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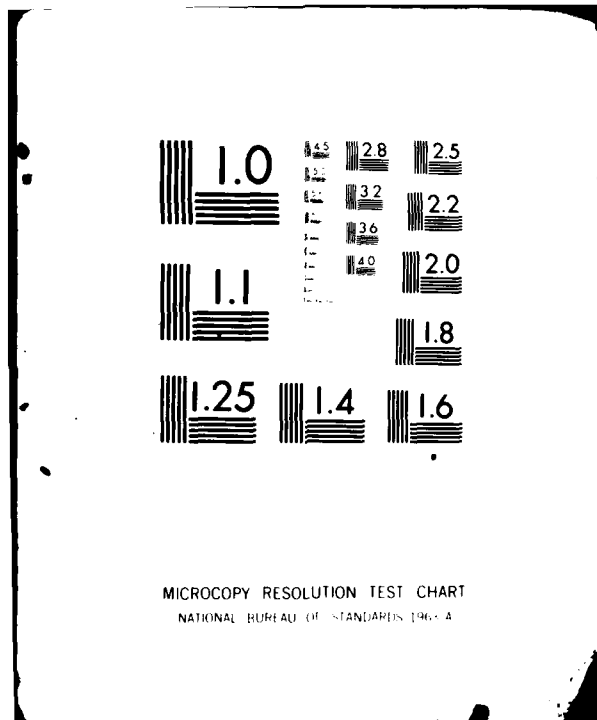
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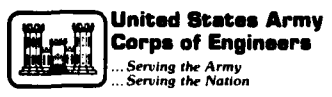
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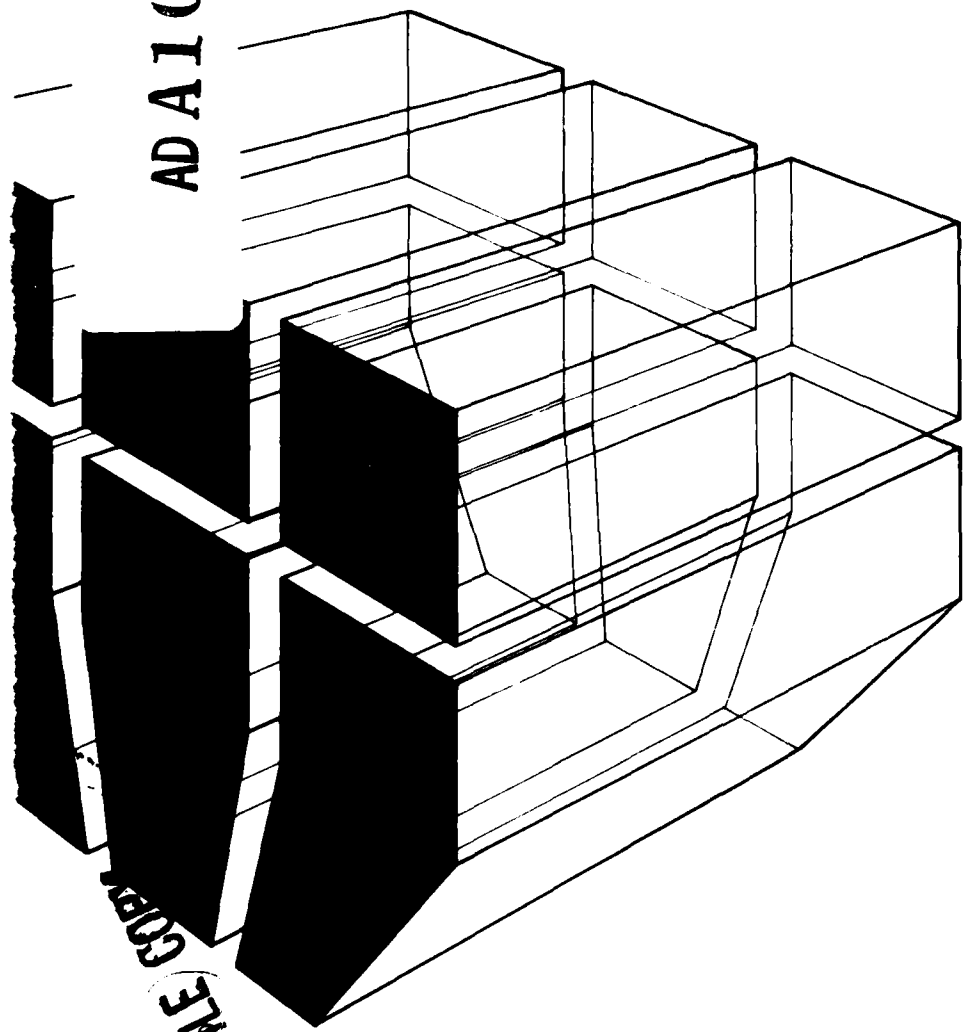
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SPECIAL REPORT N-115  
September 1981

PROPOSED TEST PLAN FOR STUDYING THE IMPACT OF  
CONSTRUCTION NOISE ON NEIGHBORING COMMUNITIES

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by  
Steven D. Hottman

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER CERL-TR-N-115	2. GOVT ACCESSION NO. AD-7703168	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) PROPOSED TEST PLAN FOR STUDYING THE IMPACT OF CONSTRUCTION NOISE ON NEIGHBORING COMMUNITIES		5. TYPE OF REPORT & PERIOD COVERED FINAL
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Steven D. Hottman		8. CONTRACT OR GRANT NUMBER(s) EPA 80-D-X0969
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. ARMY CONSTRUCTION ENGINEERING RESEARCH LABORATORY P.O. Box 4005, Champaign, IL 61820		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE September 1981
		13. NUMBER OF PAGES 29
14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES  Copies are obtainable from the National Technical Information Service Springfield, VA 22151		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)  construction noise (sound)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  ↓ This report presents a detailed test plan for studying the impact of noise from construction activities on neighboring communities. The plan details the physical noise-measurement protocol, site selection plans, attitudinal questionnaires for residential and nonresidential areas, respondent sampling plans, and equipment and personnel needs.		

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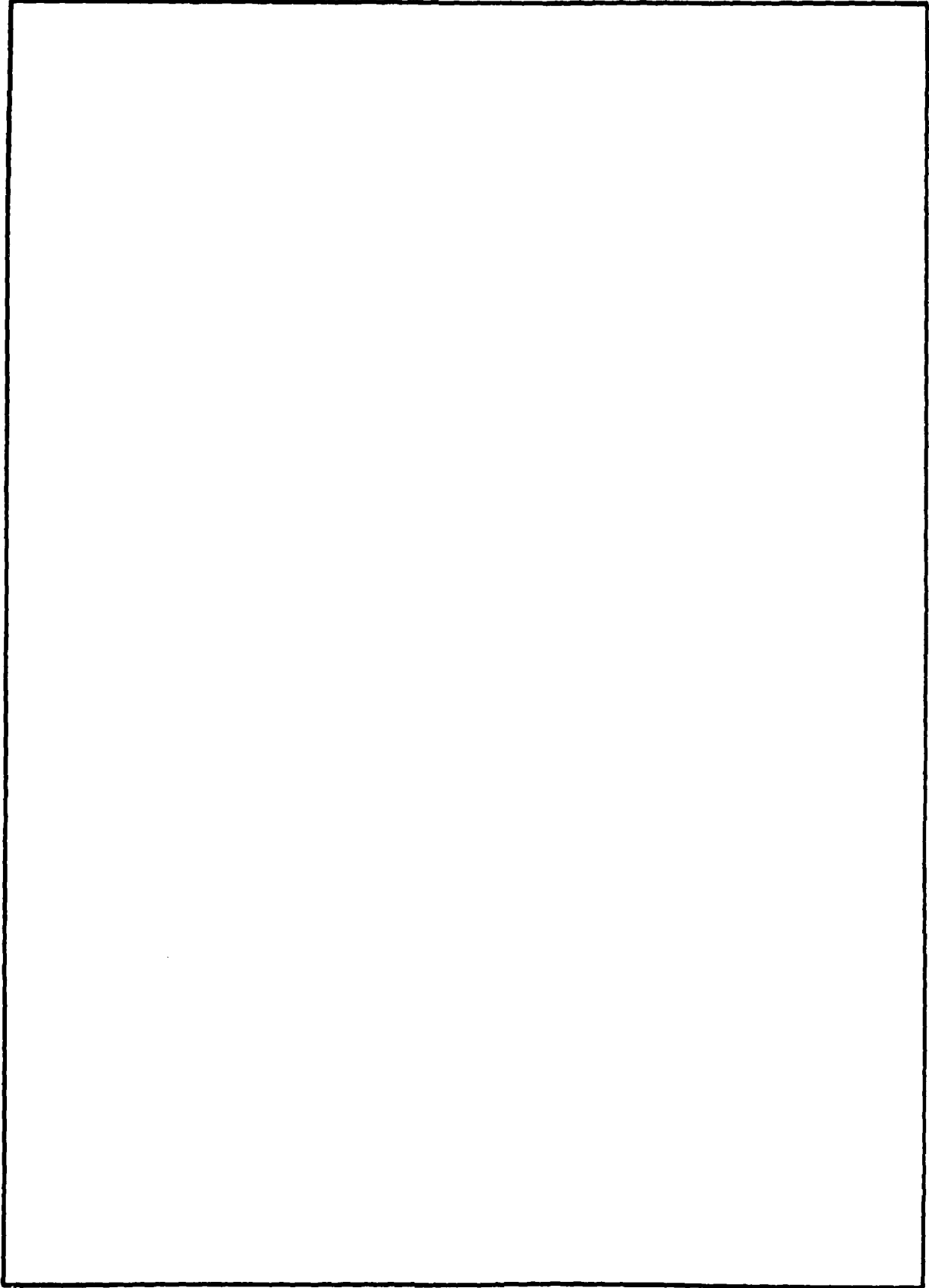
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## FOREWORD

