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# CIRCULAR

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## TRAFFIC NOISE RESEARCH NEEDS OF STATE HIGHWAY AGENCIES

mode

1 highway transportation

subject areas

12 planning

17 energy and environment

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conducted by

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## I. INTRODUCTION

In November 1983, the Federal Highway Administration (FHWA) sponsored a workshop on highway noise research needs, hosted by the Maryland State Highway Administration\*. The workshop purpose was to bring together experts from academia, government and consulting to review current traffic noise research and development (R&D) and to make recommendations on future research needs and direction.

Fifty one specific research recommendations resulted from the workshop. However, much concern was expressed at the workshop and subsequent meetings of state highway agency noise analysts that continued effort for funding of the research needs was essential. The process by which the FHWA research programs are developed relies heavily on input from state highway agencies (SHAs). Specifically, a problem that does not have demonstrated multi-state or national importance has little chance for survival in the FHWA R&D budget. Further, the key item affecting decisions on research needs is the expected benefits or cost savings that will result from the research.

Therefore, a task force was established within Transportation Research Board (TRB) Committee A1F04, Transportation-Related Noise and Vibration. The purpose of the task force is to help state noise analysts prioritize research needs.

The task force sent a survey to SHA representatives in October 1984 asking them to rate the 51 research needs, to rank those given the highest ratings, and to define any additional needs. This report documents the results of the survey. Section II describes the survey format, Section III presents the results, and a summary is given in Section IV. Appendix A lists how each State rated each need. Appendix B lists how each State ranked the Priority 5 needs. Appendix C presents a detailed description of the highest priority needs.

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\* Schneider, J.D., Proceedings of the FHWA Highway Noise Research Needs Workshop, prepared for Federal Highway Administration, Baltimore, MD, 1984.

## II. THE SURVEY

### A. Format

The 1983 FHWA workshop was divided into three panels:

- Panel 1: Physical Aspects
- Panel 2: Noise Criteria, and Sound and Behavioral Effects
- Panel 3: Economics of Abatement

Of the resultant fifty-one research needs recommendations, thirty-one were from Panel 1, seven from Panel 2 and thirteen from Panel 3. Each research need was assigned a priority of 1, 2 or 3. Twenty-four needs were given priority 1 (highest), twenty-five were given priority 2 and two were given priority 3. However, no comprehensive attempt was made to rank the needs.

In developing the survey, the Task Force decided to minimize bias to the SHA representatives by not including the panel under which each need was located nor the priority assigned to it by the panel. Rather, the SHA representatives were asked to rate and rank the needs in aggregate. To facilitate the rating, the order of the needs was reorganized by subject area (e.g., noise barriers, vehicle emissions, tire/pavement, construction noise, vibration, building noise reduction, community response, land use planning).

The reorganized needs were sequentially numbered and keyed to the one-line descriptions of each need on the survey form. The SHA representatives were then asked to rate each research need from 1 (lowest) to 5 (highest) in priority as follows:

- 5: Extremely urgent, should be done immediately.
- 4: Urgent, but should only be done after items rated 5 are completed.
- 3: Important, should be done sometime in the future after items rated "4" or "5".
- 2: Should be done at some point but not essential.
- 1: Should not be done.
- X: No opinion.

In addition, space was provided for the respondents to list and rate additional research needs. Then, on page 5 of the survey form each need rated "5" was to be ranked in order of importance.

Finally, a form was provided for the respondent to prepare his or her own research needs problem statements, including description of the problem, objectives, current activities, expected benefits/urgency, estimated person years, and estimated cost.

## B. Analysis Method

The completed survey forms were analyzed in two ways. First, the results for each research need were compiled by number of responses for each rating category. A mean rating was then completed, excluding the "no option" ratings.

Second, the rankings of all of the needs rated "5" were analyzed. Only the needs ranked "5" on page 5 of the survey were included in this analysis. A total number of points was computed for each of these needs by assigning 20 points each time the need was ranked first by a respondent, 19 points for each time ranked second, 18 points for each time ranked third, and so on.

For example, assume three States gave Research Need No. 99 a rating of 5. State A gave five other needs a rating of 5, but ranked Need No. 99 as the highest priority (1st out of 6). State B gave twelve needs a rating of 5, and ranked Need No. 99 third out of 12. State C gave four needs a "5" rating and ranked Need No. 99 second highest priority (2nd out of 4). Need 99 would then get 20 points for State A, 18 for State B and 19 for State C for a total of 57 points.

After all "Priority 5" needs were analyzed in this manner, they were then ranked in descending order of point total.

## III. SURVEY RESULTS

Thirty-one responses were received, coming from 30 U.S. State highway agencies and the Ontario Ministry of Transportation and Communication.

### A. The Fifty-one Listed Needs

Table 1 presents the summary of the results of all fifty one needs in the order contained in the survey. The full description of each research need is in the 1983 FHWA Workshop proceedings;\* descriptions of the eleven highest priority needs are in Appendix C. As described in section II.B, the Mean Value of Ratings is averaged for all of the responses for each need, excepting the "no option" ratings; the Total Number of Points is based on the rankings of only those needs rated "5" by each respondent, with 20 points for a ranking of 1 (highest), 19 points for a ranking of 2 (second highest), etc.

Table 2 presents more details on the ratings for all of the needs, with the results still in the sequential order in the survey. Note that Table 2 lists the number of responses in each rating category for each need.

