

HIGHWAY TRAFFIC NOISE IN THE UNITED STATES

Problem and Response



**U.S. Department of Transportation
Federal Highway Administration
April 2000**

TABLE OF CONTENTS

PAGE NO.

LIST OF TABLES

INTRODUCTION	1
- Purpose	1
- The Highway System	1
- The Federal/State Relationship	2
- Federal Participation in the Cost of Projects	2
THREE-PART APPROACH TO HIGHWAY NOISE ABATEMENT	3
- Land Use Planning and Control	3
- Source Control	3
- Highway Project Noise Mitigation	5
FHWA NOISE ABATEMENT PROCEDURES	6
- Noise Descriptors	6
- Impact Criteria	6
- Existing Activities	8
- Type I/Type II Projects	8
- Noise Analysis	8
- Federal Participation	9
- Noise Abatement	9
- Coordination with Local Officials	11
- Traffic Noise Prediction	11
- Construction Noise	11
NOISE BARRIERS CONSTRUCTED OR PLANNED	12
- Noise Barriers Constructed	12
- Effectiveness	15
- Public Perception	15
- Research Efforts	15
SUMMARY	16
APPENDIX	

23 CFR Part 772 - Procedures for Abatement of Highway Traffic Noise and Construction Noise

LIST OF TABLES

	<u>PAGE NO.</u>
1. Road Ownership in the United States	1
2. Classification of Roads by Functional System	2
3. Maximum Noise Emission Levels as Required by EPA for Newly Manufactured Trucks with GVWR Over 4,525 Kilograms	4
4. Maximum Noise Emission Levels as Required by EPA for In-Use Medium and Heavy Trucks with GVWR Over 4,525 Kilograms Engaged in Interstate Commerce	4
5. Noise Abatement Criteria (NAC) Hourly A-Weighted Sound Level - decibels (dBA)	7
6. Noise Barrier Construction by State	13
7. Total Noise Barrier Length by Material Type	14
8. States That Have Not Constructed Noise Barriers to Date	14
9. Barrier Attenuation	15

INTRODUCTION

Noise, defined as unwanted or excessive sound, is an undesirable by-product of our modern way of life. It can be annoying, can interfere with sleep, work, or recreation, and in extremes may cause physical and psychological damage. While noise emanates from many different sources, transportation noise is perhaps the most pervasive and difficult source to avoid in society today. Highway traffic noise is a major contributor to overall transportation noise. A broad-based effort is needed to control transportation noise. This effort must achieve the goals of personal privacy and environmental quality while continuing the flow of needed transportation services for a quality society.

Purpose

This report has been developed to provide information about the problem of highway traffic noise and the United States' response to that problem. This report summarizes 1) the general nature of the problem, 2) the response of the Federal Highway Administration (FHWA) to the problem, and 3) highway noise barriers constructed or planned. Before discussing these items, however, a general discussion of the Federal-aid highway program is included to assist the reader.

The Highway System

Most (97 percent) roads and streets in the United States are under the jurisdiction of State and local governments. The Federal jurisdiction is mainly limited to National Parks, National Forests, and other government-owned land. Generally in these areas, there are no permanent residents and, therefore, no noise problem of any extent.

Ownership of the roads in the United States is shown in Table 1.

Table 1
Road Ownership in the United States - 1998

<u>Owner</u>	<u>Linear Kilometers *</u>	<u>Percent Of All Roads</u>
Federal	193	3
State	1,241	20
Local	4,855	77

* Rounded to the nearest thousand

The Federal-aid highway program is a federally assisted, State administered grant program which provides Federal funds to State and local governments to construct and improve highways. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) set the course for future roles of federal, state, and local government in maintaining the country's highways, bridges, and mass transit facilities, and in strengthening highway safety programs. The ISTEA called for linking "...all forms of transportation in a unified, interconnected manner..economically efficient and environmentally sound...[to] move people and goods in an energy efficient manner." The ISTEA restructured the Federal-aid highway program and established two Federal-aid systems - the National Highway System (NHS) and the Interstate System, which is a component of the NHS. The revised Federal-aid program includes about 1.5 million kilometers of the 6.3 million kilometers of roads in the United States. As can be seen in Table 2, urban roadways currently comprise a small portion of total roadways, yet carry a large portion of all highway travel.

Table 2
Classification of Roads by Functional System - 1998

<u>System</u>	<u>Linear Kilometers *</u>	<u>Percent of All Roads</u>	<u>Percent of Vehicle Kilometers Traveled</u>
Urban	1,355	21.5	60.6
Rural	<u>4,934</u>	<u>78.5</u>	<u>39.4</u>
TOTAL	6,289	100.0	100.0

* Rounded to nearest thousand

The Federal/State Relationship

The FHWA is the designated Federal government agency for administering the Federal-aid highway program. The FHWA mission is to aid States in providing safe and efficient surface transportation for the movement of people and goods by all modes. The FHWA is responsible for providing guidance to State highway agencies and metropolitan planning agencies (MPOs) and for reimbursing the States and MPOs for the Federal share of projects. The States, in cooperation with MPOs, initiate, plan, design, construct, operate, and maintain the highways on the Federal-aid systems.