This work was conducted for the U.S. Environmental Protection Agency (EPA), Office of Noise Abatement and Control, under the Inter-Agency Agreements dated 11 April and 30 October 1980, EPA Reference No. EPA 80-D-X0969. The EPA Technical Monitor was Mr. Jeffrey Goldstein.

The work was performed by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (CERL). Dr. R. K. Jain is Chief of CERL-EN.

COL Louis J. Circeo is Commander and Director of CERL and Dr. L. R. Shaffer is Technical Director.

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# PROPOSED TEST PLAN FOR STUDYING THE IMPACT OF CONSTRUCTION NOISE ON NEIGHBORING COMMUNITIES

## 1 INTRODUCTION

### Background

Each day, noise associated with construction site activity impacts millions of people nationwide. Although such noise often causes many noxious psychosocial effects, including interference with daily basic human activities such as vocal communication, little quantitative information on the magnitude of its health and welfare effects is available. Particularly lacking is information on how these effects are experienced by various segments of the communities neighboring construction site noise sources.

No available attitudinal survey information can be applied directly to the problem of community annoyance and response to construction noise because the survey data currently in use have been derived from investigations dealing mainly with aircraft and traffic noise. Although these survey results have proved useful on various Governmental levels in supporting regulatory and planning activities related to aircraft and traffic noise emission, such data are of limited value in assessing or predicting construction noise problems. This is because construction activity noise is temporally different from aircraft and traffic noise: construction noise is of short duration, intermittent, and occurs during daytime hours, whereas traffic and aircraft noise are permanent, continuous, and can occur during nighttime hours. Also, community expectations and attitudes displayed toward construction noise may differ from those displayed toward aircraft and traffic sources, since the results of a construction activity provide more obvious benefits to the community than aircraft or traffic. Therefore, to provide the health and welfare information and data needed to support anticipated Governmental efforts to control or minimize construction equipment and site noise, the Environmental Protection Agency (EPA) asked the U.S. Army Construction Engineering Research Laboratory (CERL) to devise a method of acquiring community response data for construction site noise emissions.

### Objective

The objective of this study was to establish quanti-

tative relationships between construction site noise and community noise impact and response.

The objective of this report is to present a detailed test plan for the data-gathering phase of the study.

### Scope

1. Because of a recent decision to phase out the EPA Office of Noise Abatement and Control, this study will not be carried out as planned. Therefore, this report addresses only those elements of the original CERL/EPA test plan that may be applied universally to similar attitudinal surveys.

2. The test plan presented in this report details the physical noise measurement protocol, site selection plans, attitudinal questionnaires for both residential and nonresidential areas, respondent sampling plans, and equipment and personnel needs. Other areas of importance, such as personnel management and training, survey and data management, and computer code development, are not included because these elements are more specific to the test sites selected and to investigator abilities and resources.

## 2 THE CONSTRUCTION SITE ATTITUDINAL SURVEY

The purpose of the construction site attitudinal survey is to gather quantitative information which can be used to develop appropriate standards or noise control measures. More specifically, the objective of the survey is to establish quantitative relationships between community exposure indices of construction noise and the magnitude of expected community impact.

The investigation will examine human subjective response to construction-site operational variations over periods of time characteristic of construction activity. These include noises of predictable duration; i.e., those noise events that have a well-defined beginning and end. Survey respondents will include people at work as well as people at home in order to ascertain any differences in response and/or exposure between these two groups. The study will concentrate on urban and suburban construction noise. Extensive physical acoustic measurements around construction sites are required as part of this program.

Potential resource constraints—i.e., personnel, equipment, and sampling sizes—are discussed here to provide a concrete example. These constraints will probably be present in any type of study using the test plan described here.

The attitudinal survey is divided into two major areas: residential and nonresidential. Residential areas are those areas that primarily have single or multi-family dwelling units. These areas also may contain convenience stores, offices, and churches, as well as hospitals and nursing homes. Nonresidential areas are those areas that are primarily commercial, such as a downtown shopping district. These areas also may include large office buildings and light manufacturing industries.

The planned resources allow noise measurements and attitudinal surveys to be performed around about 30 construction sites. Since the expected number of survey respondents living near a given residential site is much smaller than the number living near a given nonresidential site (i.e., office), 25 of the 30 construction sites would be near residential areas, and five would be near nonresidential areas. This apportionment would yield about 500 to 700 respondents for each type of site. This number of respondents should provide a statistically significant population.

Since the residential and nonresidential impacts from construction noise are expected to differ from one another in temporal variation in annoyance, the residential portion of the study will focus on individuals exposed 8 hours per day to a noise level considerably above the ambient, but of comparatively short duration. The nonresidential exposure studied will be at a level comparable to the ambient, of long duration (occasionally on the order of years as opposed to weeks), and of individuals exposed only briefly each day as they pass by the construction site.\*

The considerations given above led CERL to design two basically different strategies for gauging the impact of construction noise. In the residential portion of the study, the noise will be monitored essentially continuously (8 hours per day, 5 days per week), and a series of short surveys will be administered. This will allow the response (annoyance) to be related to both the noise level and the length of exposure, including

\*Indications are that workers in offices directly facing major construction are seldom, if ever, annoyed by noise while they are working.

the potential decay of the annoyance after the construction is completed.

In contrast, the nonresidential portion of the project will focus on people who are exposed only intermittently to an essentially steady-state construction noise level. Noise measurements will be taken at the nonresidential sites for about 1 week. During that week, a single "man-on-the-street" type of survey will be administered. The purpose of this type of survey is to identify the degree of annoyance that may be due to construction noise in the downtown setting, as well as to depict any differences between the annoyance attributable to construction and other noise sources.

### 3 NOISE MEASUREMENT PROTOCOL

#### General

The intent of the construction site attitudinal survey is to examine relationships between measured construction noise and expected community impact. To that end, construction sites will be monitored to gather statistical noise data in terms of A-weighted  $L_{eq}$ ,  $L_1$ ,  $L_{10}$ ,  $L_{50}$ ,  $L_{90}$ , and  $L_{99}$ .  $L_{eq}$  is the energy-based average of the levels.  $L_1$ ,  $L_{10}$ , etc. are the levels which are exceeded 1, 10, 50, 90, and 99 percent of the time, respectively.  $L_1 = 90$  dB means that for 1 percent of the time, the measured levels were above 90 dB.

