each of the areas. Undertaking this program would require the addition of ten full time positions over the ten years of the program.

INTRODUCTION

Special Act 85-107, among other things, directed the Department to:

- Retest areas along state and interstate highways where noise barriers may be needed;
- Revise the Department's noise barrier priority listing;
- Develop a ten year plan for installation of noise barriers and;
- Estimate costs of designing and constructing such barriers.

This report contains a history of the Department's Statewide Noise Abatement Program, hereafter referred to as the "Retrofit Noise

Abatement Program", a discussion of the methodologies employed in the investigations, and a discussion of the results of the investigations. Preliminary cost estimates for the Retrofit Noise Abatement Program are also included.

BACKGROUND

In 1973, the Department initiated the Retrofit Noise Abatement Program. The goal of the program was to provide noise abatement relief to those areas of residential use along the existing expressway system which had been adversely affected by transportation noise. Under the program, areas impacted by traffic noise were identified and priorities for possible abatement projects were determined. Noise monitoring locations for the original program were based upon citizen complaints and/or population density patterns. The statewide priority listing was developed with the most severely affected areas receiving highest priority. Noise abatement projects were recommended for the listed areas.

In the years between 1973 and 1982, 122 areas were investigated and included on the priority listing. During this period, six noise barriers were constructed utilizing a combination of federal and state funds. Construction of these retrofit or Type II barrier projects (as they are categorized by the Federal Highway Administration) was funded through the Federal-Aid Interstate (FAI) construction program with 90% federal participation. The remaining 10% of the cost was funded by the State. As only projects along existing non-toll interstate expressways were eligible for FAI funding at that time, no projects on the toll section of I-95 or projects along intrastate expressways were advanced through design to construction.

In December 1981, the Federal Surface Transportation Act was signed into law. As a result of this federal legislation, retrofit noise barrier projects are no longer eligible for funding under the FAI program. Two retrofit barriers, both along I-84 in Southington, were built under the FAI program in 1982 since construction approval for these projects had been granted prior to passage of the act. With passage of the 1981 act, Congress stipulated that federal "4R" (Resurfacing, Reconstruction, Restoration and Rehabilitation) funding could be utilized for construction of retrofit noise barriers. However, as these more limited funds were already fully earmarked for road and bridge rehabilitation and safety projects, it was the Department's policy to use these monies for needed road and bridge projects and not for noise barriers. The above noted change in federal law effectively removed the possibility of federal monies being used to fund construction of retrofit noise barrier projects. Similarly, no dedicated State funding source for the program existed. As a result, in March 1982, the Department ceased all planning and design activities on retrofit barriers and the program was suspended.

Since that time only one retrofit noise barrier project has been advanced through design and construction and it was funded through a different mechanism. The barrier, located along I-91 southbound in Wethersfield, was constructed in 1984 under the Interstate Trade-in Program. This program was structured to provide eligible communities a high level of local input on setting priorities for use of their share of trade-in monies. Wethersfield elected to make the noise barrier their highest priority project.

Field investigations of new noise complaints received since 1981 have not been conducted on a large scale. As a result a "deferred" file of over 50 complaint locations, some previously tested, was compiled for investigation in the event that the retrofit program was reactivated.

METHODOLOGY

The reevaluation of the Retrofit Noise Abatement Program for this report consisted of two main components:

Field Monitoring at each location and determination of the L_{10} noise level. The L_{10} is the noise level which is exceeded 10% of the time.

Calculation of the Project Priority Ranking Number (PPRN). The PPRN for a location is based upon many factors including noise levels, number of receptor units (households) built before and after the expressway, land use category of the receptor and cost of abatement.

Additional information concerning the procedures utilized in monitoring of noise levels and determining of PPRN's is contained in the Appendix of this report.

Field noise readings were made at locations along both interstate and intrastate expressways. These locations were broken down as follows:

- Locations previously investigated and included on the original priority listing.

- Locations for which complaints had been received and noise readings had been deferred.

- Locations at which noise barriers had been recommended as a result of noise studies for environmental impact statements for major reconstruction projects. In these particular cases, noise barriers were not able to be constructed as integral parts of the expressway reconstruction due to funding restrictions.

RESULTS

It was determined that abatement of noise through construction of a physical noise barrier would not be feasible at 7 of the 196 eligible areas. Table 1 lists the areas for which abatement was deemed to be infeasible. As can be seen from the table, the reasons that the abatement is not considered feasible are primarily due to topographic considerations, distance to the expressway, or noisy adjacent land uses. In these cases, the construction of a noise barrier would not render a significant reduction in the noise climate of the location due to differences in elevation between roadways and the noise receptors or because a major contribution to the noise climate is from sources other than the expressway.

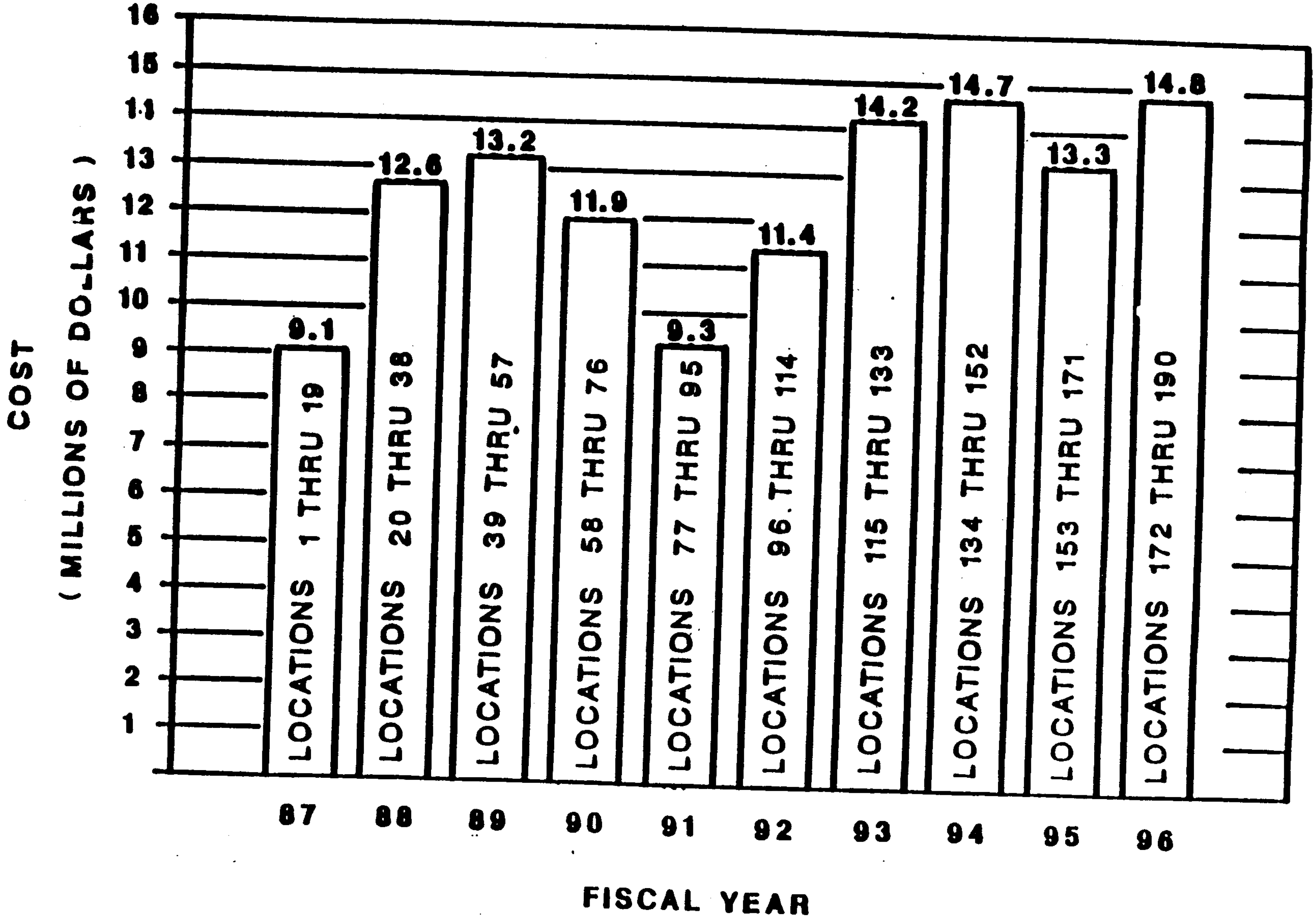
Table 2 lists the 189 locations for which abatement is considered feasible. The areas are listed in priority rank based upon the PPRN's. It should be noted that the locations (e.g. Fifth Street along I-95) listed in the table are used for general area identification only. The actual area used in calculating the PPRN and receiving benefit from abatement may include other adjacent streets. The costs are only preliminary and are based on a uniform wall noise barrier height of 15 feet and uniform unit material costs. Therefore, the actual design and construction costs for a particular barrier location could vary either up or down from the estimates contained in the list based on more detailed design information. The possibility of combination earth berm/wall barriers would also be investigated during design.

Special Act 85-107 also instructed the Department to investigate the feasibility of utilizing foliage barriers as attenuators of traffic noise. Studies have demonstrated that, in order to be effective in reducing noise levels, a dense stand of year round vegetation such as conifer plantings would have to exist between the receptor and the noise source. As the depth of such a stand would have to exceed 100 feet to gain a 5-10dBA reduction, establishment of abatement plantings along existing expressways would not be feasible due to limited rights-of-way. Therefore, abatement in this report only considers construction of wall type barriers.

The cost estimate for construction of the entire Retrofit Noise Barrier Program based upon current prices is approximately $98.2 million. A ten year design and construction breakdown for implementation of the entire program is given in Figure 1. Such a program would result in construction of 19 barriers per year and would implement the barriers in order of priority rank. The costs reflect an inflation factor of 5% per year. The cumulative cost of the program over the ten year period would be $124.5 million. Present Department of Transportation staffing would not allow for initiation of such a large long term program. Increases in staffing in both acoustic and structural engineering areas would be

FIGURE 1

TEN YEAR ABATEMENT PROGRAM



necessary prior to commencement of the program. It is estimated that ten new positions would be required over the ten years.

APPENDIX

Information Concerning Monitoring of Field Noise Readings

Following a review of aerial photographs and mapping and where feasible, noise readings were made at the receptor or dwelling in the location neighborhood situated closest to the expressway. Only those areas developed prior to May 14, 1976 are eligible for inclusion in the current study.

This date marked the issuance of Federal Aid Highway Program Manual (FHPM) 7-7-3 which provided guidance for abatement of highway traffic noise including, for the first time, retrofit barriers. It was the position of the federal government, that funds for retrofit barriers should be concentrated on residential areas constructed either prior to the expressways in question or in the period before issuance of the guidelines. It was further reasoned that residential areas developed along expressways after the issuance of FHPM 7-7-3 were constructed with full knowledge of the expressway and should not be eligible for retrofit abatement. The State has adopted these guidelines for a retrofit barrier "cut off" date.

Noise readings were made at eligible locations utilizing Type I sound level meters running strip chart recorders. During the 10 minute recordings, classified traffic counts were obtained registering the volumes of autos, medium trucks and heavy trucks. The majority of noise readings were made during either the morning or afternoon peak traffic periods. In these cases the actual classified traffic counts were utilized to calculate the L_{10} (the noise level exceeded 10% of the time) noise level at the location. For readings taken during off peak periods, computer projections of peak hour noise levels were made utilizing the off peak readings and the classified traffic counts to calibrate the computer model. This process assured that all noise levels utilized in the priority ranking procedure were compatible.

Information Concerning Calculation of the PPRN

As noted in text the actual calculation of the project priority ranking number (PPRN) for each location is based upon many factors including noise level, number of receptor units built before and after the expressway, land use category and cost of abatement. The PPRN is utilized to rank barrier locations relative to each other. In short, locations with combinations of high noise levels, dense population, and lower abatement cost would rank higher than those areas with moderate noise levels, sparse population densities, and high abatement cost. The following material covers the calculation formula for determination of the PPRN.

Town of South Windsor
1540 SULLIVAN AVENUE • SOUTH WINDSOR, CONN. 06074
AREA CODE 203/644-2511

June 7, 1990

Dear Property Owner/Resident:

RE: I 291 Project - Noise Abatement

The Connecticut Department of Transportation is in the final design stages of the proposed Interstate 291 (I-291) project in the towns of Windsor and South Windsor (State Project No. 164-179). The environmental analysis and documentation for this project has suggested that noise abatement be considered for residences located along King and North King Streets in South Windsor. The Department's Office of Environmental Planning has initiated the design of proposed noise abatement systems for these areas. A noise abatement criteria level of 70 decibels (L10dBA) has been applied to determine the level of noise that abatement is considered. This criteria is used in conjunction with guidelines issued by the Federal Highway Administration (FHWA).

The noise levels shown in the accompanying table indicate traffic noise levels along the highway corridor during peak commuter hours. Local noise levels for the peak commuter hours. Local noise levels for the peak commuter hours range from L10=68 dBA (Main Street). Future noise level is based upon the proposed roadway design and anticipated (year 2000) traffic conditions for the corridor.

The proposed noise barrier systems are illustrated on the accompanying map. The design of the noise barrier system is intended for three residential locations proximate to the study area. These locations are 721 and 729 King Street, 340 Main Street and 712 No. King Street. The level of noise at these locations equals or exceeds the noise impact criteria of L10=70 dBA. It should be noted that for effective noise abatement, the limits of a proposed noise barrier must extend beyond the limits of the benefiting property.

Tests have determined that approximately two to three decibels on an A-weighted scale (the scale that closely mimics what the human ear comprehends) is the smallest noise level change that is perceptible to the human ear. A general relationship may be helpful in understanding how human hearing responds to noise generation. An increase in ten decibels will seem to sound twice as loud to an observer. For example, noise at 70 dBA will appear to sound twice as loud as noise at 60 dBA at the same distance, assuming that the composition is generally the same for both cases.

Some common noise levels experienced would be 70 dBA for a gas lawn mower at 100 feet or for a vacuum cleaner at 10 feet. Another analogy would be human speech. Talking at a distance of three feet from the listener would measure approximately 65 dBA and shouting at the same distance would measure approximately 70 dBA.

A description of the proposed barriers is as follows:

North King Street

The limits of this barrier system extend from approximately 750 feet west of Main Street to approximately 700 feet east of where North King Street cul-de-sacs. The total length of this barrier system will be approximately 2,850 feet and have a height of 12 feet. This barrier system will provide a considerable noise reduction for 340 Main Street and 712 No. King Street on the north side of I-291. Minimal benefit may be realized for seven other residences located along this area.

King Street

This noise barrier system is proposed for the residences located on the south side of I-291. This barrier system will provide the greatest benefit to 721 and 729 King Street. The four additional residences proximate to Main Street and King Street may receive minimal benefits. The limits of this barrier system will extend from approximately 220 feet west of Main Street to approximately 500 feet east of the house located at number 652 King Street. The approximate length of this barrier system will be 2500 feet and the height will be 12 feet.

It has come to the State of Connecticut Department of Transportation's attention that, in some instances, the public's desire for noise abatement is questionable. To determine this, the Connecticut Department of Transportation has requested the Town of South Windsor to conduct a public opinion survey of the residences and property owners most affected by the proposed noise abatement systems.

A total elimination of ~~any of the~~ proposed systems can be accomplished only through a total consensus by each of the residents and property owners to receive the primary benefit. It is determined that the barrier(s) should be deleted or modified, an Agreement must be executed by each of the benefiting property owners, with authorized concurrence by the FHWA and the Town of South Windsor, per FHWA requirements.

This Agreement will be recorded with the affected property deed in the South Windsor Land Records as documentation to absolve the FHWA, the State and the Town of South Windsor from any future responsibility to provide noise abatement for the property. A sample Agreement is enclosed for your consideration. You will be notified (and provided an Agreement to be executed) upon determination of this matter. If you desire to eliminate a proposed noise barrier system, please provide the information for the Agreement for items 1 thru 3 as indicated below:

1. Grantor(s) (Property Owner(s)) name(s)

2. Grantor(s) (Property Owner(s) relationship

3. Grantor(s) (Property Owner(s) residence address

We thank you for your time and if you have any questions, please call Mr. Carmine Trotla of the Office of Environmental Planning, Connecticut Department of Transportation at 566-4272.

Very truly yours,

Agreement No. ____(No.)

RECORDED IN South Windsor LAND RECORDS

AT VOLUME ____(No.)____ PAGE (No.)

COVENANT

WHEREAS, ________(Grantor`s name(s))____, (Grantor's relationship)______, ____(Residing address)________, (Town), Connecticut ("Grantor"), is the present owner in fee simple absolute of a certain piece or parcel of land together with all buildings and improvements situated thereon commonly known as ___(Affected property address)___, South Windsor Street, Connecticut and more particularly bounded and described within an. instrument dated ___(Month/Day)________, 19 (Year) and recorded in Volume (No.) at Page (No.) of the Enfield Land Records ("Premises"); and

WHEREAS, the State of Connecticut ("State") acting by and through its Commissioner of Transportation intends to construct, erect and thereafter maintain a noise abatement barrier on the State owned land abutting the Premises ("Noise Barrier") to mitigate against traffic noise from proposed Interstate 291; and

WHEREAS, the Grantor has asked the State to forego erecting the Noise Barrier; and

WHEREAS, the State has agreed to forego the erection of the Noise Barrier upon the execution of a covenant by the Grantor releasing the State, the Town of South Windsor, a municipal corporation chartered under the laws of the State of Connecticut with an office at 1540 Sullivan Avenue, South Windsor, Connecticut, and the United States of America (collectively, "Grantee") from all claims, liabilities and damages arising out of or relating to that decision.

NOW THEREFORE, in consideration for the promises contained therein, the Grantor does hereby covenant and agree that the Premises shall henceforth and forever be subject to the following covenants, restrictions and conditions:

1. The Grantor hereby unconditionally releases and discharges the Grantee from any and all past, present and future claims, causes of action and liabilities the Grantor has or may have arising out of and/or relating to the State`s decision to forego the erection, construction and maintenance of the Noise Barrier along proposed Interstate 291 (East/West) State Project No. 164 - 179, between Station Nos. (No.) and (No.) ("Site Limits").

2. The Grantor shall never directly or indirectly ask, request, petition or otherwise seek the erection, construction or maintenance of a Noise Barrier within the Site Limits.

Agreement No. (No.)

3. This Covenant shall run with the land, shall survive any and all conveyances of the Premises, shall be binding upon the Grantor and all who have or may in the future claim title under the Grantor, and shall be binding upon the Grantor and its heirs, executors, administrators, successors and assigns.

4. This Covenant may be enforced by the State at any time, without prior notice or demand.

5. This Covenant may only be amended by the recordation of a written instrument on the South Windsor Land Records. No such instrument shall be either executed or recorded without the prior written consent of the State, which consent may be withheld at the exclusive discretion of the State.

6. The State shall promptly record this Covenant on the South Windsor land Records and supply the Grantor an executed copy of this Covenant evidencing the volume and page of recordation. However, the Grantor shall be responsible for payment of the recording fee.

Witnessed By :

(Signature)
Name: (Type Name)

(Signature)
Name: (Type Name)

Grantor:

By: (Signature)
Name: (Type Name)

By: (Signature)
Name: (Type Name)

State of Connecticut)
) ss: (Town)
County of (Type County))

On this the (No.) day of (Month) , before me, Type Officer's Name) the undersigned officer(s), personally appeared (Type Grantor's Name(s)) who acknowledged (himself/herself/themselves) to be (Grantors' relationship), and that (he/she/they) as such , being (Grantors' relationship) executed the foregoing instrument for the purposes therein contained.

In witness whereof I hereunto set my hand.

(Officer's Signature)
Commissioner of the Superior Court
Notary Public
My Commission Expires on (Month/Day), 19 (Year)

Appendix E -- Massachusetts DPW Type II Policy

MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS

POLICY ON TYPE II NOISE ABATEMENT PROGRAM

PROPOSED ACTIONS

1. To establish a policy for a Type II Noise Abatement Program.
2. To outline the procedures instrumental to implementation of the policy.

PURPOSE

1. To detail an equitable means for selecting sites eligible for noise abatement.
2. To provide noise abatement to eligible sites impacted by noise from traffic on the Interstate System of the Commonwealth of Massachusetts.

POLICY

It is the policy of the Massachusetts Department of Public Works (MDPW) to establish, maintain, and periodically update guidelines for a Type II Noise Abatement Program.

RESPONSIBILITY

The Bureau of Transportation Planning and Development is responsible for implementing the policy for a Type II Noise Abatement Program.

DEFINITIONS

Type II Project - A proposed Federal or Federal-Aid highway project for noise abatement on an existing highway.

Type II Noise Abatement Program - A program which establishes a procedure for identifying noise impacted areas and for prioritizing these areas for selection as a Type II Project.

Category B - A category of land use activities which include picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals. The noise abatement criterion for Category B is 67 dBA-Leq(h), (hourly A-weighted and exterior sound level).

Category E - A category of land use activities which include residences, motels, hotels, schools, churches, libraries, and hospitals. The noise abatement criterion for Category E is 52 dBA-Leq(h), (hourly A-weighted and interior sound level).

Revised 5/26/87

ELIGIBILITY REQUIREMENTS

1. An area or site must meet the following criteria to be eligible in a Type II Work Program.

   a. Land use and activities contiguous to an Interstate highway must be in existence on/or before May 14, 1976 or have planned land use control if development came into existence after May 14, 1976. Land use control must have been exercised by local authorities with controls over undeveloped lands adjacent to highways to prevent further development of incompatible activities.

   b. Noise impacted, sensitive receptors must be contiguous to an Interstate and include the following Category B or E uses:

      1. recreational areas

         a. parks
         b. picnic areas
         c. playgrounds
         d. active sports areas

      2. hospitals and nursing homes
         residences - (with 6 or more family units subject to adverse highway noise impacts)
      4. hotels and motels
      5. schools
      6. churches
      7. libraries

   c. There must be a noise impact which will be defined by a minimum Leq(h) of 67 dBA at the right of way of the highway and abutting property of the sensitive receptors of Category B or E. The Leq(h) of 67 dBA or more will be determin by noise monitoring.

   d. There must be economical reasonableness and physical feasibility of mitigation measures. Noise barriers will not be considered unless the projected reduction is a minimum of 10 dBA.

   e. The project must have FHWA approval.

   f. The noise analysis for the project must be in conformance with Federal and State highway traffic noise regulations, as applicable.

   g. Federal and MDPW funding must be available.

   h. The site must be on the Final Priority List.

Revised 5/26/87

PROCEDURES

1. The following procedures shall be pursued to identify noise impacted areas:

   a. Known problem sites, aerial photos, and photogrammetry will be reviewed to identify sensitive receptors and to obtain data on topography and elevations.

   b. Contruction and other plans and DPW records will be used to obtain measurements (of horizontal and vertical alignments) and Right of Way lines and to determine dates when notification of proposed construction of Interstates became official and when construction of Interstates was completed.

   c. The "FHWA Interstate Cost Estimate Book" will be used to develop road links for the Stamina II computer model. Typical cross-sections of the Interstates are also available in this book.

   d. A preliminary field reconnaissance will be conducted to positively identify receptors, to rule out areas in which mitigation measures are obviously infeasible, to take field measurements as necessary, and to verify data on maps, plans, etc.

   e. Traffic data shall include design and maximum speeds, the annual average daily traffic (AADT), the percentage of heavy trucks, medium trucks, and automobiles, and the directional distribution factor. This data will be needed for the sections of the Interstates contiguous to sensitive receptors, including ramps and intersections. The latest "FHWA Interstate Cost Estimate Book" may be used for much of this data. The BTP&D and Regional Planning Agencies (RPAs) are also sources of traffic data.

   f. Preliminary computer modelling with Stamina II will require inputs for traffic data as stated in 1(e) and inputs for site geometry including width of roadway, distance from noise source to receiver, elevations (roadway and receiver), shielding factors (buildings, trees and other features of terrain), and alpha factors (soft or hard site). The outputs from Stamina II will include noise emission levels.

   g. A preliminary priority list will be established after steps (a) through (f) are carried out. Sites with 75 dBA Leq(h) or more will be placed on this list.

h. Land use and activities will be investigated to get the data necessary to rank sites by priority and to determine eligibility under the Federal-Aid Highway Program Manual, 7-7-3,8(b). All segments of road links from List 1 with Category B and/or E activities and within 500 feet of an Interstate Highway will be identified and tabulated on List 2.

i. The acoustical feasibility of potential noise barriers will be assessed for all segments of road links on List 2 which existed on or before May 14, 1976. Segments on List 2 which originated after May 14, 1976 will also be assessed if the respective city or town has taken measures to exercise land use controls to prevent incompatible activities on its undeveloped lands adjacent to its highway(s). For the thirty loudest segments where barriers are acoustically feasible, the ambient noise will be measured and the barrier heights, lengths, and costs needed to provide a significant noise level reduction at adjacent activities will be determined using Stamina II/Optima. Areas with a noise level reduction of 10 dBA or more will be placed on List 3. Refinements to prior Stamina II computer runs may be made at this time.

2. A priority ranking system will be used to establish rank on a Final Priority List for each area on List 3. Numerical values will be asigned as follows:

   a. development - 5 points each year development existed since highway was opened;

   b. residences, hotels, motels;

      1. 1 point per residence in development for 68-72 dBA (Leq) range
      2. 5 points per residence in development for 73-77 dBA (Leq) range
      3. 25 points per residence in development for over 77 dBA (Leq) range

   (For multi-story apartment buildings, only first floor/ground floor units will be considered.)

   c. schools, hospitals, nursing homes, libraries, recreational areas;

      1. 10 points each for 68-72 dBA (Leq) range
      2. 50 points each for over 72 dBA (Leq) range

d. churches

   1. 5 points each for 68-72 dBA (Leq) range
   2. 25 points each for over 72 dBA (Leq) range

A cost per decibel reduction per unit will be calculated for each development. Numerical rank will be assigned to each site and placed on the Final Priority List with the highest value first. As funding becomes available, studies will be done based on order of rank on list as well on cost effectiveness.

3. After a priority project is selected, questionnaires will be sent to residents in impacted areas. Public meetings will be held to provide information about possible abatement measures. If necessary, a slide presentation on noise barriers will be given, and a record of public sentiment about barriers will be made.

   Coordination and consultation with FHWA will precede analysis to assure funding and to assess scope of analysis. The analysis should be of sufficient scope to meet federal requirements for funding and should include:

   a. identification of existing activities, developed lands, and undeveloped lands for which development is planned, designed, and programmed, and which may be affected by noise from the highway;

   b. prediction of traffic noise levels;

   c. determination of existing noise levels;

   d. determination and identificaton of traffic noise impacts(s);

   e. examination and evaluation of alternatives for noise abatement measures which reduce the noise impact(s) (for proposed noise barriers - a minimum of 10 dBA reduction is required); and

   f. consideration of benefits and cost of abatement measures (cost/dBA reduction/unit) versus overall social, economic, and environmental effects.

   The last step of the analysis will include selection of noise abatement measures, if feasible. Noise barriers will then be designed and constructed for approved projects. Insulation of public use or nonprofit institutional structures will also be considered.

   After abatement measures are completed, follow-up measures will be taken. These will include questionnaires to those directly affected, noise measurements to verify model effectiveness, etc., and maintenance.

Appendix F -- Excerpts from Wisconsin Noise Barrier Study for a Type II Program

WISCONSIN NOISE BARRIER STUDY
Summary Report

Prepared

for

Wisconsin Department of Transportation
Division of Highways and Transportation Services
4802 Sheboygan Avenue
Madison, WI 53707-7916

by

Howard Needles Tammen & Bergendoff
One Park Plaza - Suite 600
11270 West Park Place
Milwaukee, WI 53224

May 29, 1990

EXECUTIVE SUMMARY

With increasing statewide public interest in noise barrier construction it became apparent that a systematic approach was needed to determine where future freeway noise barriers could be constructed. The 1987 Wisconsin Act 27, s. 3052(3g)(b), required the Department to develop criteria and procedures for siting noise barriers.

The Department fulfilled the requirements of the 1987 Wisconsin Act 27 with the preparation of an Administrative Rule, TRANS 405. It was approved by the appropriate Senate and Assembly committees and became effective on September 1, 1989.

The purpose of this study was to develop an objective method for identifying freeway noise abatement needs and determining the comparative ranking of these needs. Study objectives included determining noise levels in residential areas adjacent to the freeways, identifying residential areas that are eligible for consideration of noise abatement in accordance with the provisions of TRANS 405, preparing preliminary noise barrier designs for eligible residential areas, and developing a method to compare and rank eligible residential noise barrier areas.

To achieve the study purpose and objectives, 135 miles of specific freeway segments in 28 municipalities in Wisconsin were selected for detailed analysis.

Based upon this study, 209 locations with 3042 residences, were identified where the Leq sound level equals or exceeds 67 dBA. Preliminary noise barrier designs were developed for each of these areas. The 209 noise barriers range in cost from $44,481 to $1,657,379, with a total cost of $107,307,476.

Of the 209 locations that are exposed to freeway sound levels at or above the 67 dBA Leq criterion, 68 residential areas, with 1733 residences, in 16 municipalities in Wisconsin, meet the cost-effectiveness criterion of TRANS 405. These 68 barriers have a total estimated construction cost of $36,611,166, with a range of $44,841 to $1,201,955.

There are 141 barrier locations that would require local cost-sharing participation to be considered eligible for construction under TRANS 405 criterion. The noise barriers for these areas, with 1309 residences, have a total estimated construction cost of $70,696,310, including a total local participation cost of $31,426,310. The individual barriers range in cost from $49,359 to $1,657,379.

The Department developed a method to rank eligible residential noise barrier areas, such that the relative needs can be compared when considering future noise barrier projects. The ranking method is based upon four factors; sound levels, traffic exposure, residential age, and cost-effectiveness. In this method, the Department determined that those factors that define the severity of the freeway noise problem should be given greatest weight.

I. INTRODUCTION

The first noise abatement projects in the State of Wisconsin were the construction of berms in the early 1970's along the Milwaukee Freeway System and along USH-12/18 in Madison near Waunona Way and Raywood Road. These berms were built as part of freeway modernization projects and highway improvements.

In 1976, four noise barriers were built as part of the construction of the interchange with IH-94 and the new Airport Spur Freeway (STH-119) in Milwaukee. These barriers were built adjacent to the interchange, one in each quadrant of the new facility.

From 1984 through 1988, eight noise barriers were built along existing segments of the freeway system in the Milwaukee metropolitan area. These eight barriers were authorized by two legislative mandates: Senate Bill 83, Section 2051(14) and Senate Bill 85, Section 20.395(3)(gq)(gx).

With increasing statewide public interest in noise barrier construction, the Department determined that a systematic method was warranted to identify noise abatement needs and rank these needs. The 1987 Wisconsin Act 27, s.3052(3g)(b), required the Department to develop criteria and procedures for siting noise barriers.

The Department fulfilled the requirements of the 1987 Wisconsin Act 27 with the preparation of an Administrative Rule, TRANS 405. It was approved by the appropriate Senate and Assembly committees and became effective on September 1, 1989.

II. FREEWAY NOISE STUDY

To implement the provisions of this rule, the Department completed a freeway noise study for 28 municipalities in Wisconsin. The municipalities studied included:

* Madison and Sun Prairie, Dane County
* Johnson Creek, Jefferson County
* Janesville and Beloit, Rock County
* Bayside, Fox Point, Glendale, Greenfield, Milwaukee, Oak Creek, River Hills, Wauwatosa and West Allis, Milwaukee County
* Mequon, Ozaukee County
* Germantown, Washington County
* Brookfield, Menomonee Falls and New Berlin, Waukesha County
* Green Bay, Brown County
* Appleton, Outagamie County

* Sheboygan, Sheboygan County
* Wausau, Marathon County
* La Crosse, La Crosse County
* Chippewa Falls and Bloomer, Chippewa County
* Eau Claire, Eau Claire County
* Menomonie, Dunn County

Land use adjacent the freeway segments in the study areas are a mixture of residential properties that predate the freeway, very new properties and rural land being converted to residential land uses. Based upon land use, 135 miles of specific freeway segments were selected for detailed noise analysis. The specific study areas are shown on maps contained in Appendix A.

II.A. STUDY PURPOSE AND OBJECTIVES

The purpose of this study was to develop an objective method for identifying freeway noise abatement needs and determining the comparative ranking of these needs. Study objectives included:

1. Determining noise levels in residential areas adjacent to the freeways;
2. Identifying residential areas that are eligible for consideration of noise abatement in accordance with the provisions of TRANS 405;
3. Preparing preliminary noise barrier designs for eligible residential areas; and,
4. Developing a method to compare and rank eligible residential noise barrier areas.

II.B. STUDY METHODS AND RESULTS

To achieve the study purpose and objectives, the Department and its consultant, Howard, Needles, Tammen & Bergendoff, utilized state-of-the-art methods and technology to determine noise levels and a ranking method of eligible noise barrier locations.