Federal Participation in the Cost of Projects

With a few exceptions, the FHWA does not pay for the entire cost of the projects it funds. Federal funds are normally "matched" with State and/or local government funds to account for the necessary dollars to complete the project. The Federal share is specified in legislation. Interstate System projects are typically funded 90 percent Federal and 10 percent State, but most other types of projects are funded at a slightly lower Federal share (80 percent).

THREE-PART APPROACH TO NOISE ABATEMENT

Effective control of the undesirable effects of highway traffic noise requires that land use near highways be controlled, that vehicles themselves be quieted, and that mitigation of noise be undertaken on individual highway projects.

The first component is traditionally an area of local responsibility. The other components are the joint responsibility of private industry and of Federal, State, and local governments.

Land Use Planning and Control

The Federal Government has essentially no authority to regulate land use planning or the land development process. The FHWA and other Federal agencies encourage State and local governments to practice land use planning and control in the vicinity of highways. The Federal Government advocates that local governments use their power to regulate land development in such a way that noise-sensitive land uses are either prohibited from being located adjacent to a highway, or that the developments are planned, designed, and constructed in such a way that noise impacts are minimized.

Some State and local governments have enacted legislative statutes for land use planning and control. As an example, the State of California has legislation on highway noise and compatible land use development. This State legislation requires local governments to consider the adverse environmental effects of noise in their land development process. In addition, the law gives local governments broad powers to pass ordinances relating to the use of land, including among other things, the location, size, and use of buildings and open space.

Although other States and local governments have similar laws, the entire issue of land use is extremely complicated with a vast array of competing considerations entering into any actual land use control decisions. For this reason, it is nearly impossible to measure the progress of using land use to control the effects of noise.

Source Control

The Noise Control Act of 1972 gives the Federal Environmental Protection Agency (EPA) the authority to establish noise regulations to control major sources of noise, including transportation vehicles and construction equipment. In addition, this legislation requires EPA to issue noise emission standards for motor vehicles used in Interstate commerce (vehicles used to transport commodities across State boundaries) and requires the Federal Motor Carrier Safety Administration (FMCSA) to enforce these noise emission standards.

The EPA has established regulations which set emission level standards for newly manufactured medium and heavy trucks that have a gross vehicle weight rating (GVWR) of more than 4,525 kilograms and are capable of operating on a highway or street. Table 3 shows the maximum noise emission levels allowed by the EPA noise regulations for these vehicles.

Table 3
Maximum Noise Emission Levels
as Required by EPA for Newly Manufactured Trucks
with GVWR Over 4,525 Kilograms

Effective Date	Maximum Noise Level 15 Meters from Centerline of Travel*
January 1, 1988	80 dBA

* Using the Society of Automotive Engineers, Inc. (SAE), test procedure for acceleration under 56 kph

For existing (in-use) medium and heavy trucks with a GVWR of more than 4,525 kilograms, the Federal government has authority to regulate the noise emission levels only for those that are engaged in interstate commerce. Regulation of all other in-use vehicles must be done by State or local governments. The EPA emission level standards for in-use medium and heavy trucks engaged in interstate commerce are shown in Table 4 and are enforced by the FMCSA.

Table 4
Maximum Noise Emission Levels
as Required by EPA for In-Use Medium and Heavy Trucks
with GVWR Over 4,525 Kilograms Engaged in Interstate Commerce

Effective Date	Speed	Maximum Noise Level 15 Meters from Centerline of Travel
January 8, 1986	< 56 kph	83 dBA
January 8, 1986	> 56 kph	87 dBA
January 8, 1986	Stationary	85 dBA

Highway Project Noise Mitigation

The National Environmental Policy Act (NEPA) of 1969 provides broad authority and responsibility for evaluating and mitigating adverse environmental effects including highway traffic noise. The NEPA directs the Federal government to use all practical means and measures to promote the general welfare and foster a healthy environment.

A more important Federal legislation which specifically involves abatement of highway traffic noise is the Federal-Aid Highway Act of 1970. This law mandates FHWA to develop noise standards for mitigating highway traffic noise.

The law requires promulgation of traffic noise-level criteria for various land use activities. The law further provides that FHWA not approve the plans and specifications for a federally aided highway project unless the project includes adequate noise abatement measures to comply with the standards. The FHWA has developed and implemented regulations for the mitigation of highway traffic noise in federally-aided highway projects.

The FHWA regulations for mitigation of highway traffic noise in the planning and design of federally aided highways are contained in Title 23 of the United States Code of Federal Regulations Part 772 (attached). The regulations require the following during the planning and design of a highway project: 1) identification of traffic noise impacts; examination of potential mitigation measures; 2) the incorporation of reasonable and feasible noise mitigation measures into the highway project; and 3) coordination with local officials to provide helpful information on compatible land use planning and control. The regulations contain noise abatement criteria which represent the upper limit of acceptable highway traffic noise for different types of land uses and human activities. The regulations do not require that the abatement criteria be met in every instance. Rather, they require that every reasonable and feasible effort be made to provide noise mitigation when the criteria are approached or exceeded. Compliance with the noise regulations is a prerequisite for the granting of Federal-aid highway funds for construction or reconstruction of a highway.