The statistical noise-level data should be calculated for each position each time data are collected at that position. In addition, a daily average should be computed for each position. Given this information, daily averages for each site as a whole can be calculated, that is, an all-position, all-day average. Weekly average noise contour mapping for each of the sites should be produced. Some analog data should be collected and analyzed in 1/3-octave bands, providing spectral data for identifiable sources. The measurement protocol should closely follow the Society of Automotive Engineers (SAE) standard practice (SAE #J1075).

Measurements should be taken at several (up to 12) stations around each construction site. Measurement stations should be chosen to reflect the impact of the site noise on the surrounding area. In general, these stations will be at least 15 m from the site boundary in the direction of the noise-sensitive area where the

attitudinal questionnaire will be administered, subject to the constraint of being at least 3 m from any sound-shielding or sound-reflecting object. Measurement positions at other distances from the site, generally along the same line, should be chosen to facilitate the site-noise contour mapping.

Several strategies have been developed to obtain representative noise data in the study areas. Besides the normal 8 am to 5 pm measurement days, several early-start days (about 6:30 am) and late-start days (about 10:00 am) will allow early morning and late afternoon noise data to be obtained. Measurement data also should be gathered during lulls in activity, such as during construction workers' lunch breaks. Comparison of the early morning, late afternoon, and lunchtime levels before, during, and after the construction will point out changes in the ambient levels due to the construction. The early- and late-start data will be of particular value for areas near streets with heavy rush-hour traffic. Measurements also should be conducted for different positions on a different day. This will ensure that no position is unduly biased in the calculation of long-term (e.g., weekly) averages, and also that positions that have noise which varies regularly during the day will not give false readings; e.g., measurements at a position near a concrete mixer which remains idling during the lunch break would give a false indication of typical level if that position were monitored consistently at that time.

Every effort should be made to assure high-quality and uniform data. One of the measurement team supervisors should spot-check the measurement personnel. Both "over-the-shoulder" checks and concurrent measurements for later comparison should be made. The supervisors also must make sure the data sheets are accurate and complete, both in the field and before coding. The project supervisor should check the team supervisors, and help during checks of measurement personnel.

#### **The Measurements**

A set of site maps indicating the chosen measurement positions should be part of each field kit. When the measurement person reaches a measurement position and sets up the equipment in the prescribed manner, the header portion of the data sheet will be completed (Figure 1). Wind speeds will be determined with hand-held wind meters; winds gusting to above 10 m/s (23 miles/hour) will invalidate the noise readings. Moderate to heavy rains also will invalidate readings. The "remarks" section will be used to describe the

general nature and level of activity at that particular time. The measurement person will then perform a calibration check and record the results.

During the first 10 s of consecutive 30-s intervals, the maximum sound level for the 10-s period, A-weighted, will be recorded. In addition, the major contributor to that level will be noted (e.g., "construction," "traffic," "neighborhood.") This will provide information on background as well as construction-related noise. These data will be noted at each measurement station or position around the site, with a minimum of 60 valid readings per station.

Measurements should begin at a site before construction activities begin, concurrent with the initial attitude survey, providing ambient noise data complementing the baseline attitude data. The frequency of data collection at each site will depend on the number of personnel available. Ideally, one fulltime person per site would be used for the noise measurements. However, one person could be made responsible for measurement at as many as four sites, although this would reduce confidence in the noise levels obtained. In the latter case, the sites would be visited on different days of the week to preclude biasing; the visits would be coordinated with the attitudinal surveys so that noise data from the day immediately preceding the attitudinal survey would be available. In either case, limited weekend data should be gathered, as well as some 24-hour data. In addition, if personnel and budget constraints allow, analog recordings at selected sites should be made; these would yield 1/3-octave data on various types of construction equipment.

After completion of construction, limited measurements should be made in conjunction with the post-construction attitudinal surveys.

## **4 EQUIPMENT**

The basic equipment to be used is the Type 2 sound-level meter. A primary requirement is that the unit be easy and simple to use, since most of the measurement personnel will have had little experience with the equipment. Wide-range, digital adapters have been developed for use with the available sound-level meters. The adapters have a dynamic range of at least

Site \_\_\_\_\_ Position No. \_\_\_\_\_ Date \_\_\_\_\_  
 SLN No. \_\_\_\_\_ Calibrator No. \_\_\_\_\_ Cal. Level \_\_\_\_\_ dB  
 Start Cal. \_\_\_\_\_ dB End Cal. \_\_\_\_\_ dB Wind Speed \_\_\_\_\_ Dir. \_\_\_\_\_  
 Start Time \_\_\_\_\_ End Time \_\_\_\_\_ Temp \_\_\_\_\_ °F  
 Remarks \_\_\_\_\_

Technician \_\_\_\_\_

	LEVEL (dBa)	CODE		LEVEL (dBA)	CODE
1.	_____	_____	31.	_____	_____
2.	_____	_____	32.	_____	_____
3.	_____	_____	33.	_____	_____
4.	_____	_____	34.	_____	_____
5.	_____	_____	35.	_____	_____
6.	_____	_____	36.	_____	_____
7.	_____	_____	37.	_____	_____
8.	_____	_____	38.	_____	_____
9.	_____	_____	39.	_____	_____
10.	_____	_____	40.	_____	_____
11.	_____	_____	41.	_____	_____
12.	_____	_____	42.	_____	_____
13.	_____	_____	43.	_____	_____
14.	_____	_____	44.	_____	_____
15.	_____	_____	45.	_____	_____
16.	_____	_____	46.	_____	_____
17.	_____	_____	47.	_____	_____
18.	_____	_____	48.	_____	_____
19.	_____	_____	49.	_____	_____
20.	_____	_____	50.	_____	_____
21.	_____	_____	51.	_____	_____
22.	_____	_____	52.	_____	_____
23.	_____	_____	53.	_____	_____
24.	_____	_____	54.	_____	_____
25.	_____	_____	55.	_____	_____
26.	_____	_____	56.	_____	_____
27.	_____	_____	57.	_____	_____
28.	_____	_____	58.	_____	_____
29.	_____	_____	59.	_____	_____
30.	_____	_____	60.	_____	_____

CODE

- A. Equipment on site (Permanent)
- B. Equipment on site (Transient)
- C. Equipment and materials traveling to or from the site.
- T. External traffic
- N. Neighborhood
- Z. Aircraft
- X. Other

Coded by \_\_\_\_\_ Date \_\_\_\_\_

Checked by \_\_\_\_\_ Date \_\_\_\_\_

QA: by \_\_\_\_\_ Date \_\_\_\_\_

Remarks:

Figure 1. Data form.

60 dB,\* and hence allow monitoring over a large range without changing the scale setting. This feature will minimize the loss of data due to unexpected high or low levels. One unit will be required for each of the measurement personnel; backup units also will be needed. Each unit will require a calibrator for field use; in addition, pistonphones for calibration checks should be used. Calibration checks before and after each data set, plus pistonphone checks of each unit at the beginning and end of each day, will ensure data validity and continuity. Each unit also will be furnished with a tripod and windscreen. Other peripheral items, such as stop watches, clipboards, log books, and extra batteries, should be provided.

For long-term measurements (e.g., 24-hour or weekend), noise-level recorders will be used. One such unit, with microphone, power supply, and printer, should be assigned to each of the measurement supervisors. Analog data will require portable tape recorders and microphones.

A terminal with telephone interface or, alternatively, a keypunch machine, will be required to enter data into the computer. The former, with hard copy output, is preferred for data verification.

## 5 SITE SELECTION

The selection of appropriate construction projects is critical to the successful completion of the study. For the residential portion of the study, the following criteria have been judged most important:

1. **The number of available respondents.** For the results of the attitudinal surveys to be significant, at least 25 respondents will be required at any one site. Hence, at least 50 residences must be impacted by the construction noise, assuming a 50 percent success rate for contacts.

2. **Noise potential.** The projects selected should emit relatively high noise levels for at least 2 weeks in order to have a measurable impact. Also, the absence of barriers and the proximity of the construction to the respondents are considered to be important.

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\*These adapters were designed and constructed by CERL (see Appendix).

3. **Project length.** The average length of the projects chosen should be about 8 weeks. Projects longer than 16 weeks or shorter than 2 weeks should be avoided because of the attitudinal survey design.

