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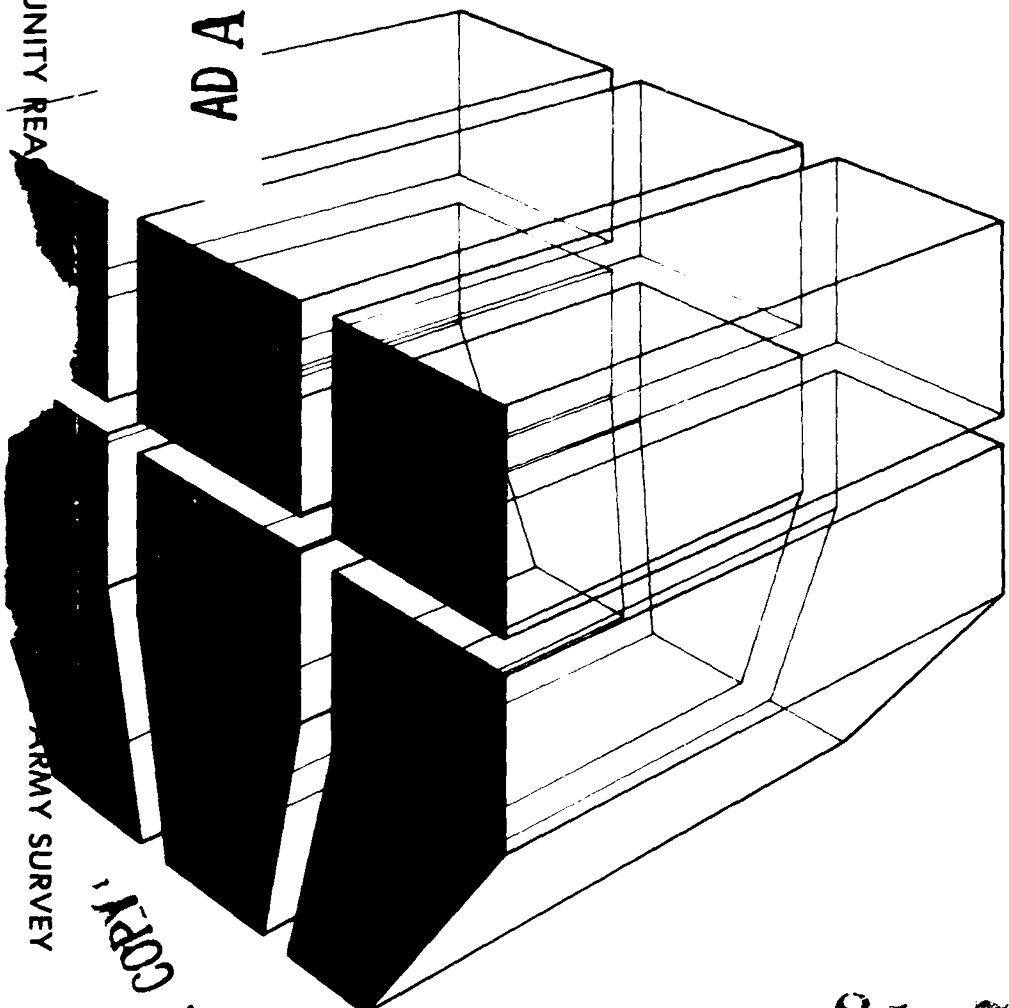
COMMUNITY REACTION TO IMPULSE NOISE: INITIAL ARMY SURVEY



by
Paul D. Schomer

CERL

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This report gives the results of a noise-impact attitudinal survey done in the Fort Bragg/Fayetteville, NC, area. It shows that to the extent normal sources like airplanes fit an energy model (such as the day/night average sound level [DNL]), impulse noise also fits an energy model. The growth of annoyance levels in a community with increases of loudness occurs similarly for impulse noise and for aircraft and helicopters. The growth of annoyance in a community with increases in the frequency of occurrence of events occurs in a similar way for all noises, except that the integration period for

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impulse noise apparently extends down to "once every few months," whereas annoyance all but dies away for other noises when the frequency of occurrence drops this low. All types of noise sources have roughly the same nighttime noise penalty -- 7 to 10 dB.

C-weighting is the best available standard measure; a C-weighted DNL (CDNL) which includes no threshold or impulse correction factor offers the best model to describe community response. To establish an equivalency between CDNL levels used to assess impulse noise and A-weighted DNL (ADNL) levels used to assess other noise, it is necessary to find a common denominator. It is recommended that the percent of the community "highly annoyed" in a given noise climate be that common denominator. With this common denominator, about 6 dB must be added to the numerical value of the CDNL level.

FOREWORD

This research was conducted for the Directorate of Military Programs, Office of the Chief of Engineers, under Project 4A762720A896, "Environment Quality Technology"; Task A, "Environmental Impact Monitoring Management Assessment and Planning"; Work Unit 024, "Validation and Refinement of Community Response to Blast Noise Contours." The applicable QCR is 3.01.007. Mr. Gordon Velasco, DAEN-MPE-I, was OCE Technical Monitor.

The work was performed by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (CERL). Appreciation is expressed to Robert Neathammer of CERL for his input. 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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1 INTRODUCTION

Background

Noise produced by Army training activities has become a major concern of Army planners because of the encroachment of off-installation housing and other noise-sensitive land uses into areas subject to high levels of training noise. Technical Manual 5-803-2 provides guidelines for locating noise-sensitive land uses on an installation and Army Regulation 210-20 provides off-installation guidance. Blast noise contours created using the Blast Noise Prediction Computer Program developed by the U.S. Army Construction Engineering Research Laboratory (CERL) are used to identify areas which are compatible with these land uses.[1]

The National Academy of Science and the Environmental Protection Agency (EPA) have established a metric -- the A-weighted day/night average sound level (ADNL) -- that environmental planners can use to evaluate the effect of common noise sources such as traffic, neighborhood, and aircraft noise. They have also adopted a C-weighted DNL (CDNL) as an interim measure for impulse noise.[2] However, more research on impulse noise is needed before this interim measure can be enhanced and validated. This research is being done by the Army, since impulse noise is mainly an Army problem, and includes such sources as armor, artillery, demolition, and helicopters.

This report presents the results of the first Army study into the measurable characteristics of such impulse noise sources; the results will be used by the National Academy of Science and the EPA to modify, as needed, their current interim procedures for the assessment of impulse noise.

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1 V. Pawlowska and L. M. Little, The Blast Noise Prediction Program: User Reference Manual, Interim Report (IR) N-75/ADA074050 (U.S. Army Construction Engineering Research Laboratory [CERL], August 1979); Environmental Protection: Planning in the Noise Environment, Technical Manual (TM) 5-803-2 (Department of the Army [DA], 15 June 1978); and Army Regulation (AR) 210-20, Master Planning for Army Installations (DA, 26 January 1976).

2 Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare With An Adequate Margin of Safety, EPA Report 550/9-74-004,PB239429 (Environmental Protection Agency [EPA], March 1974); and Guidelines for Preparing Environmental Impact Statements on Noise, Committee on Hearing, Bioacoustics, and Biomechanics (CHABA), ADA044384 (National Academy of Science, 1977).

Purpose

The purpose of this report is to (1) document the Army's first attitudinal survey with respect to impulse noise and (2) to provide data and recommendations on modifications to the interim procedures for assessment of impulse noise.

Approach

In conjunction with other Army and Air Force laboratories having experience in these areas, the EPA, and nationally recognized experts, a survey instrument and test plan were developed. Overall, the plan was to question the same group of respondents about several different types of noise. The major types of noise included: blast noise, helicopters, fixed-wing aircraft, street traffic, children and pets. These five categories of noise were treated in parallel throughout the questionnaire, providing a context in which community response to impulse and helicopter noise could be compared to the more normal civilian noise sources which have been the focus of so much previous study and effort. This was done to isolate similarities and differences between models to describe impulse noise or helicopter noise as compared to models to describe aircraft, traffic, or neighborhood noise. Moreover, long-term measurements of actual noise and predictions (provided by computer-generated contours) were used to further study the details of models to describe community reaction to impulse noise.

Fort Bragg and its surrounding area was selected as the site for the first survey. Criteria for its selection included the presence of impulse noise, rotary- and fixed-wing aircraft, major road networks, and affected populations of potential respondents. The survey was administered during the summer of 1978 under contract to the University of Illinois Survey Research Laboratory (SRL). After the survey was complete, CERL began about 5 months of intensive noise monitoring in and around Fort Bragg. Operational data were collected by Fort Bragg for the 1 year preceding and 1 year subsequent to the survey and supplied to CERL so that yearly average noise-level predictions could be made by computer.

Mode of Technology Transfer

The results of this study will impact on TM 5-803-2, Planning in the Noise Environment (DA, 15 June 1978).

2 HISTORICAL BACKGROUND AND PREDOMINANT STUDY ISSUES

Environmental noise, its assessment and control, has concerned civilized man for at least 2000 years -- even the Romans and Greeks found it necessary to enact ordinances prohibiting the early morning use of chariots in residential areas. Today, noise produced by transportation sources continues to receive the greatest emphasis in study and research.[3]

During the past 30 years, many attitudinal surveys have been conducted worldwide to better understand and assess human and community response to noise. These studies, which concentrate primarily on automobile and truck traffic, rail, and fixed-wing aircraft noise, have resulted in a proliferation of noise assessment models. In general, these models, in one fashion or another, take into account the following:

1. The sound level of the noise events

2. The frequency of occurrence of the noise events

3. The time of day at which the noise events occur.

These models measure sound amplitudes in many different ways, including: A-level fast, A-level slow, Perceived Noise Level, Effective Perceived Noise Level, Tone-Corrected Effective Perceived Noise Level, A-weighted sound exposure level (SEL), and tone-corrected A weighted SEL.

The effect that numbers of noise events have on community reaction has also been the focus of considerable debate and discussion. Some models and researchers have suggested there is no relation at all. At the other extreme, models have employed a relation using 145 times the log of the number of events. Most models have settled on a relation which uses about 10 times the log of the number of events.

Time of day differences are also controversial. Some researchers contend that noise at night is no more or little more of a problem than noise during the day. Others would prohibit all noise at night. In general, models use a 10-decibel (dB) nighttime penalty. Recently, some models such as the Community Equivalent Noise Level have incorporated a 5-dB evening penalty. (See Appendix A for an historical bibliography of noise models.)

Many of these models have been used in the United States. The Department of Defense (DOD) and the Federal Aviation Administration (FAA) have used the composite noise rating (CNR) and the noise exposure forecast (NEF) to assess aircraft noise; the Federal Highway Administration (FHA) and State highway departments have used the L_{10} (the A-weighted level exceeded 10 percent of the time) to assess highway noise; the Department of Transportation (DOT) has used the L_{eq} (the mean A-weighted level) to assess railroad noise; and the Department of Housing and Urban Development (HUD) has used the L_{33} (the A-weighted

[3] William J. Galloway and Dwight E. Bishop, Noise Exposure Forecasts: Evolution, Evaluation, Extensions, and Land Use Interpretations, Contract No. FA68WA-1900 (Department of Transportation, Federal Aviation Administration, Office of Noise Abatement, August 1970).

level exceeded 33 percent of the time) as the criterion for housing location with respect to noise. In accordance with the requirements of the Noise Control Act of 1972, the EPA's Office of Noise Abatement and Control has brought a degree of order to this chaotic situation.[4] The ADNL was created to characterize environmental noise. Levels were established by the EPA "requisite to protect health and welfare with an adequate margin of safety."[5] In concert with the majority of models, the ADNL is based on a 10 times the log of the number of events relation, and it includes a 10-dB nighttime penalty. As indicated by its title, it uses the A frequency weighting and its definition implies the true integration of the square of the A-weighted sound pressure.

Schultz has re-analyzed the data from 18 of the worldwide attitudinal surveys.[6] Table 1 lists these surveys and Figure 1 illustrates some of his results. Basically, these worldwide results tend to collapse onto a single curve which relates the percent of a community found to be "highly annoyed" as a function of the DNL. This concentration on the percent of a community "highly annoyed," rather than on the individual, has marked a great step forward in understanding community response to noise. Many previous researchers concentrated on the ability to predict individual reaction to noise. These efforts rarely achieved a correlation coefficient with noise which exceeded 0.4.[7] Many theories were advanced to explain this poor correlation. Primarily, these theories concentrated on "intervening variables" such as a person's attitude towards the noise source, willingness to complain, etc. This poor correlation can readily be explained by noting that the surveys typically categorized respondents into 5 to 10 dB ranges and had little, if any, real knowledge of the indoor noise exposure or of the respondent's life-style. Concentrating on community rather than individual averages over these individual variations provides much more meaningful data for the administrator and regulator.

Procedurally, the report of Working Group 69 of the National Academy of Science Committee on Hearing Bioacoustics and Biomechanics (CHABA) had systematized the use of DNL and the Schultz-derived function for environmental assessment and land planning. This report was prepared for the EPA, which will soon issue a draft of its proposed procedures based on this report.[8]

Unfortunately for the Army, its major noise sources do not readily fit in the context of those studied during the past 30 years and which led to the development of the DNL measure. The Army's noise comes primarily from training activities and from weapon systems. Number one on the list is the large impulse noise created by armor fire, artillery, and demolition. Also on this

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4 Noise Control Act of 1972, Public Law 92-574, 86 Stat 1234.

5 Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare With an Adequate Margin of Safety, EPA Report 5-50/9-74-004, PB239429 (EPA, March 1974).

6 Theodore J. Schultz, "Synthesis of Social Surveys and Noise Annoyance," Journal of the Acoustical Society of America, Vol. 64, No. 2 (August 1978), pp 377-406.

7 Fred L. Hall and S. Martin Taylor, "The Reliability of Social Survey Data on Noise Effect," Journal of the Acoustical Society of America, Supplement 1, Vol. 67 (1980), p 533.

8 Guidelines for Preparing Environmental Impact Statements on Noise, CHABA, ADA044384 (National Academy of Science, 1977).

Table 1

Worldwide Attitudinal Survey Summary

"Noise -- Final Report," Cmmd. 2056, July 1963, Her Majesty's Stationery Office, London (the so-called "Wilson Report"), Appendix XI.

Robert Josse, "La Gêne Causée parle Bruit des Avions [Annoyance Caused by Aircraft Noise]," Rep. 100, Cahier 869, June 1969, Centre Scientifique et Technique du Bâtiment, Paris; pp 46-51; and Ariel Alexandre, "Prevision de la Gene due au Bruit autour des Aeroports et Perspectives sur les Moyens d'y Remedier" [Prediction of Annoyance Due to Noise Around Airports and Speculations on the Means for Controlling It], Anthropol. Appl., Doc. A.A.28/70 (April 1970).

"Fluglärmwirkungen, Eine interdisziplinäre Untersuchung über die Auswirkungen des Fluglärms suf den Menschen," [Effects of Aircraft Noise: An Interdisciplinary Investigation of the Effects of Aircraft Noise on Man], (in three volumes: Main Report, Appendices, and Social-scientific Supplementary Report), Deutsche Forschungsgemeinschaft, Bonn-Bad Godesberg, 1974. Papers reporting this study were also presented at the International Congress on Noise as a Public Health Question, Dubrovnik (13-18 May 1973), pp 765-776; at InterNoise 73, Copenhagen (22-24 August 1973), pp 289-297); and at the Symposium on Noise in Transportation, University of Southampton (22-23 July 1974), Paper No. 1, Sec. III.

D. Aubrée, S. Auzou and J. M. Rapin, "Étude de la Gene due au Trafic Automobile Urbain: Compte Rendu Scientifique [Study of the Annoyance Due to Urban Automotive Traffic: Scientific Report]," no report number (June 1971), Centre Scientifique et Technique du Bâtiment, Paris.

Ragnar Rylander, Stefan Sörensen and Anders Kajland, "Störningsreaktioner vid Flybullerexponering," [Annoyance Reactions from Aircraft Noise Exposure], no report number, April 1972, joint report from the Institute of Hygiene, The Karolinska Institute and the Department of Environmental Hygiene, National Environmental Protection Board, Stockholm, Sweden (in Swedish).

"Sozio-psychologische Fluglärmuntersuchung in Gebiet der drei Schweizer Flughafen: Zürich, Genf, Basel [Sociopsychological Investigation of Aircraft Noise in the Vicinities of Three Swiss Airports: Zürich, Geneva and Basel], no report number, Arbeitsgemeinschaft für soziopsychologische Fuglärmuntersuchungen, Bern (June 1973).

F. J. Langdon, "Noise Nuisance Caused by Road Traffic in Residential Areas, Part I and Part II," J. Sound Vib. 47(2), 243-263 and 265-282 (22 July 1976).

D. Aubrée, "Enquête Acoustique et Sociologique Permettant de Definir une Echelle de la Gêne Eprouvée par l'Homme dans son Logement du Fait des Bruits de Train" [Acoustical and Sociological Investigation Permitting the Definition of a Scale of Annoyance Felt by People in their Dwellings Due to the Noise of Trains], no report number, Centre Scientifique et Technique du Bâtiment, Paris (June 1973). See also Refs. 52 and 53.

Myles A. Simpson, Karl S. Pearsons, Sanford A. Fidell and Richard H. Muehlenbeck, "Social Survey and Noise Measurement Program to Assess the Effects of Noise on the Urban Environment: Data Acquisition and Presentation," Report No. 2753 (July 1974), Bolt Beranek and Newman, Inc., Submitted to the U.S. Environmental Protection Agency, Office of Noise Control and Abatement, Washington, DC 20460. The data from this survey are not yet published; however, portions of the raw questionnaire response were analyzed for the purposes of this report.

Theodore J. Schultz, "Synthesis of Social Surveys on Noise Annoyance," Journal of the Accoustical Society of America, Vol. 64, No. 2 (August 1978), p 380.

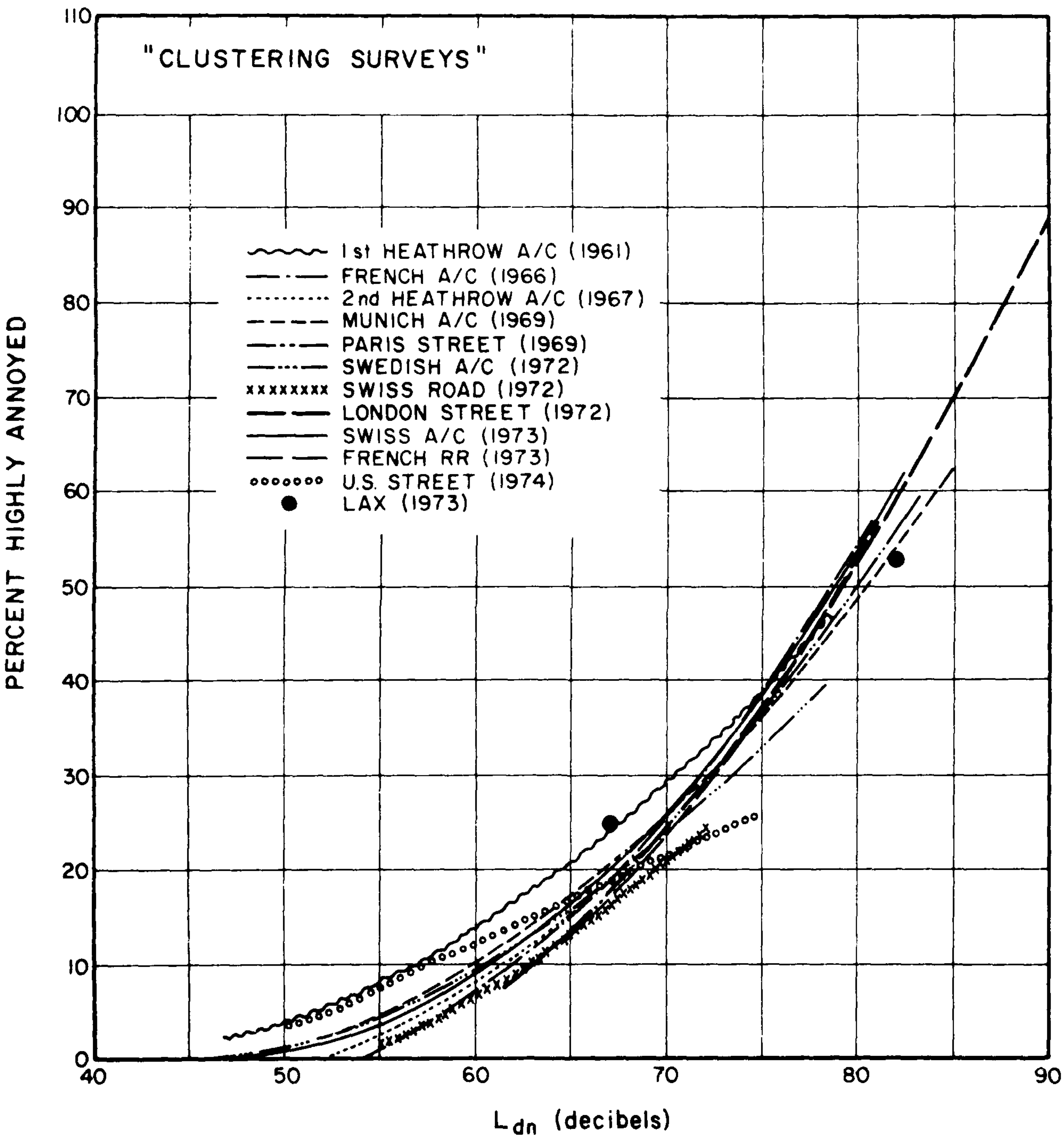

Figure 1. Summary of annoyance data from the surveys listed in Table 1. (Reproduced by permission from Theodore J. Schultz, "Synthesis of Social Surveys and Noise Annoyance," Journal of the Acoustical Society of America, Vol. 64, No. 2 [August 1978, pp 377-406].)

list are rockets (primarily small ground-to-ground), helicopters (the Army owns about 80 percent of the country's helicopters), and small arms. This study primarily considers the impulse noise generated by large weapons.

Working Group 69 of CHABA, noting the problem of large amplitude impulse noise such as that generated by Army weapons, quarries, or sonic booms, created interim procedures for the assessment of this type of noise based on limited data dealing with sonic booms. These data came primarily from the Oklahoma City sonic boom study.[9] EPA adopted these interim procedures and recommended them by letter to other Federal agencies. DOD adopted these procedures in their Air Installations Compatible Use Zones (AICUZ) instruction and in the Joint Services Manual, known within the Army as TM 5-803-2.[10] Basically, this interim procedure uses C-weighting rather than A-weighting, since the C-weighting was found by the committee to be a readily available standard curve which better incorporated the low-frequency sound energies which affected building vibration (since building vibration was the main adverse factor in community response to sonic booms). These procedures consider an impulsive environment having a certain CDNL level to be equivalent in community response (percent "highly annoyed") as another community having a numerically equal ADNL level resulting from traditional noise sources such as aircraft or vehicles.

This CDNL procedure was created on an interim basis with the full understanding of all parties concerned (CHABA working groups 69 and 84, EPA, and DOD). As part of this understanding, CERL is conducting several attitudinal surveys to develop specific data which would better define and clarify community response to impulse noise.

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[9] P. N. Borsky, Community Reactions to Sonic Booms in the Oklahoma City Area, Vol. II: Data on Community Reactions and Interpretations, TR 65-37 (Air Force Aeromedical Research Laboratory [AMRL], 1965).

[10] Air Installations Compatible Use Zones, DOD Instruction 4165-57 (Department of Defense [DOD], 1973); and Environmental Protection: Planning in the Noise Environment, TM 5-803-2 (DA, 15 June 1978).

3 DATA DEVELOPMENT

CERL needed three types of data for its study: attitudinal information; predicted noise contours; and physically monitored, site-specific information. This chapter and its associated appendices describe the measures and procedures used to develop and obtain these data.