FHWA NOISE ABATEMENT PROCEDURES

The FHWA noise abatement procedures are codified in the Code of Federal Regulations (23 CFR 772). The procedures are described in the following sections.

Noise Descriptors

Noise descriptors are used to describe the time-varying nature of noise. The L_{10} and Leq noise descriptors are used in the abatement procedures. The former is the noise level exceeded 10% of the time in the noisiest hour of the day. The latter is the constant, average sound level, which over a period of time contains the same amount of sound energy as the varying levels of the traffic noise. The L_{10} is a statistical descriptor that is easy for most people to determine and understand. While the Leq descriptor is harder for inexperienced people to understand, it has the advantages over L_{10} of being more reliable for low-volume roadways and of permitting noise levels from different sources to be added directly to one another for inclusion in noise analyses. Leq for typical traffic conditions is usually about 3 dBA less than L_{10} for the same conditions.

Impact Criteria

A traffic noise impact occurs when either of the following conditions exist:

- (1) The projected traffic noise levels approach or exceed the noise abatement criteria (NAC) shown in Table 5, or
- (2) The projected traffic noise levels substantially exceed the existing noise levels in an area.

Table 5
Noise Abatement Criteria (NAC)
Hourly A-Weighted Sound Level - decibels (dBA)*

<u>Activity Category</u>	<u>Leq(h)</u>	<u>L₁₀(h)</u>	<u>Description of Activity Category</u>
A	57 (Exterior)	60 (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)	70 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	75 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	--	--	Undeveloped lands.
E	52 (Interior)	55 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

* Either L₁₀(h) or Leq(h) (but not both) may be used on a project.

There is no mandated definition for what constitutes a substantial increase over existing noise levels in an area. Most State highway agencies use either a 10 dBA increase or a 15 dBA increase in noise levels to define a "substantial increase" in existing noise levels. Several State highway agencies use a sliding scale to define substantial increase. The sliding scale combines the increase in noise levels with the absolute values of the noise levels, allowing for a greater increase at lower absolute levels before a substantial increase occurs.

Existing Activities

The location of existing activities in the vicinity of various study alternatives for a highway project are identified by individual land uses, or by broad categories of land use for which a single NAC level may apply. In some cases, lands which are undeveloped at the time of the project may be known to be under consideration for development in the future. If this is the case and definite commitments have been made to develop the land, then, these lands are treated as developed and the highway noise impacts assessed accordingly. Primary consideration for highway traffic noise analysis is normally given to exterior areas where frequent human use occurs.

Type I/ Type II Projects

The FHWA regulation makes a distinction between projects for which noise abatement is considered as a feature in a new or expanded highway and those for which noise abatement is considered as a retrofit feature on an existing highway. The former are defined as Type I projects, the latter as Type II. For Type I projects, the consideration of noise abatement as part of the highway construction project is mandatory if Federal-aid funds are to be used and if a traffic noise impact is expected to occur. Type II projects are, however, completely voluntary on the part of the individual States, and such projects compete for funds with all the other construction needs of the States. It should be noted that the National Highway System Designation Act of 1995 (NHS) restricted Federal participation in Type II noise barriers to those projects that were approved before November 28, 1995 or are proposed along lands where land development or substantial construction predated the existence of any highway.

Noise Analysis

Analysis of the traffic noise impacts expected from construction of a highway involves a number of technical steps. The traffic noise analysis includes the following for each alternative under detailed study:

- (1) identification of existing activities, developed lands, and undeveloped lands for which development is planned, designed and programmed, which may be affected by traffic noise from the highway;
- (2) determination of existing noise levels;
- (3) prediction of traffic noise levels;

- (4) determination of traffic noise impacts; and
- (5) examination and evaluation of alternative noise abatement measures for reducing or eliminating the traffic noise impacts.

If potential traffic noise impacts are identified, noise abatement is considered and implemented, if it is found to be both reasonable and feasible. The views of the impacted residents are a major consideration in reaching a decision on the reasonableness of abatement measures to be provided. When noise abatement measures are being considered, every reasonable effort is made to obtain substantial noise reductions. Substantial noise reductions have been defined by State highway agencies to typically range from 5 to 10 dBA.

Federal Participation

Federal funds may be used for noise abatement measures where:

- (1) a traffic noise impact has been identified,
- (2) the noise abatement measures will reduce the traffic noise impact, and
- (3) the overall noise abatement benefits are determined to outweigh the overall adverse social, economic, and environmental effects and the costs of the noise abatement measures.

The Federal share of the abatement costs is at the same participating ratio as for the system on which the project is located.

Noise Abatement

If traffic noise impacts are identified, various noise abatement measures are considered to mitigate the adverse impacts. The construction of a noise barrier is the mitigation measure most often associated with the concept of noise abatement. For this reason a special section on noise barriers, which begins on page 12, has been included in this report to discuss this subject in more detail.

Other possible noise abatement measures include traffic management measures, creating buffer zones, planting vegetation, installing noise insulation in buildings, and relocating the highway.