II.B.1. DETERMINATION OF FREEWAY NOISE LEVELS

In the development of study methods, the Department considered and evaluated several techniques for determining freeway noise levels; both by measurement, and by computer simulation.

Field measurements can provide very accurate data for the time period monitored, but unless measurements were repeated numerous times at each site, it is difficult to determine whether high Leq noise levels were measured. Noise levels can be influenced by typical urban noises that are not traffic related; barking dogs, lawn mowers, aircraft flyovers, fire sirens, construction activities, and local street noise. These non-freeway traffic related noise levels can be avoided, but it greatly lengthens the monitoring time or invalidates portions of data. Representative traffic field measurements cannot be taken when the pavement is wet or when there is snow on the ground. Measurements also vary by other ground cover conditions. All of these factors, when taken together, severely limit the ability to conduct a thorough noise measurement program. Also, field noise measurements for 135 miles of statewide freeways would be very expensive and labor intensive. Finally, the Department's experience with field noise measurements in Milwaukee suggests that some residents believe that noise levels are highest the day before or the day after the measurements were taken.

An alternative to field measurements is to use a computer simulation model to predict freeway sound levels. The Federal Highway Administration's (FHWA) "Stamina 2.0 - Traffic Noise Prediction Model" accurately predicts sound levels for complex highway traffic flow situations found on urban freeways. The computer simulation model was developed for FHWA by the acoustical consulting firm of Bolt, Beranek, and Newman (BBN) of Cambridge, Mass. This model (or earlier versions) has been in use nationwide for at least 15 years. Extensive validation of the Stamina 2.0 occurred during its initial development, and many other state highway agencies, including Wisconsin, have tested its ability to accurately predict traffic noise levels. It is the standard method that virtually every state highway agency (and many local agencies) uses to predict highway sound levels. The FHWA model has been accepted by the U.S. Environmental Protection Agency for use in environmental studies conducted in compliance with the National Environmental Policy Act.

The Department determined that the use of FHWA's computer simulation model overcomes all the disadvantages of field measurements, yields representative freeway sound levels, and is the most appropriate method to use for this study.

II.B.2 STAMINA 2.0 TRAFFIC NOISE PREDICTION MODEL

The noise level at any point is a function of the noise level at the source (the reference noise level), the distance from the source to the receptor, and any attenuation between the source and the receptor. A brief description of noise terminology and sources of highway noise is presented in Appendix B. The National Reference Energy Mean Emission Levels as a function of speed were used as the reference noise levels and are presented in Appendix C.

The STAMINA 2.0 computer model predicts the noise level at a receptor resulting from the source, which is defined as a series of straight line roadway segments. The model uses the vehicle speeds to calculate the source noise level of each type of vehicle from the reference energy levels as shown in Appendix C. The roads, receptors, and topographic features are defined with a three dimensional coordinate system. The roadway, receptor, topographic and barrier coordinates were developed from aerial mosaics of each study area (1 inch : 200-foot scale), as built plans of each roadway as supplied by the Department, and a field survey including video taping of each study area. The data for the Milwaukee area was developed from topographic CADD's mapping (1 inch : 100-foot scale). For the rest of the state, topographic field surveys were used to obtain relative elevations.

Traffic sound levels increase with vehicle speeds. Traffic sound levels increase as traffic volumes increase. Traffic speeds decrease as traffic volumes increase in capacity-controlled situations. The combination of traffic volume and speed conditions that represent "Level of Service - C" operational conditions produce the highest traffic sound levels on a regular basis. "Level of Service - C" conditions normally occur in some metropolitan areas in the period before and after the morning and afternoon rush hours, and sometimes several other hours of the day and night. In most instances,"Level of Service - C" traffic volumes and associated running speeds were used to predict the "worst case" noise levels for this study. When Level of Service - C" volumes were not reached on a regular daily basis, peak hour and the specific vehicle mix for the peak hour were used. In the Milwaukee metropolitan area, only four freeway segments did not regularly operate at "Level of Service - C", while elsewhere in the State, only two freeways regularly operate at "Level of Service - C" volumes.

Average daily traffic volumes are expected to increase in all study areas. Therefore, the freeway segments that were modeled with peak hour traffic have the potential to eventually reach daily occurrences of Level of Service - C traffic conditions. When this happens, an increase in Leq noise levels would also occur. Appendix D presents the existing peak hour traffic volumes, the Level of Service - C capacity, the number of years it would take to reach these conditions with both a 2%/year and 3%/year growth rate and the resultant increase in Leq noise levels. Examination of Appendix D indicates that increases in noise levels will be insignificant for the next few decades throughout most of the study areas.

Traffic sound levels are also dependent upon the number of trucks in the traffic stream. For a sound generation standpoint, one truck, operating at freeway speeds, produces the same amount of sound as approximately 32 cars operating at the same speed. For purposes of this study, truck volumes were determined from traffic count data the Department obtains on a regular basis.

II.B.3 IDENTIFICATION OF RESIDENTIAL AREAS ELIGIBLE FOR NOISE ABATEMENT

The identification of residential areas eligible for consideration of noise abatement was a three step process. First, the freeway sound levels that were determined from the Stamina 2.0 modeling effort were compared with the noise level criterion in TRANS 405. This criterion states that, to be considered for a noise barrier, a residential receptor along an existing freeway shall be exposed to existing noise levels that equal or exceed 67 dBA Leq. This criterion agrees with the Federal Highway Administration's (FHWA) Noise Abatement Criteria (NAC). A copy of TRANS 405 is presented in Appendix E.

The second step in this process was to prepare preliminary designs for the candidate noise barrier locations that satisfied the TRANS 405 noise exposure criterion. The purpose of this preliminary design effort was to determine the approximate length and height of each barrier, such that barrier costs could be estimated. The estimated construction costs were based upon a unit price that would provide a basic austere noise barrier. Also, average sound level reduction values were computed for each barrier location. Finally, the number of residences directly abutting each barrier location were determined.

In the third step of the eligibility determination process, the total construction cost and number of residences abutting each barrier location were compared to the criteria of TRANS 405. This criterion states that . . . "The total cost of a noise barrier may not exceed $30,000 per abutting residence."

The Department determined that an abutting residence is any habitable dwelling unit situated directly adjacent to the limits of a freeway noise barrier, without any other dwelling units being located between the abutting dwelling unit and the freeway. Also, a residence must be exposed to a freeway sound level of 67 dBA Leq or greater to be considered as abutting residence.

II.B.4 PRELIMINARY NOISE BARRIER DESIGN

The results of the STAMINA modeling effort identified those residential areas in the study areas adjacent to the freeway system that are exposed to noise levels that equal or exceed 67 dBA Leq. Based upon a data base created by STAMINA, the computer model OPTIMA was used to design the heights and lengths for the noise barriers protecting each of these areas.

II.B.4(A) DESIGN CRITERIA

The design criteria for the noise barriers analysis is established in TRANS 405, "A noise barrier protecting a receptor shall reduce noise levels by a minimum of 8 decibels". Most people perceive a 8 decibel reduction in sound levels to be cutting the noise almost in half. The Department, for purposes of this study, established an 8 decibel reduction design goal for each barrier location. However, preliminary design techniques with OPTIMA do not permit obtaining exactly 8 decibels of reduction for each barrier without going into very time consuming final design procedures. Hence, barriers were preliminarily designed to get as close to the 8.0 decibel reduction as was appropriate within the time and budget constraints of this study. In an effort to evaluate all potential barrier locations on a fair and uniform basis, barrier construction costs were estimated on the basis that each barrier would provide an 8.0 decibel reduction in freeway Leq sound levels. With the 8 decibel reduction goal, most barriers would lower freeway sounds to below the 67 dBA level, but some of the higher noise level locations would still be above the 67 dBA level. In these latter locations, freeway sound reduction to the 67 dBA level would require extraordinary high (and costly) barriers.

II.B.4(B) RESULTS OF PRELIMINARY NOISE BARRIER DESIGNS

The results of STAMINA 2.0 modelling indicate that there are 209 locations, with 3042 residences, exposed to noise levels at or above the TRANS 405 criterion of 67 dBA leq. The modeled Leq noise levels at these residences ranges from 67 dBA to 76 dBA. Each of these potential noise barrier locations is listed in Appendix F.

II.B.4(C) SPECIAL NOISE BARRIER DESIGN CONSIDERATIONS

The noise barriers presented in this study represent preliminary designs. The exact location, length, or height could be modified in the final design process. These barriers represent acoustically ideal barriers, and even though special design considerations were identified, the barriers have not been analyzed to the detail required for final design. These special design considerations may cause a barrier to be less than ideally effective. This factor does not eliminate a barrier from further consideration. The special design considerations identified in this study include bridges, utilities, and drainage.

II.B.4(D) SOUND LEVELS IN UNDEVELOPED AREAS

A goal of both WisDOT's TRANS 405 and FHWA's Noise Abatement Criteria is to eliminate OR minimize future residential noise impacts adjacent to freeways presently bordered by undeveloped land. The study presents data that shows the distance to which 67 dBA Leq presently extends from the freeway. In addition, graphs are presented in Appendix G that show the distance to 67 dBA Leq from the edge of pavement of the near travel lane as a function of number of lanes, median width, truck percentage and posted speed limit for Level of Service - C operating conditions adjacent to lands that could eventually be developed for residential land use.

Before an eligible noise barrier is considered for construction, TRANS 405 requires the local government to provide the Department with documentation of its land use controls which take these freeway sound levels at undeveloped lands into consideration.

II.C. RESIDENTIAL AREAS ELIGIBLE FOR NOISE ABATEMENT

The data for each potential noise barrier location investigated in II.B.4.(B) was then compared to the cost-effectiveness criteria of TRANS 405, which states that. . ."The total cost of a noise barrier may not exceed $30,000 per abutting residence." The table in Appendix F lists, in bold-face type, all noise barrier locations that are eligible for construction, without any local cost-sharing participation. Of the 209 locations that are exposed to freeway sound levels at or above the 67 dBA Leq criterion, 69 residential areas, with 1733 residences, meet the cost-effectiveness criteria of TRANS 405. These 68 barriers have an estimated construction cost of $36,611,166.

Also listed on the table in Appendix F, in italics, are all barrier locations that require local cost-sharing participation to be considered eligible for construction under TRANS 405 criterion. The noise barriers for these 141 residential areas, with 1309 residences, have a total estimated construction cost of $70,696,310, including a total local participation cost of $31,426,310. The "Local Cost" column in Appendix F lists the local cost-share for each barrier. This local participating cost is equal to the total estimated barrier construction cost, minus $30,000 per abutting residence times the number of abutting residences. The Department has determined that the local cost-sharing participation, will be required, prior to project programming, to schedule a specific noise barrier project for construction. However, local participation, in excess of the required amount, will not be allowed for the purpose of improving the ranking of an eligible noise barrier project.

The total estimated construction cost of all 209 noise barriers, protecting 3042 residences, is $107,307,476.

II.D. RANKING OF ELIGIBLE NOISE BARRIER LOCATIONS

The objective of this portion of the study was to develop a method to rank eligible residential areas, such that relative needs can be compared when considering future noise barrier projects. This task was accomplished by reviewing other State Highway Department's siting criteria and procedures, selecting those factors that the Department determined were important in ranking Wisconsin sites, and finally ranking all 209 Wisconsin sites.

II.D.1 SURVEY OF STATE HIGHWAY DEPARTMENTS

A phone survey was conducted in order to determine which states had adopted or were developing a noise abatement program for existing highways. Currently, nine states have such abatement programs. Of these nine states, seven have a ranking methodology. Of the states contacted, two states, Minnesota and Georgia, had dropped their programs due to excessive cost. Oregon does not have a formal policy. However, they are willing to provide abatement as long as it is acoustically effective and the local residences contribute 33 percent of the total construction cost. New York has put their program on hold due to lack of federal funding. Illinois is sponsoring graduate study at the University of Illinois in order to develop a ranking methodology. Iowa has a program, but does not have a ranking method. Instead, they rely on field measurements and treat each case on an individual basis in terms of barrier cost and effectiveness. Most of the states considered noise reduction, the number of residences affected, and barrier cost as important factors in ranking noise barrier locations.

II.D.2 NOISE BARRIER RANKING FACTORS

In developing the Wisconsin ranking method, each other state's ranking method was examined in terms of mathematical formulation and dependent variables. Based upon discussions with the Department, the following variables were considered important in ranking noise barrier locations: Sound level, traffic exposure, age of residential development, and cost effectiveness.

After consultation with the Department, the equation selected to rank the eligible noise barrier sites was based upon four factors: Sound level (Energy), traffic exposure, average age of residences, and cost per residence per decibel of noise reduction.

II.D.2(A) SOUND LEVEL (ENERGY)

The energy level (E) is a unit-less number defined by the following equation:

$$E=10^{dBA/10}$$

where dBA is the Leq sound level modeled at each receptor. The average energy level (E) for a barrier is defined by the following equation:

$$E=\sum_{i=1}^{N}(10^{dBAi/10}xRESi)/\sum_{i=1}^{N}RESi$$

where N is the number of receptors modeled for the barrier, dBA is Leq sound level at the ith receptor and RES is the number of residences for the ith receptor.

II.D.2(B) TRAFFIC EXPOSURE

The traffic exposure factor (TF) was used to account for the duration of sound exposure at the residential areas along the freeway in any given 24-hour period as a function of average daily traffic and the Level of Service - C capacity of the freeway. The traffic factor is expressed as:

$$TF=ADT/24xLOSC$$

where ADT is the average daily traffic as published by the Department and Level of Service - C is the Level of Service - C traffic service volume determined for each freeway segment as one of the tasks of this study. The TF was developed so that if a freeway segment operated at optimum volume and speed for an entire day, every day of the year, the TF would be equal to one.

II.D.2(C) AGE FACTOR

The age factor (AF) for a residential area is the age of a residence in terms of the age of the adjacent freeway segment. The age factor (AF) is expressed as:

$$AF=\sum_{i=1}^{N}((SY-RESYi)xRESi)/\sum_{i=1}^{N}RESi$$

where SY is study year (1989), RES is the representative year of construction for the ith residence (if the RES is older than the abutting freeway, the RESY equals the opening year of abutting freeway) and RES is the number of residences for the ith receptor.

II.D.2(D) COST EFFECTIVENESS

The noise barrier cost effectiveness factor (CEF) was determined by dividing the estimated construction cost of each defined noise barrier by the number of abutting residences adjacent to the barrier. The equation is written as follows:

$$CEF=CC/\sum_{i=1}^{N}RESi/WIL$$

where CC is the estimated barrier construction cost and RES is the number of abutting residences for the ith receptor.

II.D.3 BARRIER FACTOR WEIGHTING

The Department then conducted an analyses to determine the relative weight of each factor. The Department determined that the majority of the weight should be given to those factors that define the severity of the freeway noise problem. Accordingly, the Department assigned the following weights to each of the four factors:

Sound Level (Energy)	=	50%
Traffic Exposure	=	25%
Residential Age	=	15%
Cost Effectiveness	=	10%
Total	=	100%

The noise barrier ranking (R) is expressed as:

$$R=0.5(E)+0.25(TF)+0.15(AF)+0.10(CEF)$$

II.D.4 NOISE BARRIER RANKINGS

The ranking of each noise barrier relative to the other barriers was performed by normalizing each of the barrier factors using standard deviation techniques and summing all four factors with the appropriate weighting factors for each barrier to arrive at a score. The method is based upon standardizing each barrier factor around the mean. This technique required four steps; the first step converted the barrier factor to standard deviation units, the second step converted the standard deviation units to a standardized score, the third step applied the weighting factors and the fourth step summed the four scores.

The standard deviation units (Z) were defined accordingly:

$$Zi=(Bfi-\mu)/\sigma$$

where Bf is the value of a barrier factor, μ is the mean of the barrier factors, and σ is the standard deviation of the barrier factors.

Zi was then converted into a standardized score (SSi) for each barrier factor using a standard published Z Table. The standardized scores were multiplied by 100. The final Department Ranking Equation is expressed as:

$$R=0.50(SSe)+0.25(SSt)+0.15(SSa)+0.10(SSce)$$

where SS is the standardized score for each barrier factor with the subscripts e, t, a & ce representing sound level (energy), traffic exposure, age, and cost effectiveness respectively.

These barriers and scores were then sorted in descending order, highest barrier score first, to rank each barrier relative to the other barriers. The final results of this ranking analysis for all 209 noise barrier locations are presented in Appendix F.

III. STUDY FINDINGS

Based upon this study, 209 locations with 3042 residences, were identified where the Leq sound level equals or exceeds 67 dBA. Preliminary noise barrier designs were developed for each of these areas. The 209 noise barriers range in cost from $44,481 to $1,657,379, with a total cost of $107,307,476. Each noise barrier was reviewed for design considerations. Except in the case of eliminating a noise barrier on a bridge for structural design reasons, other design considerations should not affect the acoustical characteristics of the noise barriers.

Of the 209 locations that are exposed to freeway sound levels at or above the 67 dBA Leq criterion, 68 residential areas, with 1733 residences, in 16 municipalities in Wisconsin, meet the cost-effectiveness criterion of TRANS 405. These 68 barriers have a total estimated construction cost of $36,611,166, with a range of $44,841 to $1,201,955.

There are 141 barrier locations that would require local cost-sharing participation to be considered eligible for construction under TRANS 405 criterion. The noise barriers for these areas, with 1309 residences, have a total estimated construction cost of $70,696,310, including a total local participation cost of $31,426,310. The individual barriers range in cost from $49,359 to $1,657,379.

The Department developed a method to rank eligible residential noise barrier areas, such that the relative needs can be compared when considering future noise barrier projects. The ranking method is based upon four factors; sound levels, traffic exposure, residential age, and cost-effectiveness. In this method, the Department determined that those factors that define the severity of the freeway noise problem should be given greatest weight.

Chapter Trans 405

SITING NOISE BARRIERS

Trans 405.01 Purpose. In accordance with s. 3052 (3g) (b), 1987 Wis. Act 27, this chapter sets forth the procedures and criteria used by the department for evaluating and selecting site locations for noise barrier installation and for ensuring local participation in the siting process.

History: Cr. Register, August, 1989, No. 404, eff. 9-1-89.

Trans 405.02 Definitions. In this chapter:

(1) "Department" means the department of transportation.

(2) "Existing noise level" means the highest hourly noise level caused by existing conditions in a particular area.

(3) "Future noise level" means the highest hourly traffic noise level based on estimated traffic volumes within a 20 year period after the completion of construction of the new highway facility.

(4) "Noise barrier" means any device, which reduces the transmission of highway traffic noise from a highway to an adjacent receptor, including, but not limited to, earth berms, walls made from timber, metal, concrete, or any combination thereof.

(5) "Noise level" means the sound level obtained through use of A-weighting characteristics. The unit of measure is the decibel (dB), commonly referred to as dBA when A-weighting is used.

(6) "Receptor" means an outdoor place where frequent human use occurs and a lowered noise level would be of benefit.

(7) "Residence" means the official location of a household.

(8) "Retrofit project" means a proposed project for the construction of noise barriers along an existing highway.

History: Cr. Register, August, 1989, No. 404, eff. 9-1-89.

Trans 405.03 Applicability. (1) The provisions of this chapter shall apply to all freeways and expressways under the jurisdiction of the department under ss. 59.965 and 84.295, Stats.

(2) This chapter is to be applied so as to avoid conflict with obligations of the department, under ss. 84.015 and 84.03, Stats., to comply with criteria and standards of federal agencies for obtaining and using federal funds.

History: Cr. Register, August, 1989, No. 404, eff. 9-1-89.

Trans 405.04 Siting criteria and policies. (1) Noise barriers shall be designed to provide protection only to the ground floor of abutting buildings and not other parts of the buildings.

(2) For the department to consider a site for construction of a noise barrier, the site shall meet the following criteria:

(a) For retrofit projects, a receptor shall be exposed to existing noise levels which equal or exceed the levels in Table 1.

(b) For new highway projects, a receptor shall have predicted future noise levels which equal or exceed the levels in Table 1 or which exceed existing noise levels by 15 decibels or more.

(c) A noise barrier protecting a receptor shall reduce noise levels by a minimum of 8 decibels.

(d) The total cost of a noise barrier may not exceed $30,000 in 1988 dollars per abutting residence. The department may annually adjust this $30,000 maximum figure up or down based on changes in the construction price index after 1988. Other land use categories shall be analyzed on a site specific basis to determine cost effectiveness.

TABLE 1

NOISE LEVEL CRITERIA FOR CONSIDERING BARRIERS

Land Use Category	Leq(h)[1] (dBA)	Description of Land Use Category
A	57 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	—	Undeveloped lands.
E[2]	52 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

[1] "Leq" means the equivalent steady-state sound level, which in a stated period of time contains the same acoustic energy as the time-varying sound level during the same period. For purposes of measuring or predicting noise levels, a receptor is assumed to be at ear height, located five feet above ground surface.

"Leq(h)" means the hourly value of Leq.

[2] "Use of interior noise levels shall be limited to situations where exterior noise levels are not applicable.

History: Cr. Register, August, 1989, No. 404, eff. 9-1-89.

Trans 405.05 Local participation. The department shall ensure local participation in the siting of noise barriers through the following:

(1) The department shall hold one or more informational meetings, in a location convenient to the locality to be affected by the siting, to pro-

vide an opportunity for local participation in the selection and development of the noise barrier installation project. The department shall arrange for published notice of each informational meeting. The department shall also give direct written notice of each informational meeting to each person owning real property or leasing a residence in the following locations:

(a) Within 500 feet in any direction from the proposed noise barrier or

(b) Within the areas directly behind the proposed noise barrier and directly across the highway from the proposed noise barrier where the highest hourly traffic noise level equals or exceeds 67 decibels.

(2) For a proposed noise barrier project to be considered for construction, the local government, prior to completion of final design of a proposed noise barrier, shall furnish the department with:

(a) A formal resolution supporting the proposed barrier project.

(b) Documentation of its land use controls which:

1. Apply to land adjacent to freeways or expressways; and

2. Would reasonably eliminate the need for state-funded noise barriers in highway rights-of-way adjacent to future developments.

History: Cr. Register, August, 1989, No. 404, eff. 9-1-89.

Trans 405.06 Program. The department, upon receiving a community request for a noise barrier project, shall evaluate and program eligible retrofit noise barrier projects in the highway programming process. Factors considered in this process shall include, but are not limited to, cost of the project, date of adjacent development along the proposed site, traffic noise levels, number of benefiting receptors, community acceptance of the proposed noise barrier, and predicted noise level reduction.

History: Cr. Register, August, 1989, No. 404, eff. 9-1-89.

Appendix G -- Type II Priority Rating System for New Jersey

NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND DEMONSTRATION

PRIORITY RATING INDEX

A. General

This priority index is a relatively simple equation used to determine a community's total noise impact. The index is based on three measures of noise impact. These measures are the population (weighted with a factor for land use sensitivity), the magnitude of noise impact (the degree of annoyance and energy content), and the duration of noise impact (the number of years people have been exposed to high traffic noise levels).

The information from each community land use which is used to determine the priority rating consists of eight pieces of data. A description of each piece of data and the variable assigned in the fortran computer program follows.

1. Population (P) - the total number of people exposed to noise levels above Noise Abatement Criteria for the respective land use (see data piece number 6, page D-3).

2. Sensitive Area Usage (U) - the decimal fraction representing the average portion of a 24 hour day during which a person or persons would occupy the noise sensitive area. For example, if the area is occupied for 12 hours, U = 0.50.

3. Weighted Land Use (W) - empirical weighting of noise sensitivity based on land usage (see Table A, next page).

TABLE A

Empirical Weighting of Noise Sensitive Land Use

Weighting	Land Use
1	Category C
2	sports complex, playground, picnic area
3	residences, apartments, motels, hotels
4	schools, churches, libraries, hospitals
6	Category A

4. Equivalent Sound Level (LEQ) - the highest hourly L_{eq} measured during the time period when a sensitive land area is normally in use.

5. Noise Pollution Level (LNP) - the highest hourly L_{NP} measured during the time period when a sensitive land area is normally in use.

6. Noise Abatement Criteria (NAC)-the L_{eq} noise levels that define noise impact in FHPM 7.7.3

Category A	-	57dBA (Exterior)
Category B	-	67dBA (Exterior)
Category C	-	72dBA (Exterior)
Category E	-	52dBA (Interior)

When interior sensitive land uses (Category E) are being prioritized using an exterior noise measurement, the noise reduction due to the exterior of a building must be accounted for based on Table B, next page.

TABLE B

Building Attenuation by Structure Type

Building Type	Window Condition	Noise Reduction Due To Structure
All	Open	10 dB
Light Frame	Ordinary Sash (closed)	20
Light Frame	Storm Windows	25
Masonry	Single Glazed	25
Masonry	Double Glazed	35

7. Population Percentage Before Road (B) - a decimal fraction representing the percentage of the total population using a sensitive land use that was present before the road was opened. For example, if 45%, B=0.45.

8. Years (RO) - the number of years that the roadway has been open.

B. Rating Equation

The priority rating is ten times the common logarithm of the sum of the multiple products of the population, magnitude, and duration of noise impact for all sensitive land uses within a given project.

In other words:

$$\text{Project Rating} = 10 \times \log \left[\sum_{i=1}^{n} (C_1 \times C_2 \times C_3)_i \right]$$

where:

n = number of sensitive land use types within a community.

C_1 = population exposed to noise impact

C_2 = magnitude of noise impact

C_3 = duration of noise impact

1. Population Factor

Factor C_1 is the number of noise impacts. It is basically a measure of the number of people exposed to noise levels above the Noise Abatement Criteria. It is determined as follows:

$$C_1 = P \times U \times W$$

where:

P - is the total impacted population utilizing a sensitive land use.

U - is the decimal fraction representing the typical number of hours a person is present at a sensitive land use during a 24 hour day (average hours a person present/24).

W - is an empirical weighting (determined by the Bureau of Environmental Analysis) based on the noise sensitivity of a particular area.

This factor (C_1) will double if any of the three variables double.

The population (P) of an impacted residential area is determined by multiplying the number of impacted residences by the average New Jersey household size. The population of other impacted areas is determined from park usage figures, congregation size, number of affected classrooms multiplied by 25 people or number of people employed in a Category C area.

The sensitive area usage (U) quantifies the differences between the amount of time that various sensitive land areas are in use during a 24 hour day.

The weighted land use (W) is used to adjust the population figures to account for their degree of noise sensitivity by use of the empirical constants in Table A.

2. Magnitude of Impact Factor

The measure for the magnitude of noise impact is factor C_2. It is a function of the energy content and annoyance (perceived loudness) of traffic noise. Both factors are used to account for the peak overall noise level and peak intrusiveness of the noise.

The function relating the energy content of noise is applied to the total impacted population of a sensitive area. This function is referenced to the NAC. A doubling of this term corresponds to a 3dB increase in noise level and also a doubling of the acoustical energy content of the noise. The function is:

$$\text{Energy Content} = 10^{[L_{eq}-NAC]/10}$$

where:

L_{eq} - is the measured highest hourly equivalent noise level while the area is in use.

- is the appropriate Noise Abatment Criteria for a sensitive area as defined by FHPM 7.7.3.

The term chosen to reflect annoyance is the Noise Pollution Level which is defined as follows:

$$L_{NP} = L_{eq} + K\sigma$$

where:

L_{eq} - is the A-weighted equivalent continuous sound level during the measurement period.

K - is a constant set at 2.56 providing the best fit with data for subjective response to aircraft and traffic noise.

σ - is the standard deviation in decibels of the instantaneous sound level during the measurement period.

The L_{NP} is comprised of two terms, the equivalent noise level and the increase in annoyance caused by fluctuations in that level. This term was developed by D.W. Robinson of the British National Physical Laboratory. The L_{NP} can best be described by comparing a steady state noise level and a time varying noise level having the same L_{eq}. If the time varying noise level is such that the term "$K\sigma$" is equal to 10dB then the time varying noise will be as annoying as a steady state noise level 10dB higher or twice as loud.

The basic L_{NP} equation was modified to show these increases in annoyance directly when referenced to a steady state NAC. The function is:

$$\text{Annoyance} = 2^{[L_{NP} - NAC]/10}$$

where:

L_{NP} - is the measured highest hourly noise pollution level while a sensitive area is in use.

NAC - is the appropriate Noise Abatement Criteria for a sensitive area as defined by FHPM 7.7.3.

This function is set so that an increase of one in the exponent (corresponding to a 10dB increase or doubling of loudness) will result in a doubling of annoyance. This basic function remains unchanged and is multiplied by the fraction of the total population who are located in land uses developed after the roadway was constructed to account for annoyance to them.

The function is then:

$$\text{Annoyance} = A \times 2^{[L_{NP} - NAC]/10}$$

where:

A - is the percentage of the total population that moved in after the roadway was opened expressed as a decimal fraction (A = 1 - B).

The function has an additional 10dB added to the exponent to account for a doubling of annoyance to people present before the roadway was opened. The function then becomes:

$$\text{Annoyance} = B \times 2^{[(L_{NP}-NAC)+10]/10}$$

where:

B - is the percentage of the total population present before the roadway was opened expressed as a decimal fraction.

The total annoyance term is then the sum of these two functions.

The total noise magnitude factor is the product of the energy content and annoyance terms as follows:

$$C_2 = (10^{[L_{eq}-NAC]/10}) \times [(B \times 2^{[(L_{NP}-NAC)+10]/10}) + (A \times 2^{[L_{NP}-NAC]/10})]$$

3. Duration Of Impact Factor

The measure for the duration of noise impact is Factor C_3. It is based on the number of years that the population has been exposed to high traffic noise levels.

Where people were present before the roadway was constructed the measure for duration is as follows:

$$\text{Duration} = B \times RO$$

where:

B - is the percentage of total population present before the roadway was opened expressed as a decimal fraction.

RO- is the number of years the roadway has been open.

Where people moved in after the roadway was open the duration measure is as follows:

$$\text{Duration} = A \times (RO/2)$$

where:

A - is the percentage of total population that moved in after the roadway was opened expressed as a decimal fraction.

RO/2- the mean number of years that residents who moved in after the roadway was opened have been present.

The total duration of impact term is the sum of these two quantities as follows:

$$C_3 = \frac{[B \times RO] + [A \times (RO/2)]}{2}$$

The sum is divided by 2 to reduce the magnitude of the final ranking number.