The survey instrument was a questionnaire developed by CERL and outside consultants nationally and internationally recognized for their expertise and experience in this area. The questionnaire was reviewed by the EPA Office of Noise Abatement and Control and individuals from the Air Force Aeromedical Research Laboratory and the Army Aeromedical Research Laboratory. To enhance the cross-comparability of CERL's data, the review group recommended that CERL adopt the five-level adjective description scale for annoyance used in many earlier American surveys.

The survey instrument was typical of those previously used in the United States and other Western countries. It was administered face to face, and took about 30 minutes. The University of Illinois SRL handled the details of survey administration and sampling.

Using the currently recommended procedures by the National Academy of Science and the EPA, CDNL noise contours were predicted by computer for the blast noise resulting from such activities as armor and artillery fire; ADNL contours were predicted for some of the helicopter operations. These physical predictions of exterior noise zones are based on about 1 year's operational data. A goal was set for the number of questionnaires to be completed in each of seven distinct noise zone strata, i.e., four blast noise strata, two helicopter noise strata, and one control area. Households within each stratum were randomly sampled. The respondent within a household was selected randomly from among all those in the household over 18 years of age. Because there were few households within the highest blast noise zone, almost 100 percent of households within this zone were sampled.

The study area was in the vicinity of Fort Bragg, NC. Only small towns and the moderate-size city of Fayetteville (200,000) are in the immediate area. The general noise climate has existed as it is for many years.

Questionnaire Design

Two survey instruments were used: the Interviewer Report Form (IRF) and the Community Attitudes Survey (CAS) questionnaire. The questionnaire was designed to determine what noises people hear and the frequency and level of annoyance, and to compare various noises. The IRS and CAS were designed by CERL, Dr. Paul Borsky of Columbia University, and the Illinois SRL.

The IRF was completed by the interviewer based on his* observations, and is shown in Appendix B. Demographic data about the respondent and his household, house, and neighborhood were recorded in addition to the respondent's attitude toward noise.

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* The male pronoun is used throughout this report to refer to both genders.

The CAS is shown in Appendix C. It begins by asking information on the respondent's rating of the neighborhood, likes and dislikes about the neighborhood, and if the respondent ever considered moving away. After this general beginning, Questions 9 through 36 are devoted to noise areas. Question 9 was intended to find out what noises the respondent hears; the interviewer was allowed to prompt the respondent by noise source name. Question 10 evaluated the frequency and magnitude of the noises. Question 11 evaluated seasonality and general annoyance level of the noises.

Questions 12 through 18 addressed the frequency of occurrence and the annoyance level of noises heard for various times of the day; it also established whether the noises occurred on weekdays or weekends. Questions 20, 21 and 27 evaluated noise interference with the respondent's activities. Questions 23, 24, and 26 dealt with vibration and damages caused by noises. Questions 25 and 26 were concerned with frightening or startling noises. Question 27 asked whether noise interfered with activities which require care and concentration. Questions 28 and 29 were concerned with noises that disturb the respondent's (or his household's) rest and recreation. Question 30 evaluated the respondent's opinion of how much could, should, and is done about noises. Questions 31 and 32 asked about the respondent's sensitivity to noises. Questions 33 and 34 dealt with the respondent's attitude toward Government installations and asked him whether he thought he should complain to them about noises. Question 35 asked if anything had ever been done about noises. Questions 37 through 41 were demographic questions.

Survey data were analyzed by CERL using the Statistical Package for the Social Sciences on CDC 6700 computers, located at the Naval Ship Research and Design Center, Carter Rock, MD and at Boeing Computer Services, Renton, WA.

Sample Design

The sample population included both rural and urban residents of the Fort Bragg area. The geographic area containing the survey population was divided into four CDNL contours of blast noise, and two DNL contours of helicopter noise. (These initial contours were based on 1976 data.)

Specific site data for blast noise were collected at:

Intensity Stratum	Sites
70 to 75 dB	The towns of Ashley, Ashmont, and McCain (on the west boundary of the installation); the trailer park near South Sicily Airfield (on the installation's south boundary); Pope Air Force Base air corridor (northeast of the installation in the Manchester-Tank Creek area).
65 to 70 dB	The towns of Southern Pines, Aberdeen, Pine Hill, Five Points, and Montrose (west of the installation); Raeford (south of the installation); the western portion of the installation housing area; and, for helicopter noise, the towns of College Lakes and Warrenwood (south of Simmons Army Airfield).

Intensity Stratum (Cont'd)	Sites (Cont'd)
60 to 65 dB	The towns of Pinehurst and Pine Bluff (west of the installation); the remainder (and majority) of the installation residential area; Spring Lake (north-east of the installation); and for helicopter noise, the Fayetteville suburbs of Pine Crest Acres and Shaw Heights.
Below 60 dB	The city of Fayetteville (except for sections on the approach to Simmons Field); and, near Interstate 95, the residential areas just north of East Fayetteville and the town of Ardulusa.

For helicopter noise, the sites were:

Intensity Stratum	Site
Over 70 dB	Portions of the towns of College Lakes and Pine Ridge (east of Simmons Army Airfield).
65-70 dB	Portions of Shaw Heights, North Point Village, Rollingwood, Pinecrest, Warrenwood, and Pleasant Acres (south and east of Simmons Field).

In addition to the above, a control stratum was formed consisting of households exposed to intensity levels of less than 60 dB (either blast or helicopter noise), but located near a major interstate highway.

The overall allocation plan of the sample of 2000 and the number of completed interviews were:

Blast Intensity	Number of Interviews	Helicopter Intensity	Number of Interviews
70 to 75 dB	450 (486)	65 to 70 dB	125 (254)
65 to 70 dB	450 (512)	65 to 70 dB	125
60 to 65 dB	350 (353)		
Below 60 dB	275*(285)	Over 70 dB	225 (257)
	1525 (1636)		475 (511)

A total of 2343 persons were contacted and 2147 (92 percent) were interviewed. This extraordinarily high response rate resulted in 2147 completed interviews, rather than the 2000 planned.

Because the helicopter strata overlap was embedded in the blast contour strata of 60 to 65 dB and below 60 dB, the interviews in the overlap area were counted as part of the blast sample. With the addition of the helicopter interviews, the total sample size of the 60 to 65 dB blast stratum was 475 interviews, while that of the 60 dB blast stratum was 625 interviews.

* Includes 50 control interviews.

To select a representative probability sample, listings were either obtained or prepared of the number of households and their street locations in each intensity stratum. This was done using the Fayetteville city directory, telephone directories (where phone coverage of households was nearly complete), and actual field counting of housing units in communities where directory coverage was incomplete.

Within each of the seven strata, interview households were selected from the lists according to systematic probability sampling procedures. Every nth household was chosen from the population listing, beginning at a randomly selected starting point. The sampling fraction in each stratum was the ratio between the total number of households in the stratum and the desired sample size. Owing to the small size of the communities -- both in population and in geographic area -- sampling in clusters of households was not necessary. This was an advantage, since cluster sampling done to reduce the cost of data collection causes a slight reduction in the precision of the survey estimates as compared to a nonclustered sample of the same size.

A problem arose in the sampling in the 70 to 75 dB areas. The Pope Air Force Base air corridor northeast of Fort Bragg in the Manchester-Tank Creek area was categorized as 70 to 75 dB in the sampling scheme when it was actually in the 65 to 70 dB area. Thus, there are actually only 139 dwelling units in the 70 to 75 dB area (Ashley Heights, Ashmont, McCain, and S. Sicily). This area should have been 100 percent sampled, rather than the 52 percent rate used.

Further refinements of the blast contour predictions (based on 1 year's new data) were made after the survey was completed. These predictions and the number of respondents were:

Decibel Zone	Number Respondents
63 to 67	72
58 to 62	205
54 to 57	894
48 to 53	967
No classification	9
TOTAL	2147

The survey and analyses results indicate future surveys should select more subjects from the high decibel areas and fewer in the lower ones. The total sample should be decreased.

Monitoring Data

Seventeen locations in and around Fort Bragg were monitored over a 5-month period using CERL-designed, true-integrating noise-exposure level meters.[11] One of the monitor sites was kept fixed for the entire 5 months; the

[11] Aaron Averbuch, et al., True-Integrating Environmental Noise Monitor and Sound-Exposure Meter, Volumes I through IV, TR N-41/ADA060958, ADA072002, ADA083320, and ADA083321 (CERL May 1978, June 1979, and March 1980).

others rotated back and forth in pairs on a 1-week schedule. Different pairs of sites switched on different days in order to spread the workload. Table 2 lists the monitor site locations in metric coordinates. Figure 2 shows the location of monitors with respect to Fort Bragg; it also shows the final 1-year blast noise contours and major population centers. Appendix D describes, in detail, the 17 monitor sites. Appendix E describes the operation of the noise monitors.

Blast Noise Contours

Daily operational data were gathered for the entire year following administration of the survey. The first 5 months data gathering coincided with the noise monitoring. In addition, yearly total operations were tabulated for the year preceding administration of the survey. Based on these data, contours were constructed for the year preceding administration of the survey and specific CDNL predicted values were developed for each of the 17 monitored sites. The predictions at each of the monitored sites were only for the days during which monitoring had been performed and accurate data developed. Thus, as described in Chapter 6, it is possible to compare the predicted and monitored data and to adjust them to the 1-year prediction based on the monitoring results. To form the 1-year prediction for the year preceding administration of the survey, the operational mix of firing point and target usage developed during the year following the survey was adjusted such that the total numbers of operations of different weapon types equalled the values supplied by Fort Bragg for the year preceding the survey. Appendix F lists these different data sources and describes how they were used to predict the 1-year contours for the period preceding the survey and for the specific levels predicted at the 17 monitor sites.

Table 2

Monitor Sites in Metric Coordinates

Site	Coordinates
1	506,823
2	490,873
3	606,789
4	699,800
5	436,894
6	473,935
7	881,885
8	400,960
9	605,717
10	767,788
11	866,797
12	911,823
13	810,889
14	845,914
15	823,952
16	912,901
17	905,885

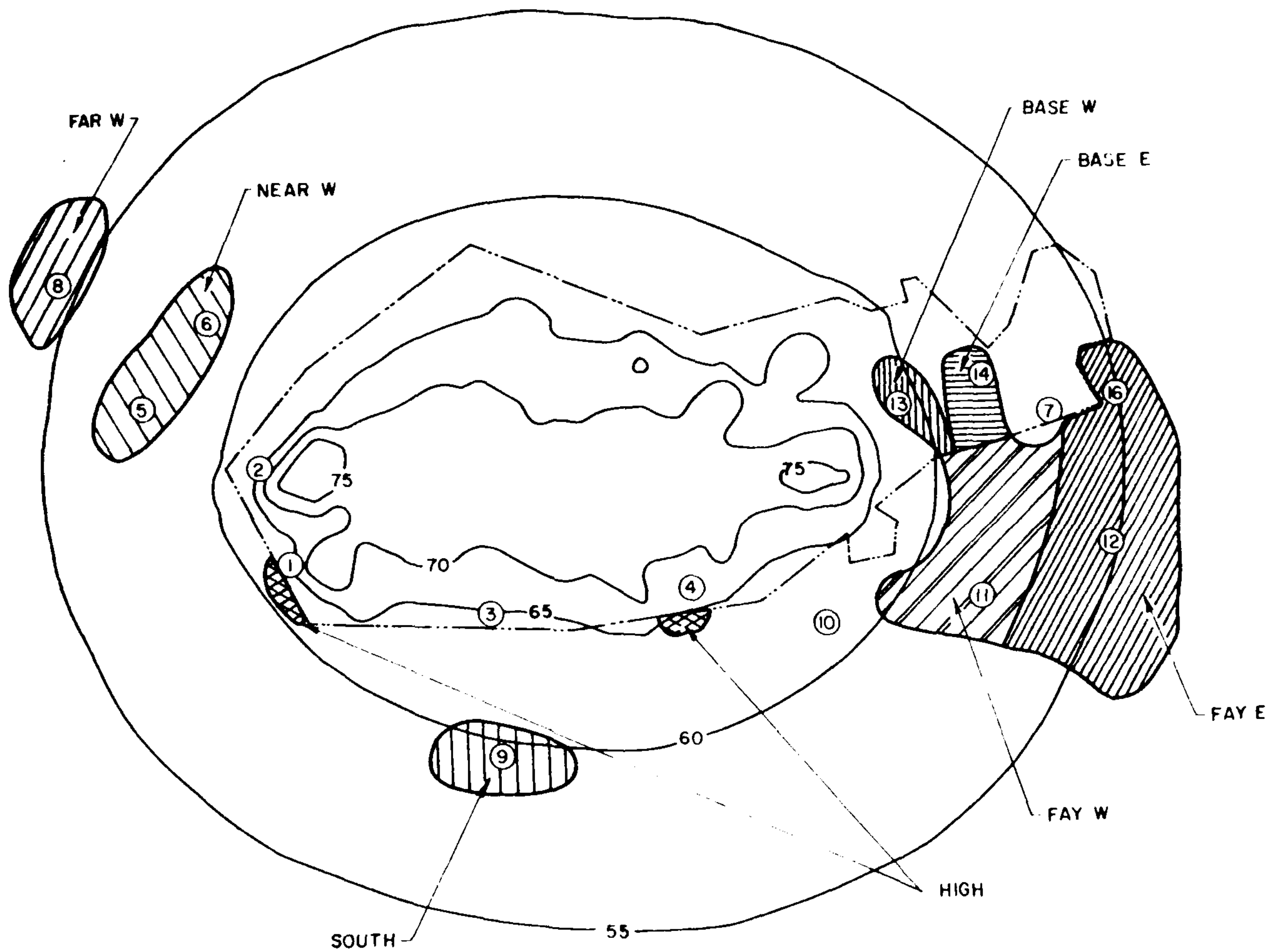

Figure 2. Final 1-year blast noise contours.

4 THE GROWTH OF COMMUNITY ANNOYANCE WITH LOUDNESS OF EVENTS AND WITH FREQUENCY OF EVENTS

Models to describe community reaction to noise have been the focus of study for at least the past quarter century.[12] Common to most of these models are three hypotheses:

Hypothesis 1: Community response increases monotonically with sound amplitude.

Hypothesis 2: Community response increases monotonically with frequency of occurrence.

Hypothesis 3: Community response to sound at night increases vs the same sound during daytime.

The DNL measure is typical of these models. It hypothesizes that (1) community reaction grows in direct proportion to the growth in SEL, (2) community reaction grows in proportion to 10 log of the number of events, and (3) a nighttime (2200 to 0700 hr) penalty of 10 dB is appropriate.[13] Indeed, Schultz has shown excellent agreement for survey data taken worldwide when the percentage of "highly annoyed" respondents in a given noise zone is analyzed.[14]

In most surveys, respondents are stratified by noise zone, and percentages of respondents within a noise zone are analyzed. Schultz, however, has defined "highly annoyed" respondents. According to his definition, "highly annoyed" respondents were those that chose the top 1-1/2 to 2 categories on a five-point scale; the half step range resulted from the specifics of the scale and word use. Based on this, Schultz demonstrated a very clear function relating "highly annoyed" respondents and the DNL noise zone.

In this chapter, CERL's analysis takes an entirely new approach. Rather than categorize respondents on the basis of exterior noise zone strata, CERL categorized them on the basis of their own perception of loudness and frequency of occurrence. This approach was designed to eliminate the variability in results often found within a noise zone. This variability occurs because different building construction, life-styles (i.e., TVs and radios on or off), and window and room exposures with respect to rather localized noise sources

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[12] K. N. Steven and A. C. Pietrasanta, Procedures for Estimating Noise Exposure and Resulting Community Reactions from Air Base Operations, WADC TN-57-10 (Wright-Patterson Air Force Base, Ohio, 1957); and W. J. Galloway and D. E. Bishop, Noise Exposure Forecast: Evolution, Evaluation, Extensions, and Land Use Interpretations, Federal Aviation Administration Report No. FAA-NO-70-9 (Department of Transportation, 1970).

[13] Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA Report 550/9-74-004, PB239429 (EPA, March 1974).

[14] Theodore J. Schultz, "Synthesis of Social Surveys and Noise Annoyance," Journal of the Acoustical Society of America, Vol. 64, No. 2 (August 1978), pp 377-406.

(i.e., children or street traffic, etc.) combine to effect a rather large uncertainty as to the actual exposure received by any individual respondent, even though the exterior noise zone in an area may be a constant.

A second reason for this rather unconventional approach is the difficulty of independently analyzing Hypotheses 1 and 2 with conventional methods. Conventional analysis techniques predict or measure exterior noise zones based on amplitudes of events and frequencies of occurrence. Both are highly correlated within any noise zone because of the physical realities of the situation. But it is the differing life-styles, building constructions, and building orientations which allow for *the differences in actual received* loudness and received frequencies of occurrence by respondents indoors. Since measurement of the received dose of each respondent to each source was well beyond the resources of this study, the next best means to study Hypotheses 1 and 2 was to use the respondent's own perception of loudness and frequency of occurrence of events.

Although proof that the respondents are accurate noise monitors is impossible without actual interior loudness and frequency measurements, the analysis below indicates that, in general, the respondents differentiated between differing amplitudes and differing frequencies of occurrence. (Actual indoor measurements were beyond the scope of this study.)

As a part of the survey, respondents were asked the following question: "What are some of the different kinds of noises you hear around here?" Spontaneous answers were recorded. The respondents were also prompted with the following sources if they did not spontaneously indicate them: artillery, street traffic, airplanes, helicopters, children and dogs.

Next, the respondents were asked: "How loud is the noise from (*source*) compared to normal conversation?" They could respond: much more, more, about the same, less, much less, or (*don't know*). The (*don't know*) was not a written choice and very few respondents chose it -- less than 1 percent.

Next, respondents were asked, "How often do you hear (*source of noise*)?" They could respond: every day, several times a week, several times a month, once every few months, or less often than that. As above, they could also respond by (*don't know*) and again less than 1 percent responded in this fashion. If a respondent answered every day, he was asked how many times.

In the next question, respondents were asked (by source) a series of questions which included: "Do you hear (*source of noise*) more often during a certain time of year?"; "What season is that?"; "Some days more than others?"; etc. The last part of this question asked: "In general, taking everything into consideration, does the noise from (*source*) ever bother or annoy you?" The possible response was either yes or no. If yes, they were asked: "Overall, how annoyed are you by noise from (*source*)?" The possible responses were: extremely, very much, moderately, and slightly. The "not at all" response, which is the fifth point in the five-point scale, was given by the "no" response to the yes/no filter question described above.

The analysis in this chapter makes use of these three questions which, in effect, asked the respondents (1) how loud the sound appears to them, (2) how often they perceive it, and (3) how annoyed they are overall. That information, plus the nighttime penalty, are the generalized ingredients in most noise models, including the DNL model.

Before going into the general analysis, it is useful to examine the responses to the above questions by noise zone area. While the specifics of a noise model to describe impulse noise are the subject of Chapter 6, some of the data given in Chapter 6 can be used here to indicate that the respondents' perception of the frequency of occurrence and loudness of noise events generally correspond with prediction. Figure 2 showed predicted noise contours resulting from impulse noise in the vicinity of the study base. Indicated on this figure are several discreet respondent geographic areas. These contours are in 5-dB increments; the absolute values are unimportant for the purpose of this discussion. Tables 3 and 4 give the responses to the "how loud" and "how frequent" questions by geographic area.

These tables show that respondent judgments of loudness and of frequency of occurrence decrease as noise level lessens and distance away from the installation increases. Responses within a given zone are generally equivalent. When the responses of Fay E to Fay W, Near W to Far W, and Base E to Base W are compared, it can be seen that responses in the Fay W area show no significant differences from the responses in the Base Total area; this comparison takes into account the fact that the Base Total area is in perhaps a 1 dB higher noise zone (on average). This shows that different groups objectively report frequency of occurrence and loudness. The data in Chapter 6 show that these same groups (on and off the installation) significantly differ on their levels of annoyance.

Tables 5 through 9 present the basic data used in this analysis, i.e., blast sources (e.g., artillery), helicopters, airplanes, street traffic, and children and pets. Each table has 25 cells. The rows indicate the respondents' assessment of the loudness compared to normal conversation; the scale ranges from "much more" to "much less." The columns indicate the respondents' assessment of frequency of occurrence; this scale ranges from "everyday" to "less often than once every few months." Each cell has four numbers which, in order, are: the number of respondents in that cell indicating the highest category of annoyance, the number of respondents in that cell indicating the second highest category of annoyance, the total number of respondents in that cell, and the percentage of respondents within the cell "highly annoyed" (the sum of the first two numbers divided by the third).

Figure 3 graphically illustrates the data in Tables 5 through 9. It has five parts (based on the five types of noise sources) and is broken into the same number of response cells as the tables. A solid circle with area proportional to the percent "highly annoyed" is in each cell. Figure 3 shows that the annoyance increases both with perceived amplitude and with perceived frequency of occurrence. It also shows, as is known from the physics of sound propagation involved, that blast noise events occur no more often than several per week, except in the areas very near the sources. In these areas, the events also exhibit the greatest loudness. This figure also shows that the community response to blast noise continues when events occur once every few months, whereas for the other sources, there is no meaningful community

Table 3

Loudness Judgments
Noise Levels Compared to Normal Conversation

Area	Much More	More	Same	Less	Much Less	Never Hear
HIGH	37.5	16.7	18.1	8.3	0	19.4
FAY W	14.9	15.5	12.6	13.8	1.7	40.2
FAY E	10.9	15.8	15.7	11.5	3.2	42.3
BASE W	17.1	25.4	12.2	11.2	3.4	30.7
BASE E	13.2	12.7	13.2	5.9	2.9	51.2
BASE TOTAL	15.1	19.0	12.7	8.5	3.2	41.0
SOUTH W	17.6	27.0	4.1	6.8	1.4	43.2
NEAR W	12.0	14.7	18.3	19.5	6.0	29.1
FAR W	0	7.1	4.8	26.2	4.8	57.1

Table 4

Frequency of Occurrence

Area	Everyday	Several Per Week	Several Per Month	Once Every Few Months	Less Often	Never Hear
HIGH	18.1	29.2	25.0	8.3	0	19.4
FAY W	5.2	14.9	21.8	14.4	2.3	40.2
FAY E	2.4	13.8	21.5	17.2	1.7	42.3
BASE W	9.8	25.9	23.9	8.8	1.0	30.7
BASE E	2.9	13.2	22.4	7.3	1.5	51.2
BASE TOTAL	6.3	19.5	23.2	8.0	1.2	41.0
SOUTH	8.1	21.6	17.6	8.1	0	43.2
NEAR W	2.0	13.1	27.9	24.7	1.6	29.1
FAR W	0	0	19.0	19.0	2.4	57.1

Table 5

Artillery Noises -- Survey Responses

Frequency	Loudness* Much More	More	Same	Less	Much Less
Daily	19 6 43 (58)	1 5 21 (29)	0 0 13 (0)	0 0 10 (0)	0 0 2 (0)
Several Per Week	21 14 98 (36)	9 16 98 (26)	5 9 79 (18)	2 1 54 (6)	1 0 9 (11)
Several Per Month	15 21 96 (37)	7 15 142 (15)	2 7 116 (8)	2 1 92 (3)	1 0 28 (4)
Once Every Few Months	6 5 42 (26)	1 5 71 (8)	0 2 100 (2)	0 1 84 (1)	0 1 23 (4)
Less Often	0 0 1 (0)	0 1 8 (13)	0 0 5 (0)	0 0 11 (0)	0 0 8 (0)

*The first three numbers in each cell are the numbers expressing (1) extreme annoyance, (2) very much annoyance, and (3) the total number of respondents in the cell. The fourth number, in parentheses, is the percent "highly annoyed."