Traffic management measures can sometimes reduce noise problems. For example, if acceptable alternative truck routes are available, trucks can be prohibited from certain streets and roads, or they can be permitted to use certain streets and roads only during daylight hours. Traffic lights can be changed to smooth out the flow of traffic and to eliminate the need for frequent stops and starts. Speed limits can be reduced; however, about a 32 kilometer-per-hour reduction in speed is necessary for a readily noticeable (5 dBA) decrease in noise levels.

Buffer zones are undeveloped, open spaces which border a highway. Buffer zones are created when a highway agency purchases land, or development rights, in addition to the normal right-of-way, so that future dwellings cannot be constructed close to the highway. This prevents the possibility of constructing dwellings which would otherwise experience an excessive noise level from nearby highway traffic. An additional benefit of buffer zones is improvement of the roadside appearance. However, because of the tremendous amount of land which must be purchased and because in many cases dwellings already border existing roads, creating buffer zones is often not possible. While Federal-aid highway funds may be used on a highway project to create buffer zones, this measure has not been used very often.

Vegetation, which is so high, wide, and dense that it cannot be seen over or through, can decrease highway traffic noise. However, it requires a 61-meter width of such vegetation to reduce noise by 10 decibels, which cuts in half the loudness of traffic noise. It is not feasible to plant enough vegetation along a road to achieve such reductions. If vegetation already exists, it can be saved to maintain a psychological relief, if not an actual lessening of traffic noise levels. If vegetation does not exist, it can be planted for psychological relief, not to reduce traffic noise levels.

Insulating buildings can greatly reduce highway traffic noise, especially when windows are sealed and cracks and other openings are filled. Sometimes noise-absorbing material can be placed in the walls of new buildings during construction. However, insulation can be costly, because air conditioning is usually necessary once the windows are sealed. Federal-aid highway funds may be used for noise insulation of public-use or non-profit institutional structures. Such funds may also be used for noise insulation of residences and other private-use buildings where noise impacts are severe and no other type of abatement is possible. Very few private-use buildings have been noise insulated with Federal-aid highway funds. The majority of Federal-aid highway funds used for noise insulation has been spent to noise insulate schools. In many parts of the country, highway agencies do not have the authority to insulate buildings; thus, in those States, noise insulation cannot be included as part of a highway project.

A noise attenuation measure which should always be considered is the possibility of altering the highway location to avoid those land use areas which have been determined to have a potential traffic noise impact. Since sound intensity decays with distance from the source, increased distance between the noise source and receiver will reduce the noise impact. It may also be possible to obtain attenuation by depressing the roadway slightly to produce a break in the line of sight from the source to the receiver. Potential noise reduction should be considered with the many other factors which influence the selection of roadway alignment.

Coordination With Local Officials

The FHWA noise regulation requires coordination with local officials whose jurisdictions are affected. The primary purpose of this coordination is to promote compatibility between land development and highways.

Highway agencies furnish the following information to appropriate local officials:

- (1) Estimated future traffic noise levels at various distances from the highway improvement.
- (2) Locations where local communities should protect future land development from becoming incompatible with anticipated highway traffic noise levels.

Traffic Noise Prediction

The FHWA has developed a model to accurately predict future highway traffic noise levels. State highway agencies either use the FHWA model for highway traffic noise analysis or a model based upon the same methodology as that contained in the FHWA model.

The FHWA has also developed national averages of vehicle emission levels to be used in the FHWA prediction model. State highway agencies either use the national average levels or measure their own levels based upon FHWA measurement procedures.

Construction Noise

Highway construction noise is often viewed by the public as being short term and a necessary price for growth and improvement. Highway construction noise should generally be addressed in a qualitative, rather than quantitative, manner commensurate with the scope of the highway project. Construction noise levels may be predicted, if warranted. If potential construction noise impacts are identified, a common sense approach should be utilized to incorporate appropriate abatement measures into the highway project.

NOISE BARRIERS CONSTRUCTED OR PLANNED

Noise barriers are solid obstructions built between the highway and the homes along the highway. Effective noise barriers can reduce noise levels by ten to fifteen decibels, cutting the loudness of traffic noise in half. Barriers can be formed from earth mounds along the road (usually called earth berms) or from high, vertical walls. Earth berms have a very natural appearance and are usually attractive. However, an earth berm can require quite a lot of land, if it is very high. Walls take less space. They are usually limited to eight meters in height because of structural and aesthetic reasons. Noise walls can be built out of wood, stucco, concrete, masonry, metal, and other materials. Noise barriers are designed and constructed to be visually pleasing and blend with their surroundings.

Noise Barriers Constructed

The Federal-aid highway program has always been based on a strong State-Federal partnership. At the core of that partnership is a philosophy of trust and flexibility, and a belief that the States are in the best position to make investment decisions that are based on the needs and priorities of their citizens. The FHWA noise regulations give each State department of transportation (DOT) flexibility in determining the reasonableness and feasibility of noise abatement and, thus, in balancing the benefits of noise abatement against the overall adverse social, economic, and environmental effects and costs of the noise abatement measures. The State DOT must base its determination on the interest of the overall public good, keeping in mind all the elements of the highway program (need, funding, environmental impacts, public involvement, etc.). Congress affirmed and extended the philosophy of partnership, trust, and flexibility in the enactment of ISTEA.