Table 3 then lists all of the research needs in descending order of mean value of the ratings. Finally, Table 4 lists all needs that were given Priority 5 ratings in descending order based on total number of Priority 5 points.

Many observations can be made on the results for the 51 needs listed in the survey. These observations indicate general trends, but hide specific differences. For example, Need 25, Tire/Pavement Modelling Phase I, was given a priority of 5 by only two respondents; however, both agencies made it their highest ranked need (see Appendices A and B for details). Thus, this topic is of extreme urgency to these two States.

The Task Force wants to emphasize the following findings. Readers are also invited to draw additional conclusions.

1. All of the 51 needs had an average rating above 2, which was defined as "should be done at some point..."
2. The top 3 needs, according to state noise analysts, were:

<u>No.</u>	<u>Research Need</u>	<u>Average Rating</u>	<u>Total Points for Rating of 5</u>	<u>Number Times Rated 5</u>
1	- Multiple Reflections Model	3.9	214	12
39	- Microcomputer Test Cases	3.8	188	11
16	- Assess Existing Low Speed Emission Data	3.6	176	10

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\* Ibid.

3. A second tier of most important needs would be:

<u>No.</u>	<u>Research Need</u>	<u>Average Rating</u>	<u>Total Points for Rating of 5</u>	<u>Number Times Rated 5</u>
34	- Prepare Citizen Info on Vibration	3.5	153	10
18	- Assess Existing Truck-on-grade Emission Data	3.5	154	9
51	- Survey Legal Decisions	3.7	130	8
17	- Measurements of Low-speed Emissions	3.4	133	8
11	- Cost Effectiveness of Absorptive Barriers	3.4	133	8
47	- Establish Tech Transfer Mechanism	3.4	127	8
19	- Measurement of Truck-on-grade emission Data	3.4	111	7

4. One other need that had a very high average rating, but lower total Priority 5 points:

<u>No.</u>	<u>Research Need</u>	<u>Average Rating</u>	<u>Total Points for Rating of 5</u>	<u>Number Times Rated 5</u>
4 -	Study Multiple Diffraction in STAMINA	3.5	68	5

5. The needs with more than half of ratings being 4 (urgent) or 5 (extremely urgent):

<u>No.</u>	<u>Research Need</u>	<u># of 5's</u>	<u># of 4's</u>	<u># of 4's &amp; 5's</u>
1 -	Multiple Reflections Model	12	7	19
51 -	Survey Legal Decisions	8	10	18
39 -	Microcomputer Test Cases	11	5	16
16 -	Assess Existing Low Speed Emissions Data	10	6	16
18 -	Assess Existing Truck-on-grade Emissions Data	9	6	15
4 -	Study Multiple Diffraction in STAMINA	4	11	15
33 -	Construction Noise Model Field Data	7	8	15

6. Likewise, trends emerge for the least important needs, according to State noise analysts. The lowest rated needs were:

<u>No.</u>	<u>Research Need</u>	<u>Rating</u>	<u># of Priority 5 Points</u>
27 -	Tire/Pavement, Modelling, Phase III	2.1	20
28 -	Tire/Pavement, Assess Existing Data	2.1	20
30 -	Tire/Pavement, Pavement Design Manual	2.3	38
31 -	Tire/Pavement, Life Cycle Costs	2.3	0
6 -	Atmos Corrections for Barrier Predictions	2.3	36
26 -	Tire/Pavement, Modelling, Phase II	2.4	39
29 -	Tire/Pavement, Sound Absorption by Open-Graded Mix	2.4	20

(It should be noted that Needs 25-30 were all ranked in a tie for the highest priority need but by the same agency. This agency also placed Needs 20-23 in a tie for the second highest ranked need.)

7. The needs with the most ratings of 1 ("should not be done") were:

<u>No.</u>	<u>Research Need</u>	<u># of 1's</u>	<u>Mean Rating</u>
28	- Tire/Pavement, Assess Existing Data	9	2.1
27	- Tire/Pavement, Modelling, Phase III	7	2.1
29	- Tire/Pavement, Sound Absorption by Open-Graded Mix	7	2.4
30	- Tire/Pavement, Pavement Design Manual	7	2.3
6	- Atmos Corrections for Barrier Predictions	6	2.6
24	- Source Control Enforcement	6	2.6
31	- Tire/Pavement, Life Cycle Costs	6	2.3



TABLE 1--SUMMARY OF SURVEY RESULTS

<u>No.</u>	<u>Research Need</u>	<u>Priority 5 Points*</u>	<u>Mean Rating</u>
1.	Barriers, Multiple Reflections: Develop and Validate Prediction Model	214	3.9
2.	Barriers, Shapes: Develop Measurement Program to Determine Effectiveness	71	3.1
3.	Barriers, Design: Prepare Design Manual Based on State Practices	81	3.3
4.	Barriers, multiple Diffraction: Review STAMINA-OPTIMA Treatment	68	3.5
5.	Barriers, Insertion Loss: Validate and Improve Existing Models Addressing Propagation Over Many Surfaces	33	3.1
6.	Barriers, Atmospheric Effects: Explore Atmospheric Parameter Corrections for Insertion Loss Prediction	36	2.3
7.	Barriers, Modelling: Develop Insertion Loss Model Including All Relevant Parameters	93	3.5
8.	Barriers, Planning Model: Refine Insertion Loss Research Model for Planners	33	2.6
9.	Barriers, Measurement: Build Upon Proposed ANSI Standard, as Needed	0	2.7
10.	Barriers, Social Survey: Develop Manual on Recommended Techniques	32	2.8
11.	Barriers, Cost Effectiveness of Absorptive Barriers: Gather Data, Study Relationships, prepare Guidelines	133	3.4
12.	Barriers, National Physical Design Criteria: Develop Criteria Based on Risk Analysis and Life Cycle Costing	105	3.3
13.	Barriers, Cost Effectiveness Criteria: Gather and Analyze State Data: Distribute Results	96	3.4
14.	Barriers, Minimum Insertion Loss Criteria: Establish Such Criteria for Various Scenarios Based on Surveys and Literature Review	55	2.9

\* Based on 20 points for a Priority 5 items being ranked first by a State, 19 points for being ranked second, etc.