Table 6

Airplane Noises -- Survey Responses

Frequency	Loudness* Much More	More	Same	Less	Much Less
Daily	30 47 176 (44)	5 23 162 (17)	5 6 89 (12)	1 0 45 (2)	0 0 8 (0)
Several Per Week	10 10 66 (30)	2 8 127 (8)	1 2 86 (3)	0 1 47 (2)	0 0 15 (0)
Several Per Month	3 5 18 (44)	2 1 45 (7)	1 1 66 (3)	0 0 29 (0)	0 0 [illegible] (0)
Once Every Few Months	0 0 4 (0)	0 1 14 (7)	0 0 13 (0)	0 0 10 (0)	0 0 4 (0)
Less Often	0 0 3 (0)	0 0 1 (0)	0 0 6 (0)	0 0 6 (0)	0 1 2 (50)

*The first three numbers in each cell are the numbers expressing (1) extreme annoyance, (2) very much annoyance, and (3) the total number of respondents in the cell. The fourth number, in parentheses, is the percent "highly annoyed."

Table 7

Helicopter Noises -- Survey Responses

Frequency	Loudness*: Much More	More	Same	Less	Much Less
Daily	51 44 201 (47)	11 15 157 (17)	2 8 65 (15)	0 1 23 (4)	0 0 7 (0)
Several Per Week	24 29 126 (42)	1 12 140 (9)	1 3 101 (4)	0 2 49 (4)	0 0 9 (0)
Several Per Month	4 7 34 (32)	2 4 65 (9)	0 0 61 (0)	0 0 35 (0)	0 0 5 (0)
Once Every Few Months	1 0 9 (11)	0 0 9 (0)	0 0 18 (0)	0 0 20 (0)	0 0 9 (0)
Less Often	0 0 2 (0)	0 0 1 (0)	0 0 9 (0)	0 0 6 (0)	0 1 5 (20)

*The first three numbers in each cell are the numbers expressing (1) extreme annoyance, (2) very much annoyance, and (3) the total number of respondents in the cell. The fourth number, in parentheses, is the percent "highly annoyed."

Table 8

Street Traffic Noises -- Survey Responses

Frequency	Loudness*: Much More	More	Same	Less	Much Less
Daily	33 26 106 (56)	13 44 164 (35)	9 14 130 (18)	3 2 81 (6)	0 1 19 (5)
Several Per Week	10 8 37 (49)	7 9 61 (26)	1 5 39 (15)	2 4 33 (18)	0 0 9 (0)
Several Per Month	2 2 8 (50)	3 2 23 (22)	0 0 10 (0)	1 0 11 (9)	0 0 5 (0)
Once Every Few Months	0 1 3 (33)	0 0 4 (0)	0 0 4 (0)	0 0 2 (0)	0 0 2 (0)
Less Often	1 0 1 (100)	1 0 2 (50)	0 0 4 (0)	0 1 5 (20)	0 0 10 (0)

*The first three numbers in each cell are the numbers expressing (1) extreme annoyance, (2) very much annoyance, and (3) the total number of respondents in the cell. The fourth number, in parentheses, is the percent "highly annoyed."

Table 9

Children and Pet Noises -- Survey Responses

Frequency	Loudness* Much More	More	Same	Less	Much Less
Daily	45 26 109 (65)	23 27 141 (35)	8 22 132 (23)	5 6 88 (13)	2 4 28 (21)
Several Per Week	3 10 23 (56)	9 12 58 (36)	2 9 62 (18)	1 2 40 (8)	0 1 21 (5)
Several Per Month	2 0 5 (40)	1 1 9 (22)	1 1 16 (13)	0 0 16 (0)	0 0 7 (0)
Once Every Few Months	0 1 2 (50)	1 1 2 (100)	0 0 1 (0)	0 0 4 (0)	1 0 6 (17)
Less Often	0 0 0 (-)	0 1 3 (33)	0 0 1 (0)	0 1 8 (13)	0 0 14 (0)

*The first three numbers in each cell are the numbers expressing (1) extreme annoyance, (2) very much annoyance, and (3) the total number of respondents in the cell. The fourth number, in parentheses, is the percent "highly annoyed."

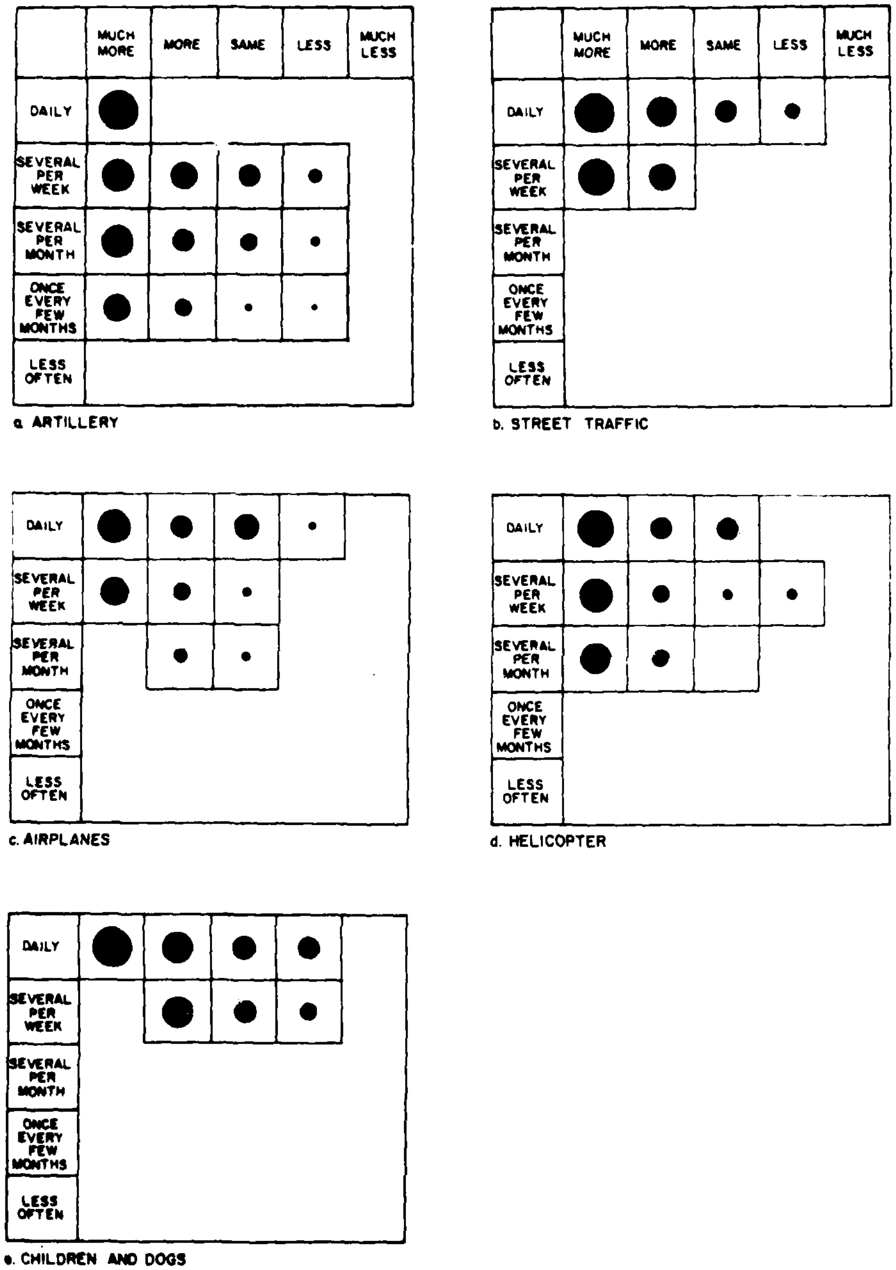

Figure 3. A pictorial representation of the percent "highly annoyed" as a function of perceived loudness (compared to normal conversation) and perceived frequency of occurrence.

response at this low rate of occurrence. (In Figure 3, cells with less than 40 total respondents have been shown as blank since the actual percentages with these few numbers of respondents are considered highly unreliable. For example, the second column in the fifth row of Table 9 shows one respondent out of a total of three as "highly annoyed" -- a percentage of 33 percent. In Figure 3, this cell is not shown because this percentage of 33 is not considered reliable.)

Discussion

To better examine the growth of the "highly annoyed" percentage as a function of increases in frequency of occurrence, data were aggregated across all levels of loudness and across several of the sources. That is, within a source or across several sources, sums were calculated over all five loudness ranges yielding the number of respondents indicating extremely annoyed, very much annoyed, and the total number of respondents. These calculations were performed for artillery alone, for helicopters alone, for traffic plus children plus aircraft, for traffic plus children plus aircraft plus helicopters, and for helicopters plus traffic plus aircraft. These groupings were chosen to contrast blast, helicopter, and all other noise sources. These data are in Table 10 and illustrated in Figure 4. Based on these data, Table 11 indicates the ratio of "highly annoyed" from one frequency of occurrence to the next (one row to the next) within each noise source grouping (see Table 10).

These data reveal five general trends:

1. Table 10 shows that for a given frequency of occurrence, the percentages of those annoyed by blast noise are somewhat larger than for the other noise sources. The other noise sources are otherwise similar.

2. Table 11 shows that the first two ratio changes for all other noises as compared to blast noise (and across all noise sources) are similar.

3. The third ratio change for blast noise (Table 11) is much larger than for the other noise sources. This indicates that the community response integration period for blast noise apparently extends down to and beyond "once every few months."

4. For the other sources, the integration period appears to be shorter, extending down to occurrences more on the order of "several per month."

5. All of the sources (in terms of community annoyance response) drop away when occurrences drop to less often than "once every few months."

Within the daily grouping for frequency of occurrence, data for helicopters, aircraft, and traffic were examined as a function of the number of events per day. These data were divided into:

1. One to two occurrences per day

2. Three to seven occurrences per day

3. Eight or more occurrences per day.

Table 10

Aggregated Data Over All Loudness by Frequency of Occurrence -- Percent "Highly Annoyed" (Number in Cell in Parentheses)

	Blast	Helicopter	Traffic + Children + Aircraft	Helicopter + Traffic + Children + Aircraft	Helicopter + Traffic + Aircraft
Daily	35 (89)	29 (453)	29 (1478)	29 (1931)	27 (1433)
Several per week	23 (338)	17* (425)	18* (724)	17* (1149)	16* (945)
Several per month	15 (474)	9* (200)	11 (275)	10* (475)	9* (427)
Once every few months	7 (320)	2 (65)	8 (75)	5 (140)	2 (125)
Less often	3 (33)	4 (23)	9 (66)	8 (155)	9 (129)

*The only significant differences (Fisher's test at the 0.05 level) are the percent "highly annoyed" for blast noise as compared to other groupings. These are indicated by an asterisk.

Table 11

Ratio Increase in Percent "Highly Annoyed" With an Increase in Perceived Frequency of Occurrence

	Blast	Helicopter	Traffic + Children + Aircraft	Helicopter + Traffic + Children + Aircraft	Helicopter + Traffic + Aircraft
Several per week to daily	1.5	1.7	1.6	1.7	1.7
Several per month to several per week	1.5	1.9	1.6	1.7	1.8
Once every few months to several per month	2.1	4.5	1.4	2.0	4.5
Less often to once every few months	2.3	0.5	0.9	0.6	0.2

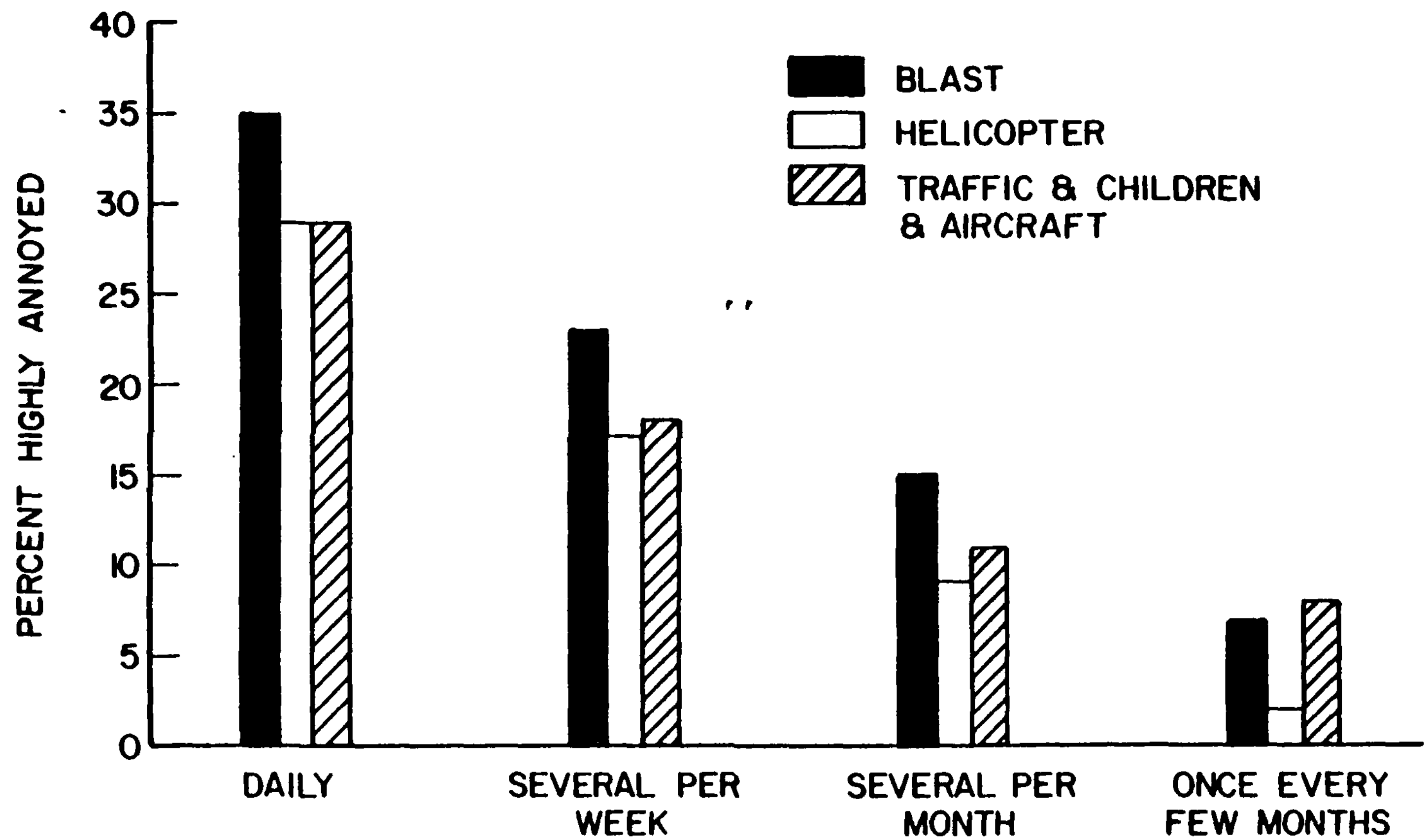

Figure 4. Judged frequency of occurrence.

Table 12 lists the results of this analysis. Examination of the percentage shift in "highly annoyed" for helicopters plus aircraft, plus traffic as a function of number of occurrences shows good consistency between the daily and yearly data. That is, the percentage change in "highly annoyed" (28/16 = 1.75) between one to two occurrences per day and three to seven occurrences per day (a factor of about 4 in frequency of occurrence) is the same as the percentage change (about 1.70) between "several per week" and "several per month" (a factor of 4 in frequency of occurrence).

One discrepancy, however, does exist. The absolute value of the percentage "highly annoyed" as a function of the number per day shifts downward when compared to the data in Table 10. For example, the percentages in the "1 to 2 per day" cell of Table 12 are about the same as the percentages for the "several per week" cell in Table 10. This seems to indicate that the growth in annoyance with frequency of occurrence undergoes some type of shift when attention changes from long-term considerations to within-a-day considerations.

Based on several studies which over a short time (minutes to hours) indicate a 3-dB growth rate for frequency of occurrence, these ratios of percentages can be correlated with the number of occurrences by calculating 10 log (ratio of the number of occurrences).[15] On this basis, the ratio of "several per week" (perhaps three) to "daily" (perhaps two) indicates a shift of 6 dB. The ratio of "several per month" to "several per week" indicates exactly 6 dB, and the ratio of "once every few months" (three or four per year) to "several per month" (30 to 40 per year) indicates about 10 dB. These data indicate that a function on the order of 30 log (ratio of percentages) corresponds to the assumed decibel shift with frequency of occurrence in formulations such as DNL.

Table 13 is similar in concept to Table 10 but averages by sources and combination of sources over frequencies of occurrence in order to examine the growth function with respect to loudness. This table is constructed for each source alone, and for children plus traffic compared to blast sources plus helicopters plus airplanes. These two groupings are formed because their members are significantly different from one another, as indicated in the table. Figures 5 and 6 graph these data, respectively.

Table 14 gives the ratio change in "highly annoyed" from one loudness to the next within each grouping. Unlike Table 6, which reveals that the ratio changes are about the same from one source to another (except for very infrequent occurrences), the ratio changes with loudness are different from one type of source to another. The trends indicate that the five sources can be divided into the two groups; from Table 8: (1) blast sources, helicopters, and airplanes; and (2) street traffic, children and pets.

[15] C. G. Rice, "Investigation of the Trade-Off Effects of Aircraft Noise and Number," Journal of Sound and Vibration, Vol. 52, No. 3 (January 1977), pp 325-344; C. G. Rice, "Development of Cumulative Noise Measure for the Prediction of General Annoyance in an Average Population," Journal of Sound and Vibration, Vol. 52, No. 3 (January 1977), pp 345-364; and S. Fidell, et al., "The Noisiness of Impulsive Sounds," Journal of the Acoustical Society of America, Vol. 48 (1970), pp 1304-1310.

Table 12

Percent of Respondents "Highly Annoyed" by Frequency of Occurrence (Number in Cell in Parentheses)

	Helicopter	Aircraft	Traffic	Helicopter + Traffic + Aircraft
8 or more	36 (152)	32 (165)	31 (264)	33 (581)
3-7 per day	30 (185)	23 (193)	32 (135)	28 (513)
1-2 per day	12 (98)	16 (101)	23 (71)	16 (270)

Table 13

Aggregated Data Over All Frequencies of Occurrence by Loudness -- Percent "Highly Annoyed" (Number in Cell in Parentheses)

Loudness/ Source	Much More	More	Same	Less	Much Less
Blast[1]	38 (280)	18 (340)	8 (313)	3 (251)	4 (70)
Airplane[1]	39 (267)	12 (349)	6 (260)	1 (137)	3 (36)
Helicopter[1]	43 (372)	12 (372)	6 (254)	2 (133)	3 (35)
Traffic[2]	54 (155)	31 (254)	16 (187)	10 (132)	2 (45)
Children[2]	63 (139)	36 (213)	20 (212)	10 (156)	11 (76)
Blast + Airplane + Helicopter[3]	40 (919)	14 (1061)	7 (827)	2 (521)	4 (141)
Traffic + Children[3]	58 (294)	33 (467)	18 (399)	10 (288)	7 (121)

[1]These three groups (by loudness level) are not significantly different from each other. Each is significantly different from the traffic and the children groups (Fisher's test at 0.01 level).

[2]These two groups (by loudness level) are not significantly different.

[3]These two groups (by loudness level) are significantly different (Fisher's test at 0.01 level).

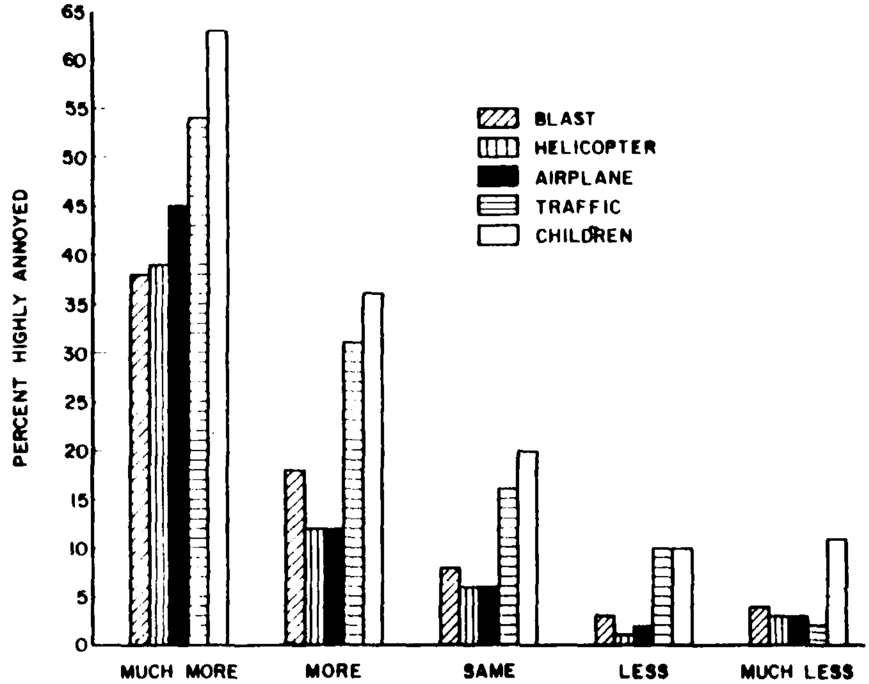

Figure 5. Judged loudness-each source alone.

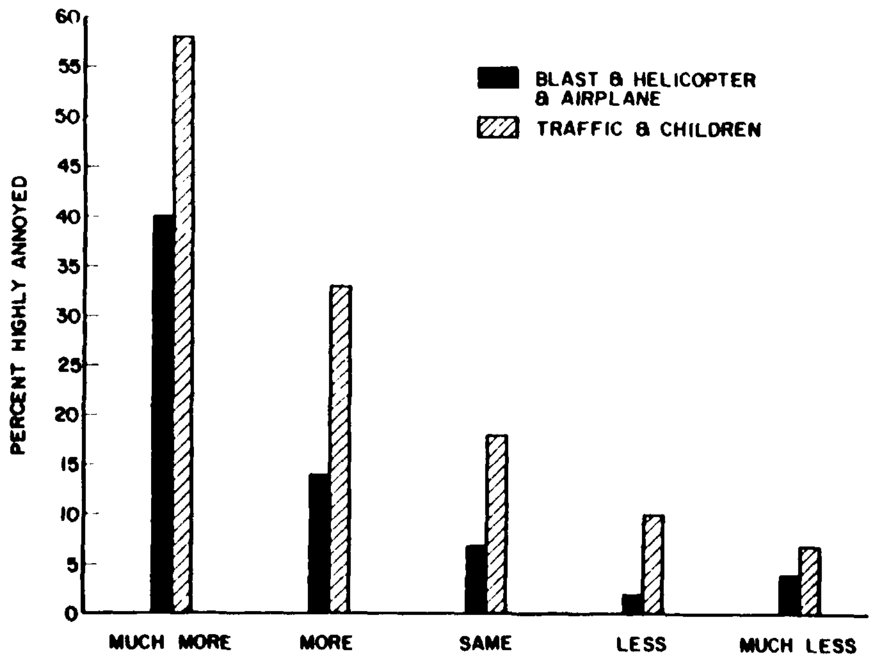

Figure 6. *Judged loudness--traffic plus children compared to blast plus helicopter plus airplane.*

There are two distinct differences between these groups: (1) for a given loudness, there is a substantially higher percentage "highly annoyed" by street traffic and children and pets than by the other group of sources, and (2) the growth slope of annoyance with loudness is steeper for the blast plus aircraft category than for the other category. That is, the percentage annoyed apparently increases more quickly for the former category than for the latter. This result -- i.e., that the growth rate for blast noise is equal to the growth rate for aircraft -- is consistent with earlier study results.[16]

Table 14

Ratio of Increase in Percent "Highly Annoyed" With Increase in Perceived Loudness

	More to Much More	Same to More	Less to Same	Much Less to Less
Blast	2.1	2.2	2.7	0.8
Airplane	3.2	2.0	6.0	0.3
Helicopter	3.6	2.0	3.0	0.7
Traffic	1.7	1.9	1.6	5.0
Children	1.7	1.8	2.0	0.9
Blast + Airplane + Helicopter	2.9	2.0	3.5	0.5
Traffic + Children	1.8	1.8	1.8	1.4

It should be noted that this survey was primarily designed to understand blast noise in the context of other more traditional noises (i.e., aircraft and traffic). The aircraft in the survey area are mainly propeller and propjet; there was very little pure jet activity. Also, with the exception of limited localized areas, helicopters operate well away from populated areas. Thus, the above result should not be construed to indicate that traffic or children would be more annoying near a major metropolitan airport. Rather, the growth rates developed above indicate that noisier jet aircraft or helicopters near to homes would be judged more annoying than corresponding louder road traffic. That is, the absolute percentages of "highly annoyed" and the growth rates are such that the curves for the two categories of sources would cross one another.