Of lesser importance are:

4. **Accessibility.** In a residential area, sidestreets provide useful straight-line access for measurement positions. Also, experience has shown that residents are quite cooperative when asked for permission to take measurements on their property.

5. **Location.** Although projects near the project office are desirable, the availability of projects and a variety of locales are deemed more important.

The nonresidential projects, by their nature, imply a different order of criteria. The accessibility and noise potential are most important because of the probable shielding from other buildings. The large "captive" audience of possible respondents provides a large statistical population. Of lesser importance are project length and location; urban projects are generally many months in length, and their impact is fairly homogeneous.

The set of projects from which the selection can be made should be provided by city, county, and State officials in the metropolitan area of concern. Experience has shown such officials are usually extremely cooperative; there should be no lack of projects from which to select.

## 6 PERSONNEL

Optimally, of the total number of personnel hired, most (~ 85 percent) would be used in the physical measurement phase; the remainder would be used as survey administrators and data processors.

If the ideal number of persons is not available, prudent scheduling should make measurements at all sites possible with 8 to 12 measurement persons. There will be two measurement supervisors, each responsible for up to eight measurement persons. These supervisors also would have minor data collection responsibilities, possibly involving the 24-hour data or the analog recordings, and quality assurance duties.

There should be about one-fourth as many survey teams as measurement persons; each survey team should have a supervisor who is an experienced survey administrator. One person should have senior supervisory responsibility for coordinating the supervisors and the measurement and survey teams.

The measurement supervisors will do initial site screening. Final selection will be made by the senior supervisor. Measurement stations at the selected sites will be determined cooperatively by the measurement supervisors and senior supervisor.

An enormous amount of data will be obtained each day. It should be coded daily from the central office directly to the computer via dedicated phone line. It is anticipated that one person will be responsible for the measurement data; survey data will require an additional person for data editing and input. These personnel should report directly to the senior supervisor.

## 7 ATTITUDE SURVEY INSTRUMENTS

### Residential

The attitude survey instruments were designed to accomplish three primary objectives:

1. Determine the level of annoyance attributed to construction noise.
2. Follow the level of annoyance as a function of exposure time.
3. Relate the obtained attitude data to data available from other surveys.

To this end, a set of five short survey questionnaires has been developed. Special attention was given to the length of each survey; respondents are more likely to cooperate with the survey team if the interview is short (i.e., less than 10 minutes). Also, care was taken to make the instruments comparable with those of previous studies (e.g., by using parallel wording) to aid comparison of the results.

Since the study emphasizes the impact of construction noise, several areas of questioning often included in more general noise impact studies have been omitted. These areas include (1) time-of-day effects, (2) questions relating construction noise annoyance to other

attitudinal issues, (3) demographics, (4) locus of annoyance, and (5) particular machine sources. The study emphasis is not on the annoyance associated with a particular type of construction equipment, but on that from the site as a whole. Focusing on types of equipment would lengthen and complicate the questionnaires considerably. Further, the average person is not familiar enough with construction machines to make accurate identifications; hence, the reliability of the responses would be highly questionable.

It was decided that closed response category questions would be used, preceded by filter questions. This set of "slightly," "moderately," "very," or "extremely annoyed" responses has been used with good results in many studies. The filter question tends to shorten the overall interview time, and to deny the respondent the "easy out" response of "not at all annoyed."

The surveys are designed to focus the respondent's attention on his or her feelings for the "past week" and the "past year." These same two integration times should be used in reducing the noise data and may provide insight into how the construction noise affects general noise impact.

Attitude Survey No. 1 (AS-1) is the preconstruction instrument (Figure 2). The main goals of this interview are to establish baseline data on traffic noise annoyance and general neighborhood satisfaction, and to identify respondents for future interviews. The traffic annoyance question is used in all surveys and serves as a calibration point. The neighborhood satisfaction value is paired with the same one used in the postconstruction series to detect any general construction-noise effects on neighborhood satisfaction. This interview should be conducted face-to-face during the week just before the construction project is scheduled to begin. Immediately after the interview, the Interviewer Report Form will be completed (Figure 3). Data from this form should allow early detection of anomalies of a particular respondent or site.

Forms AS-2 and AS-3 are administered during the construction (Figures 4 and 5). The AS-2 interviews are made after 2 weeks of construction. AS-3 is administered several times; i.e., after 4, 8, 16, etc. weeks of construction. These interviews monitor changes in sensitivity to construction noise as a function of cumulative exposure time.

Forms AS-4 and AS-5 are for the postconstruction interviews (Figures 6 and 7). AS-4 is used 2 weeks after

Site \_\_\_\_\_  
 Interview # \_\_\_\_\_  
 Date \_\_\_\_\_ Time \_\_\_\_\_  
 Interviewer \_\_\_\_\_

(C.C.)  
 (1,2)  
 (4,5)  
 (7,8,9)

Hello, My name is \_\_\_\_\_. I'm from the Engineering Research Lab. We are doing a study about how people feel about living in different places. May I have a few minutes of your time to get some of your views about living in this area?

1. About how long have you been living here? (11)

_____ Years _____ Months	0 - 1 months.....1	
	2 - 6 months.....2	
	7 - 12 months .....3	
	more than 12 months .....4	
	Refused .....8	
	Don't Know.....9	

2. In general, how do you rate this neighborhood, the area within 2 or 3 blocks, as a place to live? Do you rate it as an excellent, good, fair, poor, or very poor place to live? (12)

	Excellent .....1	
	Good .....2	
	Fair .....3	
	Poor .....4	
	Refused .....8	
	Don't Know.....9	

3. Now I'd like to ask about your feelings about noises you hear while you're home or in your neighborhood. By noise, I mean sound you would rather not hear.

Over the past year, have you been bothered or annoyed by noises from:

a. Aircraft? (14)

Would you say you were:	No (Go to b) ..... 1	
	Yes ..... 2	
	Slightly annoyed ..... 3	
	Moderately annoyed..... 4	
	Very annoyed ..... 5	
	Extremely annoyed ..... 6	
	Refused ..... 8	
	Don't Know ..... 9	

b. Street traffic? (15)

Would you say you were:	No (Go to a)..... 1	
	Yes ..... 2	
	Slightly annoyed..... 3	
	Moderately annoyed ..... 4	
	Very annoyed ..... 5	
	Extremely annoyed ..... 6	
	Refused ..... 8	
	Don't Know ..... 9	

c. Children outdoors? (16)

Would you say you were:	No (Go to d) ..... 1	
	Yes ..... 2	
	Slightly annoyed ..... 3	
	Moderately annoyed ..... 4	
	Very annoyed ..... 5	
	Extremely annoyed ..... 6	
	Refused ..... 8	
	Don't Know ..... 9	

d. Construction? (17)

Would you say you were:	No (Go to e)..... 1	
	Yes ..... 2	
	Slightly annoyed ..... 3	
	Moderately annoyed ..... 4	
	Very annoyed ..... 5	
	Extremely annoyed ..... 6	
	Refused ..... 8	
	Don't Know ..... 9	

Figure 2. Attitude survey No. 1.

- e. Other things? (verbatim \_\_\_\_\_) (18)
- |                         |   |
|-------------------------|---|
| No (Go to 4).....       | 1 |
| Yes .....               | 2 |
| Slightly annoyed .....  | 3 |
| Moderately annoyed..... | 4 |
| Very annoyed .....      | 5 |
| Extremely annoyed.....  | 6 |
| Refused .....           | 8 |
| Don't know .....        | 9 |
4. Now I'd like to ask you about a few background items to help us analyze the results of this survey. At no time will any of this information be used to identify anyone.
- a. What is the highest grade of school you have completed? (20,21)
- \_\_\_\_\_ Years 88. (Refused) 99. (Don't know)
- b. What is your age group? Is it: (22)
- |                               |   |
|-------------------------------|---|
| 30 years or younger .....     | 1 |
| Between 31 and 40 years ..... | 2 |
| Between 41 and 50 years ..... | 3 |
| Between 51 and 60 years ..... | 4 |
| or over 60 years .....        | 5 |
| Refused .....                 | 8 |
| Don't know .....              | 9 |
- c. Do you own or rent your residence? (23)
- |                  |   |
|------------------|---|
| Own .....        | 1 |
| Rent .....       | 2 |
| Refused .....    | 8 |
| Don't know ..... | 9 |
5. Thank you very much for your time and help. I'm sure this will be a great help in this study. We'll be contacting a few people in this neighborhood from time to time over the next several weeks to ask them a few questions like the ones you've just been kind enough to answer. Could you give us a telephone number where we can get in touch with you if we need your help again for a few minutes? And could we please have a name we can identify you by should we call later?
- |                              |                       |         |
|------------------------------|-----------------------|---------|
| Phone No. _____              | Refused 999-999-9999  | (25-34) |
| Name _____                   | No Phone 888-888-8888 |         |
| Best time to reach you _____ |                       | (36,37) |

Thank you again for your help.