The flexibility in noise abatement decisionmaking is reflected by data indicating that some States have built many noise barriers and some have built none. Through the end of 1998, forty-four State DOTs and the Commonwealth of Puerto Rico have constructed over 2,610 linear kilometers of barriers at a cost of over \$1.4 billion (\$1.9 billion in 1998 dollars). Six States and the District of Columbia have not constructed noise barriers to date. Table 6 lists the ten States that have constructed the most noise barriers, in terms of area, length, and cost. The cost data in Table 6 give a general indication of trends. However, the data should not be used for exact comparisons, since precise, uniform individual barrier costs are very difficult to obtain. Table 7 shows total noise barrier areas by material type. Table 8 lists the six States that have not constructed noise barriers to date.

Table 6
Noise Barrier Construction By State
Through 1998

	<u>Square Meters</u> <u>(Thousands)</u>		<u>Linear</u> <u>Kilometers</u>	
California	2,849	California	777.2	
New Jersey	806	Virginia	153.3	
Virginia	790	New Jersey	142.1	
Ohio	613	Ohio	138.2	
Maryland	581	New York	110.7	
New York	496	Colorado	104.4	
Minnesota	491	Minnesota	101.8	
Illinois	346	Maryland	99.6	
Pennsylvania	333	Illinois	97.8	
Colorado	329	Pennsylvania	83.5	
10 State Total	<u>7,634</u>		<u>1,808.6</u>	

	<u>Actual Cost</u> <u>(Millions)</u>		<u>1998 Dollars</u> <u>(Millions)</u>	
California	\$399.6	California	\$487.2	
New Jersey	182.3	New Jersey	210.4	
Maryland	138.0	Maryland	153.2	
Virginia	120.8	Virginia	143.0	
New York	104.1	New York	116.5	
Pennsylvania	74.8	Pennsylvania	88.3	
Ohio	63.1	Illinois	71.0	
Illinois	61.2	Ohio	68.1	
Florida	55.1	Minnesota	62.7	
Michigan	48.1	Florida	62.3	
10 State Total	<u>\$1,247.1</u>		<u>\$1,462.7</u>	

Table 7
Total Noise Barrier Area by Material Type
Through 1998

Single Material Barriers		Combination Barriers	
<u>Material</u>	<u>Square Meters</u> <u>(Thousands)</u>	<u>Material</u>	<u>Square Meters</u> <u>(Thousands)</u>
Concrete/Precast	4,292	Berm/Wood	279
Block	2,731	Concrete/Block	166
Wood/Post & Plank	508	Wood/Concrete	155
Concrete/Unspecified	456	Berm/Concrete	138
Berm Only	344	Berm/Metal	134
Wood/Glue Laminated	294	Metal/Concrete	85
Metal/Unspecified	240	Berm/Block	72
Wood/Unspecified	239	Concrete/Brick	54
Absorptive	154	Wood/Metal	43
Brick	94	Berm/Wood/Concrete	27
Other	139	Wood/Block	26
		Berm/Wood/Metal	16
		Other	116
Total	<u>9,491</u>	Total	<u>1,311</u>

Table 8
States That Have Not Constructed Noise Barriers to Date

Alabama Mississippi Montana North Dakota Rhode Island South Dakota

Effectiveness

Noise barriers can be quite effective in reducing noise for receptors within approximately 61 meters of a highway. Table 9 summarizes barrier attenuation.

Table 9
Barrier Attenuation

<u>Reduction in Sound Level</u>	<u>Reduction in Acoustic Energy</u>	<u>Degree of Difficulty To Obtain Reduction</u>
5 dBA	70%	Simple
10 dBA	90%	Attainable
15 dBA	97%	Very Difficult
20 dBA	99%	Nearly Impossible

Barriers do have limitations. For a noise barrier to work, it must be high enough and long enough to block the view of a road. Noise barriers do very little good for homes on a hillside overlooking a road or for buildings which rise above the barrier. Openings in noise walls for driveway connections or intersecting streets greatly reduce the effectiveness of barriers. In some areas, homes are scattered too far apart to permit noise barriers to be built at a reasonable cost.

Public Perception

Overall, public reaction to highway noise barriers appears to be positive. There is, however, a wide diversity of specific reactions to barriers. Residents adjacent to barriers have stated that conversations in households are easier, sleeping conditions are better, a more relaxing environment is created, windows are opened more often, and yards are used more in the summer. Perceived non-noise benefits include increased privacy, cleaner air, improved view and sense of ruralness, and healthier lawns and shrubs. Negative reactions have included a restriction of view, a feeling of confinement, a loss of air circulation, a loss of sunlight and lighting, and poor maintenance of the barrier. Most residents near a barrier seem to feel that barriers effectively reduce traffic noise and that the benefits of barriers outweigh the disadvantages of the barriers.

Research Efforts

Over the last two decades, much work has been done within the highway program to develop the basic tools necessary to analyze the impacts of highway traffic noise. Efforts have focused on the establishment of criteria for considering highway traffic noise, the measurement and prediction of noise levels, and the development and evaluation of feasible measures to abate highway traffic noise. Today, research efforts are continuing to assure that analysis tools reflect the current state-of-the-art in highway traffic noise, while meeting the program needs of State highway agencies.