[16] P. D. Schomer, "Evaluation of C-weighted DNL for Assessment of Impulse Noise," Journal of the Acoustical Society of America, Vol. 62, No. 2 (August 1977), pp 396-399; and P. D. Schomer, "Growth Function for Human Response to Large-Amplitude Impulse Noise," Journal of the Acoustical Society of America, Vol. 64. No. 6 (December 1978), pp 1627-1632.

This also follows when the results given above are compared to other attitudinal surveys. If one makes the assumption that the loudness categories can be used to define DNL levels, then the Schultz curve can be used to directly plot the blast plus aircraft data of Table 13. This assumption is indicated as reasonable by the data in Tables 3 and 4. It is also indicated as reasonable because the distributions of perceived frequency of occurrence and of actual nighttime percentage of occurrence are both similar across the several sources, respectively. Schultz's results showed that virtually every aircraft noise survey ever performed which could be analyzed in a distinct fashion yielded virtually identical results, all of which lay practically atop his composite curve. The positions of aircraft plus blast percentages of "highly annoyed" as a function of loudness are plotted in Figure 7 by assuming that they lie on the composite slope curve. That is, the percentage "highly annoyed" is first multiplied by 0.55 (since 45 percent of respondents reported that they typically never heard the above sources). The resulting line indicating the corresponding DNL zone is indicated on the figure. Thus the four vertical lines in Figure 7 in a sense correspond to the four loudness categories: much more, more, same, less.

The traffic plus children and pet data are also plotted on Figure 7, using the assumption that the above procedure has defined the DNL level which corresponds to the four noise level categories. In this case, the data are multiplied by 0.39 since 61 percent of respondents reported they never heard these sources.

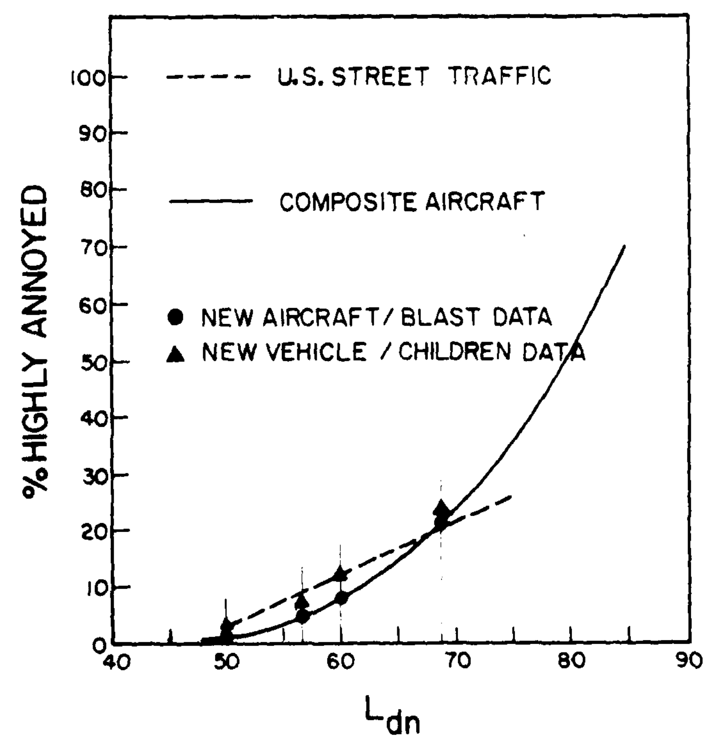

Figure 7. Comparison of growth rates with DNL level for traffic and aircraft noise. The lines are data taken from the Schultz analysis of community noise surveys; the points are taken from CERL study data.

During the last analysis step, the regression curve from the survey of United States street traffic noise was plotted on Figure 7.[17] Data from this street traffic survey are particularly comparable to CERL's data, since both surveys asked similar questions and used the same five-point scale. The United States street traffic survey asks, "How annoying was the noise in your neighborhood over the past year?" The five named response categories were: not at all, slightly, moderately, very, and extremely. This wording should be compared with the present survey which asks: "Overall, how annoyed are you by noise from (source)?" The possible responses were extremely, very much, moderately, slightly, and not at all (by a separate filter question). Figure 7 shows the close comparison of results. That is, if the aircraft data developed by CERL are plotted against the Shultz curve (which corresponds most closely to aircraft sources), then the street traffic data developed by CERL fall right along the regression line for previous street traffic surveys performed in the United States which asked a similar question. The straight line is used in this figure because this is how the street traffic was presented. It may also be that the two groups represent curves which are shifted horizontally from one another.

One possible explanation for this apparent difference in growth in annoyance with loudness for these two categories of sources may lie in people's expectations. That is, people may expect aircraft, helicopter, and blast noise to be loud and thus exhibit less annoyance when these sources are relatively quiet. But because they expect neighborhood sources to be quiet, they exhibit annoyance at relatively low loudness levels. A second possible explanation is that "fear" increases as these particular sources grow louder. Third, the blast/aircraft group represent distinct events, while the traffic/children grouping may represent a more or less constant background.

Conclusions

1. The growth in annoyance (community response) to all noises increases monotonically both with sound amplitude and with frequency of occurrence.

2. The growth of annoyance with increasing frequency of occurrence from "several per month" up to "daily" is the same across all noises. For blast noise, the integration period extends down to "once every few months."

3. The growth in annoyance with increases in amplitude differs between sources and can be divided into two categories: (a) blast noise plus helicopters plus airplanes, and (b) street traffic plus children and pets. The growth rate is steeper for (a) than for (b).

4. A residual annoyance in some segment of the population appears even when the assessed amplitude is much less than normal speech, and the frequency of occurrence is less often than "once every few months." Occasionally, this residual annoyance is even at the high annoyance level.

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[17] Theodore J. Schultz, "Synthesis of Social Surveys and Noise Annoyance," *Journal of the Acoustical Society of America*, Vol. 64, No. 2 (August 1978), pp 377-406.

5 TIME OF DAY NOISE PENALTIES

Introduction

This chapter examines the use of evening and nighttime penalties as part of the assessment of noise. Previous studies concerning these factors (cited below) concentrated mainly on fixed-wing aircraft noise and were done mainly in the vicinity of major commercial airports (e.g., London, Los Angeles, New York), where there are frequent, loud aircraft flyovers.[18] However, CERL's study was not done near any major fixed-wing aircraft facility. Instead, it concentrated on impulse noise, rotary-wing aircraft noise, general aviation aircraft noise (including a few B-727s and C-141s), urban traffic noise, and neighborhood noise from children and pets.

Earlier studies on large, fixed-wing commercial airports have been performed in a variety of ways and have yielded very mixed results. The first Heathrow survey, in London in 1961, indicated a 17-dB noise and number index (NNI) penalty for nighttime operations. This corresponds to about an 11-dB penalty in NEF or CNR and about a 10-dB penalty in DNL.[19] Fidell and Jones found no significant change in response when nighttime flights were greatly reduced at Los Angeles Airport.[20] But, as pointed out by Ollerhead, the nighttime noise that existed before nighttime flights were eliminated far outweighed the daytime noise, even with the addition of a 10-dB nighttime penalty.[21] So perhaps no significant response should be expected. Borsky, in a study of J. F. Kennedy International Airport, had results somewhere in between those of Fidell and Jones and Ollerhead.[22] His data indicate a nighttime penalty which can be shown to be on the order of 3 to 7 dB.

A second Heathrow study by Ollerhead had rather mixed results.[23] His data indicated about a 5-dB evening penalty and that some nighttime penalty should be imposed during the period when people are trying to fall asleep. A more recent Heathrow study, now in its preliminary stages, is concentrating on how noise keeps people from falling asleep, wakes them up, and the relative annoyance during different time periods.[24] Like Borsky and Ollerhead, this study

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[18] A. Wilson, Noise, Final Report (Committee on the Problem of Noise, Command 2056, H. M. Stationery Office, London, 1963).

[19] W. J. Galloway, Community Noise Exposure Resulting From Aircraft Operations, AMRL TR-73-106 (U.S. Air Force, November 1974).

[20] S. Fidell and G. Jones, "Effects of Cessation of Late-Night Flights on an Airport Community," Journal of Sound and Vibration, Vol 42, No. 4 (1975), pp 411-427.

[21] J. B. Ollerhead, "Variation of Community Response to Aircraft Noise With Time of Day," Noise Control Engineering, Vol 11, No. 2 (1978), pp 68-77.

[22] P. N. Borsky, "Sleep Interference and Annoyance by Aircraft Noise," Sound and Vibration (December 1976), pp 18-21.

[23] A. Wilson, Noise, Final Report (Committee on the Problem of Noise, Command 2056, H. M. Stationery Office, London 1963).

[24] Aircraft Noise and Sleep Disturbance, Note to Accompany a Presentation on a Preliminary Study Around Heathrow Airport for the Department of Trade, Civil Aviation Authority, DORA Communication 7815 (Directorate of Operational Research and Analysis of the Chief Scientist's Division, 1978).

finds that the annoyance per event remains relatively constant during different time periods of the day. This study also finds a much lower rate of reported awakenings by respondents as compared to the rates of awakening predicted by various laboratory studies.[25] A 1979 study found no nighttime or evening penalty either on a single event or on an L_{eq} basis.

Developed Data

As a part of CERL's survey, respondents were asked if they were generally home during the day, evenings, or night on weekdays and/or weekends. The general times of 1900, 2200, and 0700 hr were given to respondents as guidelines as to the boundaries of these time zones. Respondents home during a given time period were asked if they were bothered by each of the noise sources, and if so, how often they were bothered. They could respond: "every day," "several times a week," "several times a month," "once every few months," or "less often than that." They could also respond by (*don't know*); however, less than 1 percent of respondents replied in this fashion. Respondents who indicated they were bothered were asked how annoyed they were <u>for that time period</u> (i.e., day, evening, or night; weekday or weekend). Specifically, they were asked: "And in general, taking everything into consideration, how annoyed are you by noise from (*source*) during the (*time period*)?" Annoyance was judged on a five-point scale: extremely, very much, moderately, slightly, or not at all.

Initially, only weekday data were analyzed. Respondents were grouped according to the time periods in which they were usually at home. For example, the set of respondents usually at home days, evenings, and nights formed one group. A second group included respondents usually at home days and nights, but not evenings. A third group contained respondents at home evenings and nights, but not days. No other groupings had enough respondents to be statistically reliable. The set of respondents at home during all times formed the basic set for analysis; the other two groups were used to test for differences which might exist between the responses of people at home during all three time periods and of people at home only two of the three times.

Tables 15 through 19 list the basic data developed for the group of respondents at home during all three time periods. These tables analyze the frequency with which respondents were annoyed during each time period (i.e. day, evening, or night). Each cell of each table lists the number of respondents reporting a given frequency of annoyance (e.g. every day, several/week, etc.). Each cell of each table also contains the number of respondents within that cell who reported "high annoyance" to that frequency of annoyance <u>during that time period</u>. (In accordance with Schultz and others, "high annoyance" was defined to be those respondents choosing the top two annoyance responses out of the five-point scale described above; also see Chapter 4).[26] Each cell lists the percentage of respondents that were "highly annoyed" out of the

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[25] J. S. Lucas, et al., <u>Disturbance of Human Sleep by Subsonic Aircraft and Simulated Sonic Booms</u>, CR-1780 (National Aeronautics and Space Administration [NASA], 1971).

[26] Theodore J. Schultz, "Synthesis of Social Surveys and Noise Annoyance," <u>Journal of the Acoustical Society of America</u>, Vol. 64, No. 2 (August 1978), pp 377-406.

Table 15

Artillery (Respondents Usually Home Day, Evening, and Night During Weekdays)

Frequency of Being Bothered or Annoyed	DAYTIME			EVENING			NIGHT		
	Number Bothered	Number Highly Annoyed	Percent Highly Annoyed	Number Bothered	Number Highly Annoyed	Percent Highly Annoyed	Number Bothered	Number Highly Annoyed	Percent Highly Annoyed
Everyday	18	11	61	12	6	50	8	7	88
Several/week	47	24	51	21	13	62	20	14	70
Several/month	44	16	26	31	11	36	21	10	48
Once every few months	19	2	11	17	5	29	22	9	41
Total by time period	128	53	41	81	35	43	71	40	56
"Day/night" total	209	-	88	-	42		71	40	56

Table 16

Airplanes (Respondents Usually Home Day, Evening, and Night During Weekdays)

Frequency of Being Bothered or Annoyed	DAYTIME			EVENING			NIGHT		
	Number Bothered	Number Highly Annoyed	Percent Highly Annoyed	Number Bothered	Number Highly Annoyed	Percent Highly Annoyed	Number Bothered	Number Highly Annoyed	Percent Highly Annoyed
Everyday	56	32	57	25	10	40	14	11	78
Several/week	41	15	37	30	16	53	14	8	57
Several/month	14	2	14	13	3	23	14	3	21
Total by time period	111	49	44	68	29	43	42	22	52
"Day/night" total	179	-	78	-	44		42	22	52

Table 17

Helicopters (Respondents Usually Home Day, Evening, and Night During Weekdays)

Frequency of Being Bothered or Annoyed	DAYTIME Number Bothered	DAYTIME Number Highly Annoyed	DAYTIME Percent Highly Annoyed	EVENING Number Bothered	EVENING Number Highly Annoyed	EVENING Percent Highly Annoyed	NIGHT Number Bothered	NIGHT Number Highly Annoyed	NIGHT Percent Highly Annoyed
Everyday	72	42	58	29	19	66	16	14	88
Several/week	61	23	38	37	14	38	15	7	47
Several/month	19	2	10	15	5	33	13	4	31
Total by time period	152	67	44	81	38	47	44	25	57
"Day/night" total	233	-	105	45		44	25	57	

Table 18

Street Traffic (Respondents Usually Home Day, Evening, and Night During Weekdays)

Frequency of Being Bothered or Annoyed	DAYTIME Number Bothered	DAYTIME Number Highly Annoyed	DAYTIME Percent Highly Annoyed	EVENING Number Bothered	EVENING Number Highly Annoyed	EVENING Percent Highly Annoyed	NIGHT Number Bothered	NIGHT Number Highly Annoyed	NIGHT Percent Highly Annoyed
Everyday	51	30	59	43	27	63	18	14	78
Several/week	22	9	41	27	13	48	21	12	57
Several/month	3	2	67	8	3	37	10	3	30
Total by time period	76	41	54	74	43	58	49	29	59
"Day/night" total	154	-	84	-	55		49	29	59

Table 19

Children and Pets (Respondents Usually Home Day, Evening, and Night During Weekdays)

Frequency of Being Bothered or Annoyed	DAYTIME			EVENING			NIGHT		
	Number Bothered	Number Highly Annoyed	Percent Highly Annoyed	Number Bothered	Number Highly Annoyed	Percent Highly Annoyed	Number Bothered	Number Highly Annoyed	Percent Highly Annoyed
Everyday	52	34	65	36	29	80	37	33	89
Several/week	24	8	33	23	17	52	36	18	50
Several/month	5	1	20	9	3	33	14	7	50
Total by time period	81	43	53	68	44	64	87	58	67
"Day/night" total	149	-	87	-	58	87	58	67	

total number of respondents in the cell. For example, in Table 15, 18 respondents reported being annoyed every day during daytime by artillery and 11 expressed high annoyance -- a total of 67 percent of the 18. At the bottom of each column in each table the number of respondents are totaled and a new percentage calculated. In addition, the total number of respondents for day and evening are added together and this percentage calculated.

Table 15 (artillery noise) includes data for a frequency of occurrence of "once every few months." The other four tables terminate with a frequency of occurrence of "several per month." This practice was followed because it had been shown (Chapter 4) that the integration period for human response extends down to "once every few months" for blast noise, and because substantial community annoyance exists even for this low frequency of occurrence. For other noise sources, annoyance effectively terminates when occurrences drop much below "several per month" (Chapter 4).

For comparison, the method outlined above was used to analyze data about respondents at home only during the day and night and for respondents at home only during the evening and night. Again the numbers of respondents were totaled across the various possible frequencies of occurrence. Table 20 compares (by noise source) the daytime and nighttime percentages calculated for respondents at home during the day, evening, and night and for respondents at home only during the day and night. Table 21 does the same for the evening and nighttime periods for respondents at home during the day, evening, and night and for respondents at home only during the evening and night. These tables compare groups of respondents at home during only two of the time periods to the group of respondents at home during all three time periods. Specifically, for each noise source, they compare (1) the increase in annoyance for the same number of occurrences, and (2) the respondents' perception of the number of occurrences which are bothersome by night as compared to day or by night as compared to evening (the comparisons are between the percentage pair for each source -- column 4 for number of occurrences and column 9 for annoyance). There is an especially close comparison between the two groups: those at home during the day, evening, and night; and those at home only during the evening and night. While the comparison is not quite as good between the group at home only during the day and night as compared to the group at home during the day, evening, and night, the group at home only during the day and night is rather small (seven to 25 per cell) and so a good comparison should not be expected. For this reason, the results calculated from the day/nighttime group data are less reliable than the results calculated from the evening/nighttime group data which had 57 to 113 respondents per cell.

In an earlier question in the survey, respondents were asked: (1) how often (in general) they heard (in contrast to being bothered) a given source, (2) how loud they perceived the source to be, and (3) how annoyed they were overall. The possible responses for frequencies of occurrence and degrees of annoyance were as outlined above. Within the three groups of respondents, comparisons were made to the percentages of respondents within a grouping indicating high annoyance for the same frequencies of occurrence. Every effort was made to find any type of difference either between noise sources, between groupings, or otherwise indicating variation from one frequency of occurrence to another, since such variation would indicate that the method used in Tables 15 through 19 was not a valid procedure (i.e., adding the total numbers of respondents in the column). No differences of any kind could be

Table 20

Comparison of Responses for Respondents Home All Times (DEN) With Responses for Respondents Hone Only Daytime and Nighttime But Not Evenings (DN) Weekday Data

		Number Bothered			Number Highly Annoyed		Percent Highly Annoyed		
Source	Group	Day	Night	Ratio "Day/Night"	Day	Night	Day	Night	Ratio "Night/Day"
Artillery	DEN	128	71	1.80	53	40	41	56	1.37
	DN	21	12	1.75	7	7	33	58	1.76
Airplanes	DEN	111	42	2.64	49	22	44	52	1.18
	DN	21	7	3.00	8	7	38	100	2.63
Helicopters	DEN	152	44	3.45	67	25	44	57	1.30
	DN	25	9	2.78	12	4	48	44	0.92
Traffic	DEN	76	49	1.55	41	29	54	59	1.09
	DN	12	10	1.20	6	8	50	80	1.60
Children and Pets	DEN	81	87	0.93	43	58	53	67	1.26
	DN	12	16	0.75	8	13	67	81	1.21

Table 21

Comparison of Responses for Respondents Home All Times (DEN) With Responses for Respondents Home Only Evenings and Nighttime, But Not Daytime (EN) Weekday Data

		Number Bothered			Number Highly Annoyed		Percent Highly Annoyed		
Source	Group	Evening	Night	Ratio "Evening/Night"	Evening	Night	Evening	Night	Ratio "Evening/Day"
Artillery	DEN	81	71	1.14	35	40	43	56	1.30
	EN	111	82	1.35	47	39	42	47	1.12
Airplanes	DEN	68	42	1.62	29	22	43	52	1.21
	EN	113	73	1.55	46	46	40	63	1.58
Helicopters	DEN	81	44	1.84	38	25	47	57	1.21
	EN	105	57	1.84	54	32	51	56	1.10
Traffic	DEN	74	49	1.51	43	29	58	59	1.02
	EN	104	70	1.48	59	43	57	61	1.07
Children and Pets	DEN	68	87	0.78	44	58	64	67	1.05
	EN	112	101	1.11	57	63	51	62	1.21

determined. Indeed, the only factor which did appear is the one already noted which indicates that the blast noise grouping needs to include the frequency of occurrence of "once every few months." Because no other differences of any kind could be discovered, this analysis has not been included for the sake of brevity.

Thus, it was concluded that (1) data could be distilled by adding the number of respondents in each column (as indicated above), and (2) no significant differences existed in terms of the responses to these questions for respondents at home during the day, evening, and night and for respondents at home only during the day and night or only during the evening and night.

As a further source of data, weekend responses were also analyzed. Unlike the weekday data analysis, only the group composed of respondents normally at home during the day, evening, and night on weekends was large enough to analyze and obtain reliable results. These data and results are summarized in Table 22. This table analyzes the three time periods separately (day, evening, and night) and also gives the combined results for the day/evening period.

Table 23 further compares the various respondent groups. It shows the basic percentage of ""highly annoyed" respondents in each group for a given noise source category, the group size, and the response to the same questions by the remainder of the respondents. The data in this table show that, of the three weekday response groups, the group at home during the day, evening, and night had most nearly the same response as given by the respondents overall. It also shows that the two other groups (day/night and evening/night) exhibit slightly higher response rates than do the day/evening/night group and the respondents overall. Langdon has reported on similar results in research by Aubru; that is, greater overall annoyance for respondent groups at home part of the day rather than the whole day.[27] Respondents usually at home all times on weekends, as a group, also compare favorably with the respondents overall, but the responses are somewhat higher than for the weekday group. Thus, the groups usually at home at all times either during the week or on weekends both appear to be appropriate groups for use in analyzing and quantifying a nighttime or evening penalty. This result simplifies the analysis given below, since only respondents normally at home days, evenings, and nights need be used. By the above analysis, comparability of these groups with the respondents overall and with groups at home less often is indicated.

Analysis

A time period penalty can be based on the combination of two possible factors:

1. The percentage of respondents indicating high annoyance increases for a given frequency of being annoyed during one time period as compared to another.

[27]A. Alexander, F. J. Langdon, et al., "The Problem of Measuring the Effects of Traffic Noise," Road Traffic Noise (John Wiley & Sons, Halstead Press, 1975), p 48.

Table 22

Comparison of Responses for Respondents Home at All Times on Weekends

Source	Number Bothered				Percent Highly Annoyed			
	Day	Evening	Day Plus Evening	Night	Day	Evening	Day Plus Evening	Night
Artillery	160	143	303	130	47	50	48	49
Airplanes	140	120	260	88	46	53	49	56
Helicopters	147	130	277	87	59	58	58	65
Traffic	169	194	363	150	57	59	58	61
Children and Pets	150	173	323	183	57	60	58	62

Table 23

Comparison of Respondent Group Size and Overall Percent of "Highly Annoyed"

Group/Source	Weekdays			Weekend DEN	Weekend DEN, Without Those Also Weekday DEN	Weekend, DEN Without Those Also Weekday EN	All Respondents
	DEN	DN	EN				
Group Size	651	105	723	1432	863	805	2147
Artillery	9.2	11.4	11.9	11.1	11.6	10.3	9.6
Street Traffic	8.9	9.5	12.7	10.8	11.9	9.7	9.6
Airplanes	3.7	10.5	11.1	9.1	10.4	7.6	7.8
Helicopters	10.4	16.2	12.7	12.2	10.4	11.2	10.5
Children and Dogs	11.8	14.3	13.6	12.2	12.5	11.7	10.7

2. For a given occurrence of a set number of events, respondents are bothered by a higher percentage of these events during one time period than during another.