Figure 2. (Cont'd).

(C.C.)  
 (1,2)  
 (4,5)  
 (7,8,9)

Site \_\_\_\_\_  
 Interview # \_\_\_\_\_  
 Date \_\_\_\_\_  
 Interviewer \_\_\_\_\_

**INTERVIEWER REPORT FORM**

To be completed by Interviewer after interview:

Address \_\_\_\_\_ Sex: Male ..... 1 (12)  
 Female ..... 2

Did you notice anything in the area that would cause noise levels to be excessive? (If yes) What did you notice? (14)

Yes ..... 1 \_\_\_\_\_  
 No ..... 2 \_\_\_\_\_

Type of structure: A one family house detached from any other house .. 1 (16)  
 A mobile home ..... 2  
 A building for 2 families ..... 3  
 A building for 3 or 4 families ..... 4  
 A building for 5 to 9 families ..... 5  
 A building for 10 or more families..... 6  
 A rooming house ..... 7  
 Other (DESCRIBE) ..... 8

How many stories (floors) are in this building? (18)  
 1 to 3 stories..... 1  
 4 to 5 stories ..... 2  
 6 or more stories..... 3

Respondent's floor \_\_\_\_\_ (19)

Outside construction: Frame only ..... 1 (20)  
 Frame with some brick..... 2  
 All brick ..... 3  
 Other (Specify) ..... 4

Was there any reason to believe that the respondent's hearing was not as good as average hearing? (22)  
 Yes ..... 1  
 No ..... 2

(If yes)

Explain: \_\_\_\_\_  
 \_\_\_\_\_

Remarks: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Figure 3. Interviewer report form.

Phone No. _____	Name _____	Site _____	(1,2)
Contact Attempt: 1 2 3 4 5 6		Respondent # _____	(4,5)
Notes: _____		Project Name _____	
_____		Date _____ Time _____	(7,8,9)
_____		Interviewer _____	

Hello, this is \_\_\_\_\_. I'm with the Engineering Research Lab, and we're doing a study about how people feel about living in different places. You probably recall talking with us a few weeks ago. We're continuing the study, and I'd like to ask you a few more questions.

1. a. Over the past week have you been bothered or annoyed by noise from street traffic while you've been at home or in your neighborhood, the area within 2 or 3 blocks? (11)

- No (Go to 2) ..... 1
- Yes ..... 2
- Refused ..... 8
- Don't Know ..... 9

b. How annoyed or bothered have you been by street traffic noise this past week? (12)

- Slightly annoyed ..... 1
- Moderately annoyed ..... 2
- Very annoyed ..... 3
- Extremely annoyed ..... 4

2. Now I'd like you to think about the (Project Name) construction that began recently nearby.

a. During the past week, has the (Project Name) construction bothered or annoyed you because of:

	No	Yes	Refused	Don't Know	
1. Dust or dirt	1	2	8	9	(13)
2. Noise	1	2	8	9	(14)
3. Vibrations, shakes, rattles	1	2	8	9	(15)
4. Odors or smells	1	2	8	9	(16)
5. Blocked streets and sidewalks	1	2	8	9	(17)
6. Street congestion	1	2	8	9	(18)
7. The way it looks	1	2	8	9	(19)
8. Damage to your property	1	2	8	9	(20)
9. Anything else (_____)	1	2	8	9	(21)

b. Which of those thing bothered you the most? (22)  
# \_\_\_\_\_ Don't Know (Go to 3)..... 0

And would you say you were:

- Slightly annoyed .....1 (23)
- Moderately annoyed .....2
- Very annoyed .....3
- Extremely annoyed .....4
- Refused .....8
- Don't Know .....9

3. (If bothered by #2 above, noise, unless most bothered by noise)  
You mentioned you were bothered by noise from the (Project Name) construction. Would you say you've been: (24)

- Slightly annoyed .....1
- Moderately annoyed..... 2
- Very annoyed ..... 3
- Extremely annoyed..... 4
- Refused ..... 8
- Don't Know ..... 9

4. (If bothered by #3 above, vibration, unless most bothered by vibration)  
You mentioned you were bothered by vibration from the (Project Name) construction. Would you say you've been: (25)

- Slightly annoyed ..... 1
- Moderately annoyed ..... 2
- Very annoyed ..... 3
- Extremely annoyed ..... 4
- Refused ..... 8
- Don't Know ..... 9

Figure 4. Attitude survey No. 2.

AS  
P2.

5. Now I'd like you to consider the last year as a whole, that is, since this time last  
*(winter, spring, summer, fall)*, I'd like you to think about construction such as roads  
or buildings.

a. During the last year, have you been bothered or annoyed by noise from construction  
while you've been at home or in your neighborhood? (26)

No *(Go to 6)* ..... 1  
Yes ..... 2  
Refused ..... 8  
Don't Know ..... 9

b. Would you say that you've been:

Slightly annoyed ..... 1  
Moderately annoyed ..... 2  
Very annoyed ..... 3  
Extremely annoyed ..... 4  
Refused ..... 8  
Don't Know ..... 9 (27)

6.a. Again considering the past year as a whole, have you been bothered or annoyed by  
noise from street traffic while you've been at home or in your neighborhood? (28)

No *(Go to 7)* ..... 1  
Yes ..... 2  
Refused ..... 8  
Don't Know ..... 9

b. Would you say you've been:

Slightly annoyed ..... 1  
Moderately annoyed ..... 2  
Very annoyed ..... 3  
Extremely annoyed ..... 4  
Refused ..... 8  
Don't Know ..... 9 (29)

7. During the day, from about 7 a.m. to 5 p.m., about how many hours are you usually  
gone? *exactly*

Average Hours \_\_\_\_\_  
Less than 2 hours ..... 1  
2 - 4 hours ..... 2  
4 - 8 hours ..... 3  
More than 8 hours ..... 4  
Refused ..... 8  
Don't Know ..... 9

8. And finally, about how much longer do you expect *(Project Name)* to last?

*exactly* \_\_\_\_\_  
About 2 weeks or less ..... 1  
About 4 weeks ..... 2  
About 6 weeks ..... 3  
About 8 weeks ..... 4  
Longer than 8 weeks ..... 5  
Refused ..... 8  
Don't Know ..... 9

Thank you very much for your time and help.

Figure 4. (Cont'd).

Phone No. _____	Name _____	Site _____	(C.C.)
Contact Attempt: 1 2 3 4 5 6		Respondent # _____	(1,2)
Notes: _____		Project Name _____	(4,5)
_____		Date _____ Time _____	(7,8,9)
_____		Interviewer _____	

Hello, this is \_\_\_\_\_. I'm with the Engineering Research Lab, and we're doing a study about how people feel about living in different places. You probably recall talking with us a few weeks ago. We're continuing the study, and I'd like to ask you a few more questions.