TABLE 1--SUMMARY OF SURVEY RESULTS (cont'd)

<u>No.</u>	<u>Research Need</u>	<u>Priority 5 Points</u>	<u>Mean Rating</u>
15.	Systems-Level Abatement Strategies: Determine Relative Costs and Benefits of Different Categories of Strategies	19	2.8
16.	Low Speed Emissions, I: Assess Existing Data	176	3.6
17.	Emissions, Low Speed, II: Follow up with Measurements as Needed for Data Base Completion	133	3.4
18.	Emissions, Trucks on Grade, I: Assess Existing Data	154	3.5
19.	Emissions, Trucks on Grade, II: Follow up of Measurements to Complete Data Base	111	3.4
20.	Emissions, Component Noise Sources: Evaluate Utility of a Model Based on Individual Vehicle Noise Components	19	2.6
21.	Emissions, Component Sources, I: Identify Sensitivity of Modelling of Various Parameters	37	2.8
22.	Emissions, Component Sources, II: Characterize Emissions by Component Characteristics	19	2.7
23.	Emissions, Component Sources, Phase III: Develop Needed Data Bases	19	2.6
24.	Source Control Strategies: Study Enforcement Options, Cost and Benefits of On-the-road Fleet Emissions Control	44	2.6
25.	Tire/Pavement, Modelling, Phase I: Determine Tire/Road Interaction	40	2.5
26.	Tire/Pavement, Modelling, Phase II: Develop and Validate Model of Tire Noise Generation	39	2.4
27.	Tire/Pavement, Modelling, Phase III: Develop Model for Predicting Skid Number	20	2.1
28.	Tire/Pavement, Existing Data: Assess Existing Data using Sound Radiation Model	20	2.1
29.	Tire/Pavement, Near Field Effects: Evaluate Sound Absorptive by Open Graded Surfaces	20	2.4

TABLE 1--SUMMARY OF SURVEY RESULTS (continued)

<u>No.</u>	<u>Research Need</u>	<u>Priority 5 Points</u>	<u>Mean Rating</u>
30.	Tire/Pavement, Pavement Design Manual: Develop Manual Based on Previous Item	38	2.3
31.	Tire/Pavement, Life Cycle Costs: Identify Costs of Alternative Pavements	0	2.3
32.	Construction Noise, Tech Transfer: Disseminate Info on Existing Control Techniques and Models	84	3.3
33.	Construction Noise, Model Refinements: Further Field Validation and Data Base Expansion	101	3.4
34.	Vibration: Prepare Information for Citizens Traffic Induced Vibration	153	3.5
35.	Building Noise Reduction, Disseminate Info on Insulation Effectiveness and Economics	73	3.2
36.	Building Noise Reduction, Upper Floors: Compile Info on Building Design Features for Balconies and Interior Spaces	44	2.9
37.	Building Noise Reduction, Methods: Compile Information on Costs and Benefits	41	3.3
38.	Vegetation: Compile Information on Effects of Vegetation on Traffic Noise	111	3.2
39.	Microcomputers: Standard Noise Prediction Cases for Micro Program Calibration	188	3.8
40.	Tunnel Noise Propagation: Summarize Existing Data and Models, Evaluate Need for Further Field Work	37	2.7
41.	Community Response, Noise Exposure: Synthesize Scientific Literature for Highway Agencies	52	2.9
42.	Community Response, Multimodal Noise: Field Studies on Impact of Concurrent Transportation Noise Sources	0	2.7
43.	Community Response, Temporary Noise Exposure: Field Studies of Construction Noise Impact	0	2.9

TABLE 1--SUMMARY OF SURVEY RESULTS (cont'd)

<u>No.</u>	<u>Research Need</u>	<u>Priority 5 Points</u>	<u>Mean Rating</u>
44.	Community Response, Sleep Interference: Controlled Field Studies to Evaluate Laboratory Finding	12	2.9
45.	Community Response, Psychological Abatement Techniques: Field Surveys on Effectiveness of Such Strategies	32	2.7
46.	Community Response, Time-of-day Effects of Traffic Noise: Study and Develop Model	30	2.9
47.	Technology Transfer: Establish a Mechanism (determine information needs, dissemination methods and how to administer)	127	3.4
48.	Land Use Planning: Prepare Report with Information. Data Base for Local Agencies	37	3.0
49.	Land Use Planning, Impediments to Abatement: Identify Obstacles and Recommend Actions	38	3.1
50.	Contract Letting Procedures: Survey & Evaluate States' Procedures re Barriers	49	3.0
51.	Survey of Legal Decisions: Synthesize Noise Decisions and Categorize Issues	130	3.7