A decibel number can be ascribed to factor 1 by means of the Schultz curve (Figure 8). For example, were the percentage of high annoyance to double from one period to the next, the Schultz curve could be examined and the decibel change (at a given DNL level) found that must be present if the percent of respondents indicating high annoyance is doubled. This number is, of course, a variable depending upon the DNL level chosen as the starting point. For this analysis, DNL-65 and DNL-75 were chosen as starting points; the average of the two resulting answers was used as the decibel number. Typically, there is less than 1/2 dB difference between these two values to average, and so this averaging has a small effect. While use of the Schultz curve in this fashion is somewhat speculative, the actual factors calculated are small (0 to 3 dB), and it is really the second factor (addressed below) which is the major contributor to the penalties.

The second factor can be addressed by comparing the known physical frequency of occurrence ratio between one time period and the other to the repondent-reported ratio of the frequency of annoying events from one time period to the other. For example, respondents may be bothered by twice as many events during the day as during the night. If, however, there are 10 times as many actual occurrences during the day as during the night, then respondents (on an equal-number-of-occurrence basis) are being bothered by one-fifth as many of the available events during the day as during the night. On a 10 log basis, this would indicate that a penalty of 7 dB must be applied to events during the night.

Comparison (separately for weekdays and weekends) of the data during the day and during the evening for respondents normally at home days, evenings, and nights shows no significant differences between day and evening for either the weekday or the weekend group. These data indicate that the annoyance rate does not change between daytime and evenings. It may be that events are noticed more during the evening than during the day, thus indicating an evening penalty; however, there are no physical data to either confirm or refute this assertion.

In order to concentrate on just a nighttime penalty, the combined responses for daytime and evening ("overall" daytime) were compared to nighttime for respondents at home during the day, evening, and night (Table 24). This table uses the summed responses from the day and evening group and compares them to the nighttime responses. It does indicate the existence of a nighttime penalty. First, per occurrence there is a higher percentage of annoyance during the night than during the day. Second, for a given physical rate of occurrence, a higher percentage of events are shown to be more bothersome or annoying during the night than during the day (Table 25). The day/night ratio of bothersome events in Table 25 is used to show this result in Table 26.

Table 27 shows the calculation of the actual decibel nighttime penalty. This penalty is calculated using the Schultz curve and the actual frequency of occurrence ratio between day and night. For example, it is known that there were 6.5 times as many blast noise events during the day as during the night.

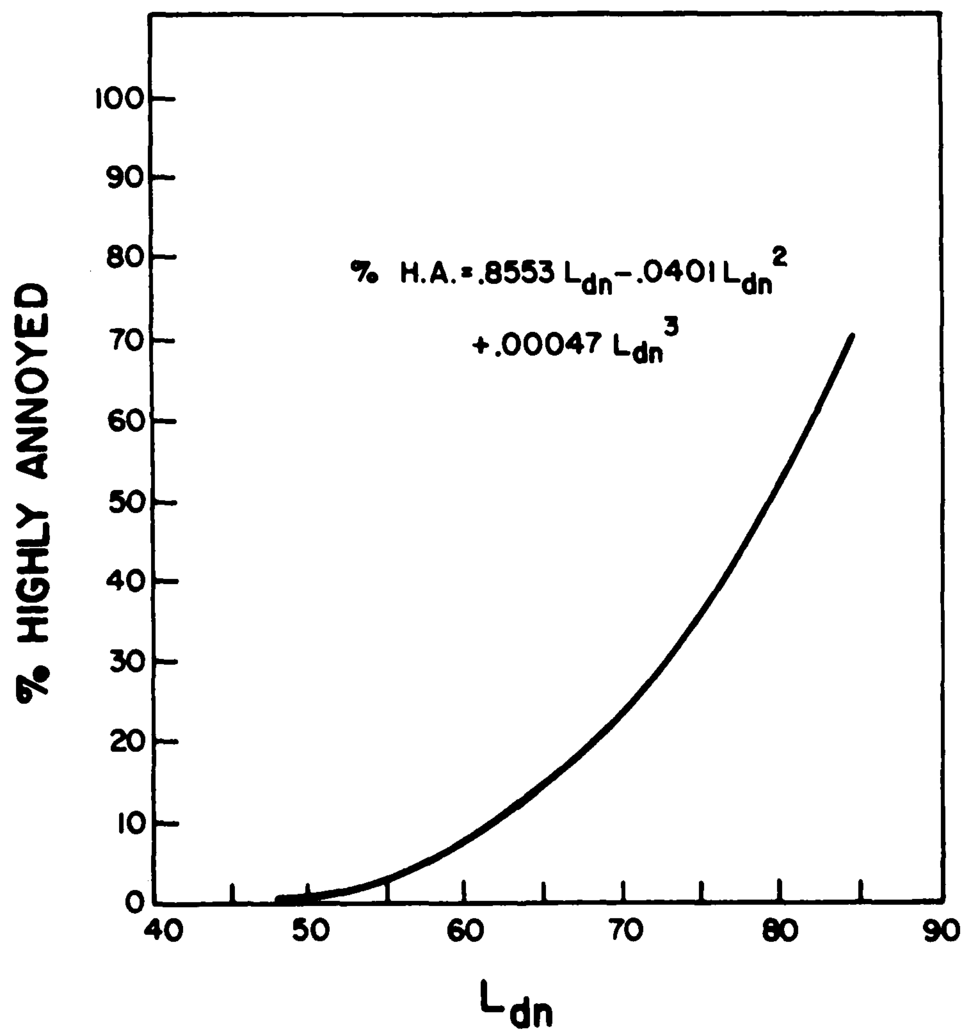

Figure 8. The Schultz curve--a synthesis of the results from attitudinal surveys worldwide (from Theodore J. Schultz, "Synthesis of Social Surveys and Noise Annoyance; Journal of the Acoustical Society of America, Vol. 64, No. 2 [August 1970], pp 377-406).

Table 24

Comparison of Responses for Respondents Home All Times (Weekdays vs Weekends)

		Number Bothered			Number Highly Annoyed		Percent Highly Annoyed		
Source	Group	Day Plus Evening	Night	Ratio (Day Plus Evening)/ Night	Day Plus Evening	Night	Day Plus Evening	Night	Ratio "Night/Day" (Plus Evening)
Artillery	DAY	209	71	2.94	88	40	42	56	1.33
	END	303	130	2.33	146	64	48	49	1.02
Airplanes	DAY	179	42	4.26	78	22	44	52	1.18
	END	260	88	2.95	128	49	49	56	1.14
Helicopters	DAY	233	44	5.29	105	25	45	57	1.27
	END	277	87	3.18	161	57	58	65	1.12
Traffic	DAY	154	49	3.14	84	29	55	59	1.07
	END	363	150	2.42	212	91	58	61	1.05
Children and Pets	DAY	149	87	1.71	87	58	58	67	1.16
	END	323	183	1.76	188	114	58	62	1.07

Table 25

Calculation of Nighttime Penalties

Source	Group	Reported Frequency Of Being Bothered; Ratio	Actual Ratio Of Occurrence	Ratio of Daytime Events Missed Relative to Night	dB Value	Ratio Increase in Highly Annoyed %	dB[1] Value	Nighttime Penalty
Artillery	Weekday	2.9	6.5[2]	2.2	3.5	1.33	3.5-	7.0
	Weekend	2.3	15.0	6.5	8.1	1.02	0+	8.1
Airplanes	Weekday	4.3	10[3]	2.3	3.7	1.18	2	5.7
	Weekend	3.0	13	4.3	6.3	1.14	1.5	7.9
Helicopters	Weekday	5.3	24[3]	4.5	6.5	1.27	3	9.6
	Weekend	3.2	24	7.5	8.8	1.12	1.5	10.3
Traffic	Weekday	3.1	12 - 20[4]	4 - 7	6 - 8	1.07	1	7 - 9
	Weekend	2.4	12 - 20	5 - 8	7 - 9	1.05	1	8 - 10
Children and Pets	Weekday	1.7	10 - 20[5]	6 - 12	8 - 11	1.16	2	10 - 13
	Weekend	1.8	10 - 20	6 - 11	8 - 11	1.07	1	9 - 12

1 From "Schultz" curve
2 Installation records
3 Records -- airfields
4 State Highway Department estimate
5 CERL estimate

Table 26

Daytime vs Nighttime Annoyance to Impulse Noise by Noise Zone

LDN Zone		Day Plus Evening: No. Home	Day Plus Evening: No. Highly Annoyed	Day Plus Evening: % Highly Annoyed	Night: No. Home	Night: No. Highly Annoyed	Night: % Highly[1] Annoyed
>60	Weekday	83	15	18	56	12	21
	Weekend	115	26	23	53	13	25
	Total [2]	645	127	20	386	86	22
≤ 60	Weekday	651	41	6	453	29	6
	Weekend	934	47	5	486	17	4
	Total[2]	5123	299	6	3237	179	6

1. Percent is always _____ (No. Highly Annoyed/No. Home) 100.

2. Total number is 5 X weekday number plus 2 X weekend number.

However, respondents reported being bothered by 2.9 as many events during the day as during the night. This ratio of 2.2 indicates a frequency of occurrence penalty of 3.5 dB (10 log [2.2] = 3.5). Again, for blast noise the percentage of people "highly annoyed" at night as compared to daytime for a given frequency of occurrence was 1.33. Using the Schultz curve at DNL-65 and DNL-75 indicates this to be an average factor of almost 3.5 dB. Adding these two factors equals the total nighttime annoyance penalty -- 7 dB.

Table 27

Predicted and Measured Noise Levels by Monitoring Site

Station	Days	Monitored ADNL	Monitored CDNL	Predicted During Monitoring (CDNL)	Predicted for Year Before Survey (CDNL)
1	11	63	103	63	66
2	84	57	88	67	64
3	34	56	70	68	64
4	81	59	73	69	66
5	81	56	46	61	58
6	12	64	49	60	58
7	78	64	49	60	58
8	44	60	42	59	55
9	42	58	49	61	59
10	34	56	53	64	62
11	26	58	58	59	57
12	12	62	51	57	55
13	28	58	54	64	61
14	33	59	55	60	58
15		72	All Aircraft Noise		
16	80	58	61	58	55
17		61	All Aircraft Noise		

Comparison With Previous Results

At first glance, the results given above are somewhat at odds with previous work. However, they lie within a pattern which emerges from these other studies. On one point, all the studies agree: the annoyance per bothersome event changes little between the different time periods. This means that bothersome events which are noticed and occur during the night or evening are little or no more annoying than are bothersome events which are noticed and occur during the day.

The second point is where the confusion arises: how often respondents notice and are bothered by aircraft flyovers.

CERL's results indicate a substantial decibel nighttime penalty in an area where there are infrequent nighttime flights. These results are quite consistent with the results of Ollerhead, who found a relatively large rate of disturbance at night as compared to evening and day in respondent groups subjected to fewer than three events per night. As data are drawn from nearer to the busy flight tracks, Ollerhead shows that it takes about 20 to 25 events per night to elicit greater response rates than he finds with the less than three events per night group.

This apparent discrepancy between areas with frequent or infrequent flights may come about because residents in the vicinity of large commercial airports, for which there are no nighttime controls, either grow used to falling asleep and sleeping through aircraft flyovers, or choose to move away from these noisy nighttime areas.

In contrast to speech or communications interference (which goes from "very poor" to "very good" within a small decibel range) effects of noise on falling asleep and being awakened are shown by laboratory studies to occur over a relatively larger decibel range. Therefore, while everyone experiences speech interference, only some subset experiences sleep interference.

As a result, surveys done near Los Angeles International Airport, John F. Kennedy International Airport, or Heathrow Airport show that people sleep through the noise at night, do not notice it to a great extent, and wake up far less frequently than predicted by laboratory studies. As a result, this self-selected or self-adapted population does not notice and is not bothered more frequently during the night as compared to during the day (for an equal number of available events). In contrast, in areas where nighttime fixed-wing aircraft flyovers are infrequent, this natural selection and adaptation does not occur.

CERL found that the frequency of observation of bothersome events increases during the night for all five source categories. Table 25 shows that this is the larger of the two components of the total time period penalty. This factor shows that respondents find a smaller percentage of available daytime events to be bothersome compared to the percentage of available nighttime events which are found bothersome. In essence, respondents notice and are bothered by a higher percent of available events during the night than during the day. For example, Table 25 shows that the ratio of noticed nighttime events relative to daytime events for helicopters during weekdays is 4.5. This factor of 4.5 defines the comparison between day and night. If, for example, respondents are bothered by one in every two events at night, then they are bothered by one in every nine events during the day; the ratio of 2 to 9 being 4.5. On a decibel basis, the ratio of 4.5 implies a 6.5 dB penalty.

An Alternate Analysis

CERL has developed a computerized model for predicting CDNL contours based on the operations at Army installations.[28] This program operates in a fashion analogous to other noise contouring programs, but is designed to implement the National Academy of Science's recommended procedures for

[28] V. Pawlowska and L. Little, The Blast Noise Prediction Program: User Reference Manual, Interim Report N-75/ADA074050 (CERL, August 1979).

assessing impulse noise.[29] Basically, the National Academy of Science procedure uses C-weighting and predicts a CDNL, including a 10-dB nighttime penalty. This formulation uses a threshold which discards single event sound-exposure levels that are less than 85 dB during the daytime and less than 75 dB at night. As options, contours can be produced for night only or for day only, and the threshold can be adjusted up or down.

CERL used this program to analyze day only and night only data; the thresholds were adjusted downward such that all audible events were included. The results showed that the night only contours (with a 10-dB penalty) are typically 0 to 2 dB greater than the day only contours in areas off-installation where the CDNL value is in the range of 50 to 70 dB.

The off-installation impulse noise survey data were analyzed by CDNL zone and time period. Table 26 lists these results for the 60 to 70 dB and the 50 to 60 dB zones. The data are shown (1) separately for weekdays, weekends, and all times, and (2) separately for daytime (day plus evening), and nighttime. The daytime data were developed by adding the total responses of those respondents indicating that they were normally at home during the day to the total for respondents indicating that they were normally at home during the evening. For these same two time groupings, the numbers of respondents in each group indicating high annoyance were summed. The percent "highly annoyed" was calculated from these two sums. The contour results, however, are based on the average day -- a reflection both of weekdays and weekends. To combine the weekday and weekend data without too heavily weighting the weekend, the weekday totals were multiplied by 5 and added to the weekend totals multiplied by 2. These overall sums were then used to again calculate the percentage of respondents "highly annoyed." The overall results show a slight increase in the percent of respondents "highly annoyed" at night as compared to the day for the higher noise zones; there was no increase for the lower noise zones. These results are consistent with the overall analysis given in this chapter.

Since the annoyance rate was the same during daytime and nighttime, it was appropriate to ask: "What nighttime penalty must be incorporated into the DNL formulation such that the daytime and nighttime contours are both about the same in size and shape?" From CERL's contour analysis, it is clear that a nighttime penalty on the order of 9 dB is required to establish this equality between daytime and nighttime. Thus, about the same nighttime penalty for impulse noise was developed as given in Table 25 and its associated discussion (p).

Conclusions

1. CERL's results clearly demonstrate the existence of a nighttime penalty (relative to day plus evening) which is on the order of 7 to 10 dB. The annoyance rate per noticed, bothersome event grows slightly during the night. For most sources, the frequency of observation of bothersome events is the primary factor contributing to the nighttime penalty.

[29] Guidelines for Preparing Environmental Impact Statements on Noise, CHABA, ADA044384 (National Academy of Science, 1977).

2. The annoyance rate per noticed, bothersome event does not appear to change greatly between day and evening. Not much can be said about evening penalties, since the data do not exist which can be analyzed to obtain the frequency of observation of bothersome events. Thus, the total penalty, if it exists, cannot be developed or verified from this analysis.

3. Comparisons among the five types of sources fit expectations. The two impulse sources -- artillery and helicopters -- exhibit the largest, although only slightly larger, annoyance rate penalties. For these sources, and especially for artillery, sleep disruption is a greater factor than speech interference, and so, the annoyance rate caused by this factor should be expected to rise during the night. The larger ratios for daytime events relative to nighttime for the traffic and children sources indicate that these sources "blend in" during the day and are noticed more frequently during the otherwise quieter nighttime period.

4. Von Gierke and others have indicated that the exterior background noise level drops by 10 dB or more during the night in most communities, and that reduced activity inside homes contributes to the general lowering of noise levels there.[30] These two factors combine to make intruding sounds more noticeable. CERL's results confirm these statements. Except for populations which have either adapted to or moved away from extremely excessive nighttime noise-impacted environments, people notice and are bothered more frequently (for a given number of available events) during the night than during the day. This factor, along with a small increase in annoyance per event during the night as compared with during the day, indicates an overall nighttime penalty on the order of 7 to 10 dB.

A word of caution is in order. Sounds may be noticed more at night because the sound propagates better at night and the received stimuli are actually louder. To this extent, predictive models which both include a nighttime penalty and also account for enhanced sound propagation at night may actually be "double counting" the nighttime penalty.

[30] H. E. Von Gierke, "Noise -- How Much Is Too Much?" Noise Control Engineering, Vol. 5, No. 1 (1975), pp 24-34; and W. A. Rosenbligh and K. N. Steven, et al., Handbook of Acoustic Noise Control, Vol 2, WADC TR-52-204, BBN (U.S. Air Force, 1953).

6 MONITORING RESULTS

Extensive 24-hour monitoring was performed in the vicinity of Fort Bragg. CERL's noise monitoring equipment was placed at 17 sites; the number of complete 24-hour days of monitoring at these sites ranged from four to 67 with 27 being a typical value. (Figure 9 shows noise contours for the study area for the year preceding the survey.) Extensive testing and checking was done to eliminate all but blast noise from the C-weighted data. Wind meters helped minimize the effects of noise generated by wind at the microphone; i.e., the monitors were turned off when the winds increased above about 18 kilometers per hour. Whenever the monitors went above the preset threshold of 105 dB peak level (95 dB at night), an analog tape recorder and a special digital timer were turned on. If the wind threshold signal came on at any time during this time period, the data in that 6-minute block were discarded. If the threshold was exceeded for more than 2 seconds, then a technician listened to the analog tape to determine if the signal was caused by impulses or some other source such as an aircraft or helicopter. If any other type of source could be detected on the analog tape, then this 6-minute block of data was also discarded. Thus, the only data included was that for which (1) the wind threshold was not triggered, (2) no other source could be heard and/or the event was less than 2 seconds in duration.

Figure 9 shows the generalized outline of the Fort Bragg study area. Overlaid on this outline are predicted CDNL contours for the year before the survey. Also shown are 15 of the 17 monitoring sites (the other two were near airfields and measured only aircraft noise). This figure also indicates generalized land areas, grouped by their geographic area and noise zone. On- and off-installation respondents in the same general area and noise zone are grouped separately. Table 27 gives the predicted and measured noise levels by monitoring site.

Based on the data in Table 27, Table 28 gives the estimated CDNL noise level by area (indicated in Figure 9) for the year preceding the survey. These yearly predictions were altered based on the results of the monitoring study. In the high noise zones, 4 dB was added to the contour values, reflecting the results of nearby on-installation monitoring. It should be noted that Sites 1 and 2 measured especially high because units assigned firing points within a kilometer of these monitors actually fired from very close to the monitors, causing the extreme departure from prediction. In the areas to the east, the monitored results ranged from 11 dB below prediction to 3 dB above prediction. As generalized "correction" values, 5 dB has been subtracted from predicted values nearer to firing points (2 to 5 miles [3.2 to 8.0 kilometers] to nearest point), and 3 dB has been subtracted from the predictions for the more distant points.

For the sites which generally measured close to prediction in the east, the predominant noise all came in one to several days, each day characterized by a period of high noise caused by focus conditions for the sound. In contrast, monitor sites 5, 6, 8, and 9 (to the south and west) exhibited no such focus days. As a consequence, Table 29 indicates a much larger difference for these locations between the computer-predicted value and the estimated value. It should be noted that if monitoring had been performed in other seasons -- i.e., when wind shears and inversions are somewhat different -- loud days

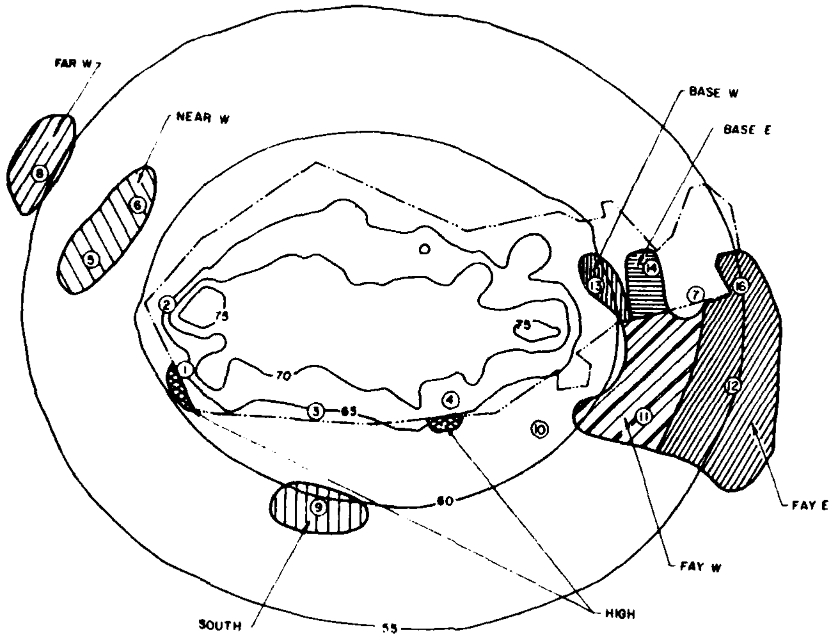

Figure 9. Predicted CDNL contours, monitor sites; and predominant respondent groups in the study area.

Table 28

Estimated CDNL Noise Level by Area for Year Before Survey

Area	CDNL	Difference from Predicted Countour (dB)
HIGH	68	+4
FAY W	54	-5
FAY E	52	-3
BASE W	56	-5
BASE E	53	-5
BASE TOTAL	55	-5
SOUTH	49	-10
NEAR W	46	-12
FAR W	40	-15

might also have been measured to the south and west. However, no data exist to confirm or deny this assertion.

Table 29

Loudness Judgments

Area	Much More	More	Same	Less	Much Less	Never Hear
HIGH	37.5	16.71	18.1	8.3	0	19.4
FAY W	14.9	15.5	12.6	13.8	1.7	40.2
FAY E	10.9	15.8	15.7	11.5	3.2	42.3
BASE W	17.1	25.4	12.2	11.2	3.4	30.7
BASE E	13.2	12.7	13.2	5.9	2.9	51.2
BASE TOTAL	15.1	19.0	12.7	8.5	3.2	41.0
SOUTH	17.6	27.0	4.1	6.8	1.4	43.2
NEAR W	12.0	14.7	18.3	19.5	6.0	29.1
FAR W	0	7.1	4.8	26.2	4.8	57.1

Measured results from CERL's monitoring were compared to predicted levels (Table 27). For each site, predictions were made only for those days during which monitoring was done. This chapter analyzes some of the deviations between those predicted and measured data.

The differences between prediction and measurement seem to follow a trend. Sites 1 and 2, which were very close to firing points, measured well above prediction. Sites 3 and 4, which were about 1 mile (1.6 kilometers) from the nearest firing point, measured 2 to 4 dB above prediction. Sites to the east (both on and off the installation) generally measured somewhat below or at the predicted level; and sites to the south and west measured far below the predicted levels.

The very high readings at Sites 1 and 2 are believed to have been caused by Marine units which fired from other than the locations they listed. Large percentage errors in small distances, and firing points closer than 300 meters to monitors, are beyond the scope of CERL's computerized prediction program. In the future, it is recommended that monitoring be done further from firing points because nothing can be learned when these differences do occur and no residences or other sensitive land uses are near these on-installation monitoring locations.

Sites 3 and 4 generally agree well with predictions; the slight increase in the measured values over prediction may well be caused by the predominant wind direction, which in the Fort Bragg area is out of the north or northeast.