1. a. Over the past week have you been bothered or annoyed by noise from street traffic while you've been at home or in your neighborhood, the area within 2 or 3 blocks? (11)
- |                    |   |
|--------------------|---|
| No (Go to 2) ..... | 1 |
| Yes .....          | 2 |
| Refused .....      | 8 |
| Don't know .....   | 9 |

- b. How annoyed or bothered have you been by street traffic noise this past week? (12)
- |                          |   |
|--------------------------|---|
| Slightly annoyed .....   | 1 |
| Moderately annoyed ..... | 2 |
| Very annoyed .....       | 3 |
| Extremely annoyed .....  | 4 |
| Refused .....            | 8 |
| Don't know .....         | 9 |

2. Now I'd like you to think about the (Project Name) construction that began recently nearby.

- a. During the past week, has the (Project Name) construction bothered or annoyed you because of:

	No	Yes	Refused	Don't know	
1. Dust or dirt	1	2	8	9	(13)
2. Noise	1	2	8	9	(14)
3. Vibrations, shakes, rattles	1	2	8	9	(15)
4. Odors or smells	1	2	8	9	(16)
5. Blocked streets and sidewalks	1	2	8	9	(17)
6. Street congestion	1	2	8	9	(18)
7. The way it looks	1	2	8	9	(19)
8. Damage to your property	1	2	8	9	(20)
9. Anything else (_____)	1	2	8	9	(21)

3. (If bothered by #2 above, noise)  
You mentioned you were bothered by noise from the (Project Name) construction. Would you say you've been: (23)

Slightly annoyed .....	1
Moderately annoyed .....	2
Very annoyed .....	3
Extremely annoyed .....	4
Refused .....	8
Don't know .....	9

4. (If bothered by #3 above, vibration)  
You mentioned you were bothered by vibration from the (Project Name) construction. Would you say you've been: (24)

Slightly annoyed .....	1
Moderately annoyed .....	2
Very annoyed .....	3
Extremely annoyed .....	4
Refused .....	8
Don't know .....	9

5. Now I'd like you to consider the last year as a whole, that is, since this time last (winter, spring, summer, fall). I'd like you to think about construction such as roads or buildings.

Figure 5. Attitude survey No. 3.

5. a. During the last year, have you been bothered or annoyed by noise from construction while you've been at home or in your neighborhood? (26)
- No (Go to 6) ..... 1
  - Yes ..... 2
  - Refused ..... 8
  - Don't know ..... 9
- b. Would you say that you've been: (27)
- Slightly annoyed ..... 1
  - Moderately annoyed ..... 2
  - Very annoyed ..... 3
  - Extremely annoyed ..... 4
  - Refused ..... 8
  - Don't know ..... 9
6. a. Again considering the past year as a whole, have you been bothered or annoyed by noise from street traffic while you've been at home or in your neighborhood? (28)
- No (Go to 7) ..... 1
  - Yes ..... 2
  - Refused ..... 8
  - Don't know ..... 9
- b. Would you say you've been: (29)
- Slightly annoyed ..... 1
  - Moderately annoyed ..... 2
  - Very annoyed ..... 3
  - Extremely annoyed ..... 4
  - Refused ..... 8
  - Don't know ..... 9
7. During the last year has construction noise ever:
- a. Interfered with your listening to radio, TV, or records? (30)
- No (Go to b)..... 1
  - Yes ..... 2
  - Refused ..... 8
  - Don't know ..... 9
- And would you say you were: (31)
- Slightly annoyed ..... 1
  - Moderately annoyed ..... 2
  - Very annoyed ..... 3
  - Extremely annoyed ..... 4
  - Refused ..... 8
  - Don't know ..... 9
- b. Has the construction noise in your neighborhood ever startled or frightened you? (32)
- No (Go to c)..... 1
  - Yes ..... 2
  - Refused ..... 8
  - Don't know ..... 9
- And would you say you were: (33)
- Slightly annoyed ..... 1
  - Moderately annoyed ..... 2
  - Very annoyed ..... 3
  - Extremely annoyed ..... 4
  - Refused ..... 8
  - Don't know ..... 9
- c. Disturbed your sleep? (34)
- No (Go to d)..... 1
  - Yes ..... 2
  - Refused ..... 8
  - Don't know ..... 9

Figure 5. (Cont'd).

And would you say you were: (35)

Slightly annoyed .....	1
Moderately annoyed .....	2
Very annoyed .....	3
Extremely annoyed .....	4
Refused .....	8
Don't know .....	9

d. Made you pause or raise your voice while talking in person or on the phone? (36)

No (Go to 8) .....	1
Yes ..	2
Refused .....	8
Don't know .....	9

And would you say you were: (37)

Slightly annoyed .....	1
Moderately annoyed .....	2
Very annoyed .....	3
Extremely annoyed .....	4
Refused .....	8
Don't know .....	9

8. During the past year has traffic noise ever:

a. Interfered with your listening to radio, TV, or records? (38)

No (Go to b) .....	1
Yes .....	2
Refused .....	8
Don't know .....	9

And would you say you were: (39)

Slightly annoyed .....	1
Moderately annoyed .....	2
Very annoyed .....	3
Extremely annoyed .....	4
Refused .....	8
Don't know .....	9

b. Has the traffic noise in your neighborhood ever startled or frightened you? (40)

No (Go to c) .....	1
Yes .....	2
Refused .....	8
Don't know .....	9

And would you say you were: (41)

Slightly annoyed .....	1
Moderately annoyed .....	2
Very annoyed .....	3
Extremely annoyed .....	4
Refused .....	8
Don't know .....	9

c. Disturbed your sleep? (42)

No (Go to d) .....	1
Yes .....	2
Refused .....	8
Don't know .....	9

And would you say you were: (43)

Slightly annoyed .....	1
Moderately annoyed .....	2
Very annoyed .....	3
Extremely annoyed .....	4
Refused .....	8
Don't know .....	9

Figure 5. (Cont'd).

- d. Made you pause or raise your voice while talking in person or on the phone? (44)
- |                   |   |
|-------------------|---|
| No (Go to 9)..... | 1 |
| Yes .....         | 2 |
| Refused .....     | 8 |
| Don't know.....   | 9 |
- And would you say you were: (45)
- |                          |   |
|--------------------------|---|
| Slightly annoyed .....   | 1 |
| Moderately annoyed ..... | 2 |
| Very annoyed .....       | 3 |
| Extremely annoyed .....  | 4 |
| Refused .....            | 8 |
| Don't know.....          | 9 |
9. During the day, from about 7 a.m. to 5 p.m., about how many hours are you usually home? *verbatim:* \_\_\_\_\_ (46)
- |                     |                         |   |
|---------------------|-------------------------|---|
| Average hours _____ | Less than 2 hours ..... | 1 |
|                     | 2 - 4 hours .....       | 2 |
|                     | 4 - 8 hours .....       | 3 |
|                     | More than 8 hours ..... | 4 |
|                     | Refused .....           | 8 |
|                     | Don't know .....        | 9 |
10. And finally, about how much longer do you expect (Project Name) to last? (47)
- verbatim:* \_\_\_\_\_
- |                             |   |
|-----------------------------|---|
| About 2 weeks or less ..... | 1 |
| About 4 weeks .....         | 2 |
| About 6 weeks .....         | 3 |
| About 8 weeks .....         | 4 |
| Longer than 8 weeks .....   | 5 |
| Refused .....               | 8 |
| Don't know .....            | 9 |

Thank you very much for your time and help.

Figure 5. (Cont'd).

Phone No. _____	Name _____	Site _____	(C.C.)
Contact Attempt: 1 2 3 4 5 6		Project Name _____	(1,2)
Notes: _____		Respondent _____	(4,5)
		Date _____ Time _____	(7,8,9)
		Interviewer _____	

Hello, This is \_\_\_\_\_ I'm with the Engineering Research Lab, and we're doing a study about how people feel about living in different places. You probably recall talking with us a few weeks ago. We're continuing the study, and I'd like to ask you a few more questions.