TABLE 2 Summary of Ratings of Noise Research Needs

<u>Research Need No.</u>	<u>No. Responses for this Need</u>	<u>No. of Responses Rated</u>						<u>Mean Value of Ratings</u>
		<u>X</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	
1	31	2	0	5	5	7	12	3.9
2	31	2	3	3	12	7	4	3.1
3	31	3	2	4	8	9	5	3.3
4	31	5	1	4	6	11	4	3.5
5	31	3	3	5	9	9	2	3.1
6	31	4	6	12	6	1	2	2.3
7	31	3	1	6	8	6	7	3.5
8	31	4	2	12	9	2	2	2.6
9	31	4	1	12	7	7	0	2.7
10	31	1	3	10	8	7	2	2.8
11	31	2	0	8	9	5	7	3.4
12	31	4	2	6	8	4	7	3.3
13	31	3	1	5	8	8	6	3.4
14	31	5	1	9	10	3	3	2.9
15	31	4	5	4	12	4	2	2.8
16	31	3	2	6	4	6	10	3.6
17	31	3	2	7	5	6	8	3.4
18	31	3	1	7	5	6	9	3.5
19	31	3	1	8	6	6	7	3.4
20	31	5	5	6	11	3	1	2.6
21	31	5	3	7	10	4	2	2.8
22	31	5	5	6	8	6	1	2.7
23	31	5	5	8	7	5	1	2.6
24	31	6	6	6	9	1	3	2.6
25	31	5	5	10	6	3	2	2.5
26	31	5	5	12	5	2	2	2.4
27	30	6	7	11	4	1	1	2.1
28	30	4	9	10	4	2	1	2.1

TABLE 2 Summary of Ratings of Noise Research Needs (continued)

<u>Research Need No.</u>	<u>No. Responses for this Need</u>	<u>No. of Responses Rated</u>						<u>Mean Value of Ratings</u>
		<u>X</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	
29	30	3	7	10	3	6	1	2.4
30	30	2	7	12	5	2	2	2.3
31	30	4	6	11	5	4	0	2.3
32	30	3	3	7	3	8	6	3.3
33	31	3	1	8	4	8	7	3.4
34	31	3	1	8	5	4	10	3.5
35	30	3	1	8	8	5	5	3.2
36	30	2	2	9	8	7	2	2.9
37	30	3	1	6	9	8	3	3.3
38	30	0	3	6	10	4	7	3.2
39	30	2	0	4	8	5	11	3.8
40	30	8	1	13	3	2	3	2.7
41	30	4	4	5	9	5	3	2.9
42	30	4	4	7	9	6	0	2.7
43	30	4	2	8	7	9	0	2.9
44	30	5	4	5	7	8	1	2.9
45	30	5	5	5	10	3	2	2.7
46	30	4	2	8	7	7	2	2.9
47	30	4	3	5	4	7	7	3.4
48	30	4	2	8	7	7	2	3.0
49	30	3	1	7	12	4	3	3.1
50	30	6	2	7	7	5	3	3.0
51	31	2	1	6	4	10	8	3.7

TABLE 3 Research Needs in Decending Order of Mean Rating

<u>Research Need No.</u>	<u>Mean Rating</u>
1	3.9
39, 51	3.8
16	3.6
4, 7, 18, 34	3.5
11, 13, 17, 19, 33, 47	3.4
3, 12, 32, 37	3.3
35, 38	3.2
2, 5, 49	3.1
48, 50	3.0
14, 36, 41, 43, 44, 46	2.9
10, 15, 21	2.8
9, 22, 40, 42, 45	2.7
8, 20, 23, 24	2.6
25	2.5
26, 29	2.4
6, 30, 31	2.3
27, 28	2.1

TABLE 4 Summary of Rankings of Needs Rated "5"

Research Need No.	No. of Times Rated 5	Rankings ( ___ out of ___ ) <sup>a</sup>	Total No. of Priority 5 Points
1	12	11/11, 1/2, 2/6, 1/5, 7/9, 1/7 1/10, 4/4, 2/3, 5/6, 2/6	214
39	11	4/6, 1/9, 1/7, 3/5, 1/5, 3/3 4/10, 4/7, 9/12, 8/12, 5/13	188
16	10	2/6, 7/11, 2/9, 2/7, 1/6, 2/5 4/7, 1/2, 6/12, 7/12	176
18	9	3/6, 1/11, 3/9, 4/7, 3/6, 5/9 6/7, 2/2, 8/12	154
34	10	6/6, 6/9, 8/9, 4/10, 2/4, 6/7 2/6, 10/16, 3/12, 10/13	153
17	8	2/2, 8/11, 4/9, 3/7, 4/6, 3/5 5/7, 6/12	133
11	8	2/2, 4/9, 9/10, 5/10, 3/3, 2/16, 6/13, 4/6	133
51	8	5/10, 7/10, 1/14, 5/7, 1/6 15/16, 1/1, 3/6	130
47	8	4/7, 5/8, 2/9, 2/5, 10/10, 1/7 16/16, 1/12	127
19	7	2/11, 5/9, 5/7, 5/6, 6/9, 7/7, 6/12	111
38	7	5/6, 9/11, 2/5, 8/8, 1/3, 10/10, 1/6	111
12	6	4/5, 3/9, 1/5, 3/16, 5/12, 5/12	105
33	7	4/8, 4/5, 7/7, 11/16, 3/4, 7/7, 10/12	101
52 <sup>b</sup>	6	7/7, 2/10, 3/7, 4/6, 8/16, 4/12	98
13	6	5/5, 1/9, 7/10, 14/16, 1/8, 2/12	96
7	6	6/7, 6/6, 5/5, 3/5, 2/7, 11/13	93
32	6	6/11, 3/8, 9/10, 12/16, 3/12, 9/12	84

<sup>a</sup> If a state gave six needs a rating of 5, and ranked Need No. 16 the second highest of the six, the entry for Need No. 16 would appear as "2/6" (second out of six).