The monitor locations to the east, both on and off the installation, generally operated and recorded the data as predicted. That is, for those sites which agree with prediction, most of the sound energy comes during 1 to 2 hours over a few days when focus conditions existed that would cause high noise levels. During other times, the monitors measured much lower noise levels. These results are in accordance with the statistical nature of sound propagation resulting from the extreme variations caused by weather conditions. The sites to the east which measured well below prediction (5 to 10 dB) apparently did so largely because the monitoring was not performed for a long enough time -- even though 5 months was spent at this effort. For example, the on-installation community response in the Base W area is much greater than in the Base E area -- and the computer predicted about 3 dB more noise -- but the measured levels at Site 13 (Base W) are 1 dB below the measured level at Site 14 (Base E). Similarly, Site 10 measures less than Site 11, and Site 7 measures much less than Site 16.

Given that (1) the negative attitudes towards the noise environment decrease with distance from the installation and (2) the prediction levels decrease with distance from the installation, one hypothesis to explain these reversals is that the number of days monitored is insufficient and that these measured values are actually correct within statistical confidence bounds which can be attached to them. CERL is studying temporal sampling requirements for noise monitoring and the temporal sampling requirements dictated solely by operational variations, on a day-to-day basis, using the data developed at Fort Bragg (see Appendix F). Preliminary analysis of data gathered in the vicinity of airports indicate that for airports, 30 to 60 days of continuous monitoring are required to develop data which lie within +2 to -3 dB of the true yearly DNL value with a 95 percent confidence. If blast data are twice as variable as aircraft data, then 4 to 8 months would be required for blast data measured to the same tolerance and confidence.

One must note that DNL is basically an energy measure. The +2 to -3 dB indicated above is ± 50 percent in energy. A next lower level, say ± 75 percent, implies +2.5 to -6 dB; and ±90 percent in energy implies about +3 to -10 dB. Thus, while the confidence band in the energy domain changes only a little, the range in decibels changes greatly. The data in Table 27 fit this trend -- only one station measured 3 dB above prediction, but several measured 10 dB or more below prediction. The only conclusion which can be reached at this time is that future monitoring should be performed at fixed locations over long periods of time; preferably 6 months to 1 year. The monitors should not be rotated on a weekly or any other basis, and should not be extremely close to firing points.

The areas to the west of the installation generally measured well below prediction, but unlike data from the eastern direction, the community response also indicates less problem than is predicted from just the computer contours. Unlike data from the east, no monitoring locations in the west ever measured high noise levels. These results seem to indicate that focus conditions in the Fort Bragg area are more common to the east than to the west.

To the south of the installation, there was only one monitor and only a relatively small number of completed questionnaires (75). The computer-predicted levels are fairly high, the community response is very high and the measured levels are very low. This data point remains somewhat a mystery.

7 A MODEL TO DESCRIBE COMMUNITY RESPONSE TO IMPULSE NOISE

Chapter 4 described how community annoyance grows as the amplitude of events and frequency of occurrence of events increase. Chapter 5 considered the existence of a quantitative value for nighttime and evening penalties. This chapter concentrates on examining various models to describe community response to impulse noise as a function of the noise predicted by that model. This chapter also describes and analyzes the type of activity disruption caused by impulse noise as compared to other forms of noise. This is done because overall annoyance to noise has often been generated as an index based on the various forms of activity disruption.

Chapter 4 results showed that the community response to impulse noise, when judged by the respondent's perception of loudness, grows in a fashion identical to the growth in community response to increases in fixed- or rotary-wing aircraft noise. This same analysis showed that the community response to blast noise grows with frequency of occurrence of events identically to the increases in community response with increase in frequency of occurrence of fixed- and rotary-wing aircraft, traffic, or neighborhood noises. That analysis indicated that there is no threshold below which impulse noises should be discarded as unimportant; however, the present National Academy of Science recommendations incorporate such a lower limit.

These results seem to indicate that if the equal energy hypothesis incorporated in the ADNL model for aircraft noise is appropriate, then the same model structure is also appropriate for impulse noise. However, it may be that the respondents' judgment of loudness does not correlate directly with the physical stimuli for blast noise in the same fashion as it does for aircraft noise. Therefore, the following analysis explores different threshold levels and the possibility of the existence of an impulse correction factor, since other researchers have suggested the existence of such a factor.[31]

As described in Chapter 4, respondents were asked to judge the loudness of the noise, the overall frequency of occurrence of the noise, and their overall annoyance to the noise (for those respondents overhearing the noise). These questions were asked for the five separate categories: impulse noise, rotary-wing aircraft, fixed-wing aircraft, vehicles, children and pets. This parallel presentation provides a context in which to examine impulse noise. Tables 29, 30, and 31 summarize the responses (by area) for impulse noise.

The data in Tables 29 and 30 show that both judged loudness and frequency of occurrence decrease as one gets further from the installation. Compare, for example, Fay E with Fay W, Base E with Base W, or Near W with Far W. Moreover, the responses from the Base Total area compare favorably with the responses from the Fay W area. The responses in the Base Total area are slightly higher, and according to Figure 9, should be since the Base Total area lies in a slightly higher noise zone. The level of responses from the South and Near W areas (as compared to other areas) seems to indicate that the

[31] K. D. Kryter, Possible Modifications to the Calculations of Perceived Noisiness, NASA CR-1636 (NASA August 1970).

monitored data (Tables 27 and 28) are low in these areas. Given the intermittent nature of enhanced propagation of blast noise, which varies with weather and season, it is possible that more extensive monitoring would have indicated substantially different measured levels.

Table 30

Frequency of Occurrence

Area	Everyday	Several Per Week	Several Per Month	Once Every Few Months	Less Often	Never Hear
HIGH	18.1	29.2	25.0	8.3	0	19.4
FAY W	5.2	14.9	21.8	14.4	2.3	40.2
FAY E	2.4	13.8	21.5	17.2	1.7	42.3
BASE W	9.8	25.9	23.9	8.8	1.0	30.7
BASE E	2.9	13.2	22.4	7.3	1.5	51.2
BASE TOTAL	6.3	19.5	23.2	8.0	1.2	41.0
SOUTH	8.1	21.6	17.6	8.1	0	43.2
NEAR W	2.0	13.1	27.9	24.7	1.6	29.1
FAR W	0	0	19.0	19.0	2.4	57.1

Table 31 shows the same trends seen in Tables 29 and 30, except for on-installation responses. On the installation, the annoyance levels are smaller than off the installation. In particular, in the Base Total area, the top three categories in Tables 29 and 30 are greater than for the Fay W area (and the noise is estimated in Table 28 to be slightly greater). However, the top three categories in Table 31 show that the overall annoyance in Base Total area lies below that of the Fay W area level. Since the top two categories, "extreme" and "very much," are used to form the high annoyance indicator, this change, 8 vs 13 percent, is found to be significant at the 0.05 level.

This difference is perhaps related to the expectations of respondents. On the installation they expect to hear blast noise, but off it they expect to leave their work behind. This is especially true since 43 percent of off-installation respondent households have at least one member working for the Government (this percentage does not include retired personnel). Because of the significant shift in on-installation judgment responses for annoyance as compared to off-installation judgment responses, only off-installation responses are used for most of the final analysis.

In addition to the questions dealing with loudness, frequency of occurrence, and overall annoyance, Question 34 asks: "Do you think people

Table 31

Overall Annoyance

Area	Extreme	Very Much	Moderate	Slight	Not at All	Never Hear
HIGH	18.1	12.5	23.6	11.1	15.3	19.4
FAY W	5.2	8.0	9.8	4.6	31.6	40.8
FAY E	3.5	4.9	9.7	4.6	34.1	42.5
BASE W	5.9	5.9	10.7	7.3	39.5	30.7
BASE E	2.4	2.4	8.8	7.3	25.9	51.7
BASE TOTAL	4.1	4.1	9.8	7.3	32.7	41.2
SOUTH	8.1	10.8	14.9	8.1	14.9	43.2
NEAR W	3.2	3.6	6.4	10.4	46.6	29.1
FAR W	0	0	4.8	11.9	26.2	57.1

Table 32

Percent Highly Annoyed; Those Who Feel They Should vs Should Not Complain About Noise From Government Facilities

Area	Group Size	% Should Complain	Highly Annoyed (Should Complain)	Highly Annoyed (Should Not Complain)	Overall Highly Annoyed	Adjusted Highly Annoyed
HIGH	72	51	45.9	14.3	30.6	33.9
FAY W	174	60	20.0	2.8	13.2	13.5
FAY E	919	62	11.8	2.8	8.4	8.4
BASE W	204	64	15.3	5.5	11.8	11.6
BASE E	204	68	7.2	0	4.8	4.5
BASE TOTAL	408	66	11.1	2.9	8.2	8.0
SOUTH	74	68	28.0	0	18.9	17.4
NEAR W	251	53	8.3	5.1	6.8	7.1
FAR W	42	53	0	0	0	0

around here ought to complain about the noise from Government facilities or operations if they find it annoying?" The possible answers were "yes" or "no." Table 32 shows, by area: (1) the group size, (2) the percentage of that group answering Question 34 in the affirmative, and (3) the percent indicating overall high annoyance (i.e., who responded either "extremely" or "very much" to the overall annoyance question dealing with artillery noise) as a function of whether Question 34 was answered affirmatively or negatively. These results show that whether the respondent thinks he ought to complain strongly influences his judgment on overall annoyance. The ratios shown in this table are about a factor of 4 between these two groups.

Table 32 also gives the overall percent "highly annoyed" within each area for the "yes" and "no" responses combined, and the overall percent "highly annoyed" which would have resulted for each group if 62 percent of each group had answered Question 34 in the affirmative. This allows for better comparison between the different areas, since the responses in the high area are otherwise probably about 10 percent low. Also, this 62 percent figure is more or less consistent with the sonic boom studies in Oklahoma City, where about 65 percent of respondents overall thought they should complain about Government facilities and 35 percent thought they should not.[32] The Oklahoma City study, of course, did not use data from respondents who thought they should not complain; it only used data from those who thought they should complain in its overall calculations and results. CERL considered the 62 percent common denominator arrangement in Table 32 a more reasonable representation of the overall community.

Activity Interference Data

A portion of the questionnaire contained 10 questions relating to activity interference and other factors thought to contribute to annoyance. These questions were:

1. Does noise ever wake you up or prevent you from falling asleep?

2. Does noise ever interfere with your listening to radio or TV?

3. Does noise ever interfere with conversation (either face to face or over the phone)?

4. Does noise ever interfere with activities out-of-doors around your home/apartment?

5. Does noise or vibration ever make your house rattle or shake?

6. Does noise ever startle you?

7. Does noise ever frighten you?

[32] P. N. Borsky, Community Reactions to Sonic Booms in the Oklahoma City Area, Vol. II: Data on Community Reactions and Interpretations, TR 65-37 (AMRL, 1965).

8. Does noise ever interfere with activities that require your care or concentration?

9. Does noise ever disturb your rest and relaxation in your home?

10. (If applicable) Does noise ever bother or disturb anyone else in the household?

For each of these 10, respondents who said these activities interfered with them were asked what noises caused interference and how often. The possible responses to the frequency of occurrence were "every day," "several times a week," "several times a month," "once every few months," "less often than that," and "don't know." Each respondent was asked, by source, how annoyed he was by that level of interference occurring that many times. For example, respondents were asked, "How annoyed are you by *(airplanes)* interfering with conversation *(several times a week)*? The possible responses were on the five-point scale -- the two end points were "extremely" and "not at all."

In the past, it has been the practice to base an overall annoyance index on a linear combination of the responses to a set of questions. For CERL's analysis, the responses to the 10 questions listed above were placed on a binary scale (rather than using the annoyance numbers as cardinal numbers ranging from 1 through 5) by defining respondents to be "highly annoyed" to a given factor if they chose either of the top two numerics on the five-point scale.

When these data were compared to those from respondents indicating overall high annoyance with that noise source, a high degree of redundancy and overlap between certain subsets of activity interferences were indicated. For example, a respondent "highly annoyed" by aircraft noise might also have problems with listening to the radio/TV, conversation face-to-face or over the phone (or both), and still have the same overall aircraft annoyance reaction. Similarly, a respondent "highly annoyed" by blast noise might indicate that the blast noise startled or frightened him (or both) and still have the same overall response. Again, the same can be said for the question relating to rest and relaxation as compared to the question relating to sleep. A respondent might choose one or the other (or both) and still have the same reaction. Thus, it was decided to merely tabulate (1) the respondents indicating high annoyance with a given factor by noise source category and (2) the number of those respondents indicating overall high annoyance. These data are in Table 33. This table shows that the primary problems with impulse noise are house rattles, startle, and fright. For airplanes and helicopters, speech interference is the major problem. Street traffic and neighborhood sources mainly interfere with sleep.

The data were examined to see if any of the activity interference factors were an indicator of whether a respondent would be "highly annoyed," or if any combination of these was a useful predictor of high annoyance. No such relation could be found. Rather, it appears that the number of factors found to be highly annoying is the best predictor of whether a respondent will be overall highly annoyed by that noise source category. Table 34 and Figure 10 illustrate these data by source category and number of factors generating high annoyance. For each source category, the percent of respondents rises as a function of the number of factors generating high annoyance until the point

Table 33

Number of Respondents Expressing High Annoyance to Indicated Factor by Noise Type

	Artillery	Street Traffic	Airplanes	Helicopters	Children/Pets
Sleep	105 (70)	118 (14)	103 (34)	80 (35)	181 (28)
Radio TV	56 (37)	82 (15)	139 (40)	168 (59)	39 (14)
Conversation	41 (36)	61 (11)	95 (29)	125 (44)	40 (8)
Outdoors	9 (8)	34 (3)	17 (5)	43 (20)	34 (5)
Rattles	350 (161)	11 (1)	89 (19)	106 (37)	2 (0)
Startle	200 (97)	55 (8)	42 (14)	44 (13)	22 (5)
Fright	112 (63)	40 (9)	39 (13)	37 (16)	16 (2)
Care/concentration	87 (55)	57 (10)	75 (24)	82 (36)	47 (13)
Rest/relaxation	131 (77)	109 (18)	100 (39)	122 (47)	119 (23)
Disturb other Household members	171 (85)	90 (11)	101 (29)	116 (39)	124 (25)

* Number in parentheses is the number of those respondents in that cell also expressing overall high annoyance to that noise type.

Table 34

Number of Percent of Respondents Expressing Overall High Annoyance as a Function of Number of Factors Which "Highly Annoyed" These Respondents

		1	2	3	4	5	6	7	8	9
Artillery	Total No.	183	97	61	49	44	20	8	7	6
	Total also Highly Annoyed	34	28	32	31	31	11	8	6	6
	% Highly Annoyed	19	29	52	63	70	55			
Street Traffic	Total No.	115	50	35	20	21	10	8	2	2
	Total also Highly Annoyed	44	28	21	12	19	8	7	2	2
	% Highly Annoyed	22	45	43	67	82	7			
Airplanes	Total No.	109	56	40	24	28	16	5	8	3
	Total also Highly Annoyed	24	25	21	16	23	12	4	5	2
	% Highly Annoyed	22	45	53	67	82	7			
Helicopters	Total No.	123	52	45	30	27	29	8	5	4
	Total also Highly Annoyed	39	21	33	18	21	24	7	5	4
	% Highly Annoyed	32	40	73	60	78	83			
Children/Pets	Total No.	137	82	36	27	14	5	1	0	0
	Total also Highly Annoyed	56	49	28	21	12	5	0	0	0
	% Highly Annoyed	41	60	78	78	86				

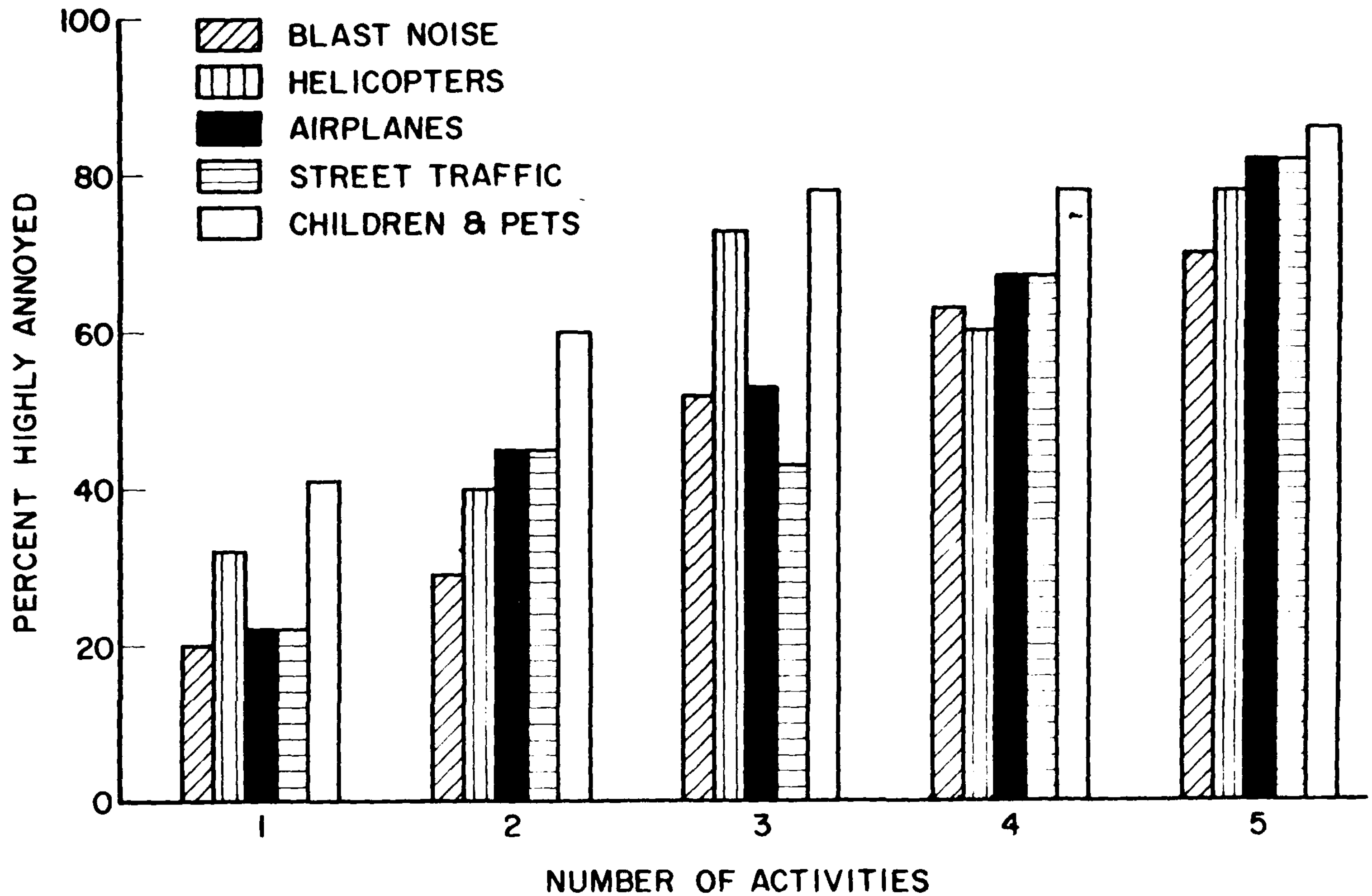

Figure 10. Percent overall "highly annoyed" by number of activity interferences causing high annoyance.

where 50 to 60 percent of respondents express high overall annoyance (usually three factors). By the time six or seven factors generate high annoyance, these few respondents almost universally indicate that they are "highly annoyed."

Alternative Data and Other Considerations

For blast noise, the data were compared to responses of those who owned their home vs those who rented. This comparison was performed only for those living off the military installation (see Table 28). No significant differences were found for the level of overall high annoyance for those who owned their homes as compared to those who rented. Areas were combined as shown in Table 35; again, there were no significant differences.

The data were also compared to responses for households with one or more members employed by the Government vs those with none. Again, no significant differences could be found in any area (Table 35).

As stated above, the current National Academy of Science procedure to assess community response to impulse noise uses C-weighting and predicts a CDNL. This CDNL includes a 10-dB nighttime penalty. This formulation discards single-event sound-exposure levels which are less than 85 dB during the daytime and less than 75 dB at night. Various variations and alternatives can be considered in addition to this basic procedure. For example, the threshold can be effectively eliminated by dropping it to 40 dB; the threshold can be kept constant both for day and night, rather than allowing the threshold to drop 10 dB at night; the threshold level can be changed to higher levels; and some form of impulse correction factor can be added based on the sound-exposure level of the event itself. Table 36 summarizes the basic data developed, and Table 37 lists the results, along with three variant means to formulate a CDNL. Table 36 includes, by area (1) the adjusted percent "highly annoyed" (from Table 32), (2) the estimated yearly CDNL (from Table 28), (3) the equivalent ADNL for the percent "highly annoyed" as taken from the Schultz relation, and (4) the difference in decibels between the latter two values. The equivalent ADNL was calculated from the Schultz relation by determining which ADNL would yield the given percent "highly annoyed." For example, an ADNL of 74 corresponds to about 34 percent of a population being described as "highly annoyed."

Table 37 summarizes the data for the base case (the presently recommended National Academy of Science procedure) and three variant cases. Case 2 raises the 85-dB threshold to 95 dB. Case 3 considers the imposition of an impulse correction factor in the formulation of the CDNL, and Case 4 eliminates any threshold or correction factor.