1. I'd like you to consider the last year as a whole, that is, since this time last (winter, spring, summer, fall). I'd like you to think about construction such as roads or buildings.
  - a. During the last year, have you been bothered or annoyed by noise from construction while you've been at home or in your neighborhood? (26)
    - No ..... 1
    - Yes ..... 2
    - Refused ..... 8
    - Don't know ..... 9
  - b. Would you say that you've been: (27)
    - Slightly annoyed ..... 1
    - Moderately annoyed ..... 2
    - Very annoyed ..... 3
    - Extremely annoyed ..... 4
    - Refused ..... 8
    - Don't know ..... 9
2. a. Again considering the past year as a whole, have you been bothered or annoyed by noise from street traffic while you've been at home or in your neighborhood? (28)
  - No ..... 1
  - Yes ..... 2
  - Refused ..... 8
  - Don't know ..... 9
- b. Would you say you've been: (29)
  - Slightly annoyed ..... 1
  - Moderately annoyed ..... 2
  - Very annoyed ..... 3
  - Extremely annoyed ..... 4
  - Refused ..... 8
  - Don't know ..... 9
3. In general, how do you rate this neighborhood, the area within 2 or 3 blocks, as a place to live? Do you rate it as an excellent, good, fair, poor, or very poor place to live? (30)
  - Excellent ..... 1
  - Good ..... 2
  - Fair ..... 3
  - Poor ..... 4
  - Refused ..... 8
  - Don't know ..... 9
4. Would you say that the recent construction has changed or will change your neighborhood for: (31)
  - Better ..... 1
  - Worse ..... 2
  - About the same ..... 3
  - Refused ..... 8
  - Don't know ..... 9

Thank you very much for your time and help.

Figure 6. Attitude survey No. 4.

AS-5  
Pl.

Phone No. \_\_\_\_\_ Name \_\_\_\_\_ Site \_\_\_\_\_  
Contact Attempt: 1 2 3 4 5 6 \_\_\_\_\_ Project Name \_\_\_\_\_  
Notes: \_\_\_\_\_ Respondent # \_\_\_\_\_  
Date \_\_\_\_\_ Time \_\_\_\_\_  
Interviewer \_\_\_\_\_

(C.C.)  
(1,2)

(4,5)  
(7,8,9)

Hello, this is \_\_\_\_\_. I'm with the Engineering Research Lab, and we're doing a study about how people feel about living in different places. You probably recall talking with us a few weeks ago. We're continuing the study, and I'd like to ask you a few more questions.

1. I'd like you to consider the last year as a whole, that is, since this time last (winter, spring, summer, fall). I'd like you to think about construction such as roads or buildings.

a. During the last year, have you been bothered or annoyed by noise from construction while you've been at home or in your neighborhood? (12)

No (Go to 2)..... 1  
Yes ..... 2  
Refused ..... 8  
Don't know ..... 9

b. Would you say that you've been:

Slightly annoyed ..... 1  
Moderately annoyed..... 2  
Very annoyed ..... 3  
Extremely annoyed ..... 4  
Refused ..... 8  
Don't know ..... 9

(13)

2. a. Again considering the past year as a whole, have you been bothered or annoyed by noise from street traffic while you've been at home or in your neighborhood? (15)

No (Go to 3)..... 1  
Yes ..... 2  
Refused ..... 8  
Don't know ..... 9

b. Would you say you've been:

Slightly annoyed..... 1  
Moderately annoyed ..... 2  
Very annoyed ..... 3  
Extremely annoyed..... 4  
Refused ..... 8  
Don't know ..... 9

(16)

Thank you very much for your time and help.

Figure 7. Attitude survey No. 5.

the completion of the construction. AS-5 is administered 2 and 4 months after the construction has ended. These instruments will provide data on the "decay" of the annoyance as a function of time. Surveys 2, 3, 4, and 5 will be administered by telephone.

Data from the various sites will be grouped in sets of high, medium, or low noise exposure for each survey. This scheme should enhance the statistics considerably. This grouping should be done very carefully to avoid anomalous average levels; e.g., fairly low average  $L_{eq}$ , but with the presence of some impulsive components which might be highly annoying.

#### **Nonresidential**

The nonresidential survey is designed to gauge annoyance with construction noise in an urban setting. This instrument focuses on two short time periods: an "instantaneous" annoyance ("just now"), and a 1-week integrated ("during the last week") annoyance. The latter is sought only from those respondents who are exposed to the noise more than twice per week.

This survey should be administered in business districts near construction, particularly large office building construction. It is a face-to-face interview, done probably in small shops or in the lobbies of larger buildings directly facing the construction. It should be administered as near as possible to the measurement positions to obtain a close correlation between actual construction noise level and annoyance. For control purposes, it also should be administered in nearby areas where the nonconstruction noise is the same level. The calibration question of this survey is the traffic noise annoyance value.

#### **Respondent Sampling Plans**

The residential surveys will probably have only a few possible respondents at each site, even though the prime criterion for site selection is the number of respondents. Therefore, the sample should be exhaustive. Further, the respondents are very likely to be female; hence, should there be more than one possible respondent in a household and one is an adult male, he

should be chosen as the respondent. Should there be more than two respondents at a residence, the selection should be made based on a table such as that shown in Figure 8. This selection plan also should endure a reasonable sampling of ages. A sample size of at least 25 respondents from each residential site is anticipated.

After a site has been chosen, a detailed list of possible respondents should be compiled (Figure 9). This list can be used to track (1) call-back attempts and (2) the survey completion status of each respondent. At least five attempts must be made to contact the respondent for each survey, varying the day and time for each attempt. Respondent attrition may be a problem as the study continues; however, persistent call-backs and short interviews should keep the attrition level low enough to maintain the reliability of the sample.

Nonresidential impact will be assessed using a single, modified "man-on-the-street" survey (Figure 10), since practical test limitations preclude a time-dependent study. A very short survey should be administered in lobbies and shops facing the construction in conjunction with the noise measurements taken at the same location. About 100 respondents should be contacted at each of the four to six sites. In addition, for control purposes, measurements should be taken and the survey administered at a location near construction, but not exposed to the construction noise.

## **8 CONCLUSION**

This report has presented a detailed test plan for studying the impact of noise from construction activities on neighboring communities. The plan details the physical noise-measurement protocol, site selection plans, attitudinal questionnaires for residential and nonresidential areas, respondent sampling plans, and equipment and personnel needs.

Interview Number	If the number of adults in the household is:					
	1	2	3	4	5	6 or more
1	1	1	2	2	3	3
2	1	2	3	3	3	5
3	1	2	3	4	5	6
4	1	1	1	1	2	2
5	1	1	1	1	1	1
6	1	2	3	4	5	5
7	1	2	2	3	4	4
8	1	1	1	2	2	2
9	1	1	2	2	3	3
10	1	2	3	4	5	6
11	1	2	2	3	4	4
12	1	1	1	1	1	1

Figure 8. Respondent selection table.

RESPONDENT LOCATION AND CONTACT RECORD

Date \_\_\_\_\_  
 Initials \_\_\_\_\_

Respondent No. \_\_\_\_\_ Address \_\_\_\_\_ Site No. \_\_\_\_\_  
 City \_\_\_\_\_

AS-1: Respondent Name (if possible) \_\_\_\_\_ Project Name \_\_\_\_\_

Contact Attempts:

	Day	Time	Date	By	
1.	_____	_____	____/____	_____	Final Result: a. Interview completed, future AS contact information obtained b. AS-1 completed, refused future contact information c. Refused d. Abandoned after 5 attempts
	Result	_____	_____	_____	
2.	_____	_____	____/____	_____	
	Result	_____	_____	_____	
3.	_____	_____	____/____	_____	
	Result	_____	_____	_____	
4.	_____	_____	____/____	_____	
	Result	_____	_____	_____	
5.	_____	_____	____/____	_____	
	Result	_____	_____	_____	
_____ 0 _____					

AS-2: Contact Attempts:

	Day	Time	Date	By	
1.	_____	_____	____/____	_____	Remarks: _____
	Result	_____	_____	_____	
2.	_____	_____	____/____	_____	
	Result	_____	_____	_____	
3.	_____	_____	____/____	_____	
	Result	_____	_____	_____	
4.	_____	_____	____/____	_____	
	Result	_____	_____	_____	
5.	_____	_____	____/____	_____	
	Result	_____	_____	_____	
_____ 0 _____					

AS-3: Contact Attempts:

	Day	Time	Date	By	
1.	_____	_____	____/____	_____	Remarks: _____
	Result	_____	_____	_____	
2.	_____	_____	____/____	_____	
	Result	_____	_____	_____	
3.	_____	_____	____/____	_____	
	Result	_____	_____	_____	
4.	_____	_____	____/____	_____	
	Result	_____	_____	_____	
5.	_____	_____	____/____	_____	
	Result	_____	_____	_____	