<sup>b</sup> "Other" category.



TABLE 4 SUMMARY of Rankings of Needs Rated "5" (continued)

Research Need No.	No. of Times Rated 5	Rankings ( ___ out of ___ ) <sup>a</sup>	Total No. of Priority 5 Points
3	5	1/5, 4/5, 6/10, 11/12, 2/13	81
35	5	6/8, 3/7, 4/16, 12/12, 7/13	73
2	4	1/2, 3/11, 2/7, 7/12	71
4	5	4/11, 9/9, 8/10, 3/6, 13/16	68
14	3	2/8, 2/12, 4/13	55
41	3	2/10, 8/10, 1/3	52
50	3	7/16, 6/12, 1/13	49
24	3	3/5, 6/7, 10/12	44
36	3	5/16, 8/13, 6/6	44
37	3	7/8, 6/16, 9/13	41
25	2	1/7, 1/12*	40
26	2	2/7, 1/12*	39
49	3	1/10, 11/12, 13/13	38
30	2	1/12*, 3/7	38
48	3	3/10, 11/12, 12/13	37
21	2	2/12**, 3/10	37
40	3	10/11, 4/7, 12/12	37
6	2	1/6, 5/5	36
5	2	5/11, 4/12	33
8	2	6/10, 3/13	33
45	2	8/9, 2/3	32
10	2	5/5, 5/6	32

<sup>a</sup> If a state gave six needs a rating of 5, and ranked Need No. 16 the second highest of the six, the entry for Need No. 16 would appear as "2/6" (second out of six).

\* All ranked "1" by same agency.

\*\* All ranked "2" by same agency.

TABLE 4 Summary of Rankings of Needs Rated "5" (continued)

Research Need No.	No. of Times Rated 5	( Ranking out of ) a	Total No. of Priority 5 Points
46	2	7/9, 5/7	30
53 <sup>b</sup>	2	6/6, 8/16	28
27	1	1/12*	20
28	1	1/12*	20
29	1	1/12*	20
15	1	2/5	19
20	1	2/12**	19
22	1	2/12**	19
23	1	2/12**	19
44	1	9/9	12
9	0	--	0
31	0	--	0
42	0	--	0
43	0	--	0

<sup>a</sup>If a state give six needs a rating of 5, and ranked Need No. 16 the second highest of the six, the entry for Need No. 16 would appear as "2/6" (second out of six).

<sup>b</sup>"Other" category.

\* All ranked "1" by same agency.

\*\*All ranked "2" by same agency.

#### Newly Suggested Research Needs

The respondents were given the opportunity to define additional research needs of importance to them that were not listed on the survey. Seven States and the province of Ontario provided eleven suggested needs, as shown in Table 5.

TABLE 5--NEWLY SUGGESTED RESEARCH TOPICS

<u>Research Topic</u>	<u>Estimated State</u>	<u>Rating Man-Years</u>	<u>Given</u>	<u>Ranking*</u>
Effects of Cold Temperature on Noise Propagation	Alaska	1	--	--
Determination of Vehicle Noise Levels for Highway Noise Computer Models	Florida	1	5	7/7
Develop a standard testing method to measure and evaluate noise generating potential of pavement surface textures.	Ontario	none given	5	2/10
Cost/Benefit of Noise Mitigation Structures Owned by Non-Profit Institutes	Oregon	1	--	--
Multiple Reflections in the 3-D Case (overhead reflection)	Texas	2	5	3/7
Develop noise emission Factors for buses	Texas	1	4	--
Intersection Noise Prediction Model	Utah	none given	4+ or 5	4/6
Street Canyon Effect of Rows of Houses or Buildings	Utah	none given	5	6/6
Noise/Noise Barrier vs. the Housing Market: How does noise effect the marketability and value of homes in urban and rural areas? How much are people willing to pay for quiet environment? ect.	Virginia	none given	5	8/16

Evaluate FHPM 7-7-3. Is speech interference still a state of the art criterion for highway noise regulation?	Virginia	none given	5	9/16
Interrupted Flow	Washington	none given	5	4/12

\* If given rating of "5" by that State (e.g., "7/7" means of the seven Priority 5 needs of a state, this need was ranked seventh in importance.

For the ten highest priority needs, the breakdown on suggested method of funding is as follows:

<u>Research Needed No.</u>	<u>Research Need</u>	<u>Funding Method</u>	<u>Response Rate*</u>
1	Multiple Reflection Model	FHWA-C	4/8
39	Microcomputer Test Cases	FHWA-C FHWA-I	3/8
16	Assess Existing Low-speed Emissions Data	FHWA-C	4/6**
18	Assess Existing Truck-on-grade Emission Data	FHWA-C	4/7**
34	Prepare Citizen Information on Vibration FHWA-C	2/2	
17	Measurements of Low-speed Emissions	FHWA-C	4/6**
47	Establish Technology Transfer Mechanism	FHWA-I	4/5**
19	Measurements of Truck-on-grade Emissions	FHWA-I	4/7**
51	Survey Legal Decision	HP&R FHWA-I	2/4 2/4
4	Study Multiple Diffraction in STAMINA/OPTIMA	FHWA-C	2/3

\* The number of responses for the listed "Funding Method" divided by the total number of funding responses.