The impulse correction factor was formulated based on the results of the sonic boom studies by Borsky in the Oklahoma City area. Appendix G contains the basic formulation of this correction. Table G2 lists the CDNL and the percent "highly annoyed" calculated for the three distances and three survey periods (having different boom overpressures) in the Oklahoma City study. Based on the percent "highly annoyed," the Schultz function was used to define an equivalent ADNL level (Figure 11). The difference between the calculated CDNL and the equivalent ADNL is shown in Table G2. Since, in Oklahoma City,

Table 35

Comparison of Percents "Highly Annoyed"--Owners vs Renters and Government Worker in Household vs No Government Worker in Household

Area	Owner		Renter		With Government Worker		Without Government Worker	
	No. of Respondents	% Highly Annoyed	No. of Respondents	% Highly Annoyed	No. of Respondents	% Highly Annoyed	No. of Respondents	% Highly Annoyed
High	(46)	32	(24)	29	(25)	36	(47)	28
Fay W + South + Near W.	(454)	11	(222)	10	(265)	10	(418)	11
Far W + Fay E	(629)	9	(317)	6	(418)	8	(542)	8

Table 36

Difference Between CDNL and the Equivalent ADNL Calculated From the Percent "Highly Annoyed" Using the Schultz Relation

Area	% Highly Annoyed	Estimated CDNL	Equivalent ADNL	Difference
HIGH	33.9	68	74	6
FAY W	13.5	54	64	10
FAY E	8.4	52	60	8
SOUTH	17.4	49	66	17
NEAR W	7.1	46	58	12
FAR W	0	40	-	-

Table 37

Alternative C-weighted Day/Night Level Formulations

	Equivalent ALDN	Case 1 (Base)		Case 2 (95 dB)		Case 3 (Imp)		Case 4 (40 dB)	
		Value	Difference	Value	Difference	Value	Difference	Value	Difference
HIGH	74	68	6	66	8	73	1	68	6
FAY W	64	54	10	52	12	57	7	56	8
FAY E	60	52	8	49	11	55	5	55	5
SOUTH	66	49	17	47	19	52	14	50	16
NEAR W	58	46	12	44	14	49	9	48	10
FAR W	-	40	-	36	-	43	-	44	-

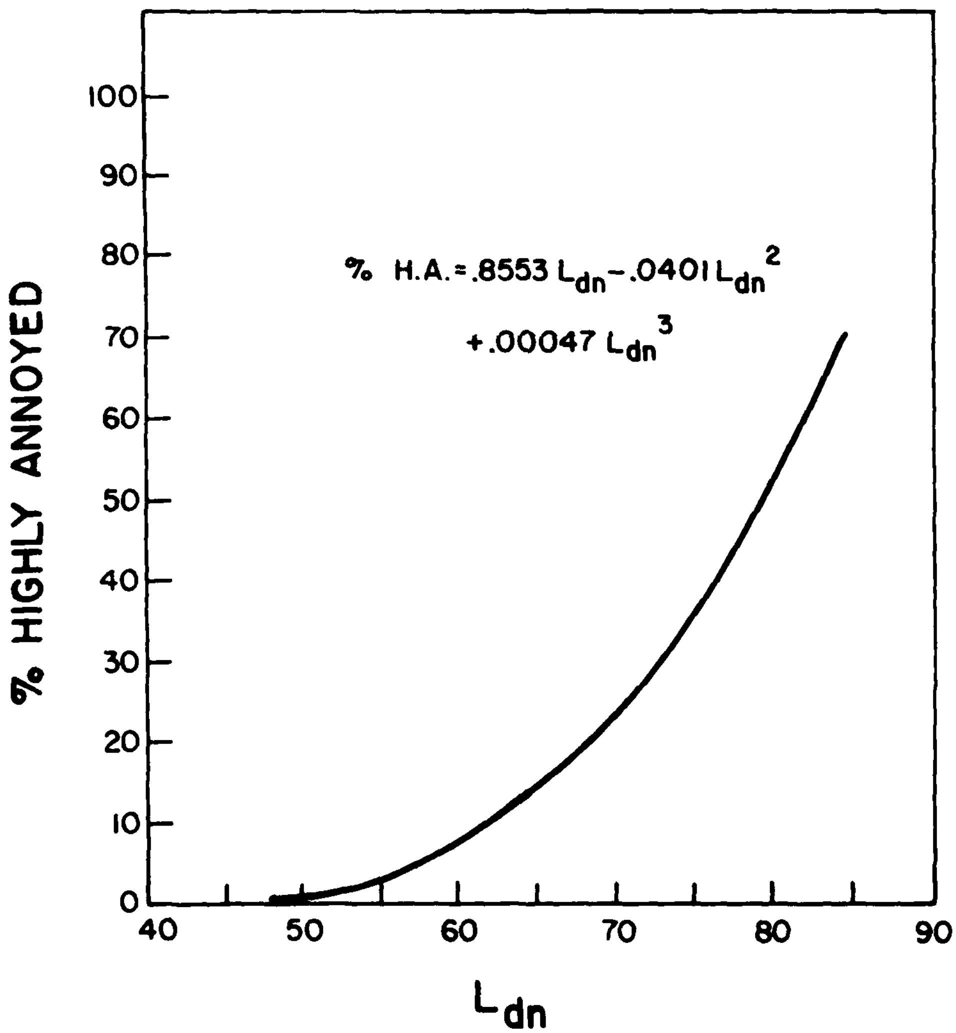

Figure 11. The Schultz relation for percent "highly annoyed" vs ADNL.

there were eight booms per day, all during daytime, the CDNL was reconverted back to a C-weighted sound-exposure level per event by adding about 40 dB to the CDNL values. These values are also shown in Table G2. Based on this table, an approximate piece-wise continuous correction function was developed:

If CSEL < 92.5 dB,
then $\overline{\text{C}}\text{SEL} = \text{CSEL}$.

If 92.5 dB < CSEL $\leq$ 102.5 dB, then
$\text{CSEL} = \text{CSEL} + (\overline{\text{C}}\text{SEL} - 92.5)$.

If CSEL > 102.5 dB, then
$\text{CSEL} = \text{CSEL} + 10$

where:

CSEL = C-weighted sound-exposure level.

Since house rattles were found to be the primary adverse factor in both the CERL and Oklahoma City studies, it is interesting to compare the responses to the house rattle question with the responses given earlier. Specifically, Table 38 gives the responses to the question which asks how frequently impulse noise caused the house to shake or rattle, and Table 39 gives the respondents' overall annoyance to the shaking and rattling. As with Tables 30 and 31, the respondents' overall judgment to blast noise obtained earlier in the survey, these data are given by geographic area. Table 38 shows that the frequency of occurrence of house rattles goes down as compared to the frequency of occurrence of hearing impulse noise (Table 30). In contrast, Table 39 shows that the annoyance to rattles goes up as compared to overall judgments of annoyance to impulse noise (Table 31).

As a further sensitivity test on the results, Figure 12 illustrates the percent "highly annoyed" (base-case analysis) vs the ranges of possible CDNL levels. One extreme is the computer prediction -- the other extreme is the full monitoring correction to the computer prediction (Tables 27 and 28). Figure 13 plots the midpoints of the ranges in Figure 12. Figure 14 plots the study values from Figure 12. In both Figures 13 and 14, a "best" fit of the Schultz curve to the data is to displace it by about 9 to 10 dB.

Comparison With Previous Results

In the Oklahoma City test, respondents were subjected to eight sonic booms per day (none during the night). The energy average peak levels of these booms in different noise zones and at different time periods ranged from 123 to 131 dB; the overall extremes were about 116 to 136 dB. In contrast, CERL's analysis used data from below the threshold of audibility up to about 145 dB.

As noted, the Borsky data only included responses from those who felt tney should complain about the noise from a Government activity or agency if it bothered them; these data were specifically addressed to the respondents' annoyance to "house rattles and shakes." These data, of course, represent the highest possible percentages, since CERL's data indicate that responses to

Table 38

Artillery Shakes/Rattles House -- Frequency of Occurrence

Area	Everyday	Several Per Week	Several Per Month	Once Every Few Months	Less Often	Never Occurs
HIGH	6.9	20.8	44.4	11.1	5.6	11.1
FAY W	0.6	13.8	24.7	19.5	4.6	36.8
FAY E	1.0	8.4	18.5	24.4	5.0	41.2
BASE W	5.9	16.6	30.2	20.0	1.5	25.9
BASE E	2.0	7.3	22.9	21.5	6.3	39.5
BASE TOTAL	3.9	12.0	26.6	20.7	3.9	32.7
SOUTH	2.7	16.2	24.3	21.6	4.1	27.0
NEAR W	0	4.4	13.9	41.4	6.8	30.3
FAR W	0	0	7.1	14.3	14.3	64.3

Table 39

Artillery Shakes/Rattles House -- Overall Annoyance

Area	Extreme	Very Much	Moderate	Slight	Not at All	Never Occurs
HIGH	25.0	13.9	27.8	13.9	8.3	11.1
FAY W	7.5	9.8	12.6	16.1	17.2	36.8
FAY E	8.2	5.8	17.0	12.4	15.1	41.2
BASE W	9.3	10.7	20.0	17.6	15.6	26.8
BASE E	6.8	7.3	18.0	13.2	15.6	39.0
BASE TOTAL	8.0	9.0	19.0	15.4	15.6	32.9
SOUTH	8.1	14.9	23.0	14.9	12.2	27.0
NEAR W	6.4	4.8	12.7	26.3	18.3	30.7
FAR W	0	2.4	2.4	14.3	16.7	64.3

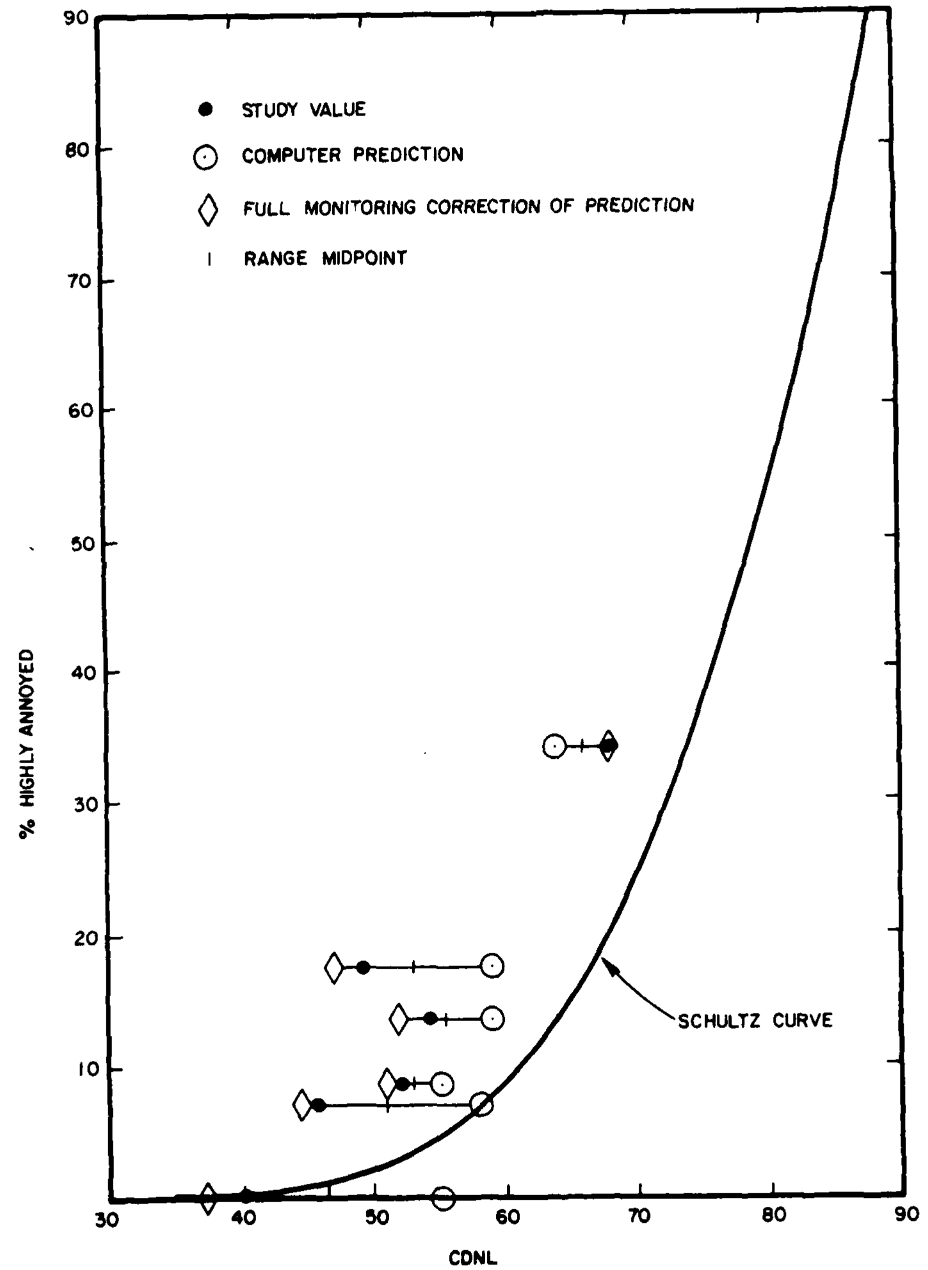

Figure 12. Percent "highly annoyed" vs CDNL for off-installation study areas; the ranges indicated show the computer-predicted values and the full monitoring correction to predicted values.

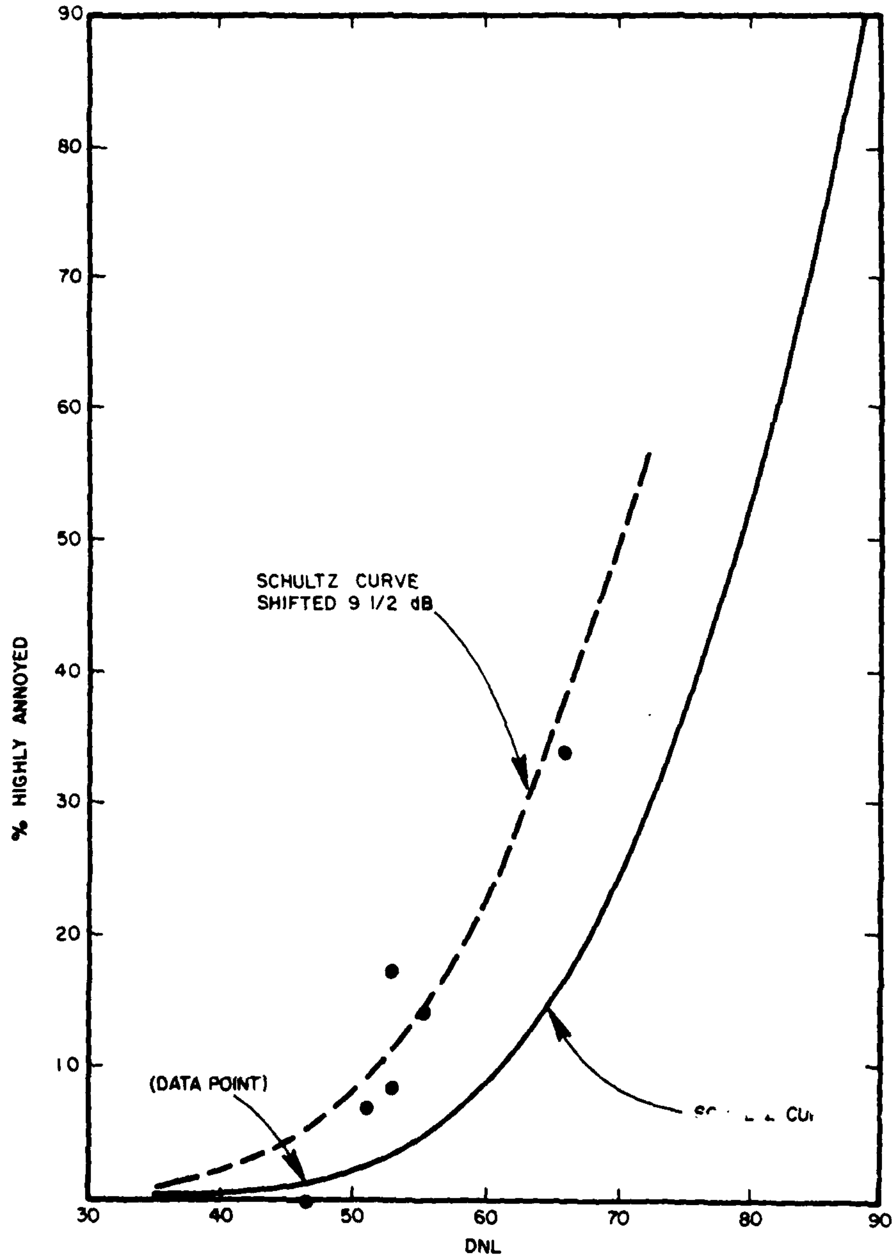

Figure 13. Percent "highly annoyed" vs CDNL for off-installation study areas; the midpoints from the ranges of Figure 12 are plotted.

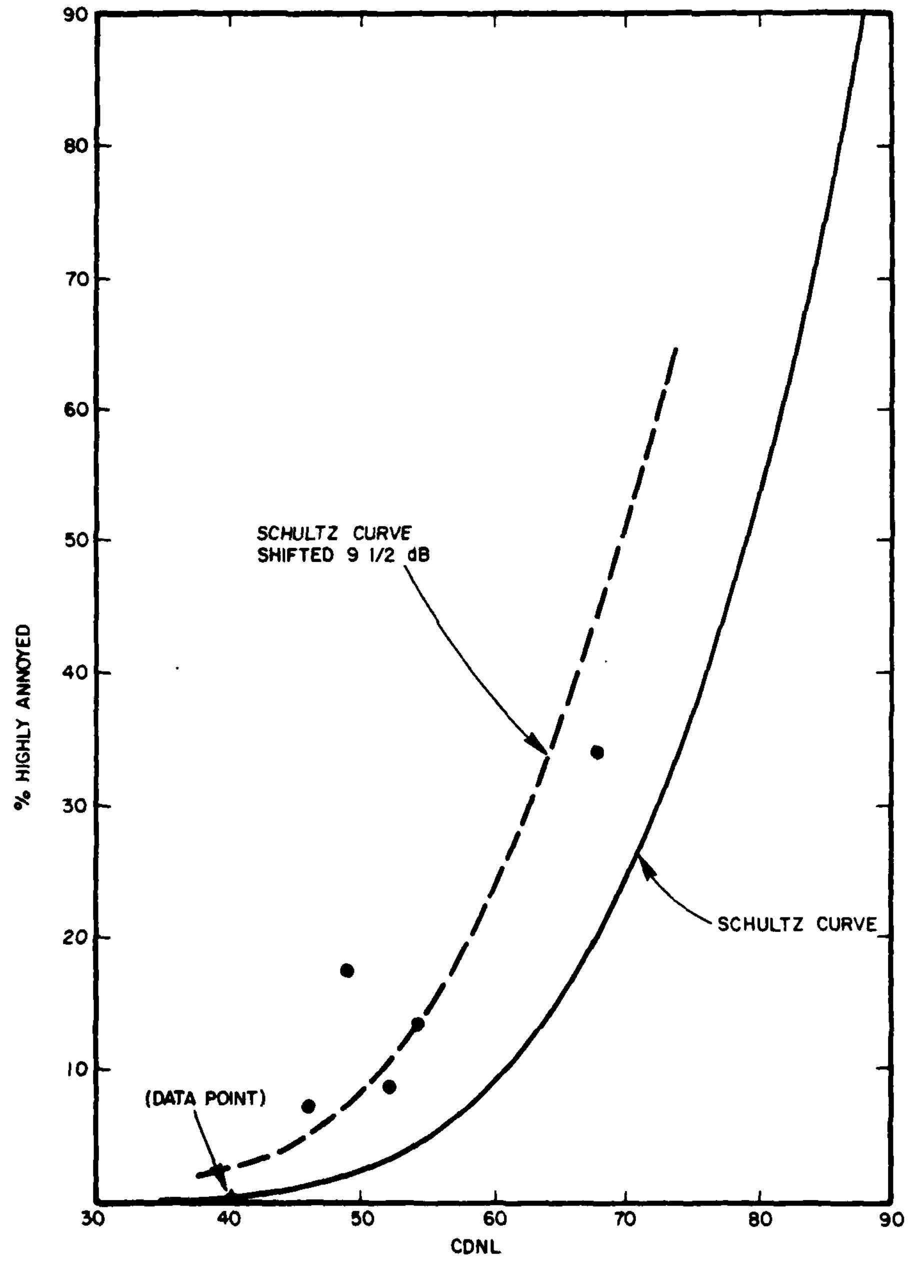

Figure 14. Percent "highly annoyed" vs CDNL for off-installation study areas; the study values from Figure 12 are plotted.

"house rattles" generate greater overall annoyance levels than do responses to the general annoyance questions; i.e., respondents who felt they should complain expressed higher annoyance (at a rate of about 4 to 1) than those who felt they should not complain. Appendix G summarizes the Borsky data and converts his peak levels into approximate CDNL levels. Table 40 summarizes CERL's results in terms of percent of respondents "highly annoyed" by building rattles (only respondents indicating that they should complain about Government activities if annoyed) as compared to the yearly CDNL and as compared with the Borsky-developed data under these same conditions. These comparisons show that for a given CDNL level, the "highly annoyed" percentage is some 10 to 20 percent larger in CERL's results than in the Borsky-developed data. Unfortunately, Borsky never asks the question dealing with overall annoyance to sonic booms. Rather, he creates an index based on the various activity interference questions.

Table 40

Percent "Highly Annoyed" by Building Rattles (Only Those Who Feel They Should Complain About Government Facilities or Operations).

Present Study			Oklahoma City* Data	
Area	LCDN	% Highly Annoyed	% Highly Annoyed	LCDN
HIGH	68	59.4	35.3	64
FAY W	54	22.8	25.9	61
FAY E	52	17.9	25.4	62
SOUTH	49	32.0	19.4	60
NEAR W	46	14.4	16.9	59
FAR W	40	4.5	16.6	60
			12.5	56
			11.0	57
			5.1	54

*From Table A1

Discussion of Data and Results

The differences between the Borsky results in Oklahoma City and CERL's results may be caused by any or all of three factors. First, the differences may reflect real differences in the response of people to the noise source. That is, for a given CDNL, the community may be much more annoyed by artillery noise than by sonic boom noise. This may mean that the CDNL measure is not the measure to be used for impulse noise; i.e., a measure is required which further emphasizes artillery noise as compared to sonic boom noise. This conclusion supports the use of C-weighting or some type of measure which cuts out more of the low frequencies, since the difference between sonic boom and artillery noise lies in the fact that the sonic boom has greater quantities of subaudible energy.

A second possible explanation is that no response differences exist. That is, if Borsky had asked a question dealing with the overall annoyance to sonic boom noise and used data from all respondents in his analysis, the responses might have been equivalent to those presented in Table 32.

The third possibility is that the apparently lowered annoyance levels result is caused by the following: (1) Oklahoma City respondents knew a test was occurring which had a fixed duration, and/or (2) had only been subjected to the sonic booms for a relatively short time (about 6 to 8 weeks for each interview period). This would further support the 1-year equal-energy concept inherent in DNL by indicating that responses to 6 weeks of noise are much lower than responses to 1 year of noise. Also, the very presence of the "test" may have influenced judgments (60 percent of the Oklahoma City respondents knew a test was in progress during the first interview period).

The results in Chapter 4, i.e., that events must occur "less often than once every few months" before annoyance dies away, tends to indicate that the community response will not reach a final "steady-state" value in less than about 1 year. Indeed, Fidell has recently shown that a single exponential can describe the rise in community response to a "step-function" increase in noise. The time constant he finds is 3 months, a result consistent with the findings in Chapter 4 of this study. Thus, the most plausible reason for the lower response in the Oklahoma City study is that the respondents knew a test was in progress and that the test did not proceed long enough for the community response to reach its final value.

Monitoring at Fort Bragg

The monitored data to the east of Fort Bragg were typically 3 to 5 dB below predicted levels. These data were characterized by one or several loud days, along with many quiet days. This monitoring result generally correlates with the community response, i.e., respondents indicated that loud events and house rattles generally occur less often than "every day" or "several times per week," especially in areas relatively distant from the installation. The monitored levels to the west and south were much lower than predicted; the data showed only generally low-noise days and none of the interspersed high-level days. However, the respondent data would seem to indicate that these high levels do occur and that the monitoring must not have gone on long enough or during the right season to record high-level days.

Near the installation boundary and areas to the south and southwest of predominant noise sources, measured levels were 2 to 4 dB above prediction. In this study area, winds were generally from the north or northeast. The resulting monitored data support published data indicating that, at relatively short distances, sound propagation is enhanced in the downwind direction (CERL's computer predictions take into account temperature inversion frequencies, but not wind directions).[33]

Alternative Weightings

Table 27 listed measured values for the ADNL at the monitor locations. This table shows no correlation between the measured A- and C-weighted levels at any site. Moreover, it is clear from Table 29 that there is no correlation between the measured A-weighted levels and the percents of respondents "highly annoyed." Both the Oklahoma City study and CERL's study show that house rattles are the predominant adverse factor in the community. Since it is predominantly the energy in the 10- to 30-Hz range which contributes to house rattles, A-weighting of impulse noise would delete nearly all the information relevant to the causation of house rattles.

Alternative CDNL Formulations

The data in Table 37 offer little definitive information regarding improved alternative formulations for a CDNL measure. Note the data on the first three areas -- High, Fay W, and Fay E (South, Near W, and Far W were based on questionable monitoring results and thus were not considered here) -- show that Case 2 is no different than Case 1; Case 4 is only marginally better than Case 1 in that the deviations among the values are slightly smaller. Case 3 (the impulse correction factor) seems to clearly move in the wrong direction by increasing the relative differences between areas.

Formation of Equivalent Levels

To assess the total noise produced by military installations, it is necessary to be able to combine and portray the effects of all noise on the surrounding community so meaningful land-use patterns can be developed, both for on and off the installation. Thus, some equivalency must be established between the measures used to assess impulse noise and the ADNL levels used to assess all other noises. The percentage of the community characterized as "highly annoyed" by a given noise environment appears to offer the best means to develop this equivalency, given the emphasis which the National Academy of Science and the EPA have placed on the use of this concept in assessing the impact of noise environments.