**Figure 9. Respondent location and contact record.**

Contact Record, p.2

Respondent No. \_\_\_\_\_ Address \_\_\_\_\_ Site No. \_\_\_\_\_

City \_\_\_\_\_

Respondent Name (if possible) \_\_\_\_\_ Project Name \_\_\_\_\_

AS-4: Contact Attempts:

	Day	Time	Date	By	Remarks:
1.	_____	_____	____/____	_____	_____
	Result	_____	_____	_____	_____
2.	_____	_____	____/____	_____	_____
	Result	_____	_____	_____	_____
3.	_____	_____	____/____	_____	_____
	Result	_____	_____	_____	_____
4.	_____	_____	____/____	_____	_____
	Result	_____	_____	_____	_____
5.	_____	_____	____/____	_____	_____
	Result	_____	_____	_____	_____

o

AS-5: Contact Attempts:

	Day	Time	Date	By	Remarks:
1.	_____	_____	____/____	_____	_____
	Result	_____	_____	_____	_____
2.	_____	_____	____/____	_____	_____
	Result	_____	_____	_____	_____
3.	_____	_____	____/____	_____	_____
	Result	_____	_____	_____	_____
4.	_____	_____	____/____	_____	_____
	Result	_____	_____	_____	_____
5.	_____	_____	____/____	_____	_____
	Result	_____	_____	_____	_____

o

Final Disposition:

Results: \_\_\_\_\_  
\_\_\_\_\_

Remarks: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Figure 9. (Cont'd).

Site \_\_\_\_\_ (C.C.)  
 Respondent # \_\_\_\_\_ (1,2)  
 Project Name \_\_\_\_\_ (4,5)  
 Date \_\_\_\_\_ Time \_\_\_\_\_ (7,8,9)  
 Interviewer \_\_\_\_\_

NONRESIDENTIAL SURVEY

We're collecting information on how people feel about construction noise. Could you please give us a minute or two so that I can ask you a few questions?

1. a. Did noise from (Project Name) bother or annoy you a moment ago? (11)  
 No..... 1  
 Yes ..... 2  
 Refused ..... 8  
 Don't know ..... 9

b. Would you say you were: (12)  
 Slightly annoyed ..... 1  
 Moderately annoyed ..... 2  
 Very annoyed ..... 3  
 Extremely annoyed ..... 4  
 Refused ..... 8  
 Don't know ..... 9

2. About how often do you pass near this construction? (15)  
 Several times a day .....1  
 Once or twice a day .....2  
 Once or twice a week (Go to 5) .3  
 Less than once a week (Go to 5) .4  
 Refused .....8  
 Don't know .....9

3. a. During the last week have you been bothered or annoyed by the noise from this construction? (16)  
 No ..... 1  
 Yes ..... 2  
 Refused ..... 8  
 Don't know ..... 9

b. Would you say you've been: (17)  
 Slightly annoyed .....1  
 Moderately annoyed ..... 2  
 Very annoyed ..... 3  
 Extremely annoyed ..... 4  
 Refused ..... 8  
 Don't know ..... 9

4. a. During the last week have you been bothered or annoyed by traffic noise in this area? (18)  
 No ..... 1  
 Yes ..... 2  
 Refused ..... 8  
 Don't know ..... 9

b. Would you say you've been: (19)  
 Slightly annoyed .....1  
 Moderately annoyed ..... 2  
 Very annoyed ..... 3  
 Extremely annoyed ..... 4  
 Refused ..... 8  
 Don't know ..... 9

Thank you very much for your time and help.

After interview: Sex of respondent: Male 1 (21)  
 Female 2  
 Age of respondent: under 30 1 (22)  
 30-50 2  
 50-65 3  
 over 65 4

Remarks: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Figure 10. Nonresidential survey.

## APPENDIX: WIDE RANGE DIGITAL ADAPTERS FOR SOUND-LEVEL METERS

The need to develop digital sound-level meters was identified early in the project. During the measurement protocol pretest phase of the project, it was noted that a wide active range would minimize data loss due to unexpectedly high or low levels. These factors led to the design of the circuit presented in Figure A1.

The circuit is based on an Analog Devices AD536AKD integrated circuit.\* This device is a wide dynamic range (60 db), true root-mean-square to direct

current converter, with a logarithmic output. Input is taken from the Type 1 or Type 2 sound-level meter AC output connector. A liquid crystal display, a Datel DM-3100U1\*\* for the pin-outs shown, is the output device.

The adapters built by CERL according to the circuit shown in Figure A1 had an accuracy of at least  $\pm 0.5$  db in the range of 60 to 120 A-weighted decibels (dBA).

\*Analog Devices, Norwood, MA 02062

\*\*Datel Intersil, Mansfield, MA 02048

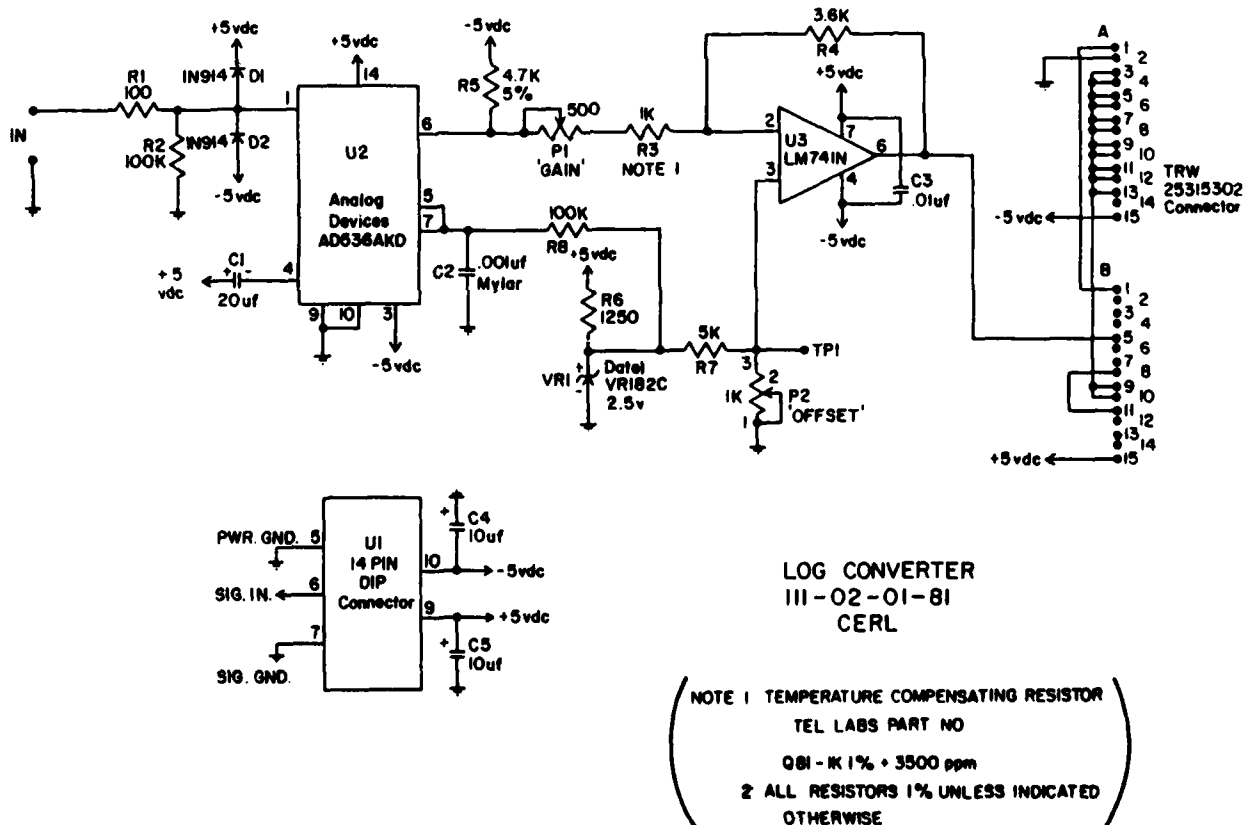


Figure A1. Wide-range digital adapter schematic.

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