\*\* The other responses were all HP&R

#### IV. SUMMARY

The 1983 FHWA Highway Noise Research Needs Workshop identified 51 research needs. TRB Committee A1F04 conducted a survey of State highway agency noise analysts for their rating and ranking of these needs.

Thirty-one survey responses were received from 30 states and Ontario. The responses indicated a need for solutions to immediate problems faced by the analyst as he or she conducts noise studies, rather than for longer-range solutions. An analysis of the data showed the following topics to be ranked the highest priority research needs by State noise analysts:

- develop a parallel noise barrier multiple reflections model
- develop standardized test cases for microcomputer versions of STAMINA/OPTIMA
- assess existing low-speed truck noise emission level data and collect additional data as needed
- assess existing truck-on-grade truck noise emission level data and collect additional data as needed
- prepare information booklet for citizens on traffic-induced vibration
- establish a technology transfer mechanism
- survey legal decisions related to traffic noise
- study and refine how STAMINA/OPTIMA handles diffraction over multiple barriers

The lowest priority items dealt with tire/pavement noise research and developing atmospheric parameter corrections for insertion loss prediction. However, even these items were rated as "extremely urgent" by some states.

In addition to the fifty-one listed research needs eleven new topics were suggested, falling into the following eight areas:

- revised vehicle emission levels, including bus levels
- interrupted flow and intersection prediction models
- reflection effects from rows of buildings and overhead structures
- mitigation for non-profit buildings
- effects of noise on housing market
- effects of cold on propagation
- develop standard test method to evaluate pavement noise
- evaluate worth of speech interference as an impact criterion

It should be noted that work has been or is being done on several of these newly suggested items. However, some of the respondents were apparently either unaware of this work or felt that more was necessary.

In either case, support is lent to the identified high priority need of a technology transfer mechanism.

TRB Committee A1F04 plans to annually update this research needs survey. In this manner, States can learn of common areas of research needs and interest.

#### APPENDIX A--DETAILED DESCRIPTION OF TEN HIGHEST PRIORITY NEEDS

1. Ranking #1, Need #1: Barriers, Multiple Reflections: Develop and Validate Prediction Model.

Develop and validate a prediction model that will take into account multiple reflections. Model should be able to:

- a) analyze two and three dimensional cases
- b) alter source locations
- c) determine at what height a barrier will create a reflection significant enough to be analyzed
- d) predict reflections to the farside of the road from a single reflecting surface
- e) rotate reflecting surfaces from perpendicular to other angles
- f) predict effect of absorptive treatment to specific wall sections utilizing variable absorption coefficients
- g) analyze reflections from other surfaces, such as buildings.

2. Ranking #2, Need #39: Microcomputers: Standard Traffic Noise Prediction Cases for Micro Program Calibration.

The STAMINA/OPTIMA program of the FHWA noise model is in the process of being adapted to microcomputer systems. Since individual systems vary, standard traffic noise cases should be created to test key elements of the computer output. A FHWA package could serve as the calibration vehicle and insure standardization of model predictions throughout proliferating microcomputer systems.

Manyears: 1

3. Ranking #3, Need #16: Emissions, Low Speed, Phase I: Assess Existing Data

Determination of low speed truck noise emission levels (less than 30 mph), acceleration and deceleration on local roads. Phase I would assess existing data of the states and the Federal Highway Administration to determine a predictor for speeds below 30 mph.

Manyears: 1 1/2

4. Ranking #4, Need #34: Vibration: Prepare Information for Citizens on Traffic Induced Vibration

Prepare concise publication in layman terms explaining sources of traffic induced vibration, addressing various transmission paths and human response, to alleviate the public's fear regarding the possibility of structural damage.

Manyyears: 1/2-1

5. Ranking #5, Need #18: Emissions, Truck on Grade, Phase I: Assess Existing Data

Determination of truck noise on grade. Phase I would assess existing data of the states and the Federal Highway Administration to determine a predictor for grades from 1 to 7%.

Manyyears: 1/2

6. Ranking #6, Need #51: Survey of Legal Discussions: Synthesize Noise-Related Decisions and Categorize Issues

Little is known on the court case decisions related to transportation noise impacts and policies. Objective is to synthesize precedent-setting legal decisions related to transportation noise issues and to categorize these issues into specific areas of concern such as impact, compensation, property damages, physiological effects, etc. Tasks include surveying all state transportation department legal decisions and laws (past and current) related to transportation noise issues, and categorizing (and report) the above decisions into specific areas.

Manyyears: 1/2

7. Ranking #7, Need #17: Emissions, Low Speed, Phase II: Follow up to Need #16 with Measurements as Needed for Data Base Completion

Phase II - Based on the results of the first phase, follow-up with measurements as required to complete the data base and prediction. Note that a +7 dBA jump discontinuity exists in the present model when predicting from 30 mph to 29 mph. Technology transfer would include incorporation into FHWA models.

Manyyears: 1 (or as determined from Phase I)

8. Ranking #8, Need #11: Barriers, Cost Effectiveness of Absorptive Barriers: Gather Data, Study Relationships, Prepare Guidelines

Problem Statement:

Sound absorbing noise barriers may be a valuable tool in mitigating noise impacts. However, few states have installed such barriers and the degree to which they should be used is not well understood. Depending on the application, less than complete absorption and resultant attenuation is a complex but poorly appreciated problem.