Appendix H -- List of Respondents to the Questionnaire to Local and Non-DOT State Noise Programs

* Newton Vaughan
Natural Resources & Env.
Management Dept.
City of Huntsville
P.O. Box 308
Huntsville, AL 35804-0308

* Robert O. Baker, Ph.D.
Prog. Mgr., Env. Sanitation
Dept. of Health & Human Services
825 "L" Street
P.O. Box 196650
Anchorage, AK 99519-6650

Joseph W. Wright
Associate Planner
Community Development
815 W. 6th St.
Corona, CA 91720

* Steve Concannon
Code Enforcement Officer
Community Development
207 N. Harvard Ave.
Claremont, CA 91711

Sid Lee
Sr. Code Enf. Officer
Building & Safety
11111 Brookshire Ave.
Darney, CA 90241

James Hagen
Zoning Complince Officer
Building and Planning
200 E. Main St.
El Cajon, CA 92020

Mark A. Vester
Mech. Engr. II
Dev. Dept. City of Fresno
2326 Fresno St.
Fresno, CA 93721

* Janet Solow
Code Envorcement Manager
Housing & Neighborhood Dev.
11391 Acacia Pkwy.
Garden Grove, CA 92640

David E. Witt
Planning Director
Dept. of Planning
8130 Allison Ave.
La Mesa, CA 92041

* Mone McElroy
Admin. Env. Div.
Building & Safet Dept.
3031 Tarrance Blvd.
Lorrane, CA 90503

* Jim Carney
Chief Inspector
Dept. of Biulding & Safety
500 Shatto Pl, Suite 520
Los Angeles, CA 91748

* Mike Gain
Public Services Supervisor
City of Modesto
P.O. Box 641
Modesto, CA 95353

Lt. Tom Merson
Traffic Maager
Paol Alto Police
275 Forrest Ave.
Paol Alto, CA 94301

* Christopher Becker
Associate Planner
Planning Dept.
City of Placentia
401 E. Chapman Ave.
Placentia, CA 92670

* Delyn Ellison
Env. Health Specialist
Dept. of Env. Management
8475 Jackson Rd., Ste 240
Sacramento, CA 95826

* Karla M. Dykes
Code Enforcement Officer
City Hall Annex, Rm. 206
809 Center St.
Santa Cruz, CA 95060

Jim Stern
Assistant Director
Community Development
110 East Cook St.
Santa Maria, CA 93454

Michael Nottoli
Comm. Service Officer
13777 Fruitvale Ave.
Saratoga, CA 95070

Michael W. Kehn
Senior Planner
Env. Services
2929 Tapo Canyon Rd.
Simi Valley, CA 93036

---

* Responded to Survey

Bob Prodoehl
Building Official
Building & Safety Div.
501 Poli
Ventura, CA 93001

* Mike Weil
Env. Enforcement Officer
City of Boulder
1739 Broadway
Boulder, CO 80302

* Richard A. Bowman
Noise Control Supervisor
Risk Management
P.O. Box 1525 #1370
Colorodo Springs, CO 80901

* Thomas Cowan
Public Health Sanitarian
Denver Dept. of Health & Hospitals
Environmental Health Services
605 Bannock St.
Denver, CO 80204

* James P. Musser
Code Enf. Officer
Consumer Regulatory Affairs
614 H. St. N.W.
Washington, DC 20001

Shirley A. Farmer
Env. Officer II
Community Dev.
201 W. Palmetto Park Rd.
Boca Raton, FL 33432

Thomas E. McDonough
Env. Enforcement Div. Admin.
Env. Management
440 Court St.
Clearwater, FL 34616

Frank Paglianite
Code Compliance/Noise Control Off.
Building & Zoning
P.O. Box 14250
Ft. Lauderdale, FL 33302

Michael A. Saclarides
Code Enf. Officer
City of Miami Beach
Fire Dept., Code Enf. Div.
1700 convention Center Dr.
P.O. Box 0
Miami Beach, FL 33119

* Ralph D. Hendrickson, Jr.
Code Administrator
CDEC Dept. Div. of Code Enf.
600 W. Blue Aeron Blvd.
City of Rivierra Beach, FL 33404

* R. Scott Anslinger, R.S.
Env. Health Officer
33 S. Arlington Heights Rd.
Arlington Heights, IL 60007

Don B. Galley
Assistant Commissioner
Dept. of Consumer Services
Room 808
121 N. LaSalle St.
Chicago, IL 60602

Greg A. Sundin
Asst. Dir. for Planning
Planning & Development Dept.
229 S. Second St.
Elkhart, IN 46516

* Bill Peters
Air Management
Evansville E.P.A.
1 N.W. 7th St., Rm. 207
Evansville, IN 47708

* Donald L. Novak
Director
Environmental Management
5925 Calumet Ave.
Hammond, IN 46320

* John R. Klaus
City Attorney
Legal Dept. Ames Mun. Bldg.
5th & Kellogg
Ames, IA 50010

Eugene F. Neibuhr, PE & LS
Public Works Director
City Hall, P.O. Box 158
Clinton, IA 52732

Glenn C. Jackson, RS
Director, Health Dept.
209 Pearl
Council Bluffs, IA 51503

Dee F. Bruemmer
Asst. City Administrator
Dept. of Administratiion
226 West 4th
Davenport, IA 52801

Barry Vosler
Zoning Enforcement Officer
Building Dept.
Armory Bldg. 602 E. 1st
Des Moines, IA 50309

* Mary Rose Corrigan, R.N.
Public Health Specialist
Dubuque Health Dept.
1300 Main St.
Dubuque, IA 52201

* Reuben Dagold
Director, Bureau of Industrial Hygiene
Baltimore City Health Dept.
303 E. Fayette St., 4th Floor
Baltimore, MD 21202

Andrew J. Cressman
Code Enforcement Officer
Div. of Public Safety
2614 Kenhill Dr.
Bowie, MD 20715

* Walter Bagby
Dir. of Neighborhood Improvement
345 State SE
Grand Rapids, MI 49503

* John P. Arnot, P.E.
City Engineer
Trenton Eng. & Bldg. Dept.
2800 Third St.
Trenton, MI 48183

James W. DeLange
Chief Bldg. Inspector
Building Inspections Div.
1155-28th St. S.W.
Wyoming, MI 49505

* John K. Nelson
Sr. Env. Health Specialist
Comm. Dev.
2215 W.O.S.R.
Bloomington, MN 55431

Stewart W. Anderson
Chief of Police
Columbia Heights Police
559 Mill St. NE
Columbia Heights, MN 55421

Herbert Wenkel
Env. Health Sanitarian
Community Dev.
P.O. Box 3368
202 East Jackson St.
Mankato, MN 56001

Gail Trenholm
Env. Health Specialist
Community Development
14600 Minnetonka Blvd.
Minnetonka, MN 55343

Doug Sandstad
Building Official
Fire & Safety
4401 Xylon Ave. N.
New Hope, MN 55428

* M. Christine Smith
Public Health Investigator
Independence Health Dept.
223 N. Memorial Dr.
Independence, MO 64051

* Bill Pugsloy
Asst. Chief Div. of Env. Health
Lincoln-Lanncaston Co. Health Dept.
2200 St. Mary's Ave.
Lincoln, NE 68502

* Patricia A. Hart
Health Officer
E. Windsor Twsp. Health Dept.
16 Lansing Blvd.
E. Windsor, NJ 08520

Claudette Campbell
Sanitary Inspector
Dept. of Env. Science
176 Broadway
Paterson, NJ 07505

* Jay H. Breedlore
Field Operations Commander
Ashville Police Dept.
P.O. Box 7148
Ashville, NC 28802

* James E. Londeree
Noise Control Specialist
Charlotte Police Dept.
825 East Fourth St.
Charlotte, NC 28202

* Dennis L. Smetano
Admin Lt.
Minot Police Dept.
515 2nd Ave. S.W.
Minot, ND 58701

Steven M. Carne
Zoning Administrator
Inspectional Services
P.O. Box 22
Dayton, OH 45405

* William J. Garber
Acting Chief, Enforcement/
Engineering
City of Toledo, Env. Services Div.
26 Main St.
Toledo, OH 43605

Bill Pedergraft
Captain, Field Div.
Norman Police Dept.
201-B West Gray
Norman, OK 73069

J. Mills
Zoning/Noise Inspector
Dept. of Planning
200 West Walker
Oklahoma City, OK 73112

* Bruce C. Cleeton
Code Enforcement Officer
Police - City of Beaverton
P.O. Box 4755
Beaverton, OR 97076

Daphne Pickens
Health Officer
Code Enforcement Dept.
1176 Old York Rd.
Abington, PA 10001

George N. Harris
Director of Public Health
Health Dept.
Long Lane & Garrett Rd.
Upper Darby, PA 19082

Eugene J. Jeffers
Director of Public Works
137 Roosevelt Ave.
Pawtucket, RI 02861

* Pat Fouler
Director of Health Dept.
Garland Dept.of Health
P.O. Box 469002
Garland, TX 75044

Ross Wilhite
Director of Planning
Dept. of Planning
Box 1089
Port Arthur, TX 77640

Diane Keay
Env. Health Supervisor
Salt Lake City Health Dept.
610 South 200 East
Salt Lake City, UT 84111

A. W. Schwarting
Lieutenant/Serv. Div. Commander
Charlottsville Police Dept.
606 E. Market St.
Charlottesville, VA 22901

William T. Weatherly, Jr.
Chief of Police
Pullman Police Dept.
S.E. 260 Kamiaken
Pullman, WA 99163

Cort Horner
Env. Health Serv. Supervisor
Seattle-King Co. Dept. of Health
Env. Division
201 Smith Tower
Seattle, WA 98104

* Randall E. Wergin
Dir. of Env. Health
City of Kenosha Health Dept.
625 52nd St.
Kenosha, WI 53140

Roger Halverson
Sergeant
Manitowoc Police Dept.
824 Jay St.
Manitowoc, WI 54220

* David Krey
Technical Coordinator
Milwaukee Health Dept.
841 N. Broadway
Milwaukee, WI 53202

Michael Weber
Sanitarian
Health Dept.
P.O. Box 1130
Oshkosh, WI 54902

* Russel B. Dupree
Chief, Office of Noise Control
Dept. of Health Services
Room 118
2151 Berkeley Way
Berkeley, CA 94704

* Joseph B. Pulaski
Principal Env. Analyst
Connecticut Dept. of Env. Protection
627 Amity Rd.
Bethany, CT 06525

* Thomas Anamizu
  Chief, Noise and Radiation Branch
  Dept. of Health
  591 Ala Moana Blvd.
  Honolulu, HI 96813-2498

* Greg Zak
  Noise Technical ADvisor
  Illinois E.P.A.
  P.O. Box 19276
  Springfield, IL 62794-9276

* Michael J. Caughlin
  Chief, Field Services and
  Noise Contol Div.
  Maryland Dept. of Env. Air
  Management Admin.
  2500 Broening Highway
  Dudalk, MD 21224

* Edward J. DiPolvere
  Chief, Office of Noise Control
  N.J. D.E.P.
  401 East State St.
  Trenton, NJ 08625

Appendix I -- EPA Newly Manufactured Product Noise Regulations for Medium and Heavy Trucks, Motorcycles, and Motorcycle Exhaust Systems

code of federal regulations

Protection of Environment

40

PARTS 190 to 259

Revised as of July 1, 1990

CONTAINING
A CODIFICATION OF DOCUMENTS
OF GENERAL APPLICABILITY
AND FUTURE EFFECT
AS OF JULY 1, 1990

With Ancillaries

Published by
the Office of the Federal Register
National Archives and Records
Administration

as a Special Edition of
the Federal Register

NATIONAL ARCHIVES AND RECORDS ADMINISTRATION 1985

APPENDIX I TO PART 204

TABLE I—SAMPLE SIZE CODE LETTERS

Batch size	Code letter
4 to 8	A.
9 to 15	B.
16 to 25	C.
26 and larger	D.

TABLE II—SAMPLING PLANS FOR INSPECTING BATCHES

Sample size code letter	Test sample	Test sample size	Cumulative test sample size	Batch inspection criteria	
				Acceptance number	Rejection number
A	1st	4	4	0	1
B	1st	3	3	0	1
C	1st	3	3	0	2
	2d	3	6	1	2
D	1st	2	2	(1)	2
	2d	2	4	(1)	2
	3d	2	6	0	2
	4th	2	8	0	3
	5th	2	10	1	3
	6th	2	12	1	3
	7th	2	14	2	3

[1] Batch acceptance not permitted at this sample size.

TABLE III—BATCH SEQUENCE PLANS

Sample size code letter	Number batches	Cumulative number batches	Sequence inspection criteria	
			Acceptance number	Rejection number
A	2	2	1	(1)
	2	4	2	4
	2	6	3	5
	2	8	4	5
B	2	2	0	(1)
	2	4	1	4
	2	6	2	5
	2	8	3	5
	2	10	4	6
	2	12	5	6
C	2	2	(2)	2
	2	4	0	2
	2	6	0	3
	2	8	1	3
	2	10	2	4
	2	12	3	4
D	2	2	0	2
	2	4	1	3
	2	6	2	4
	2	8	3	4

[1] Batch sequence rejection not permitted for this number of batches.
[2] Batch sequence acceptance not permitted for this number of batches.

TABLE IV—RECOMMENDED FORMAT FOR PORTABLE AIR COMPRESSOR NOISE DATA SHEET

Test report number: ....
Subject:
Manufacturer: .... Model: .... Serial No.: ....
Rated speed: .... Rpm: .... Rated capacity: .... cfm (m ³/n).
Configuration identification: .... Category identification: ....
Portable air compressor identification No.: .... Build Date: ....
Test conditions:
Manufacturers test site identification and location: ....
Reflecting plane composition: ....
Operating speed as tested:
Beginning of test.......... rpm
End of test.......... rpm
Air pressure supplied: .... psi (kg/cm ²) Ambient wind speed——mph (km/hr).
Actual flow rate: .... cfm (m ³/min.) Atmospheric pressure——psi (kg/cm ²).
Temperature: .... °F (°C).
Instrumentation:
Microphone Manufacturer: .... Model No.: .... Serial No ....
Sound Level Meter Manufacturer: .... Model No.: .... Serial No ....
Calibrator Manufacturer: .... Model No.: .... Serial No ....
Other and Manufacturer: .... Model No.: .... Serial No ....
Data:

Sound levels (decibels)	Background sound level at location 1 (decibels)	Location					Average sound level (decibels)
		1	2	3	4	5	
A-Weighted							

Tested by: .... Date: ....
Reported by: .... Date: ....
Supervisory personnel: .... Title: ....
Title: ....

PART 205—TRANSPORTATION EQUIPMENT NOISE EMISSION CONTROLS

Subpart A—General Provisions

Subpart B—Medium and Heavy Trucks

Authority: Secs. 6, 10, 11, 13, Pub. L. 92-574, 86 Stat. 1234 (42 U.S.C. 4905, 4909, 4910, 4912).

Source: 41 FR 15544, Apr. 13, 1976, unless otherwise noted.

Subpart A—General Provisions

§ 205.1 General applicability.

The provisions of this subpart are applicable to all products for which regulations have been published under this part and which are manufactured after the effective date of such regulations.

§ 205.2 Definitions.

(a) As used in this subpart, all terms not defined herein shall have the meaning given them in the Act.

(1) "Act" means the Noise Control Act of 1972 (Pub. L. 92-574, 86 Stat. 1234).

(2) "Administrator" means the Administrator of the Environmental Protection Agency or his authorized representative.

(3) "Agency" means the United States Environmental Protection Agency.

(4) "Export exemption" means an exemption from the prohibitions of section 10(a)(1), (2), (3), and (4) of the Act, granted by statute under section 10(b)(2) of the Act for the purpose of exporting regulated products.

(5) "National security exemption" means an exemption from the prohibitions of section 10(a)(1), (2), (3), and (5) of the Act, which may be granted under section 10(b)(1) of the Act for the purpose of national security.

(6) [Reserved]

(7) "Sound Level" means 20 times the logarithm to base 10 of the ratio of pressure of a sound to the reference pressure. The reference pressure is 20 micropascals (20 micronewtons per square meter). NOTE: Unless otherwise explicitly stated, it is to be understood that the sound pressure is the effective (rms) sound pressure, per American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.

(8) "Sound Pressure Level" means in decibels, 20 times the logarithm to the base 10 of the ratio of a sound pressure to the reference sound pressure of 20 micropascals (20 micronewtons per square meter). In the absence of any modifier, the level is understood to be that of a root-mean-square pressure. The unit of any sound level is the decibel, having the unit symbol dB.

(9) "dB(A)" means the standard abbreviation for A-weighted sound levels in decibels.

(10) "Highway" means the streets, roads, and public ways in any State.

(11) "Fast Meter Response" means that the fast dynamic response of the sound level meter shall be used. The fast dynamic response shall comply with the meter dynamic characteristics in paragraph 5.3 of the American National Standard Specification for Sound Level Meters, ANSI SI.4-1971. This publication is available from the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.

(12) "Person" means an individual, corporation, partnership, or association, and except as provided in sections 11(e) and 12(a) of the Act includes any officer, employee, department, agency or instrumentality of the United States, a State or any political subdivision of a State.

(13) "Reasonable assistance" means providing timely and unobstructed access to test products or products and records required by this part, and opportunity for copying such records or testing such test products.

(14) "Ultimate purchaser" means the first person who in good faith purchases a product for purposes other than resale.

(15) "New product" means (i) a product the equitable or legal title of which has never been transferred to an ultimate purchaser, or (ii) a product which is imported or offered for importation into the United States and which is manufactured after the effective date of a regulation under section 6 or 8 which would have been applicable to such product had it been manufactured in the United States.

(16) "Manufacturer" means any person engaged in the manufacturing or assembling of new products, or the importing of new products for resale, or who acts for and is controlled by any such person in connection with the distribution of such products.

(17) "Commerce" means trade, traffic, commerce, or transportation:

(i) Between a place in a State and any place outside thereof, or

(ii) Which affects trade, traffic, commerce, or transportation described in paragraph (a)(17)(i) of this section.

(18) "Distribute in commerce" means sell in, offer for sale in, or introduce or deliver for introduction into, commerce.

(19) "State" includes the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, American Samoa, Guam, and the Trust Territory of the Pacific Islands.

(20) "Federal Agency" means an executive agency (as defined in section 105 of Title 5, United States Code) and includes the United States Postal Service.

(21) "Environmental noise" means the intensity, duration, and the character of sounds from all sources.

(22) "Warranty" means the warranty required by section 6(c)(1) of the Act.

(23) "Tampering" means those acts prohibited by section 10(a)(2) of the Act.

(24) "Maintenance instructions" or "instructions" means those instructions for maintenance, use, and repair, which the Administrator is authorized to require pursuant to section 6(c)(1) of the Act.

(25) "Type I Sound Level Meter" means a sound level meter which meets the Type I requirements of ANSI SI.4-1972 specification for sound level meters. This publication is avail-

able from the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.

(26) "Testing exemption" means an exemption from the prohibitions of section 10(a)(1), (2), (3), and (5) of the Act, which may be granted under section 10(b)(1) of the Act for the purpose of research, investigations, studies, demonstrations, or training, but not including national security.

(27) "Product" means any transportation equipment for which regulations have been promulgated under this part and includes "test product."

(28) "Test product" means any product that is required to be tested pursuant to this part.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61457, Dec. 5, 1977]

§ 205.3 Number and gender.

As used in this part, words in the singular shall be deemed to import the plural, and words in the masculine gender shall be deemed to import the feminine and vice versa, as the case may require.

§ 205.4 Inspection and monitoring.

(a) Any inspection or monitoring activities conducted under this section shall be for the purpose of determining (1) whether test products are being selected and prepared for testing in accordance with the provisions of these regulations, (2) whether test product testing is being conducted in accordance with these regulations, and (3) whether products being produced for distribution into commerce comply with these regulations.

(b) The Director, Noise Enforcement Division, may request that a manufacturer subject to this part admit an EPA Enforcement Officer during operating hours to any of the following:

(1) Any facility or site where any product to be distributed into commerce is manufactured, assembled, or stored;

(2) Any facility or site where any tests conducted pursuant to this part or any procedures or activities connected with such tests are or were performed; and

(3) Any facility or site where any test product is present.

(c)(1) An EPA Enforcement Officer, once admitted to a facility or site, will not be authorized to do more than:

(i) To inspect and monitor test product manufacture and assembly, selection, storage, preconditioning, noise emission testing, and maintenance, and to verify correlation or calibration of test equipment;

(ii) To inspect products prior to their distribution in commerce:

(iii) To inspect and photograph any part or aspect of any such product and any component used in the assembly thereof that are reasonably related to the purpose of his entry.

(iv) [Reserved]

(v) To obtain from those in charge of the facility or site such reasonable assistance as he may request to enable him to carry out any proper function listed in this section.

(2) [Reserved]

(3) The provisions of this section apply whether the facility or site is owned or controlled by the manufacturer or by one who acts for the manufacturer.

(d) For purposes of this section:

(1) An "EPA Enforcement Officer" is an employee of the EPA Office of Enforcement who displays upon arrival at a facility or site the credentials identifying him as such an employee and a letter signed by the Director, Noise Enforcement Division designating him to make the inspection.

(2) Where test product storage areas or facilities are concerned, "operating hours" shall mean all times during which personnel other than custodial personnel are at work in the vicinity of the area or facility and have access to it.

(3) Where facilities or areas other than those covered by paragraph (d)(2) of this section are concerned, "operating hours" shall mean all times during which product manufacture or assembly is in operation or all times during which product testing and maintenance is taking place and/or production or compilation of records is taking place, or any other procedure or activity related to selective enforcement audit testing or product manufacture or assembly being carried out in a facility.

(e) The manufacturer shall admit to a facility or site an EPA Enforcement Officer who presents a warrant authorizing entry. In the absence of such warrant, entry to any facility or site under this section will be only upon the consent of the manufacturer.

(1) It is not a violation of this regulation or the Act for any person to refuse entry without a warrant.

(2) The Administrator or his designee may proceed ex parte to obtain a warrant whether or not the manufacturer has refused entry.

[41 FR 15544, Apr. 13, 1976, as amended at 43 FR 27990, June 28, 1978; 47 FR 57713, Dec. 28, 1982]

§ 205.5 Exemptions.

§ 205.5-1 Testing exemption.

(a) A new product intended to be used solely for research, investigations, studies, demonstrations or training, and so labeled or marked on the outside of the container and on the product itself, shall be exempt from the prohibitions of section 10(a)(1), (2), (3), and (5) of the Act.

(b) No request for a testing exemption is required.

(c) For purposes of section 11(d) of the Act, any testing exemption shall be void ab initio with respect to each new product, originally intended for research, investigations, studies, demonstrations, or training, but distributed in commerce for other uses.

[47 FR 57713, Dec. 28, 1982]

§ 205.5-2 National security exemptions.

(a) A new product which is produced to conform with specifications developed by a national security agency, and so labeled or marked on the outside of the container and on the product itself, shall be exempt from the prohibitions of section 10(a)(1), (2), (3), and (5) of the Act.

(b) No request for a national security exemption is required.

(c) For purposes of section 11(d) of the Act, any national security exemption shall be void ab initio with respect to each new product, originally intended to be produced to conform with specifications developed by a national security agency, but distributed in commerce for other uses.

(d) Any manufacturer or person subject to the liabilities of section 11(a) with respect to any product originally intended for a national security agency, but distributed in commerce for use in any State, may be excluded from the application of section 11(a) with respect to such product based upon a showing that such manufacturer:

(1) Had no knowledge of such product being distributed in commerce for use in any state; and

(2) Made reasonable effort to ensure that such products would not be distributed in commerce for use in any State. Such reasonable efforts would include investigation, prior dealings, contract provisions, etc.

[47 FR 57714, Dec. 28, 1982]

§ 205.5-3 Export exemptions.

(a) A new product intended solely for export, and so labeled or marked on the outside of the container and on the product itself, shall be exempt from the prohibitions of section 10(a), (1), (2), (3), and (4) of the Act.

(b) No request for an export exemption is required.

(c) For purposes of section 11(d) of the Noise Control Act, the Administrator may consider any export exemption under section 10(b)(2) as void ab initio with respect to each new product intended solely for export which is distributed in commerce for use in any State.

(d) In deciding whether to institute proceedings against a manufacturer pursuant to section 11(d)(1) of the Act with respect to any product originally intended solely for export but distributed in commerce for use in any state, the Administrator will consider:

(1) Whether the manufacturer had knowledge that such product would be distributed in commerce for use in any state; and

(2) Whether the manufacturer made reasonable efforts to ensure that such product would not be distributed in commerce for use in any state. Such reasonable efforts would include consideration of prior dealings with any person which resulted in introduction into commerce of a product manufactured for export only, investigation of

prior instances known to the manufacturer of introduction into commerce of a product manufactured for export only, and contract provisions which minimize the probability of introduction into commerce of a product manufactured for export only.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61457, Dec. 5, 1977. Redesignated at 47 FR 57714, Dec. 28, 1982]

Subpart B—Medium and Heavy Trucks

EDITORIAL NOTE: Effective January 1, 1978, the provisions of 40 CFR 205.50 through 205.59 shall not apply with respect to any fire apparatus. This action is a stay pending reconsideration of the regulation, and shall continue until 90 days following publication of notice in the FEDERAL REGISTER, as to EPA's final decision of the petition of the Truck Body and Equipment Association dated July 29, 1977. (See 43 FR 1796, Jan. 12, 1978.)

§ 205.50 Applicability.

(a) Except as otherwise provided for in these regulations the provisions of this subpart apply to any vehicle which has a gross vehicle weight rating (GVWR) in excess of 10,000 pounds, which is capable of transportation of property on a highway or street and which meets the definition of the term "new product" in the Act.

(b) The provisions of the subpart do not apply to highway, city, and school buses or to special purpose equipment which may be located on or operated from vehicles. Tests performed on vehicles containing such equipment may be carried out with the special purpose equipment in nonoperating condition. For purposes of this regulation special purpose equipment includes, but is not limited to, construction equipment, snow plows, garbage compactors and refrigeration equipment.

§ 205.51 Definitions.

(a) As used in this subpart, all terms not defined herein shall have the meaning given them in the Act or in other subparts of this part.

(1) "Acceptable Quality Level" means the maximum percentage of failing vehicles that for purposes of sampling inspection, can be considered satisfactory as a process average.

(2) "Acceptance of a batch" means that the number of noncomplying vehicles in the batch sample is less than or equal to the acceptance number as determined by the appropriate sampling plan.

(3) "Batch" means the collection of vehicles of the same category, configuration or subgroup thereof as designated by the Administrator in a test request, from which a batch sample is to be drawn, and inspected to determine conformance with the acceptability criteria.

(4) "Batch size" means the number as designated by the Administrator in the test request of vehicles of the same category or configuration in a batch.

(5) "Batch sample" means the collection of vehicles of the same category, configuration or subgroup thereof which are drawn from a batch and from which test samples are drawn.

(6) "Batch sample size" means the number of vehicles of the same category or configuration in a batch sample.

(7) "Cab over axle" or "cab over engine" means the cab which contains the operator/passenger compartment is directly above the engine and front axle and the entire cab can be tilted forward to permit access to the engine compartment.

(8) "Category" means a group of vehicle configurations which are identical in all material aspects with respect to the parameters listed in § 205.55-2.

(9) "Configuration" means the basic classification unit of a manufacturer's product line and is comprised of all vehicle designs, models or series which are identical in material aspects with respect to the parameters listed in § 205.55-3.

(10) "Acceptance of a Batch sequence" means that the number of rejected batches in the sequence is less than or equal to the acceptance number as determined by the appropriate sampling plan.

(11) "Rejection of a Batch sequence" means that the number of rejected batches in a sequence is equal to or greater than the rejection number as determined by the appropriate sampling plan.

(12) "Capable of Transportation of Property on a street or highway" means that the vehicle:

(i) Is self propelled and is capable of transporting any material or fixed apparatus, or is capable of drawing a trailer or semi-trailer;

(ii) Is capable of maintaining a cruising speed of at least 25 mph over level, paved surface;

(iii) Is equipped or can readily be equipped with features customarily associated with practical street or highway use, such features including but not being limited to: A reverse gear and a differential, fifth wheel, cargo platform or cargo enclosure, and

(iv) Does not exhibit features which render its use on a street or highway impractical, or highly unlikely, such features including, but not being limited to, tracked road means, an inordinate size or features ordinarily associated with combat or tactical vehicles.

(13) "Exhaust System" means the system comprised of a combination of components which provides for enclosed flow of exhaust gas from engine exhaust port to the atmosphere.

(14) "Gross Combination Weight Rating" (GCWR) means the value specified by the manufacturer as the loaded weight of a combination vehicle.

(15) "Gross Vehicle Weight Rating" (GVWR) means the value specified by the manufacturer as the loaded weight of a single vehicle.

(16) "Inspection Criteria" means the rejection and acceptance numbers associated with a particular sampling plan.

(17) "Model year" means the manufacturer's annual production period which includes January 1 of such calendar year: Provided, that if the manufacturer has no annual production period, the term "model year" shall mean the calendar year.

(18) "Noise Control System" includes any vehicle part, component or system the primary purpose of which is to control or cause the reduction of noise emitted from a vehicle.

(19) "Noise emission test" means a test conducted pursuant to the measurement methodology specified in this subpart.

(20) [Reserved]

(21) "Rejection of a batch" means the number of noncomplying vehicles in the batch sample is greater than or equal to the rejection number as determined by the appropriate sampling plan.

(22) "Shift" means the regular production work period for one group of workers.

(23) "Test sample" means the collection of vehicles from the same category, configuration or subgroup thereof which is drawn from the batch sample and which will receive noise emissions tests.

(24) "Failing vehicle" means that the measured emissions of the vehicle, when measured in accordance with the applicable procedure, exceeds the applicable standard.

(25) "Acceptance of a vehicle" means that the measured emissions of the vehicle when measured in accordance with the applicable procedure, conforms to the applicable standard.

(26) "Tampering" means those acts prohibited by section 10(a)(2) of the Act.

(27) "Test sample size" means the number of vehicles of the same category or configuration in a test sample.

(28) "Test vehicle" means a vehicle selected and used to demonstrate compliance with the applicable noise emission standards.

(29) "Vehicle" means any motor vehicle, machine or tractor, which is propelled by mechanical power and capable of transportation of property on a street or highway and which has a gross vehicle weight rating in excess of 10,000 pounds and a partially or fully enclosed operator's compartment.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61456, 61458, Dec. 5, 1977; 47 FR 57714, Dec. 28, 1982]

§ 205.52 Vehicle noise emission standards.

(a) Low Speed Noise Emission Standard.

Vehicles which are manufactured after the following effective dates shall be designed, built and equipped so that they will not produce sound emissions in excess of the levels indicated.

Effective date	Level
(i) January 1, 1979	83 dBA.
(ii) January 1, 1988	80 dBA.

(b) The standards set forth in paragraph (a) of this section refer to the sound emissions as measured in accordance with the procedures prescribed in § 205.54-1,2.

(c) Every manufacturer of a new motor vehicle subject to the standards prescribed in this paragraph shall, prior to taking any of the actions specified in section 10(a)(1) of the Act, comply with the other provisions of this subpart or Subpart A, as applicable.

(d) In-Use Standard. [Reserved]

(e) Low Noise Emission Product. [Reserved]

(Sec. 6, Pub. L. 92-574, 86 Stat. 1237 (42 U.S.C. 4905, 4906))

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61456, Dec. 5, 1977; 51 FR 852, Jan. 8, 1986]

§ 205.54 Test procedures.

The procedures described in this and subsequent sections will be the test program to determine the conformity of vehicles with the standards set forth in § 205.52 for the purposes of Selective Enforcement Auditing and Testing by the Administrator.

[47 FR 57714, Dec. 28, 1982]

§ 205.54-1 Low speed sound emission test procedures.

(a) *Instrumentation.* The following instrumentation shall be used, where applicable.

(1) A sound level meter which meets the Type 1 requirements of ANSI S1.4-1971, Specification for Sound Level Meters, or a sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indicating meter, providing the system meets the requirements of § 205.54-2.

(2) A sound level calibrator. The calibrator shall produce a sound pressure level, at the microphone diaphragm, that is known to within an accuracy of ±0.5 dB. The calibrator shall be checked annually to verify that its output has not changed.

(3) An engine-speed tachometer which is accurate within ±2 percent of meter reading.

(4) An anemometer or other device for measurement of ambient wind speed accurate within ±10 percent.

(5) A thermometer for measurement of ambient temperature accurate within ±1 C.

(6) A barometer for measurement of ambient pressure accurate within ±1 percent.

(b)(1) The test site shall be such that the truck radiates sound into a free field over a reflecting plane. This condition may be considered fulfilled if the test site consists of an open space free of large reflecting surfaces, such as parked vehicles, signboards, buildings or hillsides, located within 100 feet (30.4 meters) of either the vehicle path or the microphone.

(2) The microphone shall be located 50 feet ±4 in. (15.2±0.1 meter) from the centerline of truck travel and 4 feet ±4 in. (1.2±0.1 meters) above the ground plane. The microphone point is defined as the point of intersection of the vehicle path and the normal to the vehicle path drawn from the microphone. The microphone shall be oriented in a fixed position to minimize the deviation from the flattest system response over the frequency range 100 Hz to 10 kHz for a vehicle traversing from the acceleration point through the end zone.
The microphone shall be oriented with respect to the source so that the sound strikes the diaphragm at the angle for which the microphone was calibrated to have the flattest frequency response characteristic over the frequency range 100 Hz to 10 kHz.

(3) An acceleration point shall be established on the vehicle path 50 feet (15 m) before the microphone point.

(4) An end point shall be established on the vehicle path 100 feet (30 m) from the acceleration point and 50 feet (15 m) from the microphone point.

(5) The end zone is the last 40 feet (12 m) of vehicle path prior to the end point.

(6) The measurement area shall be the triangular paved (concrete or sealed asphalt) area formed by the acceleration point, the end point, and the microphone location.

(7) The reference point on the vehicle, to indicate when the vehicle is at any of the points on the vehicle path, shall be the front of the vehicle except as follows:

(i) If the horizontal distance from the front of the vehicle to the exhaust outlet is more than 200 inches (5.1 meters), tests shall be run using both the front and rear of the vehicle as reference points.

(ii) If the engine is located rearward to the center of the chassis, the rear of the vehicle shall be used as the reference point.

(8) The plane containing the vehicle path and the microphone location (plane ABCDE in Figure 1) shall be flat within ±2 inches (.05 meters).

(9) Measurements shall not be made when the road surface is wet, covered with snow, or during precipitation.

(10) Bystanders have an appreciable influence on sound level meter readings when they are in the vicinity of the vehicle or microphone; therefore not more than one person, other than the observer reading the meter, shall be within 50 feet (15.2 meters) of the vehicle path or instrument and that person shall be directly behind the observer reading the meter, on a line through the microphone and observer. To minimize the effect of the observer and the container of the sound level meter electronics on the measurements, cable should be used between the microphone and the sound level meter. No observer shall be located within 1 m in any direction of the microphone location.

(11) The maximum A-weighted fast response sound level observed at the test site immediately before and after the test shall be at least 10 dB below the regulated level.

(12) The road surface within the test site upon which the vehicle travels and, at a minimum, the measurement area (BCD in figure 205.1) shall be smooth concrete or smooth sealed asphalt, free of extraneous material such as gravel.