Highway traffic noise research has been guided and continues to be guided by representatives of State DOTs, other State government agencies, local government agencies, Federal agencies, and the academic and private sectors. An important part of this cooperative effort is the work of the Transportation Research Board Committee on Transportation-Related Noise and Vibration, which has been instrumental in identifying and prioritizing research needs. Another important part of this effort is the research work that individual States conduct within their own highway programs.

Future research efforts will strive to produce more cost effective solutions and efficient allocation of resources to deal with the problems of highway traffic noise. Emphasis is anticipated in the areas of traffic noise prediction and abatement analysis.

SUMMARY

The United States has undertaken a program which utilizes a three-part approach to the abatement of highway traffic noise. Noise-compatible development through effective land use planning and control is traditionally an area of local responsibility. Source control or control of noise emissions from the vehicles themselves is a joint responsibility of private industry and of Federal, State, and local governments. The FHWA has established noise standards for different types of land use activities adjacent to highways. These standards require that for certain types of federally-aided highway projects, States must conduct noise analyses to identify potential highway traffic noise impacts. If impacts are identified, noise abatement measures must be considered and implemented, if determined to be both reasonable and feasible. Among the various types of possible abatement measures, the construction of noise barriers is most commonly used.

APPENDIX

23 CFR PART 772 - PROCEDURES FOR ABATEMENT OF HIGHWAY TRAFFIC NOISE AND CONSTRUCTION NOISE

Sec.

772.1 Purpose.

772.3 Noise Standards.

772.5 Definitions.

772.7 Applicability.

772.9 Analysis of Traffic Noise Impacts and Abatement Measures.

772.11 Noise Abatement.

772.13 Federal Participation.

772.15 Information for Local Officials.

772.17 Traffic Noise Prediction.

772.19 Construction Noise.

Table 1 - Noise Abatement Criteria

Appendix A - National Reference Energy Mean Emission Levels as a Function of Speed

AUTHORITY: 23 U.S.C. 109(h), 109(i); 42 U.S.C. 4331, 4332; sec. 339(b), Pub. L. 104-59, 109 Stat. 568, 605; 49 CFR 1.48(b).

(Source: 47 FR 29654, July 8, 1982; 47 FR 33956, Aug. 5, 1982, and 62 FR 42903, August 11, 1997)

Sec. 772.1 Purpose.

To provide procedures for noise studies and noise abatement measures to help protect the public health and welfare, to supply noise abatement criteria, and to establish requirements for information to be given to local officials for use in the planning and design of highways approved pursuant to Title 23, United States Code (U.S.C.).

Sec. 772.3 Noise Standards.

The highway traffic noise prediction requirements, noise analyses, noise abatement criteria, and requirements for informing local officials in this regulation constitute the noise standards mandated by 23 U.S.C. 109(i). All highway projects which are developed in conformance with this regulation shall be deemed to be in conformance with the Federal Highway Administration (FHWA) noise standards.

Sec. 772.5 Definitions.

(a) Design year. The future year used to estimate the probable traffic volume for which a highway is designed. A time, 10 to 20 years, from the start of construction is usually used.

(b) Existing noise levels. The noise, resulting from the natural and mechanical sources and human activity, considered to be usually present in a particular area.

(c) L_{10} . The sound level that is exceeded 10 percent of the time (the 90th percentile) for the period under consideration.

(d) L₁₀(h). The hourly value of L10.

(e) 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 time period.

(f) L_{eq}(h). The hourly value of Leq.

(g) Traffic noise impacts. Impacts which occur when the predicted traffic noise levels approach or exceed the noise abatement criteria (Table 1), or when the predicted traffic noise levels substantially exceed the existing noise levels.

(h) 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.

(i) Type II projects. A proposed Federal or Federal-aid highway project for noise abatement on an existing highway.

Sec. 772.7 Applicability.

(a) Type I projects. This regulation applies to all Type I projects unless it is specifically indicated that a section applies only to Type II projects.

(b) Type II projects. The development and implementation of Type II projects are not mandatory requirements of 23 U.S.C. 109(i) and are, therefore, not required by this regulation. When Type II projects are proposed for Federal-aid highway participation at the option of the highway agency, the provisions of Subsec. 772.9(c), 772.13, and 772.19 of this regulation shall apply.

Sec. 772.9 Analysis of Traffic Noise Impacts and Abatement Measures.

(a) The highway agency shall determine and analyze expected traffic noise impacts and alternative noise abatement measures to mitigate these impacts, giving weight to the benefits and cost of abatement, and to the overall social, economic and environmental effects.

(b) The traffic noise analysis shall include the following for each alternative under detailed study:

- (1) Identification of existing activities, developed lands, and undeveloped lands for which development is planned, designed and programmed, which may be affected by noise from the highway;
- (2) Prediction of traffic noise levels;
- (3) Determination of existing noise levels;
- (4) Determination of traffic noise impacts; and
- (5) Examination and evaluation of alternative noise abatement measures for reducing or eliminating the noise impacts.