The objective is to quantify the value of noise absorbing barriers so that users may construct more effective noise abatement at reasonable cost. To study the interrelationship between the coefficient of absorption, gain in attenuation, and increase in cost for noise barriers which are all or partially sound absorbing. This information can then be condensed into guidelines for use by the states.

Tasks include surveying states for absorptive barrier installation and related data, surveying manufacturers for data related to cost, absorption coefficients, physical properties, etc., and categorizing available products in terms of various parameters.

Manyears: 1/2

9. Ranking #9, Need #47: Technology Transfer: Establish a Mechanism

Much information currently exists related to transportation noise. This information involves technical, legal, and administrative aspects. More information will be developed in the future. The need exists for a convenient and reliable mechanism for dissemination of this information.

Tasks include determining what information should be made available and in what detail; determining, comparing and evaluating various methods of disseminating information such as computer network, toll free number, periodic publication, etc., and determining staffing requirements and agency responsibility.

Manyears: 1/2

10. Ranking #10, Need #19: Emissions, Truck on Grade, Phase II: Follow up to Need #18 with measurements to Complete Data Base

Phase II is based on the results of the first phase, with follow-up with measurements as required to complete the data base and prediction. Implement by incorporation into models.

Manyears: 1

11. Ranking #11, Need #4: Barriers, Multiple Diffraction: Review STAMINA-OPTIMA Treatment

Review STAMINA/OPTIMA's analysis for multiple barrier interference in the presence of barriers with pavement edges, retaining walls, Jersey barriers, top of cuts, etc.

Manpower: 1/2-1



APPENDIX B --INDIVIDUAL STATE RATINGS

No.	AK	AZ	CA	CT	DE	FL	GA	HI	ID	MS	KY	LA	NE	NJ	NM	NY	NC	ME	MA	MI	MN	ON	OR	PA	SD	TN	TX	UT	VA	WV	WA	
1.	2	3	5	5	2	3	5	5	3	5	4	3	2	5	2	4	4	X	4	5	3	5	5	4	X	5	4	5	5	2	4	
2.	3	5	5	3	2	X	3	3	3	3	3	3	3	4	1	3	4	3	4	4	3	4	1	4	X	2	5	3	4	1	5	
3.	3	3	2	3	4	5	X	3	5	3	4	5	3	4	3	5	3	1	4	2	4	4	X	5	X	4	4	2	2	1	4	
4.	3	3	5	4	2	3	X	4	X	4	3	3	2	5	2	4	4	X	5	4	3	4	1	4	X	2	4	4	5	X	4	
5.	2	3	5	3	3	3	X	4	X	4	3	2	2	4	2	4	4	4	2	4	3	4	1	5	X	3	3	3	1	1	4	
6.	5	3	2	1	2	3	X	2	X	3	2	2	X	2	1	2	3	5	2	2	2	3	1	3	X	2	4	1	1	1	2	
7.	2	3	3	3	2	5	X	5	X	5	4	5	2	3	2	5	4	4	4	5	3	3	1	3	X	4	4	3	2	2	5	
8.	2	3	2	2	3	2	X	4	X	3	3	5	X	2	2	2	3	3	4	3	2	5	1	2	X	3	2	3	2	1	2	
9.	2	4	4	2	2	2	X	3	X	3	3	4	2	3	2	4	3	2	4	X	4	4	1	3	X	3	2	2	2	2	2	
10.	4	3	2	3	2	3	4	2	3	4	4	5	2	4	1	5	3	2	3	4	2	4	1	2	X	3	2	2	1	2	3	
11.	2	3	4	5	2	3	4	3	4	3	3	5	2	5	3	2	4	2	5	2	3	5	X	3	X	5	4	2	5	2	3	
12.	3	3	4	2	4	1	X	2	5	2	2	3	X	5	1	3	3	5	4	2	4	5	X	5	X	3	3	3	5	2	5	
13.	4	3	4	3	4	4	X	2	5	2	5	4	3	5	2	3	4	2	5	2	3	3	X	5	X	4	3	4	5	3	1	
14.	3	3	3	2	3	4	X	2	X	3	5	5	3	4	3	2	2	2	4	X	3	3	X	5	X	2	2	3	2	2	1	
15.	4	3	3	4	1	3	X	2	X	5	3	2	3	3	1	3	3	1	5	4	3	3	X	3	X	2	3	2	1	1	4	
16.	5	4	5	3	5	5	X	5	X	1	4	3	2	4	2	4	2	5	3	3	5	4	X	5	5	5	2	4	2	1	2	5
17.	4	5	5	4	5	5	X	5	X	1	4	3	2	4	2	4	2	5	3	3	5	4	X	2	3	2	3	2	1	2	5	
18.	5	3	5	4	5	5	X	5	X	4	3	2	2	5	2	4	2	4	3	4	5	4	X	2	5	3	3	2	1	2	5	