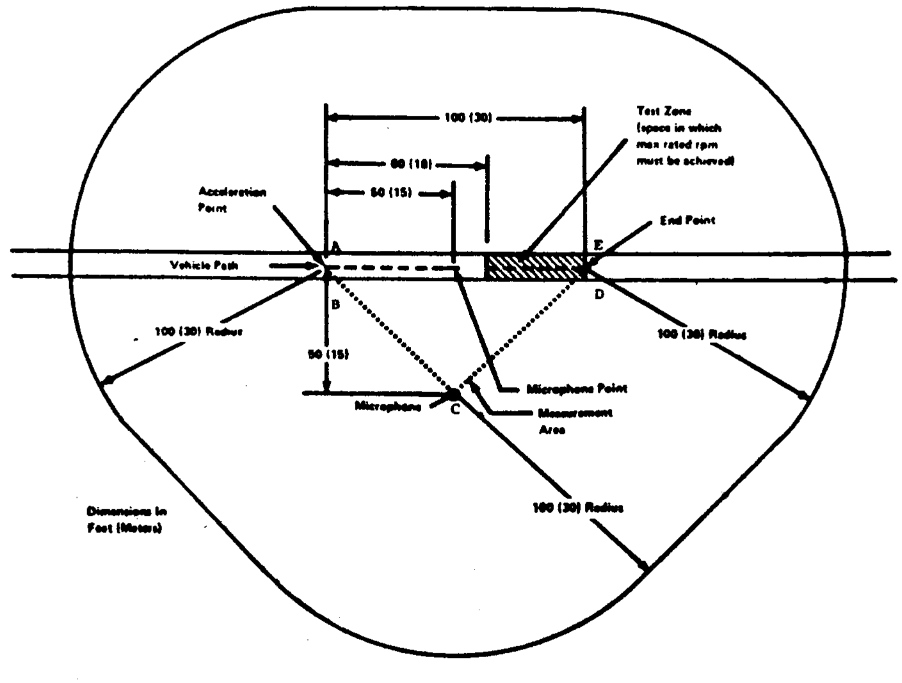


FIGURE 205.1

(13) Vehicles with diesel engines shall be tested using Number 1D or Number 2D diesel fuel possessing a cetane rating from 42 to 50 inclusive.

(14) Vehicles with gasoline engines shall use the grade of gasoline recommended by the manufacturer for use by the purchaser.

(15) Vehicles equipped with thermostatically controlled radiator fans may be tested with the fan not operating.

(c) *Procedure*—(1) *Vehicle operation for vehicles with standard transmissions.* Full throttle acceleration and closed throttle deceleration tests are to be used. A beginning engine speed and proper gear ratio must be determined for use during measurements. Closed throttle deceleration tests are required only for those vehicles equipped with an engine brake.

(i) Select the highest rear axle and/or transmission gear ("highest gear" is used in the usual sense; it is synonymous to the lowest numerical ratio) and an initial vehicle speed such that at wide-open throttle the vehicle will accelerate from the acceleration point.

(*a*) Starting at no more than two-thirds (66 percent) of maximum rated or of governed engine speed.

(*b*) Reaching maximum rated or governed engine speed within the end zone.

(*c*) Without exceeding 35 mph (56 k/h) before reaching the end point.

(*1*) Should maximum rated or governed rpm be attained before reaching the end zone, decrease the approach rpm in 100 rpm increments until maximum rated or governed rpm is attained within the end zone.

(*2*) Should maximum rated or governed rpm not be attained until beyond the end zone, select the next lower gear until maximum rated or governed rpm is attained within the end zone.

(*3*) Should the lowest gear still result in reaching maximum rated or governed rpm beyond the permissible

end zone, unload the vehicle and/or increase the approach rpm in 100 rpm increments until the maximum rated or governed rpm is reached within the end zone.

(ii) For the acceleration test, approach the acceleration point using the engine speed and gear ratio selected in paragraph (c)(1) of this section and at the acceleration point rapidly establish wide-open throttle. The vehicle reference shall be as indicated in paragraph (b)(7) of this section. Acceleration shall continue until maximum rated or governed engine speed is reached.

(iii) Wheel slip which affects maximum sound level must be avoided.

(2) *Vehicle operation for vehicles with automatic transmissions.* Full throttle acceleration and closed throttle deceleration tests are to be used. Closed throttle deceleration tests are required only for those vehicles equipped with an engine brake.

(i) Select the highest gear axle and/or transmission gear (highest gear is used in the usual sense; it is synonymous to the lowest numerical ratio) in which no up or down shifting will occur under any operational conditions of the vehicle during the test run. Also, select an initial vehicle speed such that at wide-open throttle the vehicle will accelerate from the acceleration point.

(*a*) Starting at two-thirds (66 percent) of maximum rated or of governed engine speed.

(*b*) Reaching maximum rated or governed engine speed within the end zone.

(*c*) Without exceeding 35 mph (56 k/h) before reaching the end point.

(*1*) Should maximum rated or governed rpm be attained before reaching the end zone, decrease the approach rpm in 100 rpm increments until maximum rated or governed rpm is attained within the end zone.

(*2*) Should maximum rated or governed rpm not be attained until beyond the end zone, select the next lower gear until maximum rated or governed rpm is attained within the end zone.

(*3*) Should the lowest gear still result in reaching maximum rated or governed rpm beyond the permissible end zone, unload the vehicle and/or increase the approach rpm in 100 rpm increments until the maximum rated or governed rpm is reached within the end zone, notwithstanding that approach engine speed may now exceed two-thirds of maximum rated or of full load governed engine speed.

(*4*) Should the maximum rated or governed rpm still be attained before entering the end zone, and the engine rpm during approach cannot be further lowered, begin acceleration at a point 10 feet closer to the beginning of the end zone. The approach rpm to be used is to be that rpm used prior to the moving of the acceleration point 10 feet closer to the beginning of the end zone.

(*5*) Should the maximum rated or governed rpm still be attained before entering the end zone, repeat the instructions in paragraph (c)(2)(i)(c)(4) of this section until maximum rated or governed rpm is attained within the end zone.

(ii) For the acceleration test, approach the acceleration point using the engine speed and gear ratio selected in paragraph (c)(2)(i) of this section and at the acceleration point rapidly establish wide-open throttle. The vehicle reference shall be as indicated in paragraph (b)(7) of this section. Acceleration shall continue until maximum rated or governed engine speed is reached.

(iii) Wheel slip which affects maximum sound level must be avoided.

(3) *Measurements.* (i) The meter shall be set for "fast response" and the A-weighted network.

(ii) The meter shall be observed during the period while the vehicle is accelerating or decelerating. The applicable reading shall be the highest sound level obtained for the run. The observer is cautioned to rerun the test if unrelated peaks should occur due to extraneous ambient noises. Readings shall be taken on both side of the vehicle.

(iii) The sound level associated with a side shall be the average of the first two pass-by measurements for that side, if they are within 2 dB(A) of each other. Average of measurements on each side shall be computed separately. If the first two measurements for given side differ by more than 2 dB(A), two additional measurements shall be made on each side, and the average of the two highest measurements on each side, within 2 dB(A) of each other, shall be taken as the measured vehicle sound level for that side. The reported vehicle sound level shall be the higher of the two averages.

(d) *General requirements.* (1) Measurements shall be made only when wind velocity is below 12 mph (19 km/hr).

(2) Proper usage of all test instrumentation is essential to obtain valid measurements. Operating manuals or other literature furnished by the instrument manufacturer shall be referred to for both recommended operation of the instrument and precautions to be observed. Specific items to be adequately considered are:

(i) The effects of ambient weather conditions on the performance of the instruments (for example, temperature, humidity, and barometric pressure).

(ii) Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems.

(iii) Proper acoustical calibration procedure to include the influence of extension cables, etc. Field calibration shall be made immediately before and after each test sequence. Internal calibration means is acceptable for field use, provided that external calibration is accomplished immediately before or after field use.

(3)(i) A complete calibration of the instrumentation and external acoustical calibrator over the entire frequency range of interest shall be performed at least annually and as frequently as necessary during the yearly period to insure compliance with the standards cited in American National Standard S1.4-1971 "Specifications for Sound Level Meters" for a Type 1 instrument over the frequency range 50 Hz-10,000 Hz.

(ii) If calibration devices are utilized which are not independent of ambient pressure (e.g., a piston-phone) corrections must be made for barometric or altimetric changes according to the recommendation of the instrument manufacturer.

(4) The truck shall be brought to a temperature within its normal operating temperature range prior to commencement of testing. During testing appropriate caution shall be taken to maintain the engine temperatures within such normal operating range.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 11836, Mar. 1, 1977; 42 FR 61456, Dec. 5, 1977]

§ 205.54-2 Sound data acquisition system.

(a) Systems employing tape recorders and graphic level recorders may be established as equivalent to a Type I—ANSI S1.4-1971 sound level meter for use in determining compliance with this regulation by meeting the requirements of this section (§ 205.54-2(b)). This sound data acquisition system qualification procedure is based primarily on ANSI S6.1-1973.

(1) *Performance requirements*—(i) *System frequency response.* It is required that the overall steady-state frequency response of the data acquisition system shall be within the tolerances prescribed in Table 205.1 when measured in accordance with section (2). The tolerances in Table 205.1 are applicable to either flat or A-weighted response. (See paragraph (a)(3)(iii) of this section.)

(ii) *Detector response.* To ensure that a (true) rms indication is provided, the difference between the level indicated for a 1000 Hz sinusoidal signal equivalent to a sound level of 86 dB (rms) and the level indicated for an octave band of random noise of equal energy as the sinusoidal signal centered at 1000 Hz shall be no greater than 0.5 dB. A true rms voltmeter shall be used to determine equivalence of two input signals.

(iii) *Indicating meter.* If an indicating meter is used to obtain sound levels or band pressure levels, it must meet the requirements of paragraphs (a)(1)(ii) and (vi)(B) of this section and the following.

TABLE 205.1—SYSTEM RESPONSE DATA

Freq. (hertz)	A-weighted response (Re-1000 Hz, dB)	Tolerance (decibels) Plus—	Minus—
31.5	−39.4	1.5	1.5
40.0	−34.6	1.5	1.5
50.0	−30.2	1.0	1.0
63.0	−26.2	1.0	1.0
80.0	−22.5	1.0	1.0
100.0	−19.1	1.0	1.0
125.0	−16.1	1.0	1.0
160.0	−13.4	1.0	1.0
200.0	−10.9	1.0	1.0
250.0	−8.6	1.0	1.0
315.0	−6.6	1.0	1.0
400.0	−4.8	1.0	1.0
500.0	−3.2	1.0	1.0
630.0	−1.9	1.0	1.0
800.0	−.8	1.0	1.0
1,000.0	0	1.0	1.0
1,250.0	.6	1.0	1.0
1,600.0	1.0	1.0	1.0
2,000.0	1.2	1.0	1.0
2,500.0	1.3	1.0	1.0
3,150.0	1.2	1.0	1.0
4,000.0	1.0	1.0	1.0
5,000.0	.5	1.5	2.0
6,300.0	−.1	1.5	2.0
8,000.0	−1.1	1.5	3.0
10,000.0	−2.5	2.0	4.0
12,500.0	−4.3	3.0	6.0

(A) The scale shall be graduated in 1 dB steps.

(B) No scale indication shall be more than 0.2 dB different from the true value of the signal when an input signal equivalent to 86 dB sound level indicates correctly.

(C) Maximum indication for an input signal of 1000 Hz tone burst of 0.2 sec duration shall be within the range of −2 to 0 dB with respect to the steady-state indication for a 1000 Hz tone equivalent to 86 dB sound level.

(iv) *Microphone.* If microphone is used which has not been provided as a component of a precision sound level meter, it must be determined to meet the microphone characteristics described in IEC Publication 179, Precision Sound Level Meters.

(v) *Magnetic tape recorders.* No requirements are described in this document pertaining to tape recorders, except for frequency response. Generally, recorders of adequate quality to provide the frequency response performance required will also meet other minimum requirements for distortion, signal-to-noise ratio, etc.

(vi) *Graphic level recorder dynamic response.* When using a graphic level recorder, it is necessary to select pen response settings such that the readings obtained are statistically equivalent to those obtained by directly reading a meter which meets the "fast" dynamic requirement of a precision sound level meter indicating meter system for the range of vehicles to be tested. To ensure statistical equivalence, at least 30 comparative observations of real test data shall be made and the average of the absolute value of the differences observed shall be less than 0.5 dB. The settings described in this paragraph likely assure appropriate dynamic response; however, different settings may be selected on the basis of the above requirement.

(A) Use a pen writing speed of nominally 60-100 dB/sec. If adjustable, low frequency response should be limited to about 20 Hz.

(B) Indicated overshoot for a suddenly applied 1000 Hz sinusoidal signal equivalent to 86 dB sound level shall be no more than 1.1 dB and no less than 0.1 dB.

(2) *Frequency response qualification procedure.* (i) Typical noise measurement and analysis configurations are shown in Figures 205.2 through 205.4. The qualification procedure described herein duplicates these configurations, but with the microphone replaced by an electronic sinewave oscillator. Caution should be exercised when connecting an oscillator to the input of a sound level meter to ensure, perhaps by using a resistive voltage divider network, that the input is not overloaded (see § 205.54-2(a)(2)(ii)).

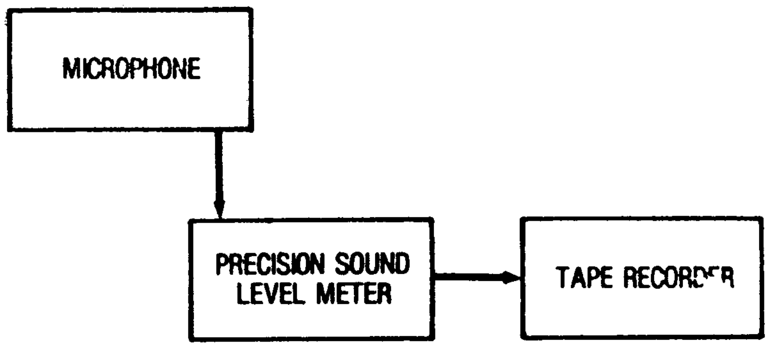


FIGURE 205.2 DATA RECORDING

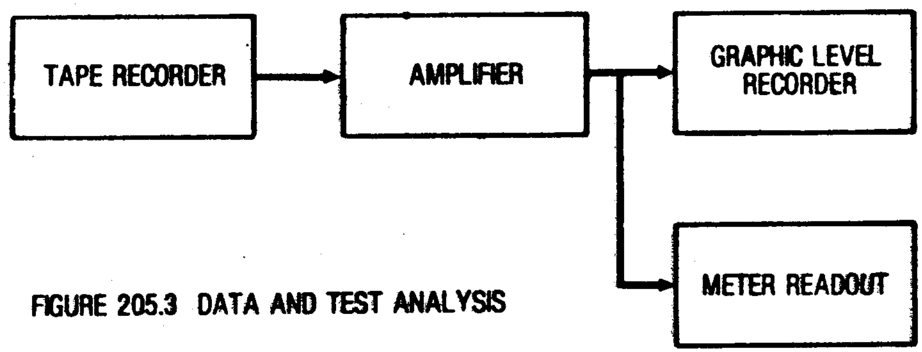


FIGURE 205.3 DATA AND TEST ANALYSIS

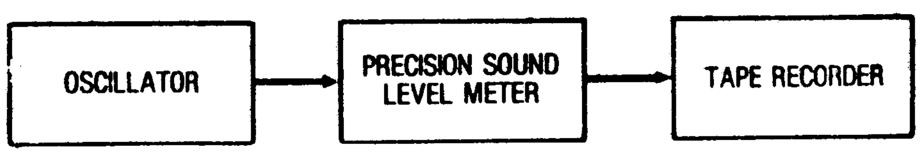


FIGURE 205.4 TEST RECORDING

(ii) Calibrate the oscillator to be used by measuring its output relative to the voltage which is equivalent to 86 dB sound level at each of the 27 frequencies listed in Table 205.1 using an electronic voltmeter of known calibration. Record the result in voltage level in dB re voltage corresponding to 86 dB sound level at 1000 Hz. This will describe the frequency response characteristics of the oscillator.

(iii) If a graphic level recorder is to be used, connect it to the oscillator output. If the oscillator and graphic level recorder can be synchronized, slowly sweep the frequency over the range of 31.5 to 12,500 Hz, recording the oscillator output. If they cannot be synchronized, record oscillator output for signals at the 27 frequencies given in Table 205.1. The differences between the combined response thus obtained and the oscillator response obtained previously will describe the frequency response of the graphic level recorder.

(iv) If visual observation of an indicating meter is to be used for obtaining data, the oscillator should be connected to the indicating meter input (such as the microphone input of a sound level meter) and the meter reading observed for a fixed oscillator output voltage setting for signals at the 27 frequencies given in Table 205.1.

(v) To check a tape recorder, connect the instruments as shown in Figure 205.4. Using a 1000 Hz tone, adjust the oscillator output level to obtain a reading 15 dB below maximum record level. If the synchronized oscillator/graphic level recorder system is to be used for analysis, record an oscillator sweep over the range of 31.5 to 12,500 Hz, using an appropriate tape recorder input attenuator setting. Alternatively, tape-record frequency tones at the 27 frequencies given in Table 205.1. Replay the tape recordings using the setup shown in Figure 205.3. Record the data on a graphic level recorder or through visual observation of the indicating meter. Subtract the oscillator frequency response in paragraph (b)(2) of this section from the response obtained through the record-playback sequence to obtain the record/reproduce frequency response of the system except for the microphone.

(vi) To obtain the overall system frequency response, add the manufacturer's microphone calibration data to the response just obtained. This may be the frequency response for the specific microphone to be used, including calibration tolerances. Alternatively, use the manufacturer's "typical" microphone response plus and minus the maximum deviation expected from "typical" including calibration tolerances. Use the microphone response curve which corresponds to the manner in which it is used in the field. It may be required to add a correction to the response curves provided to obtain field response; refer to the manufacturer's manual.

(vii) Adjustment or repair of equipment may be required to obtain response within the requirements of paragraph (a) of this section. After any adjustments, the system shall be requalified according to paragraph (b) of this section.

(3) *General comments.* (i) Calibrate tape recorders using the brand and type of magnetic tape used for actual data acquisition. Differences in tape can cause an appreciable variation in the recorder/reproduce frequency response characteristics of tape recorder.

(ii) It shall be ensured that the instrumentation used will perform within specifications and applicable tolerances over the temperature, humidity, and other environmental variation ranges which may be encountered in vehicle noise measurement works.

(iii) Qualification tests shall be performed using equipment (including cables) and recording and playback techniques identical with those used while recording vehicle noise. For example, if weighted sound level data are normally recorded use similar weighting and apply the tolerances of Table 205.1 to the weighting curve for comparison with record-playback curves. Precautions should also be taken to ensure that source and load impedances are appropriate to the device being tested. Other data acquisition systems may use any combination of microphones, sound level meters, amplifiers, tape recorders, graphic level recorders, or indicating meters. The same approach to qualifying such a system shall be taken as described in this document for the systems depicted in Figures 205.2, 205.3 and 205.4.

(b) Systems other than those specified in §§ 205.54-1(a) and 205.54-2(a) may be used for establishing compliance with this regulation. In each case the system must yield sound levels which are equivalent to those produced by a sound level meter Type 1 ANSI S1.4-1971. The manufacturer bears the burden of demonstrating such equivalence.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61456, Dec. 5, 1977; 47 FR 57714, Dec. 28, 1982]

§ 205.55 Requirements.

[47 FR 57714, Dec. 28, 1982]

§ 205.55-1 General requirements.

(a) Every new vehicle manufactured for distribution in commerce in the United States which is subject to the standards prescribed in this subpart and not exempted in accordance with § 205.5:

(1) Shall be labeled in accordance with the requirements of § 205.55-5 of this subpart.

(2) Shall conform to the applicable noise emission standard established in § 205.52 of this regulation.

(b) The requirements of paragraph (a) apply to new products which conform to the definition of vehicles in these regulations and at the time such new products are assembled to that state of completeness in which the manufacturer distributes them in commerce.

(c) Subsequent manufacturers of a new product which conforms to the definition of vehicle in these regulations when received by them from a prior manufacturer, need not fulfill the requirements of paragraph (a)(1) where such requirements have already been complied with by a prior manufacturer.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61456, Dec. 5, 1977; 47 FR 57714, Dec. 28, 1982]

§ 205.55-2 Compliance with standards.

(a)(1) Prior to distribution in commerce of vehicles of a specific configuration, the first manufactures of such vehicles must verify such configurations in accordance with the requirements of this subpart.

(2) [Reserved]

(3) At any time following receipt of notice under this section with respect to a configuration, the Administrator may require that the manufacturer ship test vehicles to the EPA test facility in order for the Administrator to perform the tests required for production verification.

(b) The requirements for purposes of testing by the Administrator and selective enforcement auditing with regard to each vehicle configuration consist of:

(1) Testing in accordance with § 205.54 of a vehicle selected in accordance with § 205.57-2, and

(2) Compliance of the test vehicle with the applicable standard when tested in accordance with § 205.54.

(c)(1) In lieu of testing vehicles of every configuration as described in paragraph (b) of this section, the manufacturer may elect to verify the configuration based on representative testing, the requirements of which consist of:

(i) Grouping configurations into a category where each category will be determined by a separate combination of at least the following parameters (a manufacturer may use more parameters):

(*a*) *Engine type.*

(*1*) Gasoline—two stroke cycle.

(*2*) Gasoline—four stroke cycle.

(*3*) Diesel—two stroke cycle.

(*4*) Diesel—four stroke cycle.

(*5*) Rotary—wankel.

(*6*) Turbine.

(*7*) Other.

(*b*) *Engine manufacturer.*

(*c*) *Engine displacement.*

(*d*) *Engine configuration* (e.g., L-6, V-8, etc.).

(*e*) *Series* (i.e., cab design) including but not limited to conventional, cab over engine, and cab forward.

(ii) Identifying the configuration within each category which emits the highest sound pressure level (dBA) based on his best technical judgment and/or emission test data;

(iii) Testing in accordance with § 205.54 of a vehicle selected in accordance with § 205.57-2 which must be a vehicle of the configuration which is identified pursuant to paragraph (c)(1)(ii) of this section as having the highest sound pressure level (estimated or actual) within the category; and

(iv) Compliance of the test vehicle with applicable standards when tested in accordance with § 205.54.

(2) Where the requirements of paragraph (c)(1) are complied with, all those configurations contained within a category are considered represented by the tested vehicle.

(3) Where the manufacturer tests a vehicle configuration which has not been determined as having the highest sound pressure level of a category, but all other requirements of paragraph (c)(1) of this section are complied with all those configurations contained with that category which are determined to have sound pressure levels no greater than the tested vehicle are considered to be represented by the tested vehicle, however, a manufacturer must for purposes of Testing by the Administrator and Selective Enforcement Auditing verify according to the requirements of paragraphs (b)(1) and/or (c)(1) of this section any configurations in the subject category which have a higher sound pressure level than the vehicle configuration tested.

(d) [Reserved]

(e) The manufacturer may, at his option, proceed with any of the following alternatives with respect to any vehicle determined not in compliance with applicable standards.

(1) In the case of representative testing a new test vehicle from another configuration must be selected according to the requirements of paragraph (c) of this section, in order to verify the configurations represented by the non-compliant vehicle.

(2) Modify the test vehicle and demonstrate by testing that it meets applicable standards. The manufacturer must modify all production vehicles of the same configuration in the same manner as the test vehicle before distribution into commerce.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61458, Dec. 5, 1977; 47 FR 57714, Dec. 28, 1982; 48 FR 27040, June 13, 1983]

§ 205.55-3 Configuration identification.

(a) A separate vehicle configuration shall be determined by each combination of the following parameters:

(1) *Exhaust system configuration.* (i) Single vertical.

(ii) Dual vertical.

(iii) Single horizontal.

(iv) Dual horizontal.

(2) *Air induction system (engine).* (i) Natural.

(ii) Turbocharged.

(3) *Fan.* (i) Diameter.

(ii) Drive.

(*a*) Direct.

(*b*) Thermostatic.

(iii) Max fan rpm.

(4) *Engine manufacturer's horsepower rating.*

(5) *Cab characteristic.* (i) Sleeper.

(ii) Non sleeper.

(6) *Category parameters listed in § 205.55-2.*

§ 205.55-4 Labeling-compliance.

(a)(1) The manufacturer of any vehicle subject to the provisions of § 205.52 shall, at the time of manufacture, affix a permanent, legible label, of the type and in the manner described below, containing the information hereinafter provided, to all such vehicles to be distributed in commerce. The labels shall be affixed in such a manner that they cannot be removed without destroying or defacing them, and shall not be affixed to any equipment which is easily detached from such vehicle.

(2) A label shall be permanently attached, in a readily visible position, in the operator's compartment.

(3) Labels for vehicles not manufactured solely for use outside the United States shall contain the following information lettered in the English language in block letters and numerals, which shall be of a color that contrasts with the background of the label:

(i) The label heading: Vehicle Noise Emission Control Information;

(ii) Full corporate name and trademark of manufacturer;

(iii) Month and year of manufacture;

(iv) The statement:

This Vehicle Conforms to U.S. EPA Regulations for Noise Emission Applicable to Medium and Heavy Trucks.

The following acts or the causing thereof by any person are prohibited by the Noise Control Act of 1972:

(A) The removal or rendering inoperative, other than for purposes of maintenance, repair, or replacement, of any noise control device or element of design (listed in the owner's manual) incorporated into this vehicle in compliance with the Noise Control Act;

(B) The use of this vehicle after such device or element of design has been removed or rendered inoperative.

(b) Labels for vehicles manufactured solely for use outside the United States shall contain the words "For Export Only."

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61456, 61458, Dec. 5, 1977. Redesignated at 47 FR 57715, Dec. 28, 1982]

§ 205.55-5 Labeling-exterior. [Reserved]

[41 FR 15544, Apr. 13, 1976. Redesignated at 47 FR 57715, Dec. 28, 1982]

§ 205.56 Testing by the Administrator.

(a)(1) The Administrator may require that any vehicles to be tested pursuant to the Act be submitted to him, at such place and time as he may reasonably designate and in such quantity and for such time as he may reasonably require for the purpose of conducting tests in accordance with test procedures described in § 205.54 to determine whether such vehicles or a manufacturer's test facility conform to applicable regulations. It is a condition of the requirements under this section that the manner in which the Administrator conducts such tests, the EPA test facility itself, and the test procedures he employs shall be based upon good engineering practice and meet or exceed the requirements of § 205.54 of the regulations.

(2) The Administrator may specify that he will conduct such testing at the manufacturer's facility, in which case instrumentation and equipment of the type required by these regulations shall be made available by the manufacturer for test operations. The Administrator may conduct such tests with his own equipment, which shall equal or exceed the performance specifications of the instrumentation or equipment specified by the Administrator in these regulations.

(3) The manufacturer may observe tests conducted by the Administrator pursuant to this section on vehicles produced by such manufacturer and may copy the data accumulated from such tests. The manufacturer may inspect any such vehicles before and after testing by the Administrator.

(b)(1) If, based on tests conducted by the Administrator or other relevant information, the Administrator determines that the test facility does not meet the requirements of § 205.54-1 (a) and (b) he will notify the manufacturer in writing of his determination and the reasons therefor.

(2) The manufacturer may at any time within 15 days after receipt of a notice issued under paragraph (b)(1) of this section request a hearing conducted in accordance with 5 U.S.C. 554 on the issue of whether his test facility was in conformance. Such notice will not take effect until 15 days after receipt by the manufacturer, or if a hearing is requested under this paragraph, until adjudication by the hearing examiner.

(3) After any notification issued under paragraph (b)(1) of this section has taken effect, no data thereafter derived from such test facility will be acceptable for purposes of this part.

(4) The manufacturer may request in writing that the Administrator reconsider his determination under paragraph (b)(1) of this section based on data or information which indicates that changes have been made to the test facility and such changes have resolved the reasons for disqualification.

(5) The Administrator will notify the manufacturer of his determination and an explanation of the reasons underlying it with regard to the requalification of the test facility within 10 working days after receipt of the manufacturer's request for reconsideration pursuant to paragraph (b)(4) of this section.

(c)(1) The Administrator will assume all reasonable costs associated with shipment of vehicles to the place designated pursuant to paragraph (a) of this section except with respect to:

(i) [Reserved]

(ii) Testing of a reasonable number of vehicles for purposes of selective enforcement auditing under § 205.57 or testing of smaller numbers of vehicles, if the manufacturer has failed to establish that there is a correlation between its test facility and the EPA test facility or the Administrator has reason to believe, and provides the manufacturer a statement of such reasons, that the vehicles to be tested would fail to meet the standard prescribed in this subpart if tested at the EPA test facility, but would meet such standard if tested at the manufacturer's test facility;

(iii) Any testing performed during a period when a notice of nonconformance of the manufacturer's test facility issued pursuant to paragraph (b) of this section is in effect;

(iv) Any testing performed at place other than the manufacturer's facility as a result of the manufacturer's failure to permit the Administrator to conduct or monitor testing as required by this part.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61456, 61459, Dec. 5, 1977; 47 FR 57715, Dec. 28, 1982]

§ 205.57 Selective enforcement auditing requirements.

§ 205.57-1 Test request.

(a) The Administrator will request all testing under § 205.57 by means of a test request addressed to the manufacturer.

(1) Except as provided in paragraphs (a) (2) and (3) of this section, the Administrator will not issue to a manufacturer during any model year more test requests than a number determined by dividing the total number of vehicles subject to this regulation which the manufacturer projects he will produce during that model year by 25,000 and rounding to the next higher whole number: Except, that the Administrator may issue one additional test request beyond the annual limit to any manufacturer for each time a batch sequence for any category, configuration or subgroup thereof of such manufacturer's production is rejected in accordance with § 205.57-7.

(2) Any test request issued against a category, configuration or subgroup thereof which the Administrator has reason to believe does not meet the standards specified in § 205.52 will not be counted against the annual limit on test requests described in paragraph (a)(1) of this section. Any such request shall include a statement of the Administrator's reason for such belief.

(3) Any test request under which testing is not completed will not be counted against the annual limit on test requests described in paragraph (a)(1) of this section.

(b) The test request will be signed by the Assistant Administrator for Enforcement or his designee. The test request will be delivered by an EPA Enforcement Officer to the plant manager or other responsible official as designated by the manufacturer.

(c) The test request will specify the vehicle category, configuration or subgroup thereof selected for testing, the batch from which sampling is to begin, the batch size, the manufacturer's plant or storage facility from which the vehicles must be selected, the time at which a vehicle must be selected. The test request will also provide for situations in which the selected configuration or category is unavailable for testing. The test request may include an alternative category or configuration selected for testing in the event that vehicles of the first specified category or configuration are not available for testing because the vehicles are not being manufactured at the specified plant and/or are not being manufactured during the specified time or not being stored at the specified plant or storage facility.

(d) Any manufacturer shall, upon receipt of the test request, select and test a batch sample of vehicles from two consecutively produced batches of the vehicle category or configurations specified in the test request in accordance with these regulations and the conditions specified in the test request.

(e)(1) Any testing conducted by the manufacturer pursuant to a test request shall be initiated within such period as is specified within the test request: Except, that such initiation may be delayed for increments of 24 hours or one business day where ambient test site weather conditions, or other conditions beyond the control of the manufacturer, in any 24-hour period do not permit testing: *Provided*, That these conditions for that period are recorded.

(2) The manufacturer shall complete emission testing on a minimum of five vehicles per day unless otherwise provided for by the Administrator or unless ambient test site conditions only permit the testing of a lesser number: Provided, that ambient test site weather conditions for that period are recorded.

(3) The manufacturer will be allowed 24 hours to ship vehicles from a batch sample from the assembly plant to the testing facility if the facility is not located at the plant or in close proximity to the plant: Except, that the Administrator may approve more time based upon a request by the manufacturer accompanied by a satisfactory justification.

(f) The Administrator may issue an order to the manufacturer to cease to distribute into commerce vehicles of a specified category or configuration being manufactured at a particular facility if:

(1) The manufacturer refuses to comply with the provisions of a test request issued by the Administrator pursuant to this section; or

(2) The manufacturer refuses to comply with any of the requirements of this section.

(g) A cease-to-distribute order shall not be issued under paragraph (f) of this section if such refusal is caused by conditions and circumstances outside the control of the manufacturer which renders it impossible to comply with the provisions of a test request or any other requirements of this section. Such conditions and circumstances shall include, but are not limited to, any uncontrollable factors which result in the temporary unavailability of equipment and personnel needed to conduct the required tests, such as equipment break-down or failure or illness of personnel, but shall not include failure of the manufacturer to adequately plan for and provide the equipment and personnel needed to conduct the tests. The manufacturer will bear the burden of establishing the presence of the conditions and circumstances required by this paragraph.

(h) Any such order shall be issued only after a notice and opportunity for a hearing.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61459, Dec. 5, 1977; 43 FR 12326, Mar. 24, 1978]

§ 205.57-2 Test vehicle sample selection.

(a) Vehicles comprising the batch sample which are required to be tested pursuant to a test request in accordance with this subpart will be selected in the manner specified in the test request from a batch of vehicles of the category or configuration specified in the test request. If the test request specifies that the vehicles comprising the batch sample must be selected randomly, the random selection will be achieved by sequentially numbering all of the vehicles in the batch and then using a table of random numbers to select the number of vehicles as specified in paragraph (c) of this section based on the batch size designated by the Administrator in the test request. An alternative random selection plan may be used by a manufacturer: *Provided*, That such a plan is approved by the Administrator. If the test request does not specify that test vehicles must be randomly selected, the manufacturer shall select test vehicles consecutively.