(c) Highway agencies proposing to use Federal-aid highway funds for Type II projects shall perform a noise analysis of sufficient scope to provide information needed to make the determination required by Sec. 772.13(a) of this chapter.

Sec. 772.11 Noise Abatement.

(a) In determining and abating traffic noise impacts, primary consideration is to be given to exterior areas. Abatement will usually be necessary only where frequent human use occurs and a lowered noise level would be of benefit.

(b) In those situations where there are no exterior activities to be affected by the traffic noise, or where the exterior activities are far from or physically shielded from the roadway in a manner that prevents an impact on exterior activities, the interior criterion shall be used as the basis of determining noise impacts.

(c) If a noise impact is identified, the abatement measures listed in Sec. 772.13(c) of this chapter must be considered.

(d) When noise abatement measures are being considered, every reasonable effort shall be made to obtain substantial noise reductions.

(e) Before adoption of a final environmental impact statement or finding of no significant impact, the highway agency shall identify:

(1) Noise abatement measures which are reasonable and feasible and which are likely to be incorporated in the project, and

(2) Noise impacts for which no apparent solution is available.

(f) The views of the impacted residents will be a major consideration in reaching a decision on the reasonableness of abatement measures to be provided.

(g) The plans and specifications will not be approved by FHWA unless those noise abatement measures which are reasonable and feasible are incorporated into the plans and specifications to reduce or eliminate the noise impact on existing activities, developed lands, or undeveloped lands for which development is planned, designed, and programmed.

Sec. 772.13 Federal Participation.

(a) Federal funds may be used for noise abatement measures where:

(1) A traffic noise impact has been identified,

(2) The noise abatement measures will reduce the traffic noise impact, and

(3) The overall noise abatement benefits are determined to outweigh the overall adverse social, economic, and environmental effects and the costs of the noise abatement measures.

(b) For Type II projects, noise abatement measures will only be approved for projects that were approved before November 28, 1995, or are proposed along lands where land development or substantial construction predated the existence of any highway. The granting of a building permit, filing of a plat plan, or a similar action must have occurred prior to right-of-way acquisition or construction approval for the original highway. Noise abatement measures will not be approved at locations where such measures were previously determined not to be reasonable and feasible for a Type I project.

(c) The noise abatement measures listed below may be incorporated in Type I and Type II

projects to reduce traffic noise impacts. The costs of such measures may be included in Federal-aid participating project costs with the Federal share being the same as that for the system on which the project is located, except that Interstate construction funds may only participate in Type I projects.

- (1) Traffic management measures (e.g., traffic control devices and signing for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, modified speed limits, and exclusive land designations).
- (2) Alteration of horizontal and vertical alignments.
- (3) Acquisition of property rights (either in fee or lesser interest) for construction of noise barriers.
- (4) Construction of noise barriers (including landscaping for aesthetic purposes) whether within or outside the highway right-of-way. Interstate construction funds may not participate in landscaping.
- (5) Acquisition of real property or interests therein (predominantly unimproved property) to serve as a buffer zone to preempt development which would be adversely impacted by traffic noise. This measure may be included in Type I projects only.
- (6) Noise insulation of public use or nonprofit institutional structures.

(d) There may be situations where (1) severe traffic noise impacts exist or are expected, and (2) the abatement measures listed above are physically infeasible or economically unreasonable. In these instances, noise abatement measures other than those listed in Sec. 772.13(c) of this chapter may be proposed for Types I and II projects by the highway agency and approved by the Regional Federal Highway Administrator on a case-by-case basis when the conditions of Sec. 772.13(a) of this chapter have been met.

Sec. 772.15 Information for Local Officials.

In an effort to prevent future traffic noise impacts on currently undeveloped lands, highway agencies shall inform local officials within whose jurisdiction the highway project is located of the following:

- (a) The best estimation of future noise levels (for various distances from the highway improvement) for both developed and undeveloped lands or properties in the immediate vicinity of the project,
- (b) Information that may be useful to local communities to protect future land development from becoming incompatible with anticipated highway noise levels, and
- (c) Eligibility for Federal-aid participation for Type II projects as described in Sec. 772.13(b) of this chapter.

Sec. 772.17 Traffic Noise Prediction.

(a) Any traffic noise prediction method is approved for use in any noise analysis required by this regulation if it generally meets the following two conditions:

- (1) The methodology is consistent with the methodology in the FHWA Highway

Traffic Noise Prediction Model (Report No.FHWA-RD-77-108)*

* These documents are available for inspection and copying as prescribed in 49 CFR Part 7, Appendix D.

(2) The prediction method uses noise emission levels obtained from one of the following:

(i) National Reference Energy Mean Emission Levels as a Function of Speed (Appendix A).

(ii) Determination of reference energy mean emission levels in Sound Procedures for Measuring Highway Noise: Final Report, DP-45-1R. *

(b) In predicting noise levels and assessing noise impacts, traffic characteristics which will yield the worst hourly traffic noise impact on a regular basis for the design year shall be used.

Sec. 772.19 Construction Noise.

The following general steps are to be performed for all Types I and II projects:

(a) Identify land uses or activities which may be affected by noise from construction of the project. The identification is to be performed during the project development studies.