APPENDIX B--cont'd

No.	AK	AZ	CA	CT	DE	FL	GA	HI	ID	MS	KY	LA	NE	NJ	NM	NY	NC	ME	MA	MI	MN	ON	OR	PA	SD	TN	TX	UT	VA	WV	WA
19.	4	3	5	4	5	5	X	5	X	3	3	2	2	5	2	4	2	4	3	4	5	4	X	2	3	3	2	2	1	2	5
20.	3	3	4	4	3	3	X	3	X	3	1	X	X	4	1	1	3	2	2	3	3	3	X	2	3	2	1	2	1	2	5
21.	2	3	4	4	3	4	X	3	X	3	3	X	X	4	1	3	2	1	3	3	3	5	X	2	2	3	2	2	1	2	5
22.	1	3	4	4	3	4	X	3	X	3	1	X	X	4	1	4	2	1	3	3	4	3	X	2	2	3	2	2	1	2	5
23.	1	3	4	4	3	4	X	3	X	2	1	X	X	4	1	2	2	1	3	3	4	3	X	2	2	3	2	2	1	2	5
24.	1	3	3	3	1	1	X	2	X	5	3	X	X	2	2	3	2	X	4	5	2	3	X	3	1	3	1	2	1	3	5
25.	4	3	4	3	2	2	X	3	X	3	1	X	1	2	3	2	2	X	2	2	5	4	X	1	1	2	3	2	2	1	5
26.	3	3	4	3	2	2	X	3	X	2	1	X	1	2	3	2	2	X	2	2	5	4	X	1	1	2	2	2	2	1	5
27.	X	3	X	2	1	1	X	3	X	2	1	X	1	2	3	2	2	X	2	2	4	3	X	1	1	2	2	2	2	1	5
28.	1	3	X	2	1	1	X	2	X	2	1	X	1	2	3	4	2	3	1	2	4	3	X	1	1	2	2	2	2	1	5
29.	1	3	2	2	1	1	X	3	X	2	1	X	1	2	3	4	2	4	4	4	4	4	X	1	1	2	2	2	2	2	5
30.	1	3	2	2	1	1	X	2	X	2	1	3	1	2	3	3	2	4	4	2	5	3	X	1	1	2	2	2	2	2	5
31.	2	3	X	2	1	1	X	3	X	2	2	X	1	2	3	2	2	4	4	4	4	3	X	1	1	2	3	2	2	1	2
32.	3	4	5	2	1	4	X	4	X	4	5	X	2	4	2	4	3	1	2	4	3	5	X	5	2	2	4	2	5	1	5
33.	4	4	4	2	1	2	X	4	X	4	5	X	2	2	2	4	3	5	3	5	3	4	5	5	2	2	5	2	5	3	4
34.	5	4	4	2	5	2	X	2	X	3	3	5	3	5	1	4	2	4	3	2	2	5	5	5	X	2	5	5	5	2	3
35.	3	3	4	2	4	2	X	3	X	3	5	5	2	3	2	4	2	3	1	5	2	4	X	5	X	2	3	2	5	3	4

APPENDIX B--cont'd

No.	AK	AZ	CA	CT	DE	FL	GA	HI	ID	MS	KY	LA	NE	NJ	NM	NY	NC	ME	MA	MI	MN	ON	OR	PA	SD	TN	TX	UT	VA	WV	WA
36.	2	4	4	2	4	3	3	3	4	3	4	5	X	2	2	3	2	1	1	4	2	4	X	3	X	2	3	2	5	2	3
37.	3	3	4	3	4	3	X	3	4	3	5	5	X	2	2	4	2	4	1	4	2	4	X	3	X	2	4	2	5	3	3
38.	5	3	5	3	4	3	5	1	5	2	5	4	2	3	2	3	5	1	3	2	2	5	X	3	3	3	4	3	1	2	4
39.	5	4	4	3	5	5	X	2	5	4	4	5	X	3	2	5	5	3	5	3	2	4	X	5	3	3	5	3	3	2	5
40.	X	4	5	2	2	2	X	2	X	X	1	X	X	2	2	2	X	2	2	5	3	3	X	4	X	2	2	3	2	2	5
41.	1	3	3	2	3	2	X	2	X	4	3	X	3	1	3	3	4	1	5	4	2	5	X	4	X	5	4	3	1	2	3
42.	3	3	2	3	2	3	X	2	X	3	3	X	2	1	2	4	4	1	4	4	1	4	X	3	X	3	4	2	1	2	3
43.	4	3	4	3	1	2	X	2	X	3	4	X	2	2	2	3	4	4	3	4	2	4	X	4	X	2	4	3	1	2	3
44.	4	3	2	3	5	1	X	2	X	4	4	X	X	1	1	2	4	1	3	4	3	3	X	3	X	4	4	3	4	2	2
45.	1	3	3	3	5	2	X	2	X	3	2	X	X	2	1	1	5	1	3	4	4	3	X	3	X	3	3	3	4	2	1
46.	4	3	2	4	5	2	X	2	X	4	2	4	1	2	3	3	4	X	4	5	2	3	X	3	X	4	3	2	1	3	2
47.	1	4	4	3	2	4	X	3	X	5	5	X	2	5	1	5	2	1	4	4	4	3	X	5	X	4	5	2	5	2	3
48.	2	4	3	4	1	2	X	2	X	4	3	5	2	2	3	3	4	1	4	2	2	X	4	4	X	4	3	3	3	2	5
49.	2	3	3	4	1	2	X	3	X	4	3	5	2	2	3	2	3	3	5	2	3	4	X	4	X	3	3	2	3	3	5
50.	2	3	3	2	X	2	X	1	X	2	2	5	3	4	2	3	4	X	4	3	2	3	X	5	X	3	4	4	5	X	1
51.	4	4	3	2	4	2	5	3	X	4	4	4	2	1	2	3	4	4	5	4	4	5	5	3	X	2	5	5	5	5	2