(1) Should a situation arise in which the configuration to be tested consists of only vehicles with automatic transmissions, they shall be tested in accordance with § 205.54-1(c)(2).

(2) If the configuration to be tested consists of both automatic transmission and standard transmission vehicles, the test vehicle shall be a standard transmission vehicle unless the manufacturer has reason to believe that the automatic transmission vehicle emits a greater sound level.

(b) The Acceptable Quality Level is 10 percent. The appropriate sampling plans associated with the designated AQL are contained in Appendix I, Table II.

(c) The appropriate batch sample size will be determined by reference to Appendix I, Table I and II. A code letter is obtained from Table I based on the batch size designated by the Administrator in a test request. The batch sample size will be obtained from Table II. The batch sample size will be equal to the maximum cumulative sample size for the appropriate code letter obtained from Table I plus an additional 10 percent rounded off to the next highest number.

(d) If the test request specifies that vehicles comprising the batch sample must be selected randomly, individual vehicles comprising the test sample will be randomly selected from the batch sample using the same random selection plan as in paragraph (a) of this section. Test sample size will be determined by entering Table II.

(e) The test vehicle of the category, configuration or subgroup thereof selected for testing shall have been assembled by the manufacturer for distribution in commerce using the manufacturer's normal production process in accordance with § 205.55-5(a).

(f) Unless otherwise indicated in the test request, the manufacturer will select the batch sample from the production batch, next scheduled after receipt of the test request, of the category or configuration specified in the test request.

(g) Unless otherwise indicated in the test request, the manufacturer shall select the vehicles designated in the test request for testing.

(h) At their discretion, EPA Enforcement Officers, rather than the manufacturer, may select the vehicles designated in the test request.

(i) The manufacturer will keep on hand all vehicles in the batch sample until such time as the batch is accepted or rejected in accordance with § 205.57-6: Except, that vehicles actually tested and found to be in conformance with these regulations need not be kept.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61459, Dec. 5, 1977; 47 FR 57715, Dec. 28, 1982; 48 FR 27039, June 13, 1983]

§ 205.57-3 Test vehicle preparation.

(a) Prior to the official test, the test vehicle selected in accordance with § 205-57-2 shall not be prepared, tested, modified, adjusted, or maintained in any manner unless such adjustments, preparation, modification and/or tests are part of the manufacturer's prescribed manufacturing and inspection procedures, and are documented in the manufacturer's internal vehicle assembly and inspection procedures or unless such adjustments and/or tests are required or permitted under this subpart or are approved in advance by the Administrator. For purposes of this section, prescribed manufacturing and inspection procedures include quality control testing and assembly procedures normally performed by the manufacturer on like products during early production so long as the resulting testing is not biased by the procedure. In the case of imported products the manufacturer may perform adjustments, preparations, modification and/or tests normally performed at the port of entry by the manufacturer to prepare the vehicle for delivery to a dealer or customer.

(b) Equipment or fixtures necessary to conduct the test may be installed on the vehicle: *Provided*, That such equipment or fixtures shall have no effect on the noise emissions of the vehicle, as determined by measurement methodology.

(c) In the event of vehicle malfunction (i.e., failure to start, misfiring cylinder, etc.) the manufacturer may perform the maintenance that is necessary to enable the vehicle to operate in a normal manner.

(d) No quality control, testing, assembly or selection procedures shall be used on the completed vehicle or any portion thereof, including parts and subassemblies, that will not normally be used during the production and assembly of all other vehicles of the category which will be distributed in commerce, unless such procedures are required or permitted under this subpart.

[47 FR 57715, Dec. 28, 1982; 48 FR 27039, June 13, 1983]

§ 205.57-4 Testing procedures.

(a) The manufacturer shall conduct one valid test in accordance with the test procedures specified in § 205.54 of this subpart for each vehicle selected for testing pursuant to this subpart.

(b) No maintenance will be performed on test vehicles except as provided for by § 205.57-3. In the event a vehicle is unable to complete the emission test, the manufacturer may replace the vehicle. Any replacement vehicle will be a production vehicle of the same configuration as the replaced vehicle. It will be randomly selected from the batch sample and will be subject to all the provisions of these regulations.

§ 205.57-5 Reporting of the test results.

(a) Within 5 working days after completion of testing of all vehicles in a batch sample the manufacturer shall submit to the Administrator a final report which will include the information required by the test request in the format stipulated in the test request in addition to the following:

(1) The name, location, and description of the manufacturer's emission test facilities which meet the specifications of § 205.54 and were utilized to conduct testing reported pursuant to this section: Except, that a test facility that has been described in a previous submission under this subpart need not again be described but must be identified as such.

(2) A description of the random vehicle selection method used, referencing any tables of random numbers that were used, name of the person in charge of the random number selection, if the vehicle test request specifies a random vehicle selection.

(3) The following information for each noise emission test conducted,

(i) The completed data sheet required by § 205.54 for all noise emission tests including: For each invalid test, the reason for invalidation.

(ii) A complete description of any modification, repair, preparation, maintenance, and/or testing which could affect the noise emissions of the vehicle and which was performed on the test vehicle but will not be performed on all other production vehicles.

(iii) The reason for the replacement where a replacement vehicle was authorized by the Administrator, and, if any, the test results for the replaced vehicles.

(4) A complete description of the sound data acquisition system if other than those specified in §§ 205.54-1(a) and 205.54-2(a).

(5) The following statement and endorsement:

This report is submitted pursuant to section 6 and section 13 of the Noise Control Act of 1972. To the best of ____________ (company name) knowledge, all testing for which data are reported herein was conducted in strict conformance with applicable regulations under 40 CFR 205.1 et seq., all the data reported herein are a true and accurate representation of such testing and all other information reported herein is true and accurate. I am aware of the penalties associated with violations of the Noise Control Act of 1972 and the regulations thereunder.

____
(authorized representative)

(b) All information required to be forwarded to the Administrator pursuant to this section shall be addressed to Director, Noise Enforcement Division (EN-387), U.S. Environmental Protection Agency, Washington, DC 20460.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61459, Dec. 5, 1977; 43 FR 12326, Mar. 24, 1978]

§ 205.57-6 Acceptance and rejection of batches.

(a) The batch from which a batch sample is selected will be accepted or rejected based upon the number of failing vehicles in the batch sample. A sufficient number of test samples will be drawn from the batch sample until the cumulative number of failing vehicles is less than or equal to the acceptance number or greater than or equal to the rejection number appropriate for the cumulative number of vehicles tested. The acceptance and rejection numbers listed in Appendix I, Table II at the appropriate code letter obtained according to § 205.57-2 will be used in determining whether the acceptance or rejection of a batch has occurred.

(b) Acceptance or rejection of a batch takes place when the decision that a vehicle is a failing vehicle is made on the last vehicle required to make a decision under paragraph (a) of this section.

§ 205.57-7 Acceptance and rejection of batch sequence.

(a) The manufacturer will continue to inspect consecutive batches until the batch sequence is accepted or rejected based upon the number of rejected batches. A sufficient number of consecutive batches will be inspected until the cumulative number of rejected batches is less than or equal to the sequence acceptance number of greater than or equal to the sequence rejection number appropriate for the cumulative number of batches inspected. The acceptance and rejection numbers listed in Appendix I, Table III at the appropriate code letter obtained according to § 205.57-2 will be used in determining whether the acceptance or rejection of a batch sequence has occurred.

(b) Acceptance or rejection of a batch sequence takes place when the decision that a vehicle is a failing vehicle is made on the last vehicle required to make a decision under paragraph (a) of this section.

(c) If the batch sequence is accepted, the manufacture will not be required to perform any additional testing on vehicles from subsequent batches pursuant to the initiating test request.

(d) The Administrator may terminate testing earlier than required in paragraph (b) of this section based on a request by the manufacturer accompanied by voluntary cessation of distribution in commerce, of vehicles from the category, configuration or subgroup in question manufactured at the plant which produced the vehicles under test: *Provided*, That before reinitiating distribution in commerce of vehicles from such plant of such vehicle category, configuration or subgroup, the manufacturer must take the action described in § 205.57-9(a)(1) and (a)(2).

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61460, Dec. 5, 1977]

§ 205.57-8 Continued testing.

(a) If a batch sequence is rejected in accordance with paragraph (b) of § 205.57-7, the Administrator may require that any or all vehicles of that category, configuration of subgroup thereof produced at that plant be tested before distribution in commerce.

(b) The Administrator will notify the manufacturer in writing of his intent to require such continued testing of vehicles pursuant to paragraph (a) of this section.

(c) The manufacturer may request a hearing on the issues of whether the selective enforcement audit was conducted properly; whether the criteria for batch sequence rejection in § 204.57-7 have been met; and, the appropriateness or scope of a continued testing order. In the event that a hearing is requested, the hearing shall begin no later than 15 days after the date on which the Administrator received the hearing request. Neither the request for a hearing nor the fact that a hearing is in progress shall affect the reponsibility of the manufacturer to commence and continue testing required by the Administrator pursuant to paragraph (a) of this section.

(d) Any tested vehicle which demonstrated conformance with the applicable standards may be distributed into commerce.

(e) Any knowing distribution into commerce of a vehicle which does not comply with the applicable standards is a prohibited act.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61460, Dec. 5, 1977; 44 FR 54296, Sept. 19, 1979]

§ 205.57-9 Prohibition on distribution in commerce; manufacturer's remedy.

(a) The Administrator will permit the cessation of continued testing under § 205.57-8 once the manufacturer has taken the following actions:

(1) Submit a written report to the Administrator which identifies the reason for the noncompliance of the vehicles, describes the problem and describes the proposed quality control and/or quality assurance remedies to be taken by the manufacturer to correct the problem or follows the requirements for an engineering change. Such requirements include the following:

(i) Any change to a configuration with respect to any of the parameters stated in § 205.55-3 shall constitute the addition of a new and separate configuration or category to the manufacturer's product line.

(ii) When a manufacturer introduces a new category or configuration to his product line, he shall proceed in accordance with § 205.55-2.

(iii) If the configuration to be added can be grouped within a verified category and the new configuration is estimated to have a lower sound pressure level than a previously verified configuration within the same category, the configuration shall be considered verified.

(2) Demonstrates that the specified vehicle category, configuration or subgroup thereof has passed a retest conducted in accordance with § 205.57 and the conditions specified in the initial test request.

(3) The manufacturer may begin testing under paragraph (a)(2) of this section upon submitting such report, and may cease continued testing upon making the demonstration required by paragraph (a)(2) of this section, provided that the Administrator may require resumption of continued testing if he determines that the manufacturer has not satisfied the requirements of paragraphs (a)(1) and (2) of this section.

(b) Any vehicle failing the prescribed noise emission tests conducted pursuant to this Subpart B may not be distributed in commerce until necessary adjustments or repairs have been made and the vehicle passes a retest.

(c) No vehicles of a rejected batch which are still in the hands of the manufacturer may be distributed in commerce unless the manufacturer has demonstrated to the satisfaction of the Administrator that such vehicles do in fact conform to the regulations: Except, that any vehicle that has been tested and does, in fact, conform with these regulations may be distributed in commerce.

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61460, Dec. 5, 1977; 47 FR 57715, Dec. 28, 1982]

§ 205.58 In-use requirements.

§ 205.58-1 Warranty.

(a) The vehicle manufacturer shall include the owner's manual or in other information supplied to the ulitmate purchaser the following statement:

NOISE EMISSIONS WARRANTY

(Name of vehicle manufacturer) warrants to the first person who purchases this vehicle for purposes other than resale and to each subsequent purchaser that this vehicle as manufactured by (names of vehicle manufacturer), was designed, built and equipped to conform at the time it left (name of vehicle manufacturer)'s control with all applicable U.S. EPA Noise Control Regulations.

This warranty covers this vehicle as designed, built and equipped by (Name of vehicle manufacturer), and is not limited to any particular part, component or system of the vehicle manufactured by (name of vehicle manufacturer). Defects in design, assembly or in any part, component or system of the vehicle as manufactured by (name of vehicle manufacturer), which, at the time it left (name of vehicle manufacturer)'s control, caused noise emissions to exceed Federal standards, are covered by this warranty for the life of the vehicle.

[41 FR 15544, Apr. 13, 1976, as amended at 47 FR 57715, Dec. 28, 1982; 48 FR 27040, June 13, 1983]

§ 205.58-2 Tampering.

(a) For each configuration of vehicles covered by this part, the manufacturer shall develop a list of those acts which, in his judgment, might be done to the vehicle in use and which would constitute the removal or rendering inoperative of noise control devices or elements of design of the vehicle.

(b) The manufacturer shall include in the owner's manual the following information:

(1) The statement:

TAMPERING WITH NOISE CONTROL SYSTEM PROHIBITED

Federal law prohibits the following acts or the causing thereof:

(1) The removal or rendering inoperative by any person, other than for purposes of maintenance, repair, or replacement, of any device or element of design incorporated into any new vehicle for the purpose of noise control prior to its sale or delivery to the ultimate purchaser or while it is in use; or (2) the use of the vehicle after such device or element of design has been removed or rendered inoperative by any person.

(2) The statement:

Among those acts presumed to constitute tampering are the acts listed below.

Immediately following this statement, the manufacturer shall include the list developed under paragraph (a) of this section.

(c) Any act included in the list prepared pursuant to paragraph (a) of this section is presumed to constitute tampering; however, in any case in which a proscribed act has been committed and it can be shown that such act resulted in no increase in the noise level of the vehicle or that the vehicle still meets the noise emission standard of § 205.52, such act will not constitute tampering.

(d) The provisions of this section are not intended to preclude any State or local jurisdiction from adopting and enforcing its own prohibitions against the removal or rendering inoperative of noise control systems on vehicles subject to this part.

[41 FR 15544, Apr. 13, 1976, as amended at 47 FR 57715, Dec. 28, 1982; 48 FR 27040, June 13, 1983]

§ 205.58-3 Instructions for maintenance, use and repair.

(a)(1) The manufacturer shall provide to the ultimate purchaser of each vehicle covered by this subpart written instructions for the proper maintenance, use and repair of the vehicle in order to provide reasonable assurance of the elimination or minimization of noise emission degradation throughout the life of the vehicle.

(2) The purpose of the instructions is to inform purchasers and mechanics of those acts necessary to reasonably assure that degradation of noise emission level is eliminated or minimized during the life of the vehicle. Manufacturers should prepare the instructions with this purpose in mind. The instructions should be clear and, to the extent practicable, written in nontechnical language.

(3) The instructions must not be used to secure an unfair competitive advantage. They should not restrict replacement equipment to original equipment or service to dealer service. Manufacturers who so restrict replacement equipment should be prepared to make public any performance specifications on such equipment.

(b) For the purpose of encouraging proper maintenance, the manufacturer shall provide a record or log book which shall contain a schedule for the performance of all required noise emission control maintenance. Space shall be provided in this record book so that the purchaser can note what maintenance was done, by whom, where and when.

[41 FR 15544, Apr. 13, 1976, as amended at 47 FR 57716, Dec. 28, 1982]

§ 205.59 Recall of noncomplying vehicles.

(a) Pursuant to section 11(d)(1) of the Act, the Administrator may issue an order to the manufacturer to recall and repair or modify any vehicle distributed in commerce not in compliance with this subpart.

(b) A recall order issued pursuant to this section shall be based upon a determination by the Administrator that vehicles of a specified category or configuration have been distributed in commerce which do not conform to the regulations. Such determination may be based on:

(1) A technical analysis of the noise emission characteristics of the category or configuration in question; or

(2) Any other relevant information, including test data.

(c) For the purposes of this section, noise emissions may be measured by any test prescribed in § 205.54 for testing prior to sale or any other test which has been demonstrated to correlate with the prescribed test procedure.

(d) Any such order shall be issued only after notice and an opportunity for a hearing.

(e) All costs, including labor and parts, associated with the recall and repair or modification of non-complying vehicles under this section shall be borne by the manufacturer.

(f) This section shall not limit the discretion of the Administrator to take any other actions which are authorized by the Act.

Appendix I to Subpart B

Table I—Sample Size Code Letters

Batch size	Code letter
4 to 8	A.
9 to 15	B.

Table I—Sample Size Code Letters—Continued

Batch size	Code letter
16 to 25	C.
26 and larger	D.

Table II—Sampling Plans for Inspecting Batches

Sample size code letter	Test sample	Test sample size	Cumulative test sample size	Batch inspection criteria	
				Acceptance No.	Rejection No.
A	1st	4	4	0	1
B	1st	3	3	0	1
C	1st	3	3	0	2
	2d	3	6	1	2
D	1st	2	2	(1)	2
	2d	2	4	(1)	2
	3d	2	6	0	2
	4th	2	8	0	3
	5th	2	10	1	3
	6th	2	12	1	3
	7th	2	14	2	3

[1] Batch acceptance not permitted at this sample size.

Table III—Batch Sequence Plans

Sample size code letter	Number of batches	Cumulative number of batches	Sequence inspection criteria	
			Acceptance No.	Rejection No.
A	2	2	1	(2)
	2	4	2	4
	2	6	3	5
	2	8	4	5
B	2	2	0	(2)
	2	4	1	4
	2	6	2	5
	2	8	3	5
	2	10	4	6
	2	12	5	6
C	2	2	(1)	2
	2	4	0	2
	2	6	0	3
	2	8	1	3
	2	10	2	4
	2	12	3	4
D	2	2	0	2
	2	4	1	3
	2	6	2	4
	2	8	3	4

[1] Batch sequence acceptance not permitted for this number of batches.
[2] Batch sequence rejection not permitted for this number of batches.

Table IV—Recommended Format for Vehicle Noise Data Sheet

Test Report Number: .... Manufacturer: ....
VEHICLE:
Trade Name: .... VIN: ....

Table IV—Recommended Format for Vehicle Noise Data Sheet—Continued

Model Year: .... Other Reference No: ....
Configuration Identification: .... Category Identification: ....
Test Site Identification and Location: ....
INSTRUMENTATION:
Microphone Manufacturer: .... Model No: .... Serial No: ....
Sound Level Manufacturer: .... Model No: .... Serial No: ....
Calibrator Manufacturer: .... Model No: .... Serial No: ....
Other and Manufacturer: .... Model No: .... Serial No: ....
TEST DATA:
Approach Gear: .... Date of Test: ....
Approach RPM: .... Temp: .... Wind: ....
Acceleration Test: ....
Deceleration Test: ....

Acceleration Test

	Run No. 1	2	3	4	5
dBA Left					
Right					
Highest RPM attained in End Zone					
Calculated Sound Pressure .... dBA					

Deceleration Test with Exhaust Brake Applied

dBA Left ....
Right ....
Calculated Sound Pressure .... dBA
TEST Personnel: ....
(Name)
Recorded By: .... Date: ....
(Signature)
Supervisor: .... Title: ....
(Signature)

[41 FR 15544, Apr. 13, 1976, as amended at 42 FR 61460, Dec. 5, 1977]

Subpart C—[Reserved]

Subpart D—Motorcycles

Source: 45 FR 86708, Dec. 31, 1980, unless otherwise noted.

§ 205.150 Applicability.

(a) Except as otherwise provided in these regulations, the provisions of this subpart apply to 1983 and subsequent model year motorcycles manufactured after December 31, 1982, which meet the definition of "new product" in the Act.

(b) The provisions of this subpart do not apply to electric or battery-powered motorcycles.

(c) Except as provided in § 205.158, the provisions of this subpart do not apply to competition motorcycles as defined in § 205.151(a)(3).

§ 205.151 Definitions.

(a) As used in this subpart and in Subpart E, all terms not defined herein shall have the meaning given them in the Act or in Subpart A of this part.

(1) "Motorcycle" means any motor vehicle, other than a tractor, that:

(i) Has two or three wheels;

(ii) Has a curb mass less than or equal to 680 kg (1499 lb); and

(iii) Is capable, with an 80 kg (176 lb) driver, of achieving a maximum speed of at least 24 km/h (15 mph) over a level paved surface.

(2) "Street motorcycle" means:

(i) Any motorcycle that:

(A) With an 80 kg (176 lb) driver, is capable of achieving a maximum speed of at least 40 km/h (25 mph) over a level paved surface; and

(B) Is equipped with features customarily associated with practical street or highway use, such features including but not limited to any of the following: stoplight, horn, rear view mirror, turn signals; or

(ii) Any motorcycle that:

(A) Has an engine displacement less than 50 cubic centimeters;

(B) Produces no more than two brake horse power;

(C) With a 80 kg (176 lb) driver, cannot exceed 48 km/h (30 mph) over a level paved surface.

(3) "Competition motorcycle" means any motorcycle designed and marketed solely for use in closed course competition events.

(4) "Off-road motorcycle" means any motorcycle that is not a street motorcycle or competition motorcycle.

(5) "Acceleration test procedure" means the measurement methodologies specified in Appendix I.

(6) "Acceptable quality level" (AQL) means the maximum allowable average percentage of vehicles or exhaust systems that can fail sampling inspection under a Selective Enforcement Audit.

(7) "Acoustical Assurance Period" (AAP) means a specified period of time or miles driven after sale to the ultimate purchaser during which a newly manufactured vehicle or exhaust system, properly used and maintained, must continue in compliance with the Federal standard.

(8) "Advertised Engine Displacement" means the rounded off volumetric engine capacity used for marketing purposes by the motorcycle manufacturer.

(9) "Category" means a group of vehicle configurations which are identical in all material aspects with respect to the parameters listed in § 205.157-2 of this subpart.

(10) "Class" means a group of vehicles which are identical in all material aspects with respect to the parameters listed in § 205.155 of this subpart.

(11) "Closed course competition event" means any organized competition event covering an enclosed, repeated or confined route intended for easy viewing of the entire route by all spectators. Such events include short track, dirt track, drag race, speedway, hillclimb, ice race, and the Bonneville Speed Trials.

(12) "Closing rpm" means the engine speed in Figure 2 of Appendix I.

(13) "Configuration" means the basic classification unit of a manufacturer's product line and is comprised of all vehicle designs, models or series which are identical in all material aspects with respect to the parameters listed in § 205.157-3 of this subpart.

(14) "Engine displacement" means volumetric engine capacity as defined in § 205.153.

(15) "Exhaust system" means the combination of components which provides for the enclosed flow of exhaust gas from the engine exhaust port to the atmosphere. "Exhaust system" further means any constituent components of the combination which conduct exhaust gases and which are sold as separate products. "Exhaust System" does not mean any of the constituent components of the combination, alone, which do not conduct exhaust gases, such as brackets and other mounting hardware.

(16) "Failing vehicle" means a vehicle whose noise level is in excess of the applicable standard.

(17) "Maximum rated RPM" means the engine speed measured in revolutions per minute (RPM) at which peak net brake power (SAE J-245) is developed for motorcycles of a given configuration.

(18) "Model specific code" means the designation used for labeling purposes in §§ 205.158 and 205.169 for identifying the motorcycle manufacturer, class, and "advertised engine displacement," respectively.

(19) "Model year" means the manufacturer's annual production period, which includes January 1 of any calendar year, or if the manufacturer has no annual production period, the term "model year" shall mean the calendar year.

(20) "Motorcycle noise level" means the A-weighted noise level of a motorcycle as measured by the acceleration test procedure.

(21) "Noise control system" means any vehicle part, component or system, the purpose of which includes control or the reduction of noise emitted from a vehicle, including all exhaust system components.

(22) "Noise emission standard" means the noise levels in § 205.152 or § 205.166.

(23) "Noise emission test" means a test conducted pursuant to a measurement methodology specified in this subpart.

(24) [Reserved]

(25) "Serial number" means the identification number assigned by the manufacturer to a specific production unit.

(26) "Tampering" means the removal or rendering inoperative by any person, other than for purposes of maintenance, repair, or replacement, of any device or element of design incorporated into any product in compliance with regulations under section 6, prior to its sale or delivery to the ultimate purchaser or while it is in use; or the use of a product after such device or element of design has been removed or rendered inoperative by any person.

(27) "Test vehicle" means a vehicle in a Selective Enforcement Audit test sample.

(28) "Tractor" means for the purposes of this subpart, any two or three wheeled vehicle used exclusively for agricultural purposes, or for snow plowing, including self-propelled machines used exclusively in growing, harvesting or handling farm produce.

(29) "Vehicle" means any motorcycle regulated pursuant to this subpart.

(30) "Warranty" means the warranty required by section 6(d)(1) of the Act.

[45 FR 86708, Dec. 31, 1980, as amended at 47 FR 57720, Dec. 28, 1982]

§ 205.152 Noise emission standards.

(a) *Noise emission standards.* (1) Street motorcycles of the following and subsequent model years must not produce noise emissions in excess of the levels indicated:

(i) Street motorcycles other than those that meet the definition of § 205.151(a)(2)(ii):

Model year	A-weighted noise level (dB)
(A) 1983	83
(B) 1986	80

(ii) Street motorcycles that meet the definition of § 205.151(a)(2)(ii) (moped-type street motorcycles):

Model year	A-weighted noise level (dB)
(A) 1983	70

(2) Off-road motorcycles of the following and subsequent model years must not produce noise emissions in excess of the levels indicated:

(i) Off-road motorcycles with engine displacements of 170 cc and lower:

Model year	A-weighted noise level (dB)
(A) 1983	83
(B) 1986	80

(ii) Off-road motorcycles with engine displacements greater than 170 cc:

Model year	A-weighted noise level (dB)
(A) 1983	86
(B) 1986	82

(3) Street motorcycles must be designed, built and equipped so that, when properly maintained and used, they will not produce noise emissions in excess of the levels specified in paragraph (a)(1) of this section, for an Acoustical Assurance Period of one year or a distance of 6000 km (3730 mi) after the time of sale to the ultimate purchaser, whichever occurs first.

(4) Off-road motorcycles must be designed, built and equipped so that, when properly maintained and used, they will not produce noise emissions in excess of the levels specified in paragraph (a)(2) of this section, for an Acoustical Assurance Period of one year or a distance of 3000 km (1865

mi) after the time of sale to the ultimate purchaser, whichever occurs first.

(5) At the time of sale to the ultimate purchaser, all products must comply with the standards set forth in paragraphs (a)(1) and (2) of this section.

(b) *Measurement procedure.* (1) The standards set forth in paragraph (a) of this section refer to noise emissions as measured in accordance with the measurement methodology specified in Appendix I-1 for all motorcycles except those street motorcycles that meet the definition of § 205.151(a)(2)(ii).

(2) The standards set forth in paragraph (a) of this section for street motorcycles that meet the definition of § 205.151(a)(2)(ii) (moped-type street motorcycles) refer to noise emissions measured in accordance with the measurement methodology specified in Appendix I-2.

(c) *Low noise emission product standard.* For the purpose of Low-Noise-Emission Product certification pursuant to 40 CFR Part 203, motorcycles procured by the Federal government after the following dates must not produce noise emissions in excess of the noise levels indicated:

(1) For street motorcycles with engine displacement greater than 170 cc:

Date	A-weighted noise level (dB)
(i) January 1, 1982	73
(ii) January 1, 1989	71

(2) For off-road motorcycles with engine displacements greater than 170 cc:

Date	A-weighted noise level (dB)
(i) January 1, 1982	75

(3) For off-road motorcycles with engine displacement 170 cc and lower and street motorcycles with engine displacement 170 cc and lower that do not meet the definition of § 205.151(a)(2)(ii):

Date	A-weighted noise level (dB)
(i) January 1, 1982	71

(4) For street motorcycles that meet the definition of § 205.151(a)(2)(ii) (moped-type street motorcycles):

Date	A-weighted noise level (dB)
(i) January 1, 1982	69

These levels refer to noise emissions as measured in accordance with the measurement methodologies specified in Appendix I. LNEP's must also meet all requirements contained in paragraphs (a)(3), (4), and (5), of this section.

(Secs. 10 and 15 of the Noise Control Act, (42 U.S.C. 4909, 4914))

§ 205.153 Engine displacement.

(a) Engine displacement must be calculated using nominal engine values and rounded to the nearest whole cubic centimeter, in accordance with American Society for Testing Materials (ASTM) E 29-67.

(b) For rotary engines, displacement means the maximum volume of a combustion chamber between two rotor tip seals minus the minimum volume of that combustion chamber between those two rotor seals times three times the number of rotors.

cc=(Maximum chamber volume − minimum chamber volume) × 3 × number of rotors.

§ 205.154 Consideration of alternative test procedures.

The Administrator may approve applications from manufacturers of motorcycles for the approval of test procedures which differ from those contained in this subpart so long as the alternative procedures have been demonstrated to correlate with the prescribed procedure. To be acceptable, alternative test procedures must be such that the test results obtained will identify all those test motorcycles which would not comply with the

noise emission standards prescribed in § 205.152 when tested in accordance with the measurement methodology specified in Appendix I. After approval by the Administrator, testing conducted by manufacturers using alternative test procedures will be accepted by the Administrator for all purposes including, but not limited to, selective enforcement audit testing.

[45 FR 86708, Dec. 31, 1980, as amended at 47 FR 57720, Dec. 28, 1982]

§ 205.155 Motorcycle class and manufacturer abbreviation.

(a) Motorcycles must be grouped into classes determined by separate combinations of the following parameters:

(1) Engine type:

(i) Gasoline—two stroke.

(ii) Gasoline—four stroke.

(iii) Gasoline—rotary.

(iv) Other.

(2) Engine displacement.

(3) Engine configuration:

(i) Number of cylinders.

(ii) Cylinder arrangement (i.e., in line, opposed, etc.).

(4) Exhaust system:

(i) Muffler: (A) Type, (B) Location, (C) Number.

(ii) Expansion chambers: (A) Location, (B) Size.

(iii) Spark arrestors.

(iv) Other exhaust system components.

§ 205.156 [Reserved]

§ 205.157 Requirements.

[47 FR 57720, Dec. 28, 1982]

§ 205.157-1 General requirements.

(a) Each manufacturer of vehicles manufactured for distribution in commerce in the United States which are subject to the standards prescribed in this subpart and not exempted in accordance with Subpart A, § 205.5:

(1) Shall be labeled in accordance with the requirements of § 205.158 of this subpart.

(2) Must ensure that each vehicle conforms to the applicable noise emission standard establishd in § 205.152 of this subpart.

(b) The requirements of paragraph (a) of this section apply to new products which conform to the definition of vehicles in these regulations and at the time such new products are assembled to that state of completeness in which the manufacturer sends them to a subsequent manufacturer or otherwise distributes them in commerce.

(c) Subsequent manufacturers of a new product which conforms to the definition of vehicle in these regulations when received by them from a prior manufacturer, need not fulfill the requirements of paragraph (a)(1) of this section where such requirements have already been complied with by a prior manufacturer.

(d) The manufacturer who is required to conduct product verification testing to demonstrate compliance with a particular standard, must satisfy all other provisions of this subpart applicable to that standard, including but not limited to, record keeping, reporting and in-use requirements.

[45 FR 86708, Dec. 31, 1980, as amended at 47 FR 57720, Dec. 28, 1982]

§ 205.157-2 Compliance with standards.

(a)(1) Prior to distribution in commerce of vehicles of a specific configuration, the first manufacturer of such vehicle must verify such configurations in accordance with the requirements of this subpart.

(2) [Reserved]

(3) At any time following receipt of notice under paragraph (a)(2)(iii) of this section with respect to a configuration, the Administrator may require that the manufacturer ship test vehicles to an EPA test facility for the required production verification testing.

(b) The requirements for purposes of testing by the Administrator and selective enforcement auditing with regard to each vehicle configuration consist of:

(1) Testing in accordance with § 205.160-4 of a vehicle selected in accordance with § 205.160-2.

(2) Compliance of the test vehicle with the applicable standard when tested in accordance with § 205.160-4.

(c)(1) In lieu of testing vehicles of every configuration as described in paragraph (b) of this section, the manufacturer may elect to verify the configuration based on representative testing. The requirements of representative testing are:

(i) Grouping configurations into categories where each category is determined by a separate combination of at least the following parameters (a manufacturer may use more parameters):

(A) Engine type: (*1*) Gasoline-two stroke; (*2*) gasoline-four stroke; (*3*) gasoline-rotary; and (*4*) other.

(B) Engine displacement.

(C) Engine configuration: (*1*) Number of cylinders; and (*2*) cylinder arrangement (i.e., in line, opposed, etc.)

(ii) Identifying the configuration within each category which emits the highest A-weighted sound level (in dB).

(iii) Testing in accordance with § 205.160-4 of a vehicle selected in accordance with § 205.160-2 which much be a vehicle of the configuration which is identified pursuant to paragraph (c)(1)(ii) of this section as having the highest sound pressure level (estimated or actual) within the category.

(iv) Demonstrating compliance of that vehicle with the applicable standard when tested in accordance with the test procedure specified in Appendix I.

(2) Where the requirements of paragraph (c)(1) of this section are complied with, all those configurations contained within a category are considered represented by the tested vehicle.