(b) Determine the measures which are needed in the plans and specifications to minimize or eliminate adverse construction noise impacts to the community. This determination shall include a weighing of the benefits achieved and the overall adverse social, economic and environmental effects and the costs of the abatement measures.

(c) Incorporate the needed abatement measures in the plans and specifications.

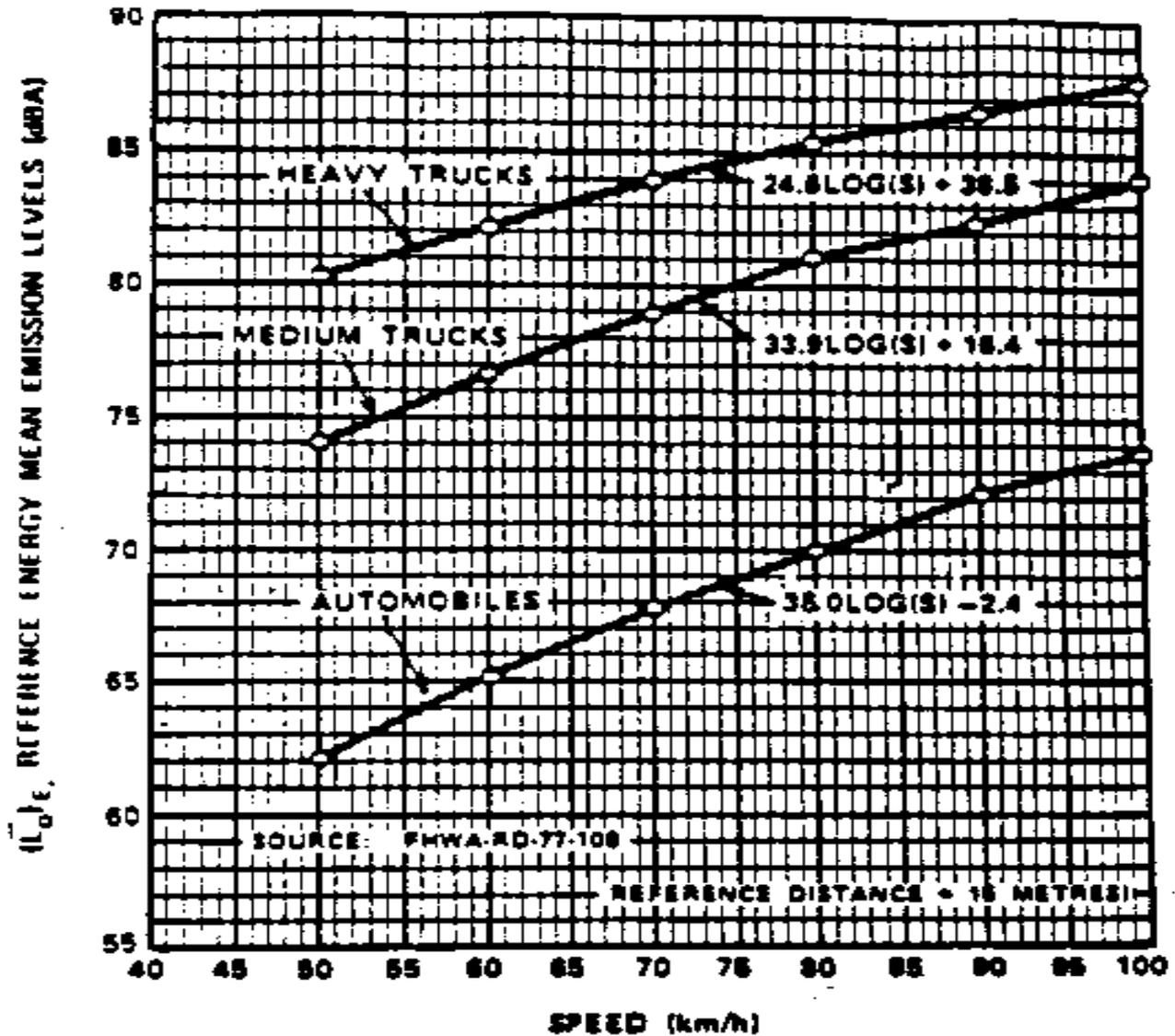
TABLE 1

Noise Abatement Criteria (NAC) Hourly A-Weighted Sound Level - decibels (dBA)*

<u>Activity Category</u>	<u>Leq(h)</u>	<u>L₁₀(h)</u>	<u>Description of Activity Category</u>
A	57 (Exterior)	60 (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)	70 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	75 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	--	--	Undeveloped lands.
E	52 (Interior)	55 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

* Either L₁₀(h) or Leq(h) (but not both) may be used on a project.

APPENDIX A



LEGEND:

1. AUTOMOBILES: ALL VEHICLES WITH TWO AXLES AND FOUR WHEELS.
2. MEDIUM TRUCKS: ALL VEHICLES WITH TWO AXLES AND SIX WHEELS.
3. HEAVY TRUCKS: ALL VEHICLES WITH THREE OR MORE AXLES.

National Reference Energy Mean Emission Levels as a Function of Speed