(3) Where the manufacturer tests a vehicle configuration which has not been determined as having the highest sound pressure level of a category, but all other requirements of paragraph (c)(1) of this section are complied with, all those configurations contained within that category which are determined to have sound pressure levels not greater than the tested vehicle are considered to be represented by the tested vehicle; however, a manufacturer must for purposes of Testing by the Administrator and Selective Enforcement Auditing verify according to the requirements of (b)(1) and/or (c)(1) of this section any configurations in the subject category which have a higher sound pressure level than the vehicle configuration tested.

(d) A manufacturer may elect for purposes of Testing by the Administrator and Selective Enforcement Auditing to use representative testing pursuant to paragraph (c) of this section for all or part of his product line.

(e) The manufacturer has the following alternatives if any test vehicle is determined to not be in compliance with applicable standards:

(1) In the case of representative testing, a new test vehicle from another configuration must be selected according to the requirements of paragraph (c) of this section, in order to verify the configurations represented by the non-compliant vehicle.

(2) Modify the test vehicle and demonstrate by testing that it meets applicable standards. The manufacturer must modify all production vehicles of the same configuration in the same manner as the test vehicle before distribution into commerce.

[45 FR 86708, Dec. 31, 1980, as amended at 47 FR 57720, Dec. 28, 1982]

§ 205.157-3 Configuration identification

(a) A separate vehicle configuration shall be determined by each combination of the following parameters:

(1) Exhaust system (engine): (i) Mufflers; (ii) expansion chambers; (iii) spark arrestors; and (iv) other exhaust system components.

(2) Air induction system (engine): (i) Intake muffler; (ii) intake ducting; and (iii) air cleaner element.

(3) Vehicle drive train: (i) Chain; and (ii) shaft.

(4) Transmission gear ratio: (i) Standard transmission; and (ii) automatic transmission.

(5) Cooling system configuration: (i) Natural air cooled; (ii) liquid cooled; and (iii) forced air cooled.

(6) Category parameters listed in § 205.157-2.

(b) [Reserved]

§ 205.158 Labeling requirements.

(a)(1) The manufacturer of any vehicle subject to this subpart must, at the time of manufacture, affix a label, of the type specified in paragraphs (a)(2), (3), and (4) of this section, to all such vehicles to be distributed in commerce.

(2) The label must be plastic or metal and be welded, riveted, or otherwise permanently attached in a readily visible position.

(3) The label must be affixed by the vehicle manufacturer to the vehicle in such a manner that the label cannot be removed without destroying or defacing it, and must not be affixed to any piece of equipment that is easily detached from such vehicle.

(4) The label must be lettered in the English language in legible block letters and numerals, which must be of a color that contrasts with the background of the label.

(5) The label must contain the following information:

(i) The label heading: Motorcycle Noise Emission Control Information;

(ii) The statement:

This —— (model year) —— (model specific code) motorcycle, —— (serial number), meets EPA noise emission requirements of —— (noise emission standard) dBA at —— (closing rpm) rpm by the Federal test procedure. Modifications which cause this motorcycle to exceed Federal noise standards are prohibited by Federal law. See owner's manual.

(6) The model specific code is limited to ten spaces which includes three spaces for the manufacturer's abbreviation (see paragraph (a)(7) of this section), three spaces for the class identification, and four spaces for the advertised engine displacement respectively.

(7) All motorcycle manufacturers shall use the following abbreviations in their model specific code.

BMW	BMW
Bultaco	BUL
Can-Am Bombardier	CAB
Chaparral	CHA
Cheeta	CHE
Ducati	DUC
Fox	FOX
Harley Davidson	HAR
Heald	HEA
Hercules	HER
Hodaka	HOD
Honda	HON
Husqvarna	HUS
JAWA/CZ	JAW
Kawasaki	KAW
KTM	KTM
Laverda	LAV
Moto Benilli	BEN
Moto Guzzi	GUZ
Moto Morini	MOR
MV Agusta	MVA
Norton Triumph	TRI
Rokon	ROK
Suzuki	SUZ
Yamaha	YAM

(8) Moped manufacturers only shall use the following abbreviations in their model specific code.

AMF	AMF
Benelli	BEL
Califfo	CAL
Carabela	CAR
Cimatti	CIM
Columbia	COL
E-Z Rider	EZR
Flying Dutchman	FLY
Ford	FOI
Gadabout	GAD
Garelli	GAR
Gitane	GIT
Honda	HON
Indian	IND
Intramotor	INT
Italvelo	ITA
Kreidler	KRE
Lazer	LAZ
Malagati	MAL
Morini	MOI
Motobecane/Solex	MBE
Moto Guzzi	GUZ
Negrini	NEG
Odyssey	ODY
Pacer	PAC
Pack-A-Way	PAK
Peugeot	PEU
Puch	PUC
Riviera	RIV
Sachs	SAC
Safari	SAF
Scorpion	SCO
Smily	SMI
Snark	SNA
Sori II	SON
Speed Bird	SPE
Sprinter	SPR
SuVega	SUV
Tomas	TOM
Vaespa	VES
Yankee Peddler	YAN

(9) If a new motorcycle manufacturer begins production of vehicles subject to this regulation, the Administrator will assign him a 3-letter manufacturer abbreviation as soon as reasonably practical after his existence is known to the Agency.

(b) Any vehicle manufactured in the United States solely for use outside the United States must be clearly labeled in accordance with the provisions of paragraphs (a)(2), (3), and (4) of this section with the statement; "For Export Only".

(c) Any competition motorcycle as defined in § 205.151(a)(3), shall be labeled in accordance with the provisions of paragraphs (a)(1), (2), (3) and (4) of this section with the statement:

This motorcycle is designed for closed course competition use only. It does not conform to U.S. EPA motorcycle noise standards.

(d) It will be permissible for manufacturers to meet the requirements of this section by consolidating these labeling requirements with other government labeling requirements in one or more labels, provided the provisions of paragraphs (a)(2), (3) and (4) of this section are met.

[45 FR 86708, Dec. 31, 1980, as amended at 47 FR 57721, Dec. 28, 1982]

§ 205.159 Testing by the Administrator.

(a)(1) In order for the Administrator to determine whether such vehicles or a manufacturer's test facility conform to applicable regulations, the Administrator may require that vehicles to be tested pursuant to the Act be submitted to him, at such place and time as he reasonably designates. He may designate the quantity of vehicles and the duration of time he reasonably requires for the purpose of conducting tests in accordance with test procedures described in Appendix I. The manner in which the Administrator conducts such tests, the EPA test facility, and the test procedures employed will be based upon good engineering practice and meet or exceed the requirements of Appendix I of the regulations.

(2) If the Administrator specifies that he will conduct such testing at the manufacturer's facility, the manufacturer shall make available instrumentation and equipment of the type required for test operations by these regulations. The Administrator may conduct such tests with his own equipment, having specifications equal to or exceeding the performance specifications of the instrumentation and equipment required in these regulations.

(3) The manufacturer may observe tests conducted by the Administrator pursuant to this section on vehicles produced by the manufacturer and may copy the data accumulated from such tests. The manufacturer may inspect any of the vehicles before and after testing by the Administrator.

(b)(1) If, based on tests conducted by the Administrator, or on other relevant information, the Administrator determines that the test facility does not meet the requirements of Appendix I (or the requirements for an alternative test procedure approved under § 205.154), the Administrator will give notice to the manufacturer in writing of his determination and the reasons underlying it.

(2) The manufacturer may, at any time within 15 days after receipt of a notice issued under paragraph (b)(1) of this section, request a hearing conducted in accordance with 5 U.S.C. 554 on the issue of whether his test facility met the requirements as specified in Appendix I (or the alternative procedure). Such notice will not take effect until 15 days after its receipt by the manufacturer or, if a hearing is requested under this paragraph, until adjudication by the Administrative law judge.

(3) After any notice issued under paragraph (b)(1) of this section has taken effect, no data thereafter derived from that test facility will be acceptable for purposes of this subpart.

(4) The manufacturer may request in writing that the Administrator reconsider his determination under paragraph (b)(1) of this section based on data or information which indicates that changes have been made to the test facility and that those changes have resolved the reasons for disqualification.

(5) Within 10 working days after receipt of the manufacturer's request for reconsideration pursuant to paragraph (b)(4) of this section, the Administrator will notify the manufacturer of his determination and of the reasons underlyng it with regard to the requalification of the test facility.

(c) The Administrator will assume all reasonable costs associated with shipment of vehicles to the place designated pursuant to paragraph (a) of this section except with respect to:

(1) Any production verification testing performed at a place other than the manufacturer's facility as provided in § 205.157-2(a), or as a result of the manufacturer's not owning or having access to a test facility;

(2) Testing of a reasonable number of vehicles (i) for purposes of selective enforcement auditing under § 205.160, (ii) or if the manufacturer has failed to establish that there is a correlation between its test facility and the EPA test facility, (iii) or the Administrator has reason to believe, and provides the manufacturer with a statement of such reason, that the vehicles to be tested would fail to meet the standard prescribed in this subpart if tested at the EPA test facility even though they would meet such standard if tested at the manufacturer's test facility;

(3) Any testing performed during a period when a notice issued pursuant to paragraph (b) of this section is in effect;

(4) Any testing performed at a place other than the manufacturer's facility as a result of the manufacturer's failure to permit the Administrator to conduct or monitor testing as required by this subpart; and

(5) Testing of up to 10 percent of the manufacturer's test vehicles for a model year if the Administrator determines testing these vehicles at the EPA test site is necessary to assure that a manufacturer has acted or is acting in compliance with the Act.

[45 FR 86708, Dec. 31, 1980, as amended at 47 FR 57721, Dec. 28, 1982]

§ 205.160 Selective enforcement auditing (SEA) requirements.

§ 205.160-1 Test request.

(a) The Administrator will request all testing under § 205.160 by means of a test request addressed to the manufacturer.

(b) The test request will be signed by the Assistant Administrator for Enforcement or his designee. The test request will be delivered to the plant manager or other responsible official as designated by the manufacturer.

(c) The test request will specify the vehicle category, configuration or configuration subgroup selected for testing, the manufacturer's plant or storage facility from which the vehicles must be selected, and the time at which the vehicles must be selected. The test request will also provide for situations in which the selected category, configuration, or configuration subgroup is unavailable for testing. The test request may include an alternative category, configuration, or configuration subgroup designated for testing in the event that vehicles of the first specified category, configuration, or configuration subgroup are not available for testing because the vehicles are not being manufactured at the specified plant, are not being manufactured during the specified time, or are not being stored at the specified plant or storage facility.

(d)(1) If the manufacturer projects a yearly production of fewer than 50 vehicles of the specified category, configuration or configuration subgroup to be tested, then within five (5) days of receipt of the request, the manufacturer must notify the Administrator of such low volume production. The Administrator will then provide a revised test request specifying a testing plan which imposes no greater risk of failure (5%) at the acceptable quality level (10%) than the plan in Appendix II. Upon receipt of the revised test request, the manufacturer must select and test a sample of vehicles from the category, configuration or configuration subgroup specified in the test request in accordance with this subpart and the conditions specified in the test request.

(2) If the manufacturer produces 50 or more vehicles of the specified category, configuration or configuration subgroup per year, then upon receipt of the test request, the manufacturer must select and test a sample of vehicles from the category, configuration or configuration subgroup specified in the test request in accordance with this subpart and the conditions specified in the test request.

(e)(1) Any testing conducted by the manufacturer under a test request must be initiated within the time period specified in the test request; except that initiation may be delayed for increments of 24 hours or one business day where ambient test site weather conditions, or other conditions beyond the control of the manufacturer, in that 24-hour period, do not permit testing. The manufacturer must record the conditions for this period.

(2) The manufacturer must complete noise emission testing on a minimum of ten vehicles per day unless otherwise provided by the Administrator or unless ambient test site conditions permit only the testing of a lesser number in which case the ambient test site weather conditions for that period must be recorded.

(3) The manufacturer is allowed 24 hours to ship vehicles from a sample from the assembly plant to the testing facility if the facility is not located at the plant or in close proximity to the plant. The Administrator may approve more time based upon a request by the manufacturer accompanied by a satisfactory justification.

(f) The Administrator may issue an order to the manufacturer to cease distribution in commerce of vehicles of a specified category, configuration, or configuration subgroup being manufactured at a particular facility, if:

(1) The manufacturer refuses to comply with the provisions of a test request issued by the Administrator under this section; or

(2) The manufacturer refuses to comply with any of the requirements of this section.

(g) A cease distribution order will not be issued under paragraph (f) of this section if the manufacturer's refusal is caused by conditions and circumstances outside his control which render compliance with the provisions of a test request or with any other requirements of this section impossible. Conditions and circumstances outside the control of the manufacturer include, but are not limited to, the temporary unavailability of equipment and personnel needed to conduct the required tests caused by uncontrollable factors, such as equipment breakdown or failure or illness of personnel. Failure of the manufacturer to adequately plan for and provide the equipment and personnel needed to conduct the tests do not constitute uncontrollable factors. The manufacturer must bear the burden of establishing the presence of the conditions and circumstances required by this paragraph.

(h) Any order to cease distribution will be issued only after a notice and opportunity for a hearing in accordance with 5 U.S.C. 554.

§ 205.160-2 Test sample selection and preparation.

(a) Vehicles comprising the sample which are required to be tested under a test request in accordance with this subpart must be selected consecutively as they are produced. Before the official test, the test vehicle must not be prepared, tested, modified, adjusted, or maintained in any manner unless such preparation, tests, modifications, adjustments or maintenance are part of the manufacturer's prescribed manufacturing and inspection procedures, and are documented in the manufacturer's internal vehicle assembly and inspection procedures, are required or permitted under this subpart, or are approved in advance by the Administrator. For purposes of this section, prescribed manufacturing and inspection procedures include quality control testing and assembly procedures normally performed by the manufacturer on like products during early production if the resulting testing is not biased by this procedure. In the case of imported products, the manufacturer may perform adjustments, preparations, modification or tests normally performed at the port of entry by the manufacturer to prepare the vehicle for delivery to a dealer or customer.

(1) Equipment or fixtures necessary to conduct the test may be installed on the vehicle if such equipment or fixtures have no effect on the noise emissions of the vehicle, as determined by the measurement methodology.

(2) In the event of a vehicle malfunction (i.e., failure to start, etc.) the manufacturer may perform the maintenance that is necessary to enable the vehicle to operate in a normal manner. This maintenance must be documented and reported in the SEA report.

(3) No quality control, quality assurance testing, assembly or selection procedures may be used on the test vehicle or any portion of the test vehicle including parts and subassemblies, unless such quality control, quality assurance testing, assembly or selection

procedures are used normally during the production and assembly of all other vehicles of this configuration which will be distributed in commerce, are required or permitted under this subpart or are approved in advance by the Administrator.

(4) If a vehicle is unable to complete the noise tests, the manufacturer may replace the vehicle. Any replacement vehicle must be a production vehicle of the same configuration as the replaced vehicle or a noisier configuration and will be subject to all the provisions of these regulations. Any replacement must be reported in the SEA report.

(b) The Acceptable Quality Level (AQL) is 10 percent. The appropriate sampling plans associated with the designated AQL are contained in Appendix II or the test request.

(c) The vehicles of the category, configuration or configuration subgroup selected for testing must be assembled by the manufacturer for distribution in commerce using the manufacturer's normal production process.

(d) Unless otherwise indicated in the test request, the manufacturer must initiate testing with the vehicles of the category, configuration or configuration subgroup specified in the test request which are next scheduled for production after receipt of the test request.

(e) The manufacturer must keep on hand all products in the test sample until the sample is accepted or rejected in accordance with § 205.160-6; except that vehicles actually tested and found to be in conformance with this regulation need not be kept.

[45 FR 86708, Dec. 31, 1980, as amended at 47 FR 57721, Dec. 28, 1982]

§ 205.160-3 [Reserved]

§ 205.160-4 Testing procedures.

(a) The manufacturer must conduct one valid test in accordance with the appropriate test procedures specified in Appendix I, on each vehicle selected for testing under this subpart.

(b) In the event a vehicle is unable to complete the noise emission test, the manufacturer may replace the vehicle. Any replacement vehicle must be a production vehicle of the same category, configuration or subgroup as the vehicle which it replaced, and it is subject to all the provisions of this subpart.

[45 FR 86708, Dec. 31, 1980, as amended at 47 FR 57721, Dec. 28, 1982]

§ 205.160-5 Reporting of the test results.

(a)(1) The manufacturer must submit a copy of the test report for all testing conducted pursuant to § 205.160 at the conclusion of each 24-hour period during which testing is done.

(2) For each test conducted the manufacturer must provide the following information:

(i) Category, configuration or configuration subgroup identification where applicable;

(ii) Year, make, assembly date, and model of vehicle;

(iii) Vehicle serial number; and

(iv) Test results by serial numbers.

(b) In the case where an EPA Enforcement Officer is present during testing required by this subpart, the written reports requested in paragraph (a) of this section may be given directly to the Enforcement Officer.

(c) Within 5 days after completion of testing of an SEA, the manufacturer must submit to the Administrator a final report which will include the following:

(1) The name, location, and description of the manufacturer's noise emission test facilities which meet the specifications of Appendix I, and were utilized to conduct testing reported under this section, except, that a test facility that has been described in a previous submission under this subpart need not again be described, but must be identified as that facility.

(2) The following information for each noise emission test conducted:

(i) The individual records for the test vehicles required by § 205.161(a)(2) for all noise emission tests including for each invalid test, the reason for invalidation.

(ii) A complete description of any modification, repair, preparation, maintenance, or testing which could affect the noise emissions of the product and which was performed on the test vehicle but not performed on all other production vehicles; and,

(iii) The test results for any replaced vehicle and the reason for its replacement.

(3) A complete description of the sound data acquisition system if other than those specified in Appendix I.

(4) The following statement and endorsement:

This report is submitted pursuant to section 6 and section 13 of the Noise Control Act of 1972. To the best of——(company name) knowledge, all testing for which data are reported here was conducted in strict conformance with applicable regulations under 40 CFR Part 205 *et seq.*, all the data reported here are a true and accurate representation of such testing, and all other information reported here is true and accurate. I am aware of the penalties associated with violations of the Noise Control Act of 1972 and the regulations thereunder.——(authorized representative).

(5) Additional information required by the test request.

(d) Information required to be submitted to the Administrator under this section must be sent to the following address: Director, Noise and Radiation Enforcement Division, (EN-387), U.S. Environmental Protection Agency, Washington, DC 20460.

§ 205.160-6 Passing or failing under SEA.

(a) A failing vehicle is one whose measured noise level is in excess of the applicable noise emission standard in § 205.152.

(b) The number of failing vehicles in a sample determines whether the sample passes or fails (See applicable tables in Appendix II). If the number of failing vehicles is greater than or equal to the number of Column B, the sample fails. If the number of failing vehicles is less than or equal to the number in Column A, the sample passes.

(c) Pass or failure of an SEA takes place when a decision that a vehicle is a passing or failing unit is made on the last vehicle required to make a decision under paragraph (b) of this section.

(d) If the manufacturer passes the SEA, he will not be required to perform any additional testing on subsequent vehicles to satisfy the test request.

(e) The Administrator may terminate testing earlier than required in paragraph (b) of this section, based on a request by the manufacturer, accompanied by voluntarily ceasing distribution in commerce of vehicles from the category, configuration or configuration subgroup in question, manufactured at the plant which produced the products being tested. Before reinitiating distribution in commerce of that vehicle category, configuration or configuration subgroup from that plant, the manufacturer must take the action described in § 205.160-8(a)(1) and (2).

§ 205.160-7 Continued testing.

(a) If an SEA failure occurs according to paragraph (b) of § 205.160-6, the Administrator may require that any or all vehicles of that category, configuration or configuration subgroup produced at that plant be tested before distribution in commerce.

(b) The Administrator will notify the manufacturer in writing of his intent to require continued testing of vehicles under paragraph (a) of this section.

(c) The manufacturer may request a hearing on the issues of whether the SEA was conducted properly; whether the criteria for SEA failure have been met; and the appropriateness or scope of a continued testing order. If a hearing is requested, the hearing will begin no later than 15 days after the date on which the Administrator received the hearing request. Neither the request for a hearing nor the fact that a hearing is in progress will affect the responsibility of the manufacturer to commence and continue testing required by the Administrator pursuant to paragraph (a) of this section.

(d) Any tested vehicle which demonstrates conformance with the applicable standard may be distributed into commerce.

(e) Any distribution into commerce of a vehicle which does not comply with the applicable standard is a prohibited act.

§ 205.160-8 Prohibition of distribution in commerce; manufacturer's remedy.

(a) The Administrator will permit the manufacturer to cease testing under § 205.160-7 after the manufacturer has taken the following actions:

(1) Submission of a written report to the Administrator which identifies the reason for the noncompliance of the vehicles, describes the problem and/or quality control or quality assurance remedies to be taken by the manufacturer to correct the problem.

(2) Demonstration that the specified vehicle category, configuration or configuration subgroup has passed a retest conducted in accordance with § 205.160, and the conditions specified in the test request.

(b) The manufacturer may begin testing under paragraph (a)(2) of this section upon submitting the report required by paragraph (a)(1) of this section, and may cease continued testing upon making the demonstration required by paragraph (a)(2) of this section. The Administrator may require resumption of continued testing if he determines that the manufacturer has not satisfied the requirements of paragraphs (a)(1) and (2) of this section.

(c) Any vehicle failing the prescribed noise emission tests conducted pursuant to Appendix I may not be distributed in commerce until necessary adjustments or repairs have been made and the vehicle passes a retest.

[45 FR 86708, Dec. 31, 1980, as amended at 47 FR 57721, Dec. 28, 1982]

§ 205.162 In-use requirements.

§ 205.162-1 Warranty.

(a) The vehicle manufacturer who is required to production verify under this subpart must include in the owner's manual or in other information supplied to the ultimate purchaser the following statement:

NOISE EMISSIONS WARRANTY [RESERVED]

[45 FR 86708, Dec. 31, 1980, as amended at 48 FR 27040, June 13, 1983]

§ 205.162-2 Tampering.

(a) For each configuration of vehicles covered by this part, the manufacturer shall develop a list of acts which, in his judgment, constitute the removal or rendering totally or partially inoperative, other than for purposes of maintenance, repair, or replacement of noise control devices or elements of design of the vehicle.

(b) The manufacturer shall include in the owner's manual the following information:

(1) The statement:

TAMPERING WITH NOISE CONTROL SYSTEM PROHIBITED

Federal law prohibits the following acts or causing thereof:

(1) The removal or rendering inoperative by any person other than for purposes of maintenance, repair, or replacement, of any device or element of design incorporated into any new vehicle for the purpose of noise control prior to its sale or delivery to the ultimate purchaser or while it is in use, or (2) the use of the vehicle after such device or element of design has been removed or rendered inoperative by any person.

(2) The statement:

Among those acts presumed to constitute tampering are the acts listed below.

Immediately following this statement, the manufacturer must include the list developed under paragraph (a) of this section.

(c) Any act included in the list prepared pursuant to paragraph (a) of this section is presumed to constitute tampering; however, in any case in which a presumed act of tampering has been committed and it can be shown that such act resulted in no increase in the noise level of the vehicle or that the vehicle still meets the noise emission standard of § 205.152, the act will not constitute tampering.

(d) The provisions of this section are not intended to preclude any State or local jurisdiction from adopting and enforcing its own prohibitions against the removal or rendering inoperative of noise control systems on vehicles subject to this part.

[45 FR 86708, Dec. 31, 1980, as amended at 47 FR 57721, Dec. 28, 1982]

§ 205.162-3 Instructions for maintenance, use, and repair.

(a)(1) The manufacturer must provide to the purchaser of each vehicle covered by this subpart written instructions for the proper maintenance, use, and repair of the vehicle in order to provide reasonable assurance of the elimination or minimization of noise emission degradation throughout the life of the vehicle.

(2) The purpose of the instructions is to inform purchasers and mechanics of the acts necessary to reasonably assure that degradation of noise emission level is eliminated or minimized during the life of the vehicle. Manufacturers shall prepare the instructions with this purpose in mind. The instructions shall be clear and, to the extent practicable, written in nontechnical language.

(3) The instructions must not be used to secure an unfair competitive advantage. They shall not restrict replacement equipment to original equipment or restrict service to dealer service unless such manufacturer makes public the performance specifications on such equipment.

(b) For the purpose of encouraging proper maintenance, the manufacturer must provide a record or log book which shall contain a schedule for the performance of all required noise emission control maintenance. Space must be provided in this record book so that the purchaser can note what maintenance was done, by whom, where, and when.

[45 FR 86708, Dec. 31, 1980, as amended at 47 FR 57722, Dec. 28, 1982]

§ 205.163 Recall of noncomplying motorcycles; relabeling of mislabeled motorcycles.

(a) Pursuant to section 11(d)(1) of the Act, the Administrator may issue an order to the manufacturer to recall, repair, modify, or relabel any vehicles distributed in commerce which are not in compliance with this subpart.

(b) A recall order issued under this section shall be based upon a determination by the Administrator that vehicles of a specified category, configuration, or class which do not conform to the regulations or are improperly labeled have been distributed in commerce. This determination may be based on: (1) A technical analysis of the noise emission characteristics of the category, configuration, or class in question; or (2) any other relevant information, including test data.

(c) For the purpose of this section, noise emissions are to be measured by the appropriate test procedure prescribed in Appendix I prior to sale or any other test which has been demonstrated to correlate with the prescribed test procedure in accordance with § 205.154.

(d) Any order to recall shall be issued only after notice and an opportunity for a hearing.

(e) All cost, including labor and parts, associated with the recall and repair or modification of noncomplying vehicles and relabeling of mislabeled vehicles under this section shall be borne by the manufacturer.

(f) This section shall not limit the discretion of the Administrator to take any other actions which are authorized by the Act.

APPENDIX I TO SUBPARTS D AND E—MOTORCYCLE NOISE EMISSION TEST PROCEDURES

EDITORIAL NOTE: The text of Appendix I follows Subpart E.

Subpart E—Motorcycle Exhaust Systems

AUTHORITY: Sec. 6 of the Noise Control Act (42 U.S.C. 4905).

SOURCE: 45 FR 86718, Dec. 31, 1980, unless otherwise noted.

§ 205.164 Applicability.

(a) Except as otherwise provided in these regulations, the provisions of this subpart apply to any motorcycle replacement exhaust system or motorcycle replacement exhaust system component which:

(1) Meets the definition of the term "new product" in the Act; and

(2) Is designed and marketed for use on any motorcycle subject to the provisions of Subpart D of this part.

(b) The provisions of § 205.169 additionally apply to the motorcycle exhaust systems originally installed on vehicles subject to the requirements of Subpart D of this part.

(c) The provisions of § 205.169(d)(3) additionally apply to motorcycle replacement exhaust systems manufactured after January 1, 1983 that are designed and marketed for use on motorcycles manufactured before January 1, 1983.

(d) Except as provided for in § 205.169, the provisions of this subpart do not apply to exhaust systems which are designed and marketed solely for use on competition motorcycles as defined in § 205.151(a)(3).

(e) The provisions of the subpart do not apply to exhaust header pipes sold as separate products.

§ 205.165 Definitions.

(a) As used in this subpart, all terms not defined herein have the meaning given them in Subpart D of this part or in the Act.

(1) "Category" means a group of exhaust systems which are identical in all material aspects with respect to the parameters listed in § 205.168 of this subpart.

(2) "Exhaust header pipe" means any tube of constant diameter which conducts exhaust gas from an engine exhaust port to other exhaust system components which provide noise attenuation. Tubes with cross connections or internal baffling are not considered to be "exhaust header pipes."

(3) "Failing exhaust system" means that, when installed on any Federally regulated motorcycle for which it is designed and marketed, that motorcycle and exhaust system exceed the applicable standards.

(4) "Federally regulated motorcycle" means, for the purpose of this subpart, any motorcyle subject to the noise standards of Subpart D of this part.

(5) "Federal standards" means, for the purpose of this subpart, the standards specified in § 205.152(a)(1), (2) and (3).

(6) [Reserved]

(7) "Stock configuration" means that no modifications have been made to the orginal equipment motorcycle that would affect the noise emissions of the vehicle when measured according to the acceleration test procedure.

(8) "Test exhaust system" means an exhaust system in Selective Enforcement Audit test sample.

(b) [Reserved]

[45 FR 86718, Dec. 31, 1980, as amended at 47 FR 57722, Dec. 28, 1982]

§ 205.166 Noise emission standards.

(a) *Noise emission standards.* (1) Exhaust systems and exhaust system components that are designed and marketed for use on any Federally regulated street motorcycle of the following and subsequent model years must be designed and built so that when installed on any such motorcycle which is in compliance with the requirements of Subpart D of this part, they will not cause that motorcycle to produce noise emissions in excess of the levels indicated:

(i) Systems designed and marketed for use on street motorcycles other than those that meet the definition of § 205.151(a)(2)(ii):

Motorcycle model year	A-weighted noise level (dB)
(A) 1983	83
(B) 1986	80

(ii) Systems designed and marketed for street motorcycles that meet the definition of § 205.151(a)(2)(ii) (moped-type street motorcycles):

Motorcycle model year	A-weighted noise level (dB)
(A) 1983	70

(2) Exhaust systems and exhaust system components that are designed and marketed for use on any Federally regulated off-road motorcycle of the following and subsequent model years must be designed and built so that, at the time of sale, when installed on any such motorcycle which is in compliance with the requirements of Subpart D of this part, they will not cause that motorcycle to produce noise emissions in excess of the levels indicated:

(i) Systems designed and marketed for use on off-road motorcycles with engine displacements of 170 cc and lower:

Motorcycle model year	A-weighted noise level (dB)
(A) 1983	83
(B) 1986	80

(ii) Systems designed and marketed for use on off-road motorcycles with engine displacements greater than 170 cc:

Motorcycle model year	A-weighted noise level (dB)
(A) 1983	86
(B) 1986	82

(3) Exhaust systems and exhaust system components that are designed and marketed for use on any Federally regulated street motorcycle shall be designed and built so that, when installed on any such motorcycle which is in compliance with the requirements of Subpart D of this part, and when both the motorcycle and the exhaust system are properly maintained and used, they will not cause that motorcycle to produce noise emissions in excess of the levels specified in paragraph (a)(1) of this section, for an Acoustical Assurance Period of one year or a distance of 6000 km (3729 mi) after the time of sale to the ultimate purchaser, whichever occurs first.

(4) Exhaust systems and exhaust system components that are designed and marketed for use on any Federally regulated off-road motorcycle must be designed and built so that, when installed on any such motorcycle which is in compliance with the requirements of Subpart D of this part, and when both the motorcycle and the exhaust system are properly maintained and used, they will not cause that motorcycle to produce noise emissions in excess of the levels specified in paragraph (a)(2) of this section, for an Acoustical Assurance Period of one year or a distance of 3000 km (1865 mi) after the time of sale to the ultimate purchaser, whichever occurs first.

(5) At the time of sale to the ultimate purchaser all products must comply with the standards set forth in paragraphs (a)(1) and (2) of this section.

(b) *Measurement procedure.* (1)(i) The standards set forth in paragraph (a) of this section refer to the noise emissions as measured in accordance with the measurement methodology specified in Appendix I-1 for all motorcycles except those street motorcycles meeting the definition of § 205.151(a)(2)(ii). Exhaust systems which alter a motorcycle's maximum rated RPM shall be tested using the unmodified motorcycle's maximum rated RPM to determine closing RPM or test RPM.

(ii) The standards set forth in paragraph (a) of this section for street motorcycles meeting the definition of § 205.151(a)(2)(ii) (moped-type street motorcycles) refer to noise emissions measured in accordance with the measurement methodology specified in Appendix I-2.

(2) Exhaust system components sold as separate products shall be tested as part of a system made up of that part and original equipment components to complete the system.

(3) Exhaust system components sold as separate products which are incompatible with original equipment components necessary to make a complete exhaust system, or which would not meet standards as prescribed in this subpart in such configuration, may be tested with non-original equipment components provided that the provisions of § 205.169(e)(1)(ii)(B) are carried out.

§ 205.167 Consideration of alternative test procedures.

The Administrator may approve applications from manufacturers of original equipment and replacement exhaust systems for the approval of test procedures which differ from those contained in this subpart so long as the alternative procedures have been demonstrated to correlate with the prescribed procedure. To be acceptable, alternative test procedures must be such that the test results obtained will identify all those test exhaust systems which would not comply with the noise emission standards prescribed in § 205.166 when tested in accordance with the measurement methodology specified in Appendix I. After approval by the Administrator, testing conducted by manufacturers using alternative test procedures may be accepted by the Administrator for all purposes including, but not limited to, production verification testing and selective enforcement audit testing.

§ 205.168 Requirements.

[47 FR 57722, Dec. 28, 1982]

§ 205.168-1 General requirements.

(a) Each manufacturer of motorcycle exhaust systems manufactured for Federally regulated motorcycles and distributed in commerce in the United States which are subject to the noise emission standards prescribed in this subpart and not exempted in accordance with Subpart A, § 205.5:

(1) Must label each exhaust system in accordance with the requirements of § 205.169 of this subpart; and

(2) Must only manufacture exhaust systems which conform to the applicable noise emission standard established in § 205.166 of this regulation when installed on any Federally regulated motorcycle for which it has been designed and marketed.

(b) The manufacturer who is required to conduct testing to demonstrate compliance with a particular standard must satisfy all other provisions of this subpart applicable to that standard.

(c) Prior to distribution into commerce of exhaust systems of a specific category, the manufacturer of the exhaust system shall verify the category in accordance with this subpart.

(1) Not withstanding paragraph (a)(1) of this section, the manufacturer may distribute in commerce exhaust systems of that category for up to 90 days if weather or other conditions beyond the control of the manufacturer make testing of a category impossible and if the following conditions are met:

(i) The manufacturer performs the tests required under paragraph (d) or (e) of this section on such category as soon as conditions permit;

(d) The requirements for each exhaust system category consist of:

(1) Testing in accordance with § 205.171-1 of an exhaust system selected in accordance with § 205.171-2.

(2) Compliance of the test exhaust system on a motorcycle for which it is marketed with the applicable standard when tested in accordance with Appendix I; and

(e) A manufacturer is required to verify all categories of exhaust systems within his product line for each class of Federally regulated motorcycle for which it is designed and marketed. A category of a replacement exhaust system is defined by a separate combination of at least the following parameters:

(1) *Muffler/Silencer:* (i) Volume; (ii) type of absorption material; (iii) amount of absorption material; (iv) length; (v) diameter; (vi) directional flow of exhaust gas; (vii) interior construction; (viii) shell and inner construction material; (ix) number of header pipes entering muffler; and (x) specific motorcycle application.

(2) *Expansion Chamber:* (i) Volume; (ii) diameter; (iii) construction material; (iv) directional flow of exhaust gas; (v) length; and (vi) specific motorcycle application.

(3) *Spark Arrestors:* (i) Volume; (ii) construction material; (iii) directional flow of exhaust gas; (iv) length; (v) diameter, and (vi) specific motorcycle application.

(4) *Other Exhaust System Components:* (i) Volume; (ii) shape; (iii) length; (iv) diameter; (v) material; (vi) directional flow of exhaust gas; and (vii) specific motorcycle application.

(f) Exhaust system components sold as separate products shall be tested pursuant to § 205.166(b).

(g) Original equipment exhaust systems that are also sold as replacement systems for the same motorcycle configuration need not be tested under this subpart if they have been tested or represented in a test report under Subpart D of this part.

(h) A manufacturer has the following alternatives if any test exhaust system is determined not to be in compliance with applicable standards:

(i) Modify the test exhaust system and demonstrate by testing that it meets applicable standards. The manufacturer must modify all production exhaust systems of the same category in the same manner as the test exhaust system before distribution in commerce.

[47 FR 57722, Dec. 28, 1982; 48 FR 27040, June 13, 1983]

§ 205.168-11 **Order to cease distribution.**

(a) If a category of exhaust systems is found not to comply with this subpart because it has not been verified or labeled as required by § 205.169, the Administrator may issue an order to the manufacturer to cease distribution in commerce exhaust systems of that category. This order will not be issued if the manufacturer has made a good faith attempt to properly production verify the category and can establish such good faith.

(b) Any such order shall be issued after notice and opportunity for a hearing which will be held in accordance with title 5 U.S.C. 554.

[45 FR 86718, Dec. 31, 1980, as amended at 48 FR 27040, June 13, 1983]

§ 205.169 **Labeling requirements.**

(a) The manufacturer of any product (including the manufacturer of newly produced motorcycles) subject to this subpart must, at the time of manufacture, affix a permanent, legible label, or mark of the type and in the manner described below, containing the information provided below, to all such exhaust systems or exhaust system components to be distributed in commerce.

(b) The labels or marks shall be affixed in such a manner that they cannot be removed without destroying or defacing them, and must not be applied to any part which is easily detached from such product.

(c) The label or mark shall be in a readily visible position when the exhaust system or exhaust system component is installed on all motorcycles for which it is designed and marketed.

(d) All required language shall be lettered in the English language in block letters and numerals in a color that contrasts with its background.

(e) The label or mark must contain the following information:

(1) For exhaust systems subject to the noise emission standards of § 205.166:

(i) The label heading: Motorcycle Exhaust System Noise Emission Control Information;

(ii)(A) For original equipment and replacement exhaust system, the following statement:

This (manufacturer's name) exhaust system (serial number) meets EPA noise emission requirements of (noise emission standard) dBA for the following motorcycles: (list of model specific codes). Installation of this exhaust system on motorcycle models not specified may violate Federal law.

(B) For exhaust system components designed and marketed for motorcycles, and tested in accordance with § 205.168 as a constituent of a complete exhaust system comprising nonoriginal equipment components (other than itself), as provided for in § 205.166(b)(3), the following statement:

This (manufacturer's name) (type of component) (serial number), when installed with a legal (type of component), meets EPA noise emission requirements of (noise emission standard) dBA for the following motorcycles: (list of model specific codes). Installation of this exhaust system components on motorcycle models not specified may violate Federal law.

(iii) The model specific code must be the same as used by the motorcycle manufacturer and described in § 205.158(a)(6).

(2) For exhaust systems designed solely for use on competition motorcycles (as defined by § 205.151(a)(3) and so designated and labeled by the manufacturer), the statement:

This product is designed for use on closed course competition motorcycles only and does not conform to U.S. EPA noise emission standards. Used on motorcycles subject to EPA noise regulations constitutes tampering and is a violation of Federal law unless it can be shown that such use does not cause the motorcycle to exceed applicable Federal standards.

(3) For exhaust systems designed solely for use on motorcyles manufactured before January 1, 1982, the statement:

This product is designed for use on pre-1982 model year motorcycles only and does not conform to U.S. EPA noise emission standards. Use on motorcycles subject to EPA noise regulations constitutes tampering and is a violation of Federal law unless it can be shown that such use does not cause the motorcycle to exceed applicable Federal standards.

(4) For replacement exhaust systems manufactured in the United States solely for use outside the U.S. and not conforming to the noise emissions standards of this regulation, the statement: "For Export Only."

[45 FR 86718, Dec. 31, 1980, as amended at 47 FR 57722, Dec. 28, 1982]

§ 205.170 **Testing by the Administrator.**

(a)(1) In order for the Administrator to determine whether such exhaust systems or a manufacturer's test facility conform to applicable regulations, the Administrator may require that exhaust systems to be tested pursuant to the Act be submitted to him, at such place and time as he reasonably designates. He may designate the quantity of exhaust systems and the duration of time he reasonably requires for the purpose of conducting tests in accordance with test procedures described in Appendix I. The manner in which the Administrator conducts such tests, the EPA test facility, and the test procedures employed will be based upon good engineering practice and meet or exceed the requirements of Appendix I.

(2) If the Administrator specifies that he will conduct such testing at the manufacturer's facility, the manufacturer shall make available instrumentation and equipment of the type required for test operators by these regulations. The Administrator may conduct such tests with his own equipment, having specifications equal to or exceeding the performance specifications of the instrumentation and equipment required in these regulations.

(3) The manufacturer may observe tests conducted by the Administrator pursuant to this section on exhaust systems produced by the manufacturer and may copy the data accumulated from such tests. The manufacturer may inspect any of the exhaust systems before and after testing by the Administrator.

(b)(1) If, based on tests conducted by the Administrator or on other relevant information, the Administrator determines that the test facility does not meet the requirements of Appendix I or the requirements for an alternative test procedure approved under § 205.154, the Administrator will give notice to the manufacturer in writing of his determination and the reasons underlying it.

(2) The manufacturer may, at any time within 15 days after receipt of a notice issued under paragraph (b)(1) of this section, request a hearing conducted in accordance with 5 U.S.C. 554 on the issue of whether his test facility met the requirements. Such notice will not take effect until 15 days after its receipt by the manufacturer, or, if a hearing is requested under this paragraph, until adjudication by the administrative law judge.

(3) After any notice issued under paragraph (b)(1) of this section has taken effect, no data thereafter derived from that test facility will be acceptable for purposes of this subpart.

(4) The manufacturer may request in writing that the Administrator reconsider his determination under paragraph (b)(1) of this section based on data or information which indicates that changes have been made to the test facility and that such changes have resolved the reasons for disqualification.

(5) Within 10 working days after receipt of the manufacturer's request for reconsideration pursuant to paragraph (b)(4) of this section, the Administrator will notify the manufacturer of his determination and the reasons underlying it with regard to the requalification of the test facility.

(c) The Administrator will assume all reasonable costs associated with shipment of exhaust systems to the place designated pursuant to paragraph (a) of this section except with respect to:

(1) [Reserved]

(2) Testing of a reasonable number of exhaust systems (i) for purposes of selective enforcement auditing under § 205.171, or (ii) if the manufacturer has failed to establish that there is a

correlation between its test facility and the EPA test facility, or (iii) the Administrator has reason to believe, and provides the manufacturer with a statement of such reason, that the exhaust systems to be tested would fail to meet the standard prescribed in this subpart if tested at the EPA test facility, even though they would meet such standard if tested at the manufacturer's test facility;

(3) Any testing performed during a period when a notice of nonconformance of the manufacturer's test facility issued pursuant to paragraph (b) of this section is in effect;

(4) Any testing performed at a place other than the manufacturer's facility as a result of the manufacturer's failure to permit the Administrator to conduct or monitor testing as required by this subpart; and

(5) In addition to any exhaust systems included in paragraphs (c)(2), (3), or (4) of this section, testing of up to 10 percent of the manufacturer's exhaust systems for a model year if the Administrator determines testing these exhaust systems at the EPA test site is necessary to assure that a manufacturer has acted or is acting in compliance with the Act.

(Secs. 11 and 13 of the Noise Control Act (42 U.S.C. 4910, 4912); 42 U.S.C. 4905; 86 Stat. 1237 and secs. 6, 10, 11, 13, Pub. L. 92-574, 86 Stat. 1234 (42 U.S.C. 4905, 4909, 4910, 4912))

[45 FR 86718, Dec. 31, 1980; 46 FR 4918, Jan. 19, 1981, as amended at 47 FR 57722, Dec. 28, 1982; 49 FR 26738, June 29, 1984]

§ 205.171 Selective enforcement auditing (SEA) requirements.

§ 205.171-1 Test request.

(a) The Administrator will request all testing under § 205.171 by means of a test request addressed to the manufacturer.

(b) The test request will be signed by the Assistant Administrator for Enforcement or his designee. The test request will be delivered to the plant manager or other responsible official as designated by the manufacturer.

(c) The test request will specify the exhaust system category, model and model year of motorcycle selected for testing, the manufacturer's plant or storage facility from which the exhaust systems must be selected, the method of selection and the time at which the exhaust systems must be selected. The test request will also provide for situations in which the selected exhaust system is unavailable for testing. The test request may include an alternative exhaust system category designated for testing in the event that exhaust systems of the first specified category are not available for testing because the exhaust systems are not being manufactured at the specified plant or are not being manufactured during the specified time or are not being stored at the specified plant or storage facility.

(d)(1) If the manufacturer projects a yearly production of fewer than 50 exhaust systems of the specified category to be tested, then, within five (5) days of receipt of the request, the manufacturer must notify the Administrator of such low volume production. The Administrator will then provide a revised test request specifying a testing plan which imposes no greater risk of failure (5%) at the acceptable quality level (10%) than the plan in Appendix II. Upon receipt of the revised test request, the manufacturer must select and test a sample of exhaust systems from the category specified in the test request in accordance with this subpart and the conditions specified in the test request.

(2) If the manufacturer produces 50 or more of the specified category, then, upon receipt of the test request, the manufacturer must select and test a sample of exhaust systems for the category specified in the test request in accordance with this subpart and the conditions specified in the test request.

(e)(1) Any testing conducted by the manufacturer under a test request must be initiated within the time period specified in the test request; except that initiation may be delayed for increments of 24 hours or one business day where ambient test site weather conditions, or other conditions beyond the control of the manufacturer, in that 24-hour period do not permit testing. The manufacturer must record the conditions for this period.

(2) The manufacturer must complete noise emission testing on a minimum of ten exhaust systems per day unless otherwise provided by the Administrator or unless ambient test site conditions permit only the testing of a lesser number, in which event the ambient test site weather conditions for that period must be recorded.

(3) The manufacturer is allowed 24 hours to ship exhaust systems from a sample from the assembly plant to the testing facility if the facility is not located at the plant or in close proximity to the plant. The Administrator may approve more time based upon a request by the manufacturer accompanied by a satisfactory justification.

(f) The Administrator may issue an order to the manufacturer to cease distribution in commerce of exhaust systems of a specified category being manufactured at a particular facility if:

(1) The manufacturer refuses to comply with the provisions of a test request issued by the Administrator under this section; or

(2) The manufacturer refuses to comply with any of the requirements of this section.

(g) A cease distribution order will not be issued under paragraph (f) of this section if the manufacturer's refusal is caused by conditions and circumstances outside his control which render compliance with the provisions of a test request or with any other requirements of this section impossible. Conditions and circumstances outside the control of the manufacturer include, but are not limited to, the temporary unavailability of equipment and personnel needed to conduct the required tests, caused by uncontrollable factors such as equipment breakdown or failure or illness of personnel. Failure of the manufacturer to adequately plan for and provide the equipment and personnel needed to conduct the tests does not constitute uncontrollable factors. The manufacturer must bear the burden of establishing the presence of the conditions and circumstances required by this paragraph.

(h) Any order to cease distribution will be issued only after notice and opportunity for a hearing in accordance with 5 U.S.C. 554.

§ 205.171-2 Test exhaust system selection and preparation.

(a)(1) Exhaust systems comprising the sample which are required to be tested under a test request in accordance with this subpart must be selected consecutively as they are produced.

(2) Test motorcycles and test exhaust systems to be used for testing of exhaust systems must be of the subject class which has been assembled using the manufacturer's normal production processes, in stock configuration including exhaust system, as sold or offered for sale in commerce.

(3) Before the official test, the test motorcycle and test exhaust system must not be prepared, tested, modified, adjusted, or maintained in any manner unless such preparation, tests, modifications, adjustments or maintenance are part of the original equipment manufacturer's prescribed manufacturing and inspection procedures, and are documented in the manufacturer's internal motorcycle assembly and inspection procedures, or are required or permitted under this subpart, or are approved in advance by the Administrator.

(4) Equipment or fixtures necessary to conduct the test may be installed on the motorcycle, if such equipment or fixtures shall have no effect on the noise emissions of the motorcycle as determined by the measurement methodology.

(5) In the event of a motorcycle malfunction (i.e., failure to start, etc.) maintenance that is necessary may be performed to enable the vehicle to operate in a normal manner. This maintenance must be documented and reported in the final report prepared and submitted in accordance with this subpart.

(6) No quality control, quality assurance testing, assembly or selection procedures may be used on the test vehicle or any portion thereof, including parts and subassemblies, that will not normally be used during the production and assembly of all other motorcycles of that class which will be distributed in commerce, unless such pro-

cedures are required or permitted under this subpart or are approved in advance by the Administrator.

(b) The Acceptable Quality Level (AQL) is 10 percent. The appropriate sampling plans associated with the designated AQL are contained in Appendix II or the test request.

(c) The exhaust systems of the category selected for testing must be assembled by the manufacturer for distribution in commerce using the manufacturer's normal production process.

(d) Unless otherwise indicated in the test request, the manufacturer must initiate testing with the exhaust systems of the category specified in the test request which are next scheduled for production after receipt of the test request.

(e) The manufacturer must keep on hand all products in the test sample until the sample is accepted or rejected in accordance with § 205.171-8; except that exhaust systems actually tested and found to be in conformance with this regulation need not be kept.

[45 FR 86718, Dec. 31, 1980, as amended at 47 FR 57723, Dec. 28, 1982]

§ 205.171-3 Test motorcycle sample selection.

A test motorcycle to be used for selective enforcement audit testing of exhaust systems must be a motorcycle of the subject class which has been assembled using the manufacturer's normal production process, in stock configuration including exhaust system, and sold or offered for sale in commerce.

§ 205.171-6 Testing procedures.

(a) The manufacturer of the exhaust system must conduct one valid test in accordance with the appropriate test procedure specified in Appendix I for each exhaust system selected for testing under this subpart.

(b) No maintenance may be performed on the test exhaust system except as provided by § 205.171-2. In the event an exhaust system is unable to complete the noise emission test, the manufacturer may replace the exhaust system. Any replacement exhaust system must be a production exhaust system of the same category as the exhaust system which it replaced, and it is subject to all the provisions of this subpart.

[45 FR 86718, Dec. 31, 1980, as amended at 47 FR 57723, Dec. 28, 1982]

§ 205.171-7 Reporting of the test results.

(a)(1) The manufacturer must submit a copy of the test report for all testing conducted pursuant to § 205.171 at the conclusion of each 24-hour period during which testing is done.

(2) For each test conducted, the manufacturer must provide the following information:

(i) Category identification where applicable;

(ii) Year, manufacturing date, serial number and model of exhaust system;

(iii) Year, make serial number, and model of test motorcycle; and

(iv) Test results by serial numbers.

(b) In the case where an EPA Enforcement Officer is present during testing required by this subpart, the written reports requested in paragraph (a) of this section may be given directly to the Enforcement Officer.

(c) Within 5 days after completion of an SEA, the manufacturer must submit to the Administrator a final report which will include the following:

(1) The name, location, and description of the manufacturer's noise emission test facilities which meet the specifications of Appendix I and where utilized to conduct testing reported under this section, except, that a test facility that has been described in a previous submission under this subpart need not again be described, but must be identified as that facility.

(2) The following information for each noise emission test conducted:

(i) The individual records required by § 205.172 (a)(2) for all noise emission tests including for each invalid test, the reason for invalidation;

(ii) A complete description of any modification, repair, preparation, maintenance, or testing, which could affect the noise emissions of the product and which was performed on the test exhaust system but not performed on all other production exhaust systems;

(iii) The test results for any replacement exhaust system and the reason for its replacement.

(3) A complete description of the sound data acquisition system if other than that specified in Appendix I.

(4) The following statement and endorsement:

This report is submitted pursuant to section 6 and section 13 of the Noise Control Act of 1972. To the best of (company name) knowledge, all testing for which data is reported here was conducted in strict conformance with applicable regulations under 40 CFR Part 205 *et seq.*, all the data reported here are a true and accurate representation of such testing, and all other information reported here is true and accurate. I am aware of the penalties associated with violations of the Noise Control Act of 1972 and the regulations thereunder. (authorized representative).

(5) Additional information required by the test request.

(d) Information required to be submitted to the Administrator under this section must be sent to the following address: Director, Noise and Radiation Enforcement Division, (EN-387), U.S. Environmental Protection Agency, Washington, DC 20460.

§ 205.171-8 Passing or failing under SEA.

(a) A failing exhaust system is one which, when installed on any motorcycle which is in compliance with the requirements of Subpart D and for which it is designed and marketed, together with such motorcycle produces a measured noise level in excess of the applicable noise emission standard in § 205.166.

(b) The number of failing vehicles in a sample determines whether the sample passes or fails (See applicable tables in Appendix II). If the number of failing vehicles is greater than or equal to the number in Column B, the sample fails. If the number of failing vehicles is less than or equal to the number in Column A, the sample passes.

(c) Pass or failure of a SEA takes place when a decision that an exhaust system is a passing or failing unit is made on the last exhaust system required to make a decision under paragraph (b) of this section.

(d) If the manufacturer passes the SEA, he will not be required to perform any additional testing on subsequent exhaust systems to satisfy the test request.

(e) The Administrator may terminate testing earlier than required in paragraph (b) of this section, based on a request by the manufacturer, accompanied by voluntarily ceasing distribution in commerce of exhaust systems from the category in question, manufactured at the plant which produced the exhaust systems being tested. Before reinitiating distribution in commerce of that exhaust system category from that plant, the manufacturer must take the action described in § 205.171-10(a)(1) and (2).

§ 205.171-9 Continued testing.

(a) If an SEA failure occurs according to paragraph (b) of § 205.171-8, the Administrator may require that any or all exhaust systems of that category produced at that plant be tested before distribution in commerce.

(b) The Administrator will notify the manufacturer in writing of his intent to require continued testing of exhaust systems under paragraph (a) of this section.

(c) The manufacturer may request a hearing on the issues of whether the SEA was conducted properly; whether the criteria for SEA failure have been met; and the appropriateness or scope of a continued testing order. If a hearing is requested, the hearing will begin no later than 15 days after the date on which the Administrator received the hearing request. Neither the request for a hearing nor the fact that a hearing is in progress will affect the responsibility of the manufacturer to commence and continue testing required by the Administrator pursuant to paragraph (a) of this section.

(d) Any tested exhaust system which demonstrates conformance with the applicable standard may be distributed into commerce.

(e) Any distribution into commerce of an exhaust system which does not comply with the applicable standard is a prohibited act.

§ 205.171-10 Prohibition on distribution in commerce; manufacturer's remedy.

(a) The Administrator will permit the manufacturer to cease testing under § 205.171-9 after the manufacturer has taken the following actions:

(1) Submission of a written report to the Administrator which identifies the reason for the noncompliance of the exhaust systems, describes the problem and describes the proposed quality control or quality assurance remedies to be taken by the manufacturer to correct the problem.

(2) Demonstration that the specified exhaust system category has passed a retest conducted in accordance with § 205.171 and the conditions specified in the test request.

(b) The manufacturer may begin testing under paragraph (a)(2) of this section upon submitting the report, required by paragraph (a)(1) of this section any may cease continued testing upon making the demonstration required by paragraph (a)(2) of this section. The Administrator may require resumption of continued testing if he determines that the manufacturer has not satisfied the requirements of paragraphs (a)(1) and (2) of this section.

(c) Any exhaust system failing the noise emission tests conducted pursuant to Appendix I may not be distributed into commerce until necessary adjustment or repairs have been made and the exhaust system passes a retest.

[45 FR 86718, Dec. 31, 1980, as amended at 47 FR 57723, Dec. 28, 1982]

§ 205.172 Maintenance of records; submittal of information.

(a) Except as otherwise provided in regulation, the manufacturer of any new exhaust system subject to any of the standards or procedures prescribed in this subpart must establish, maintain and retain the following adequately organized and indexed records:

(1) General records:

(i) Identification and description by category parameters of all exhaust systems in the manufacturer's product line;

(ii) A description of any procedures other than those contained in this subpart used to perform noise emission tests on any test exhaust system;

(iii) A record of the calibration of the acoustical instrumentation as is described in Appendix I;

(iv) A record of the date of manufacture of each exhaust system subject to this subpart, keyed to the serial number.

(2) Individual records for test exhaust systems:

(i) A complete record of all noise emission tests performed for Production Verification and Selective Enforcement Audit (except tests performed by EPA directly), including all individual worksheets and other documentation or exact copies relating to each test;

(ii) A record of the information recorded as described in Appendix I; and

(iii) A record and description of all repairs, maintenance and other servicing which were performed before successful testing of the exhaust system pursuant to these regulations and which could affect the noise emission of the exhaust system, giving the date and time of the maintenance or service, the reason for it, the person authorizing it, and the names of supervisory personnel responsible for the conduct of the maintenance or service.

(3) A properly filed production verification report following the format prescribed by the Administrator in § 205.168-3 fulfills the requirements of paragraphs (a)(1)(i) and (ii) of this section.

(4) All records required to be maintained under this subpart must be retained by the manufacturer for a period of three (3) years from the production verification date. Records may be retained as hard copy or alternatively reduced to microfilm, punch cards, etc., depending on the record retention procedures of the manufacturer; however, when an alternative method is used, all information contained in the hard copy must be contained in the copy made by the alternative method.

(b) The manufacturer must, upon request, submit to the Administrator the following information with regard to new exhaust system production:

(1) Number of exhaust systems, by category, scheduled for production for the time period designated in the request.

(2) Number of exhaust systems, by category, produced during the time period designated in the request.

(c) The reporting requirements of this regulation will no longer be effective after five (5) years from the last effective date of this regulation. However, the requirements will remain in effect if the Administrator is taking appropriate steps to repromulgate or modify the reporting requirements at that time.

§ 205.173 In-use requirements.

§ 205.173-1 Warranty.

(a) The exhaust system manufacturer must include in the information supplied to the ultimate purchaser pursuant to § 205.173-4, the following statement:

NOISE EMISSION WARRANTY

[The manufacturer] warrants that this exhaust system, at time of sale, meets all applicable U.S. E.P.A. Federal noise standards. This warranty extends to the first person who buys this exhaust system for purposes other than resale, and to all subsequent buyers. Warranty claims should be direct to ———. (Manufacturer shall fill in this blank with his name, address and telephone number.)

(b) [Reserved]

(c) All information must be sent to:

Director, Noise and Radiation Enforcement Division (EN-387), Environmental Protection Agency, Washington, DC 20460.

[45 FR 86718, Dec. 31, 1980, as amended at 47 FR 57723, Dec. 28, 1982]

§ 205.173-2 Tampering.

The manufacturer must include the following statement pursuant to § 205.173-4 with each product of that category the manufacturer distributes into commerce:

TAMPERING PROHIBITION

Federal law prohibits any modification to this exhaust system which causes the motorcycle to exceed the Federal noise standard. Use of the motorcycle with such a modified exhaust system is also prohibited.

Acts likely to constitute tampering include removal or puncturing the muffler, baffles, header pipes, or any other component which conducts exahust gases.

[45 FR 86718, Dec. 31, 1980, as amended at 47 FR 57723, Dec. 28, 1982]

§ 205.173-3 Warning statement.

The manufacturer must include the following statement pursuant to § 205.173-4 with each product of that category the manufacturer distributes into commerce:

Warning: This product should be checked for repair or replacement if the motorcycle noise has increased significantly through use. Otherwise, the owner may become subject to penalties under state and local ordinances.

[45 FR 86718, Dec. 31, 1980, as amended at 47 FR 57723, Dec. 28, 1982]

§ 205.173-4 Information sheet.

The manufacturer must include the Noise Emissions Warranty statement, Tampering Prohibition statement and the Warning statement with each product. All three statements must be printed on a white sheet or card at least 8½"×11". Each statement must cover no more than ⅓ of the sheet or card. No other printing must be on the sheet. The statements must be printed in black ink; the statement headings must be in capital letters in a minimum size type of 12 point (pica type) or its equal; and the test of the statement must be a minimum size type of 10 point (elite type) or its equal. The sheet or card must be placed with the exhaust system inside any packaging. If there is no packaging, the sheet or card must be affixed to the exhaust system so that it will not be accidentally detached in shipping.

§ 205.174 Remedial orders.

The Administrator may issue appropriate remedial orders to a manufacturer if products are distributed into commerce not in compliance with the regulations of this subpart. Potential orders are stop sale orders, orders to cease distribution, relabel, replace or recall, or any other orders appropriate in the specific circumstances. A remedial order will be issued only after notice and opportunity for a hearing in accordance with 5 U.S.C. 554.

Appendix I to Subparts D and E—Motorcycle Noise Emission Test Procedures

Appendix I-1 to Subparts D and E—Test Procedure for Street and Off-Road Motorcycles

(a) *Instrumentation.* Proper usage of all test instrumentation is essential to obtain valid measurements. Operating manuals or other literature furnished by the instrument manufacturer must be referred to for both recommended operation of the instrument and precautions to be observed. The following instrumentation must be used, where applicable:

(1) A sound level measurement system which meets the type S1A requirements of American National Standard Specification for Sound Level Meters, ANSI S1.4-1971. As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indicating instrument provided that the system meets the performance requirements of ANSI S1.4-1971. The sound level measurement system must be calibrated at least annually to insure that the system meets the performance requirements of ANSI S1.4-1971.

(2) An acoustic calibrator with an accuracy of within ±0.5 dB. The calibrator must be checked annually to verify that its output is within the specified accuracy.

(3)(i) An engine speed measurement system having the following characteristics:

(A) Steady-state accuracy of within ±3% of actual engine speed in the range of 45% to 100% of the engine speed (RPM) where peak net brake power (maximum rated RPM) is developed; and

(B) Response characteristics such that, when closing RPM is indicated under an acceleration as described below, actual engine speed is no more than 3 percent (of closing RPM) greater than the specified closing RPM.

(ii) The vehicle tachometer may be used to ascertain:

(A) The approach RPM provided its meets the specifications in paragraph (a)(3)(i)(A).

(B) The closing RPM provided it meets the specifications in paragraphs (a)(3)(i)(A) and (B).

(iii) Indirect engine speed measurement systems, such as systems which determine engine speed from vehicle speed measurement, may be used provided the specifications of paragraph (a)(1)(i) are met.

(4) An anemometer with steady-state accuracy of within ±10% at 20 km/h (12.4 mph).

(5) A microphone wind screen which does not affect microphone response more than ±0.5 dB for frequencies of 20-4000 Hz or ±1.0 dB for frequencies of 4000-10,000 Hz, taking into account the orientation of the microphone.

(b) *Test site.* (1) The measurement area within the test site must meet the following requirements and be laid out as described:

(i) The following points must be established:

(A) Microphone target point—a reference point on the vehicle path;

(B) End point— a point on the vehicle path 7.5 ± 0.3m (24.6 ± 1.0 ft) beyond the microphone target point, and

(C) Microphone location point—a point 15± 0.3m (49.2 ± 1.0 ft) from the microphone target point on a normal to the vehicle path through the microphone target point.

(ii) The microphone must be:

(A) Positioned at the microphone location point 1.2 ± 0.1 m (3.9 ± 0.3 ft) above the ground plane; and

(B) Oriented in a plane perpendicular to the vehicle path, and at an angle for which the microphone was calibrated to have the flatest response characteristics over the frequency range of 100 Hz to 10,000 Hz when measured with respect to the motorcycle source.

(iii) The surface of the ground within at least the triangular area formed by the microphone location and the points 15 ± 0.3m (49.2 ±1.0 ft.) prior to and 15 ± 0.3 m (49.2 ± 1.0 ft.) beyond the microphone target point must be flat (+ 5 cm (2.0 in)) and level (grade not more than 0.5% along vehicle path), have a concrete or sealed asphalt surface, and be free from snow, soil or other extraneous material.

(iv) The vehicle path must be relatively smooth and of sufficient length for safe acceleration, deceleration and stopping of the motorcycle.

(2) The test site must be flat, open space free of large sound-reflecting surfaces (other than the ground), such as parked vehicles, sign-boards, buildings or hillsides located within a 30 ± 0.3 m (98.4 ± 1.0 ft) radius of the microphone location and the following points on the vehicle path (see Figure 1):

(i) The microphone location point;

(ii) A point 15 ± 0.3 m (49.2 ± 1.0 ft.) before the microphone target point; and

(iii) A point 15 ± 0.3 m (49.2 ± 1.0 ft) beyond the microphone target point.

(c) *Measurement procedure.*

(1) To establish the acceleration point, the end point must be approached in second gear from the reverse of the intended test direction at a constant engine speed of 50% of maximum rated RPM or closing RPM less ten percent of (of maximum rated RPM), whichever is lower, (±2.5% of observed reading). When the front of the motorcycle reaches the end point (approached from the reverse direction), the throttle must be smoothly and fully opened to accelerate the motorcycle past the microphone target point under wide open throttle. When the motorcycle reaches closing RPM the throttle must be smoothly and fully closed. An ignition disable device may be used to turn off the engine at closing RPM in lieu of closing the throttle manually. The location of the front of the motorcycle at the time of throttle closure is the acceleration point for the test runs. The test runs must be made in the opposite direction. A sufficient number of trial runs must be made to assure accurate establishment of the acceleration point.

(2) Closing RPM must be determined according to the motorcycle engine displacement, as follows (see Figure 2):

Displacement (cc)	Closing RPM (Fraction of maximum rated RPM—percent)
0 to 175	95
176 to 675	109 to 0.08×(engine displacement in cc)
676 and above	55

(3) The distance from the acceleration point to the end point must be at least 10 m (32.8 ft). If this distance is less than 10 m (32.8 ft) by the procedure specified in paragraph (c)(1), above, third gear, if the motorcycle is so equipped, must be used. If the distance is still less than 10 m (32.8 ft), fourth gear, if the motorcycle is so equipped, must be used, and so on. If closing RPM is reached before the vehicle travels 10 m (32.8 ft), with the vehicle in its highest gear, the throttle must be opened less rapidly, but in such a manner that full throttle and closing RPM are attained at the end point.

(4) If the motorcycle is equipped with an automatic transmission, the procedure specified in paragraph (c)(1), must be followed except that the lowest selectable range must be employed, and the procedure specified in paragraph (c)(3) must be followed using the next selectable higher range, if necessary, and if the vehicle is so equipped. If closing RPM is reached before the vehicle travels 10 m (32.8 ft.), the throttle must be opened less rapidly, but in such a manner that full throttle and closing RPM are attained at the end point.

(5) Throttle opening must be controlled to avoid excessive wheel slip or lift-off.

(6) To conduct a sound measurement, the motorcycle must proceed along the vehicle path in the forward direction in second gear (or higher gear as applicable under paragraph (c)(3)) at a constant engine speed of 50% of maximum rated RPM or at closing RPM less ten percent (of maximum rated RPM), whichever is lower (± 2.5 percent of observed reading). When the front of the vehicle reaches the acceleration point, the throttle must be smoothly and fully opened. Full acceleration must continue until closing RPM is reached, which must occur within ± 1.0 m (3.3 ft.) of the end point, and at which time the throttle must be smoothly and fully closed. An ignition disable device may be used to turn off the engine at closing RPM in lieu of closing the throttle manually.

(7) A sufficient number of preliminary runs must be conducted before the testing to familiarize the rider with the test procedure and operating conditions of the vehicle. The engine temperature must be within the normal operating range prior to each run.

(d) *Measurements.* (1) The sound level meter must be set for fast response and for the A-weighting network. The microphone wind screen must be used. The sound level meter must be calibrated with the acoustic calibrator as often as is necessary throughout testing to maintain the accuracy of the measurement system.

(2) The sound level meter must be observed throughout the acceleration period. The highest sound level obtained for the run must be recorded.

(3) Measurements must be made until at least four readings from each side are within 2 dB of each other. The noise level for each side is the average of the four which are within 2 dB of each other. The noise level reported must be for that side of the motorcycle having the highest noise level.

(4) While making sound level measurements, not more than one person other than the rider and the observer reading the meter may be within 15 m (49.2 ft) of the vehicle or microphone, and that person must be directly behind the observer reading the meter, on a line through the microphone and the observer.

(5) The ambient noise level (including wind effects) at the test site due to sources other than the motorcycle being measured must be at least 10 dB lower than the noise level at the microphone location produced by the motorcycle under test.

(6) Wind speed at the test site during tests must be less than 20 km/h (12.4 mph).

(e) *Required data.* For each valid test, the following data must be recorded:

(1) Motorcycle type, serial number, model year, and date of manufacture.

(2) Names of persons conducting test.

(3) Test location.

(4) Wind speed and ambient noise level measured on the same day as the test and representative of conditions during the test.

(5) Motorcycle engine displacment, maximum rated RPM, and closing RPM.

(6) The gear used for testing if other than second gear; or type of transmission and description of testing if motorcycle is equipped with automatic transmission.

(7) Description of the sound level meter including type, serial number, and calibration date.

(8) Description of the external acoustic calibrator including type, serial number, and calibration date.

(9) Description of the tachometer or engine speed measurement system used for conducting the test.

(10) Maximum noise level for each pass on each side of the motorcycle including invalid readings and reasons for invalidation.

(11) Reported noise level.

(12) Other information as appropriate to completely describe testing conditions and procedure.

APPENDIX I-2 TO SUBPARTS D AND E—TEST PROCEDURE FOR STREET MOTORCYCLES THAT MEET THE DEFINITION OF § 205.151(A)(2)(II) (MOPED-TYPE STREET MOTORCYCLES)

(a) *Instrumentation.* Proper usage of all test instrumentation is essential to obtain valid measurements. Operating manuals or other literature furnished by the instrument manufacturer must be referred to for both recommended operation of the instrument and precautions to be observed. The following instrumentation must be used, where applicable:

(1) A sound level measurement system which meets the type SIA requirements of American National Standard Specification for Sound Level Meters, ANSI S1.4-1971. As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indicating instrument provided that the system meets the performance requirements of ANSI S1.4-1971. The sound level measurement system must be calibrated at least annually to insure that the system meets the performance requirements of ANSI S1.4-1971.

(2) An acoustic calibrator with an accuracy of within ±0.5 dB. The calibrator must be checked annually to verify that its output is within the specified accuracy.

(3) An anemometer with steady-state accuracy of within ±10% at 20 km/h (12.4 mph).

(4) A microphone wind screen which does not affect microphone response more than ±0.5 dB for frequencies of 20-4000 Hz or ±1.0 dB for frequencies of 4000-10,000 Hz, taking into account the orientation of the microphone.

(b) *Test site.* (1) The measurement area within the test site must meet the following requirements and be laid out as described:

(i) The following points must be established:

(A) Microphone target point—a reference point on the vehicle path;

(B) End point—a point on the vehicle path 7.5±0.3 m (24.6±1.0 ft) beyond the microphone target point; and

(C) Microphone location point—a point 15±0.3 m (49.2±1.0 ft) from the microphone target point on a normal to the vehicle path through the microphone target point. Alternately, the microphone location point may be a point 7.5±0.3 m (24.6±1.0 ft) from the microphone target point provided that the sound level reported is adjusted as provided in this appendix under paragraph (d)(3).

(ii) The microphone must be:

(A) Positioned at the microphone location point 1.2±0.1 m (3.9±0.3 ft) above the ground plane; and

(B) Oriented in a plane perpendicular to the vehicle path, and at an angle for which the microphone was calibrated to have the flattest response characteristics over the frequency range of 100 Hz to 10,000 Hz when measured with respect to the motorcycle source.

(iii) The surface of the ground within at least the triangular area formed by the microphone location and the points 15±0.3 m (49.2±1 ft) prior to and 15±0.3 m beyond the microphone target point must be flat (±5 cm (2.0 in)) and level (grade not more than 0.5% along vehicle path), have a concrete or sealed asphalt surface, and be free from snow, soil or other extraneous material.

(iv) The vehicle path must be relatively smooth and of sufficient length for safe acceleration, deceleration and stopping of the motorcycle.

(2) The test site must be a flat, open space free of large sound-reflecting surfaces (other than the ground), such as parked vehicles, signboards, buildings or hillsides located within a 30±0.3 m (98.4±1.0 ft) radius of the microphone location and the following points on the vehicle path (see Figure 1):

(i) The microphone location point;

(ii) A point 15±0.3 m (49.2±1 ft) before the microphone target point; and

(iii) A point 15±0.3 m (49.2±1 ft) beyond the microphone target point.

(c) *Measurement procedure.* (1) The combined weight of the test rider and test equipment used on the motorcycle must not be more than 80 kg (176 lb) nor less than 75 kg (165 lb). Weights shall be placed on the motorcycle saddle behind the rider to compensate for any difference between the actual driver/equipment load and the required 75 kg (165 lb) minimum.

(2) The motorcycle must approach the microphone target point with the throttle fully open and in the highest gear. The motorcycle must start such that maximum speed is reached before the vehicle is within 7.5 m of the microphone target point. The motorcycle must continue along the vehicle path with fully open throttle and at maximum speed past the end point, at which time the throttle must be closed.

(3) If the motorcycle is equipped with an automatic transmission, the procedure of paragraph (1), above, must be followed except that the highest selectable range shall be employed.

(d) *Measurements.* (1) The sound level meter must be set for fast response and for the A-weighting network. The microphone wind screen must be used. The sound level meter must be calibrated with the acoustic calibrator as often as is necessary throughout testing to maintain the accuracy of the measurement system.

(2) The sound level meter must be observed throughout the passby period. The highest noise level obtained for the run must be recorded.

(3) At least three measurements shall be made for each side of the motorcycle. Measurements must be made until at least three readings from each side are within 2 dB of each other. The noise level for each side must be the average of the three. The noise level reported must be for that side of the motorcycle having the highest noise level. If the microphone location point is 7.5 m from the vehicle path as allowed in this appendix under paragraph (b)(1)(i)(c), the noise level must be adjusted by subtracting 6 dB prior to being reported.

(4) While making noise level measurements, not more than one person other than the rider and the observer reading the meter may be within 15 m (49.2 ft) of the vehicle or microphone, and that person must be directly behind the observer reading the meter, on a line through the microphone and the observer.

(5) The ambient sound level (including wind effects) at the test site due to sources other than the motorcycle being measured must be no greater than 60 dB if the microphone is located 15 m from the vehicle path or 66 dB if the microphone is located 7.5 m from the vehicle path as allowed in this appendix under paragraph (b)(1)(i)(c).

(6) Wind speed at the test site during tests must be less than 20 km/h (12.4 mph).

(e) *Required data.* For each valid test, the following data must be recorded:

(1) Motorcycle type, serial number, model year, and date of manufacture.

(2) Names of persons conducting test.

(3) Test location.

(4) Wind speed and ambient noise level measured on the same day as the test and representative of conditions during the test.

(5) Description of the sound level meter including type, serial number, and calibration date.

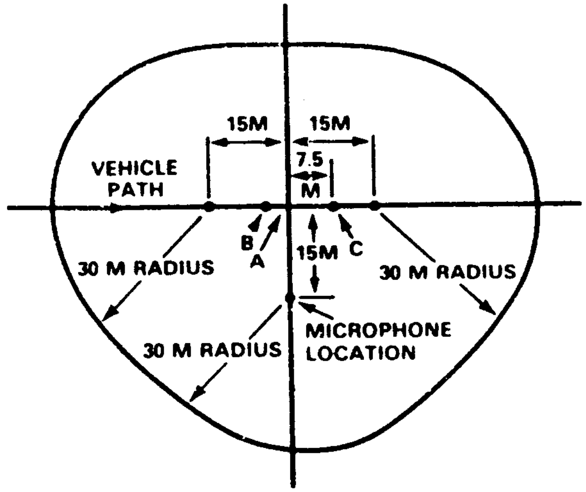
(6) Description of the external acoustic calibrator including type, serial number, and calibration date.

(7) Maximum noise level for each pass on each side of the motorcycle including invalid readings and reasons for invalidation.

(8) Reported noise level.

(9) Other information as appropriate to completely describe testing conditions and procedure.

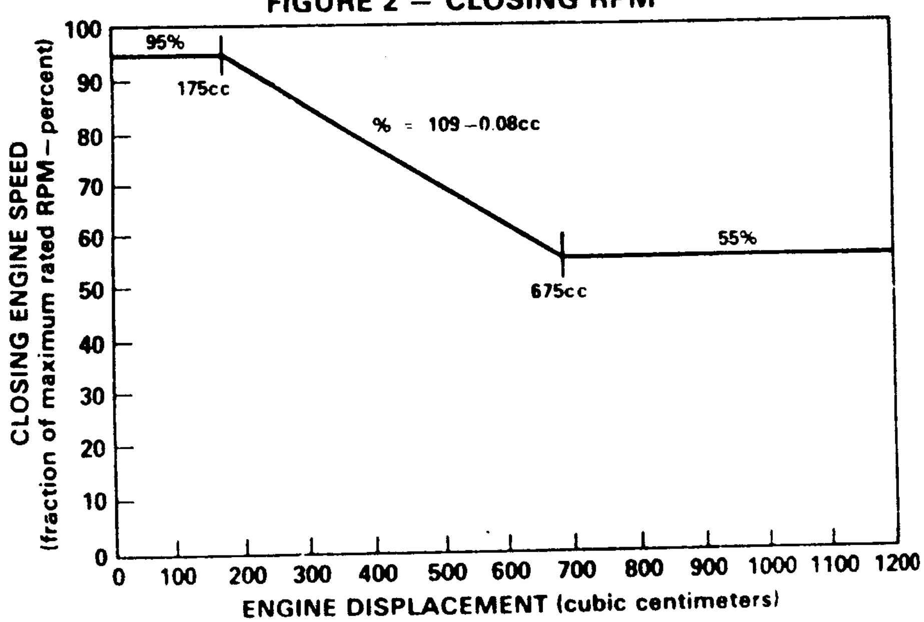
FIGURE 1 — TEST MEASUREMENT AREA



A – MICROPHONE TARGET POINT
B – ACCELERATION POINT (VARIABLE)
C – END POINT

TEST MEASUREMENT AREA

FIGURE 2 — CLOSING RPM



Appendix II to Subpart E—Sampling Tables

TABLE 1—MODEL YEAR PRODUCTION VOLUME OF 50–99 VEHICLES

Cumulative number of tests	Number of failing vehicles	
	Column A	Column B
1		
2		
3		3
4		3
5		3
6		3
7	0	3
8	0	4
9	0	4
10	0	4
11	1	4
12	1	4
13	1	5
14	1	5
15	2	5
16	2	5
17	2	5
18	2	5
19	2	5
20	4	5

TABLE 2—MODEL YEAR PRODUCTION VOLUME OF 100–199 VEHICLES

Cumulative number of tests	Number of failing vehicles	
	Column A	Column B
1		
2		
3		3
4		3
5		3
6		3
7	0	4
8	0	4
9	0	4
10	0	4
11	1	4
12	1	5
13	1	5
14	1	5
15	1	5
16	2	5
17	2	5
18	2	5
19	2	5
20	4	5

TABLE 3—MODEL YEAR PRODUCTION VOLUME OF 200–399 VEHICLES

TABLE 3—MODEL YEAR PRODUCTION VOLUME OF 200–399 VEHICLES—Continued

Cumulative number of tests	Number of failing vehicles	
	Column A	Column B
1		
2		
3		3
4		3
5		3
6		3
7	0	4
8	0	4
9	0	4
10	0	4
11	0	5
12	1	5
13	1	5
14	1	5
15	1	5
16	2	5
17	2	5
18	2	5
19	2	5
20	4	5

TABLE 4—MODEL YEAR PRODUCTION VOLUME OF 400 OR MORE VEHICLES

Cumulative number of tests	Number of failing vehicles	
	Column A	Column B
1		
2		
3		3
4		3
5		3
6		4
7	0	4
8	0	4
9	0	4
10	0	4
11	0	5
12	1	5
13	1	5
14	1	5
15	1	5
16	2	5
17	2	5
18	2	5
19	2	5
20	4	5

PART 209—RULES OF PRACTICE GOVERNING PROCEEDINGS UNDER THE NOISE CONTROL ACT OF 1972

Subpart A—Rules of Practice Governing Hearings for Orders Issued Under Section 11(d) of the Noise Control Act

Appendix J -- EPA Noise Standards for Motor Carriers Engaged in Interstate Commerce

(iii) If a locomotive load cell test stand(s) and the locomotive being tested are present and operating with stationary locomotive(s), including at least one switcher locomotive, the value L_{90} minus 3 dB is the value of the A-weighted sound level to be used in determining applicability of the standards in §§ 201.11(c), 201.12(c) and 201.16.

(iv) If a locomotive load cell test stand(s) and the locomotive being tested are present and operating, and a stationary locomotive(s) is present, and if the nearly steady-state sound level is observed to change by 10 dB, coincident with evidence of a change in operation of the locomotive load cell test stand but without apparent change in the location of stationary locomotives, another measurement of L_{90} must be made in accordance with paragraph (b) of this section. If this additional measure of L_{90} is validated and differs from the initial measure of L_{90} by an absolute value of 10 dB or more, then the higher value of L_{90} is the value of the A-weighted sound level to be used in determining applicability of the standard in § 201.16.

(2) In order to accomplish the comparison demonstration of paragraph (c)(3) of this section, when one or more source types is found not to be in compliance with the applicable standard(s), documentation of noise source information shall be necessary. This will include, but not be limited to, the approximate location of all sources of each source type present and the microphone position on a diagram of the particular railroad facility, and the distances between the microphone location and each of the sources must be estimated and reported. Additionally, if other rail or nonrail noise sources are detected, they must be identified and similarly reported.

(3) If it can be demonstrated that the validated L_{90} is less than 5 dB greater than any L_{90} measured at the same receiving property location when the source types that were operating during the initial measurement(s) are either turned off or moved, such that they can no longer be detected, the initial value(s) of L_{90} must not be used for determining applicability to the standards. This demonstration must be made at a time of day comparable to that of the initial measurements and when all other conditions are acoustically similar to those reported in paragraph (c)(2) of this section.

[45 FR 1263, Jan. 4, 1980; 47 FR 14709, Apr. 6, 1982]

§ 201.28 Testing by railroad to determine probable compliance with the standard.

(a) To determine whether it is probably complying with the regulation, and therefore whether it should institute noise abatement, a railroad may take measurements on its own property at locations that:

(1) Are between the source and receiving property

(2) Derive no greater benefit from shielding and other noise reduction features that does the receiving property; and

(3) Otherwise meet the requirements of § 201.25.

(b) Measurements made for this purpose should be in accordance with the appropriate procedures in § 201.26 or § 201.27. If the resulting level is less than the level stated in the standard, then there is probably compliance with the standard.

(c) This procedure is set forth to assist the railroad in devising its compliance plan, not as a substantive requirement of the regulation.

PART 202—MOTOR CARRIERS ENGAGED IN INTERSTATE COMMERCE

Subpart A—General Provisions

AUTHORITY: Sec. 18, 36 Stat. 1249, 42 U.S.C. 4917(a).

Subpart A—General Provisions

§ 202.10 Definitions.

As used in this part, all terms not defined herein shall have the meaning given them in the Act:

(a) "Act" means the Noise Control Act of 1972 (Pub. L. 92-574, 86 Stat. 1234)

(b) "Common carrier by motor vehicle" means any person who holds himself out to the general public to engage in the transportation by motor vehicle in interstate or foreign commerce of passengers or property or any class or classes thereof for compensation, whether over regular or irregular routes.

(c) "Contract carrier by motor vehicle" means any person who engages in transportation by motor vehicle of passengers or property in interstate or foreign commerce for compensation (other than transportation referred to in paragraph (b) of this section) under continuing contracts with one person or a limited number of persons either (1) for the furnishing of transportation services through the assignment of motor vehicles for a continuing period of time to the exclusive use of each person served or (2) for the furnishing of transportation services designed to meet the distinct need of each individual customer.

(d) "Cutout or by-pass or similar devices" means devices which vary the exhaust system gas flow so as to discharge the exhaust gas and acoustic energy to the atmosphere without passing through the entire length of the exhaust system, including all exhaust system sound attenuation components.

(e) "dB(A) means the standard abbreviation for A-weighted sound level in decibels.

(f) "Exhaust system" means the system comprised of a combination of components which provides for enclosed flow of exhaust gas from engine parts to the atmosphere.

(g) "Fast meter response" means that the fast dynamic response of the sound level meter shall be used. The fast dynamic response shall comply with the meter dynamic characteristics in paragraph 5.3 of the American National Standard Specification for Sound Level Meters, ANSI S1. 4-1971. This publication is available from the American National Standards Institute, Inc., 1420 Broadway, New York, New York 10018.

(h) "Gross Vehicle Weight Rating" (GVWR) means the value specified by the manufacturer as the loaded weight of a single vehicle.

(i) "Gross Combination Weight Rating" (GCWR) means the value specified by the manufacturer as the loaded weight of a combination vehicle.

(j) "Highway" means the streets, roads, and public ways in any State.

(k) "Interstate commerce" means the commerce between any place in a State and any place in another State or between places in the same State through another State, whether such commerce moves wholly by motor vehicle or partly by motor vehicle and partly by rail, express, water or air. This definition of "interstate commerce" for purposes of these regulations is the same as the definition of "interstate commerce" in section 203(a) of the Interstate Commerce Act. [49 U.S.C. 303(a)]

(l) "Motor carrier" means a common carrier by motor vehicle, a contract carrier by motor vehicle, or a private carrier of property by motor vehicle as those terms are defined by paragraphs (14), (15), and (17) of section 203(a) of the Interstate Commerce Act [49 U.S.C. 303(a)].

(m) "Motor vehicle" means any vehicle, machine, tractor, trailer, or semitrailer propelled or drawn by mechanical power and used upon the highways in the transportation of passengers or property, or any combination thereof, but does not include any vehicle, locomotive, or car operated exclusively on a rail or rails.

(n) "Muffler" means a device for abating the sound of escaping gases of an internal combustion engine.

(o) "Open site" means an area that is essentially free of large sound-reflecting objects, such as barriers, walls, board fences, signboards, parked vehicles, bridges, or buildings.

(p) "Private carrier of property by motor vehicle" means any person not included in terms "common carrier by motor vehicle" or "contract carrier by motor vehicle", who or which transports in interstate or foreign commerce by motor vehicle property of which such person is the owner, lessee, or bailee, when such transportation is for sale, lease, rent or bailment, or in furtherance of any commercial enterprise.

(q) "Sound level" means the quantity in decibles measured by a sound level meter satisfying the requirements of American National Standards Specification for Sound Level Meters S1.4-1971. This publication is available from the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018. Sound level is the frequency-weighted sound pressure level obtained with the standardized dynamic characteristic "fast" or "slow" and weighting A, B, or C; unless indicated otherwise, the A-weighting is understood.

[39 FR 38215, Oct. 29, 1974]

§ 202.11 Effective date.

The provisions of Subpart B shall become effective October 15, 1975, except that the provisions of § 202.20(b) and § 202.21(b) of Subpart B shall apply to motor vehicles manufactured during or after the 1986 model year.

[51 FR 852, Jan. 8, 1986]

§ 202.12 Applicability.

(a) The provisions of Subpart B apply to all motor carriers engaged in interstate commerce.

(b) The provisions of Subpart B apply only to those motor vehicles of such motor carriers which have a gross vehicle weight rating or gross combination weight rating in excess of 10,000 pounds, and only when such motor vehicles are operating under the conditions specified in Subpart B.

(c) Except as provided in paragraphs (d) and (e) of this section, the provisions of Subpart B apply to the total sound produced by such motor vehicles when operating under such conditions, including the sound produced by auxiliary equipment mounted on such motor vehicles.

(d) The provisions of Subpart B do not apply to auxiliary equipment which is normally operated only when the transporting vehicle is stationary or is moving at a speed of 5 miles per hour or less. Examples of such equipment include, but are not limited to, cranes, asphalt spreaders, ditch diggers, liquid or slurry pumps, air compressors, welders, and trash compactors.

(e) The provisions of Subpart B do not apply to warning devices, such as horns and sirens; or to emergency equipment and vehicles such as fire engines, ambulances, police vans, and rescue vans, when responding to emergency calls; or to snow plows when in operation.

(f) The provisions of § 202.20(a) and § 202.21(a) of Subpart B apply only to applicable motor vehicles manufactured prior to the 1986 model year.

(g) The provisions of § 202.20(b) and § 202.21(b) apply to all applicable motor vehicles manufactured during or after the 1986 model year.

[39 FR 38215, Oct. 29, 1974, as amended at 51 FR 852, Jan. 8, 1986]

Subpart B—Interstate Motor Carrier Operations Standards

§ 202.20 Standards for highway operations.

(a) No motor carrier subject to these regulations shall operate any motor vehicle of a type to which this regulation is applicable which at any time or under any condition of highway trade, load, acceleration or deceleration generates a sound level in excess of 86dB(A) measured on an open site with fast meter response at 50 feet from the centerline of lane of travel on highways with speed limits of 35 MPH or less; or 90 dB(A) measured on an open site with fast meter response at 50 feet from the centerline of lane of travel on highways with speed limits of more than 35 MPH.

(b) No motor carrier subject to these regulations shall operate any motor vehicle of a type to which this regulation is applicable which at any time or under any condition of highway grade, load, acceleration or deceleration generates a sound level in excess of 83 dB(A) measured on an open site with fast meter response at 50 feet from the centerline of lane of travel on highways with speed limits of 35 MPH or less; or 87 dB(A) measured on an open site with fast meter response at 50 feet from the centerline of lane of travel on highways with speed limits of more than 35 MPH.

[39 FR 38215, Oct. 29, 1974, as amended at 51 FR 852, Jan. 8, 1986]

§ 202.21 Standard for operation under stationary test.

(a) No motor carrier subject to these regulations shall operate any motor vehicle of a type to which this regulation is applicable which generates a sound level in excess of 88 dB(A) measured on an open site with fast meter response at 50 feet from the longitudinal centerline of the vehicle, when its engine is accelerated from idle with wide open throttle to governed speed with the vehicle stationary, transmission in neutral, and clutch engaged. This section shall not apply to any vehicle which is not equipped with an engine speed governor.

(b) No motor carrier subject to these regulations shall operate any motor vehicle of a type to which this regulation is applicable which generates a sound level in excess of 85 dB(A) measured on an open site with fast meter response at 50 feet from the longitudinal centerline of the vehicle when its engine is accelerated from idle with wide open throttle to governed speed with the vehicle stationary, transmission in neutral, and clutch engaged. This paragraph shall not apply to any vehicle which is not equipped with an engine speed governor.

[39 FR 38215, Oct. 29, 1974, as amended at 51 FR 852, Jan. 8, 1986]

§ 202.22 Visual exhaust system inspection.

No motor carrier subject to these regulations shall operate any motor vehicle of a type to which this regulation is applicable unless the exhaust system of such vehicle is (a) free from defects which affect sound reduction; (b) equipped with a muffler or other noise dissipative device; and (c) not equipped with any cut-out, bypass, or similar device.

§ 202.23 Visual tire inspection.

No motor carrier subject to these regulations shall at any time operate any motor vehicle of a type to which this regulation is applicable on a tire or tires having a tread pattern which as originally manufactured, or as newly retreaded, is composed primarily or cavities in the tread (excluding sipes and local chunking) which are not vented by grooves to the tire shoulder or circumferentially to each other around the tire. This § 202.23 shall not apply to any motor vehicle which is demonstrated by the motor carrier which operates it to be in compliance with the noise emission standard specified for operations on highways with speed limits of more than 35 MPH in § 202.20 of this Subpart B, if the demonstration is conducted at the highway speed limit in effect at the inspection location, or, if speed is unlimited, the demonstration is conducted at a speed of 65 MPH.

[39 FR 38215, Oct. 29, 1974]

PART 203—LOW-NOISE-EMISSION PRODUCTS

Sec.

AUTHORITY: Sec. 15, Noise Control Act 1972, Pub. L. 92-574, 86 Stat. 1234.

SOURCE: 39 FR 6670, Feb. 21, 1974, unless otherwise noted.

§ 203.1 Definitions.

(a) As used in this part, any term not defined herein shall have the meaning given it in the Noise Control Act of 1972 (Pub. L. 92-574).

(1) "Act" means the Noise Control Act of 1972 (Pub. L. 92-574).

(2) "Federal Government" include the legislative, executive, and judicial branches of the Government of th

Appendix K -- Questionnaires Used in Study

____
State

State DOT Traffic Noise Programs and Practices

1. **Abatement**: Please check one or more of the boxes for each abatement measure and give a project reference if appropriate.

Abatement Measure	Have Used	Would Consider Using	Will Not Use	Project Reference
a. Sound-absorbing barriers				
b. Tilted barriers				
c. Translucent/transparent barriers				
d. Other innovative or low cost materials or designs (specify)				
e. Barriers off State ROW				
f. Privately-funded barrier on State ROW				
g. Barrier on non-limited access facility				
h. Deck (lid) over highway				
i. Depressed highway				
j. Shifted highway alignment				
k. Provided buffer zones				
l. Chose alternative corridor/mode				
m. Canceled highway project				
n. Pavement surface treatment				
o. Noise insulation:				
1. Public facility				
2. Private facility				
p. Traffic management:				
1. Prohibit heavy trucks				
2. Prohibit all trucks				
3. Reduce truck hours				
4. Reduce speed limit				

q. Other measures (please describe)________________

State

2. **Planned Noise Barrier Expenditures**: What do you expect to spend per year on noise barriers over the next five years for:

   a. Type I projects?

   b. Type II projects?

3. **Type II Program Funding/Prioritization**: If you have a Type II Noise Barrier Program,

   a. what was the impetus behind its development (citizen complaints, legislator request, legislative action, upper management environmental commitment, lawsuits, etc.)

   b. by what mechanisms is the program being funded?

   c. have you sought or do you plan to seek partial funding from local government or from the affected citizens?

   d. what actions do you seek from local government in support of the project?

   e. how do you prioritize among potential projects?

4. **Communications Techniques**: Please describe any interesting or innovative techniques (videos, exhibits, displays, literature, public meeting, field visits, etc.) you have used to communicate with, educate, or market your noise analysis and abatement programs to:

   a. the general public

   b. people living in project areas

   c. executives or other staff in your agency

   d. legislators

   e. officials in other agencies or jurisdictions (federal, state, local or regional)

State

5. **Legal Decisions**: List any noteworthy traffic noise legal issues, decisions, settlements or precedents in your state (abatement requirement or removal, damages, condemnation, etc.)

6. **Research**:

a. Has your agency conducted in-house or sponsored contract research, development, implementation or technology transfer efforts on traffic noise in the last 10 years? ____ If yes, please list the titles and technical contact persons (please enclose a copy of the abstract page of the final report, if applicable)

b. Do you plan to conduct any research, development, implementation or technology transfer in the next 5 years? ____ If yes, please list topics, expected funding level, and expected funding mechanism

7. **Land Uses**: What has your state legislature or DOT done to encourage or require land use compatibility?

8. **Local Coordination**: How have your coordination efforts with local officials paid off in terms of:

a. local action related to a specific project (such as rezoning in project area)?

b. local policy changes or generalized actions (such as development of noise ordinance)?

____
State

9. **Administrative and Technical Matters**:

a. What roles do your staff play and how many "full time equivalent" people are assigned to traffic noise work in your:

1. main office________________________________

2. district offices________________________________

b. What is the level of education and training of your noise staff?________________

c. To what degree do you use consultants for your project noise work or noise research?

d. Describe the tools you use for traffic noise analysis (PC, CAD, etc.)________________

10. **Issues and Problems**:

a. List any issues of concern on traffic noise policy, program administration, analysis, or funding:________________

b. What do you see as the key issues in noise control: (1) at the source; (2) along the path; and, (3) at the receiver?________________

c. What is your agency's biggest problem or challenge concerning traffic noise?

State

12. <u>**Comments**</u>: Additional information in response to items in the questionnaire:

Your name and title:

Your address:

Your telephone and telefax numbers:

Would you like a copy of the results?

Send response to: Dr. William Bowlby, Vanderbilt University, Box 96, Station B, Nashville, TN 37235 (telephone: (615) 322-3683; fax (615) 322-3365)

NOISE CONTROL PROGRAM QUESTIONNAIRE

(hand written responses are very acceptable)

1. **Program Development**

   a. Under what legal authority was your program established?

   b. When?

   c. What was the primary reason for your program being established?

   d. What was the approximate cost of establishing your program?

   e. What is the approximate annual operating cost?

   f. What government assistance is available to you? Have you or do you use this assistance?

2. **Staff and Responsibilities**

   a. How many equivalent, full-time staff are needed for administration and enforcement?

   b. What noise sources does your program regulate?

c. What noise sources are exempt and under what conditions?

d. What constitutes a violation and how are complaints evaluated?

e. Approximately how many complaints are handled annually?

f. Approximately how many violations occur annually?

g. What penalties are imposed?

h. What other services does your program provide (e.g., information)?

i. If noise documents are reviewed or approved, what constitutes compliance? Are noise standards used and if so, which?

j. Are standards or criteria used for abatement considerations?

k. Are requirements placed on developers? If so, please specify.

3. Program Evaluation

What have been the major successes, setbacks, lessons, and recommendations for improvement of your program?

Thanks again for your expert help!

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

Comprehensive Review of State-of-the-Art in Traffic Noise Abatement

Survey of Motor Vehicle Manufacturers

1. Please describe your facilities, equipment, capabilities and staff for noise research, design, engineering and testing .

2. What percent of your time or budget is devoted to controlling vehicle wayside levels as opposed to vehicle interior levels?

3. What do you consider to be the major noise sources on the vehicles? Please describe the noise control measures that you have designed into your vehicles to reduce levels from these sources. What are the levels of these sources with and without these control measures?

4. In terms of ~~buses~~, trucks and motorcycles, what are you doing specifically to meet EPA New Product Noise Regulations?

5. What are your biggest problems right now in vehicle noise control? What do you see as the biggest challenges ahead?

____

____

____

____

____

6. What types of innovations do you foresee in the near term and in the long term to further quiet vehicles, (e.g., active noise control, use of electric power, etc.).

____

____

____

____

7. Please describe your alternative fuels research and how use of alternative fuels may effect vehicle noise levels.

____

____

____

____

8. Please describe any joint activities you have with tire manufacturers to reduce tire noise.

____

____

____

____

9. What is your assessment of the practical potential for further tire noise reduction?

10. What is your assessment of the potential for the use of "quiet" pavements to reduce: (1) tire noise and (2) engine/exhaust noise radiating from the underbody and reverberating between the road and the underbody?

11. What is your assessment of the noise control research and implementation from your overseas competitors? Is there much technology transfer among manufacturers?

12. Please provide data on the wayside noise levels (overall A-weighted and by frequency band) of the various models of vehicles that you produce (please describe or reference the test procedure(s)).

____

____

____

____

____

____

13. Could you please suggest noise research contact persons for the manufacturers of the various components used in your vehicles if the work is not done in-house (e.g., engines, exhaust, fans, transmissions, etc.)

____

____

____

____

14. Are there other people or organizations that we should contact on this subject?

____

____

____

____

____

15. Comments or other information.

____

____

____

____

____

____

____

____

Finally, could you please send copies of relevant reports and published articles on your noise control efforts.

Thank you for your time and expert assistance.

Name ______________________________

Title ______________________________

Company ______________________________

Address ______________________________

Telephone ______________ Telefax ______________

Return to:

Dr. William Bowlby
Vanderbilt University
Box 96, Station B
Nashville, TN 37235

WB/180/cls