The data in Table 37 and in Figures 13 and 14 (Case 4) show that the CDNL value underpredicts the percentage of respondents "highly annoyed" when used in conjunction with the Schultz relation. For example, the data show 34 percent "highly annoyed" in the 68-dB zone. The Schultz relation shows that it takes an ADNL of 74 dB to achieve 33 percent of respondents "highly annoyed." The difference between these values is the indicated 6 dB in Table 37. These data indicate that the present CDNL always underpredicts the percent "highly annoyed" when the Schultz curve is used. Adding a constant 6 dB to the CDNL values seems to be the simplest means of establishing on equivalent impulse noise level which can be directly compared with A-weighted levels. Adding 9 dB will yield equivalent DNL levels which, when the Schultz relation is used,

[33] V. Pawlowska and L. Little, The Blast Noise Prediction Program: User Reference Manual, Interim Report N-75/ADA074050 (CERL, August 1979).

closely predict the actual percent of respondents indicating high annoyance. In developing this recommendation to add a constant 6 dB, the results for areas to the south and west of the installation are somewhat discounted since the responses for loudness, frequency of occurrence, annoyance, and house rattles all indicate that noise levels are frequently higher (at least during some portion of the year) than those actually measured during the specific days of monitoring.

Conclusions

Chapters 4 and 5 established:

1. For impulse noise, the growth in annoyance for increases in loudness or in frequency of occurrence is equivalent to the corresponding annoyance growth to such common noises such as fixed-wing aircraft and vehicle noise. Thus, to the extent that fixed-wing aircraft and vehicle noise can be described by an energy model such as DNL, impulse noise can be equally described by such a model.

2. The nighttime penalty for all noises is on the order of 10 dB.

This chapter showed that a measure which takes note of house rattles is definitely required and that A-weighting cannot and does not perform this function. On the other hand, there is evidence that a measure which incorporates more low-frequency energy than does C-weighting would further emphasize sonic booms as compared to artillery noise and increase the disparity in results between these two sources. Since energy in the 10- to 30-Hz range must be included to assess the contribution of impulse noise to building rattles, C-weighting still appears to be the best available standard weighting network with which to assess impulse noise.

The present 85-dB threshold was originally incorporated because data did not exist for lower levels, and because it was felt that only "large amplitude" impulse should be considered. Chapter 4 shows that impulse noise fits an energy model in much the same way as aircraft or vehicle noise fits an energy model. Also, Table 37 shows that eliminating the threshold may decrease variation from site to site; retaining, increasing, or adding an impulse correction factor to the present threshold does not reduce this variation. Thus, it is concluded that the present 85-dB threshold adds a complexity which should be deleted because there are no data now to support its retention.

In summary, the analysis in this chapter indicates:

1. Impulse noise is described by an energy model as well as any noise is described by an energy model.

2. There is no reason to deviate from the present 10-dB nighttime penalty for impulse noise (or for any other noise).

3. C-weighting is the best available measure to characterize impulse noise.

4. There is no threshold below which impulse noise should be deleted any more than there is a threshold below which aircraft noise or vehicle noise should be deleted from DNL predictions.

5. Adding an impulse noise correction does not increase the ability of CDNL to predict community response.

6. To be able to relate impulse noise to other noises, it is recommended that equivalent CDNL levels be established by adding 6 dB to computed or measured CDNL values.

7. For a given noise level, on-installation annoyance is significantly lower than off-installation annoyance.

8. There is no difference in annoyance levels between respondents who own or rent their homes.

9. There is no difference in annoyance levels between on-installation respondents who do not have a family member working for the Government. Since 43 percent of off-installation respondents have at least one household member who worked at or for some Government facility (this 43 percent figure does not include households of retired military), there is no reason to assume that there would be any smaller levels of annoyance in a community which was less heavily made up of households who had family members working at some Government facility.

10. On-installation annoyance levels are significantly lower than are off-installation levels for the same stimuli.

8 ADDITIONAL FACTORS CORRELATED WITH COMMUNITY ANNOYANCE TO NOISE

In addition to Question 34A (discussed in Chapter 6), which asked, "Do you think people around here ought to complain about the noise from the Government facilities or operations if they find it annoying?", three other questions were asked which were found to correlate with community annoyance. These were Questions 30, 31, 35, and 36.

Question 30 asked, "How much would you say could be done to reduce the noise from (   )?". The possible answers to Part A of this question were: a great deal, quite a bit, a fair amount, not very much, nothing at all. Part B asked, "Right now, as far as you know, is there anything being done to reduce the noise from (*source*)?". The possible answers were "yes" and "no." If a respondent answered "yes," then he was asked in Part C "How much would you say is being done to reduce the noise from (*source*)?" The possible answers to this were: a great deal, quite a bit, a fair amount, not very much, nothing at all. This question was designed to get at what some researchers such as Borsky have termed "misfeasance". It was analyzed by dividing respondents into two groups. Group 1 contained those who felt that "a great deal," "quite a bit," or "fair amount" can be done to reduce the noise from (*source*), but that "nothing at all" or "not very much" was being done.

Question 31 was a simple one-part question which asked, "Compared to most people, how sensitive do you think you are to noise?" The possible responses were: much more, more, about the same, less, much less. For this question, respondents were grouped into two categories -- those responding "much more" or "more" were in Category 1, and all other respondents in Category 2.

As indicated, Question 34A asked, "Do you think people around here ought to complain about the noise from Government facilities or operations if they find it annoying?" The possible responses were "yes" or "no," and respondents were so grouped.

Question 36 was designed to get at whether a respondent identified damage potential with a given noise source. This question had three parts. Part A asked, "Are you ever concerned that any source of noise we have been talking about might cause damage in this neighborhood?" Possible responses were "yes" or "no." Part B asked, "What do you think might do this?" The possible responses were the different sources of noise the respondent had said he had heard, usually artillery, street traffic, airplanes, helicopters, children and dogs. In Part C, for those sources identified in Part B, respondents were asked, "What do you think the chances are that (*source*) might cause damage in the neighborhood in the next few years?" The possible responses were: very likely, likely, unlikely, very unlikely, almost no chance at all. Respondents who identified a given source as potentially a "very likely" or "likely" source of damage were placed in one group; all other respondents were placed in the second group.

These four questions can essentially be abbreviated by the subject matter which they deal with: Question 30 -- misfeasance, Question 31 -- sensitivity (to noise), Question 34 -- complaint potential, and Question 36 -- damage. For each question, respondents were split into two groups: yes and no. The "yes" groups were the ones that would be expected to be more bothered by the noise because of their feelings. The "no" groups represented all other respondents. Tables 41 through 44, respectively, tabulate the responses to these four questions by group and noise source category. These tables show that these four questions each divide the sample populations into two groups which are statistically significantly different from one another.

One reason for asking these questions was to determine a way of reliably predicting those respondents who would be "highly annoyed." While each of these questions offered interesting and not unexpected insights, none universally separated those respondents who were "highly annoyed" from those not "highly annoyed." To further study this issue, various combinations of these four questions were studied. These results are in Appendix H. These results are not conclusive, since the questions are not nested, i.e., the respondent indicating a high sensitivity to noise may or may not be the respondent who felt he ought to complain and may or may not be the respondent concerned about damage potential. Thus, the intersection of all "yes" responses defines a very small group of respondents. While a large percentage of this intersection of respondents is "highly annoyed," so many respondents were excluded as to make the overall exercise meaningless. The only real information which appears to have been developed is the simple fact that all four of these questions seem to correlate with high annoyance.

One question (Question 33) probed the economic importance of Fort Bragg to the community. This question asked, "How important do you think activities at (Fort Bragg) are to this community?" The results from this question proved to be not significant because most of the respondents thought Fort Bragg to be at least somewhat important. Thus, there were not enough respondents who thought Fort Bragg to be "not at all important" to provide any meaningful statistical results. In numerical terms, 1611 respondents thought Fort Bragg to be "very important"; 328 thought it to be "somewhat important"; and only 108 thought it to be "not at all important."

As indicated in Chapter 7, there was no statistical difference between owners and renters of property.

Question 35A asked: "Have you ever felt like doing something about the noise coming from any source?" If a respondent answered "yes," he was asked: "What noises?" For each of the sources which a respondent identified, he was asked whether he had actually done anything about the noise from that source and, if so, what he had done, when, and what the outcome was.

In general, the "doing something" about the noise meant complaining about the noise. The respondents who felt like doing something about the noise were really saying they felt like complaining about the noise. And those who actually did something, actually registered a complaint with some party. For example, traffic noise complaints might go to the city, complaints about children or pets might go to the next door neighbor, etc.

The data for respondents who felt like doing something and for those who actually did something have been subdivided according to those who were "highly annoyed" to that noise source, and those who were not. These data are in Table 45. In general, the data for all sources are similar. About 50 percent of respondents who felt like complaining or actually complained were also

Table 41

Results From Question 30

Question 30: Yes = "a great deal," "quite a bit" or "a fair amount" can be done to reduce noise but "not very much" or "nothing at all" is being done.

	"Yes" % Highly Annoyed	"Yes" Number Highly Annoyed	"Yes" Total	"No" % Highly Annoyed	"No" Number Highly Annoyed	"No" Total	Ratio of Percents Highly Annoyed
Blast noise	27.8	75	269	7.0	132	1878	4.0
Street traffic	30.4	136	448	4.1	70	1699	7.4
Airplanes	24.4	62	254	5.6	106	1893	4.4
Helicopters	33.1	105	317	6.6	121	1830	5.0
Children/pets	23.0	140	424	5.2	90	1723	4.4

Table 42

Results From Question 31

Question 31: Compared to most people, how sensitive do you think you are to noise? Yes = "much more" or "more," No = "same," less," much less."

Number: "Yes" = 344 "No" = 1778

	"Yes" % Highly Annoyed	"Yes" Number Highly Annoyed	"No" % Highly Annoyed	"No" Number Highly Annoyed	Ratio of Percents Highly Annoyed
Blast noise	20.2	73	7.5	133	2.7
Street traffic	19.7	68	7.4	133	2.7
Airplanes	14.5	50	6.5	117	2.2
Helicopters	18.3	63	9.1	162	2.0
Children/pets	15.4	53	9.9	176	1.6

Table 43

Results From Question 34

Question 34: Should people complain about government facilities if they are bothered or annoyed?

Number: "Yes" = 1303 "No" = 831

	"Yes"		"No"		
	% Highly Annoyed	Number Highly Annoyed	% Highly Annoyed	Number Highly Annoyed	Ratio of Percents Highly Annoyed
Blast noise	13.3	174	4.0	33	3.3
Street traffic	10.8	140	7.4	64	1.5
Airplanes	10.2	133	4.2	35	2.4
Helicopters	14.6	190	4.3	36	3.4
Children/pets	11.5	150	9.3	77	1.2

Table 44

Results From Question 36

Question 36: Cause Damage.
Part A answered "yes," and source mentioned as "very likely" or "likely" to cause damage.

	"Yes"			"No"			
	% Highly Annoyed	Number Highly Annoyed	Total	% Highly Annoyed	Number Highly Annoyed	Total	Ratio of Percents Highly Annoyed
Blast noise	36.2	88	243	6.3	119	1904	5.7
Street traffic	49.2	91	185	5.9	115	1962	8.3
Airplanes	36.3	57	157	5.6	111	1990	6.5
Helicopters	54.6	71	130	7.4	155	2017	7.4
Children/pets	59.7	40	67	9.1	190	2080	6.6

"highly annoyed" (for helicopters the percentages were somewhat higher). While 50 percent is high compared to the overall sample, the "feeling like doing something" or the actual "doing something" is evidently not a good enough predictor of the respondent who will or will not be "highly annoyed."

Table 45

Respondent Actions

	Respondents Who "Felt Like Complaining"			Respondents Who Actually Complained	
Source	Number	Number Also Highly Annoyed	%	Number	Number Also Highly Annoyed
Artillery	93	51	55	15	8
Street traffic	203	91	45	80	19
Airplanes	63	30	48	17	8
Helicopters	83	59	71	16	12
Children/pets	300	124	41	165	62

9 CONCLUSIONS

Major Conclusions

1. Impulse noise is described by an energy model as well as any noise is described by an energy model.

2. There is no reason to deviate from the present 10-dB nighttime penalty for impulse noise (or for any other noise).

3. C-weighting is the best available measure to characterize impulse noise.

4. There is no threshold below which impulse noise should be deleted from DNL predictions any more than there is a threshold below which aircraft or vehicle noise should be deleted.

5. Adding an impulse noise correction does not increase the ability of CDNL to predict community response.

6. To relate impulse noise to other noise, 6 dB must be added or computed to measured CDNL values to establish equivalence with ADNL values.

Other Conclusions

1. For a given noise level, on-installation annoyance is significantly lower than off-installation annoyance.

2. There is no difference in annoyance levels between respondents who own or rent their homes.

3. There is no difference in annoyance levels between respondents who live off the installation who have a member of their household working for the Government and those who do not have a family member working for the Government. Since 43 percent of off-installation respondents have at least one household member who worked at or for some Government facility (this 43 percent figure does not include households of retired military), there is no reason to assume that there would be any smaller levels of annoyance in a community which was less heavily made up of households who had family members working at some Government facility.

4. On-installation annoyance levels are significantly lower than off-installation levels for the same stimuli.

5. Annoyance correlates with the following four factors:

a. Belief that one should complain about Governmental activities, if bothered

b. Sensitivity to noise

c. Misfeasance (the belief that more can be done to reduce noise than is being done)

d. Fear that the source of noise will cause damage.

6. The factors listed in Conclusion 5 above, neither alone nor in combination, predict "highly annoyed" respondents.

7. Future monitoring must use fixed positions for as long as possible (1 year preferred) and be no closer than 1 kilometer from the nearest point.

14. Monitoring can precede the attitudinal surveys and its results used to develop the survey sampling plan.

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APPENDIX A:

NOISE MODELS -- BIBLIOGRAPHY*

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COMMUNITY REACTION TO IMPULSE NOISE: INITIAL ARMY SURVEY.(U)
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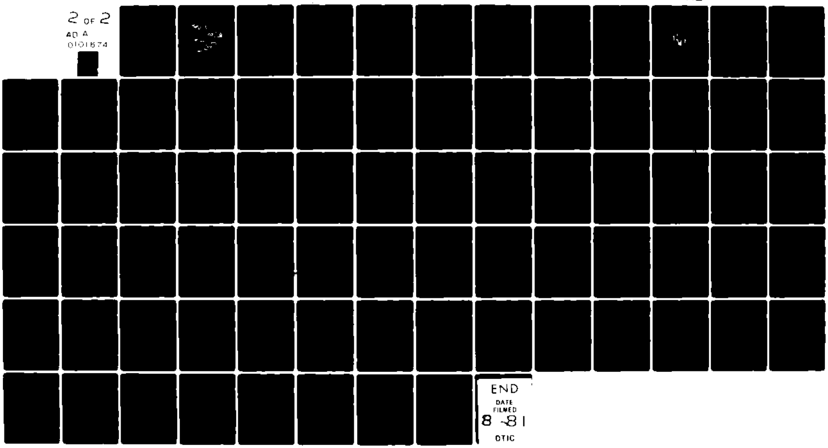

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APPENDIX B:

INTERVIEWER REPORT FORM

community attitudes survey

IRF # ______________ Questionnaire # ______________ 1-6

Segment # ______________ 7-9 Intensity Stratum # ______________ 10

Study 289

UNIVERSITY OF ILLINOIS
Survey Research Laboratory

Household Name ______________________________

Respondent Name ______________________________

Phone # ( ) ______________ If On Post, Rank (if possible) __________ 11-12

Street Address ______________________________

City ______________ Zip (City) Code __________

County ______________ County Code # __________ 13-15

State __________ State Code __________ 16-17

Description and/or Location of HU:

____

____

____

JUL 78

CONTACT RECORD

Contact Attempt (18)	Date (19–22)	Time	Result (23)	Notes	Int. I.D. # (24–26)
1			1 2 3 4 5 6 7		
2			1 2 3 4 5 6 7		
3			1 2 3 4 5 6 7		
4			1 2 3 4 5 6 7		
5			1 2 3 4 5 6 7		

Final Result

- Interview 1
- Refusal *(Specify)* ________________2
  ____
- R not home 3
- No one home 4
- HU vacant 5
- Unavailable *(Specify)* ____________6
  ____
- Other *(Specify)* ________________7

Interviewer Comments

____
____
____
____
____
____
____
____
____
____

Hello. My name is ________________________. I'm from the University Research Center. We are doing a study about how people feel about living in different places and I'd like to get some of your views about living in this area.

a. Ask: "How many people 18 years or older live here at the present time?"

b. If there is more than one such person, say: "Starting with the head of the house, please tell me the sex and age of each such person and their relation to the head."

Relation to Head (27)	Sex (28)	Age (29-30)	Adult No.	Check
Head	______	______	______	______
______________	______	______	______	______
______________	______	______	______	______
______________	______	______	______	______
______________	______	______	______	______
______________	______	______	______	______

INTERVIEWER: Assign the number 1 to the youngest adult, 2 to the next youngest adult, and so on, until each adult in the household has been assigned a number.

eligible in HH __________ 31

IRF. No.	If the number of adults in the household is: 1	2	3	4	5	6 or more
	then select:					
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

INTERVIEWER REPORT

1a. Was the respondent suspicious of the stated purpose of the interview or the interviewer?

Yes 1 32
No 2

(If Yes)

b. Explain: ____ 33-34

____ 35-36

c. Was there any reason to believe that the respondent's hearing was not as good as average hearing?

Yes 1 37
No 2

(If Yes)

d. Explain: ____ 38-39

____ 40-41

(Please use the word-pair technique to give the following ratings on the basis of your observation of the respondent. Circle one answer code for each row.)

2. **Respondent in interview situation:**

Relaxed	1	2	3	4	5	6 . . . . Tense	42
Friendly	1	2	3	4	5	6 . . . . Hostile	43
Silent	1	2	3	4	5	6 . . . . Talkative	44
Frank	1	2	3	4	5	6 . . . . Defensive	45
Helpful	1	2	3	4	5	6 . . . . Uncooperative	46
Interested	1	2	3	4	5	6 . . . . Disinterested	47
Honest	1	2	3	4	5	6 . . . . Dishonest	48

3a. During the interview could you hear . . .

(If Yes)
b. Did it interfere with the interview?

	Yes	No		Yes	No	
a. Cars or trucks going by . .	1	2	49	1	2	50
b. Artillery or other large guns	1	2	51	1	2	52
c. Airplanes	1	2	53	1	2	54
d. Helicopters	1	2	55	1	2	56
e. Other (Specify)	1	2	57	1	2	58

____

____

c. Did you notice anything in the area that would cause noise levels to be excessive?

Yes. 1 59

No. 2

(If Yes)
d. What did you notice?

______________________________ 60-61

______________________________ 62-63

____

____

4. Circle race of respondent.

White 1 64
Black 2
Spanish American. 3
American Indian. 4
Asian, Oriental 5
Other (Specify) 6

____

5. Circle sex of respondent.

Male. 1 65
Female 2

6a. Type of structure

A one family house detached from any other house . . . 1 66
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

b. How many stories (floors) are in this building?

1 to 3 stories . . . 1 67
4 to 5 stories . . . 2
6 or more stories . . . 3

7. Outside construction:

Frame only . . . 1 68
Frame with some brick . . . 2
All brick . . . 3
Other (Specify) . . . 4

8. Inside walls:

Block . . . 1 69
Plaster . . . 2
Other (Specify) . . . 3

9. Interviewer's signature and ID # : ____________

10. Date of interview: ____________

Coder________ 70-72
Keypunch________ 73-75
76-78/BK
79-80/01

APPENDIX C:

%'s Based On All 2147 Respondants

COMMUNITY ATTITUDES SURVEY

QUESTIONNAIRE No. ...

STUDY No. 289

O.M.B. 49-R0148
Expires 01 Jan 82

Time interview began: ________ *AM* / *PM*

0-6 months = 474
7-12 " = 318
13-24 " = 320
2-5 yrs = 372
5+ yrs = 640
missing = 3

1a. About how long have you been living at this address? ______ years ______ months ______ days 10-15

(If less than 1 year)

b. Where did you live before moving here?

____ 16-18

2. In general, how do you rate this neighborhood as a place to live? Do you rate it as an excellent, good, fair, poor or very poor place to live?

Excellent	1	19
Good	2	
Fair	3	
Poor	4	
Very poor	5	
Don't know	8	

3a. What are some of the things you like about living in this neighborhood—things you feel are advantages, or that make this a good place to live? *(Anything else?)*

____ 20-21

____ 22-23

____ 24-25

b. Is there any one thing you like most about living here? *(What is that?)*

____ 26-27

____

____

____

CF 163
JUL 78

4. Now, here is a list of things some people like about the community where they live. *(Show Card # 1.)* For each item, please tell me whether you feel this area has the thing described.

Do you feel this area has . . .

	Yes	No	*(Don't know)*
a. Clean and well kept streets?	1	2	8
b. Good steady employment opportunities?	1	2	8
c. Good schools?	1	2	8
d. Good public transportation?	1	2	8
e. Quiet residential neighborhoods?	1	2	8
f. Neighbors who know and help each other?	1	2	8
g. Space for children to play?	1	2	8
h. Good parks and recreational facilities?	1	2	8
i. Good police protection?	1	2	8

5a. Have you ever considered moving away from this community or neighborhood?

Yes. 1
No *(Skip to Q. 6)* 2

b. For what reasons have you felt like moving? *(Anything else?)*

(1) ______________________________

(2) ______________________________ 40-41

(3) ______________________________ 42-43

6. Very few places are entirely perfect. *(So, I'd like to ask you . . .)* what are some of the things you don't like about living here—things you may feel are nuisances, irritations, bothersome or disturbing to you?

______________________________ 44-45

______________________________ 46-47

______________________________ 48-49

CF 163 A

7. Now here is a list of things some people dislike about the place where they live. *(Show Card # 2.)* For each item, please tell me whether you feel this area has the thing described.

First . . .

a. Do you feel this area has . . .

b. Now, thinking of it being an area with . . . *(item mentioned)*, how much does this bother or annoy you? *(Show Card # 3.)*
Read categories and circle answer code.

	Yes	No	*(Don't know)*		Extremely	Very much	Moderately	Slightly	Not at all	*(Don't know)*	
1. A poor or inconvenient location?	1	2	8	50	1	2	3	4	5	8	51
2. Inadequate community facilities, shopping and services?	1	2	8	52	1	2	3	4	5	8	53
3. Too much noise?	1	2	8	54	1	2	3	4	5	8	55
4. Dangerous road traffic conditions? . .	1	2	8	56	1	2	3	4	5	8	57
5. Dangerous air traffic conditions?	1	2	8	58	1	2	3	4	5	8	59
6. Overcrowded conditions? . .	1	2	8	60	1	2	3	4	5	8	61
7. Poor climate and weather? .	1	2	8	62	1	2	3	4	5	8	63
8. Unsafe conditions?	1	2	8	64	1	2	3	4	5	8	65
9. Bad odors and air pollution? . . .	1	2	8	66	1	2	3	4	5	8	67

8. On the whole, would you say that this neighborhood was noisy, quiet, or is it somewhere in between?

Noisy 1 68
Quiet 2
In between 3

CF 163 B

For Q. 9 only, rank the sources in the order they are mentioned.	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
	____ 69	____ 74	____ 7	____ 12	____ 17	____ 22	____ 27

D.02

9. What are some of the different kinds of noises you hear around here? *(By noises, I mean sounds you would rather not hear.) (Any others?)*

(Circle Code 1 for each of the noises listed below which is mentioned spontaneously. Then prompt for any of these noises not mentioned, by asking, "Do you ever hear noise from . . . around here?" Rank the noises above in the order they are mentioned.)

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
Yes *(mentioned spontaneously)*	1 29.0	1 26.6	1 25.4	1 22.4	1 17.8	1 18.5	1 2.3
Yes *(prompted)*.	2 35.7	2 11.5	2 26.2	2 34.8	2 21.3	2 2.1	2 .3
Rank the noises above							
No, never hear	3 39.4	3 61.9	3 48.3	3 42.8	3 60.7	3 79.5	3 97.4

(If Yes [code 1 or 2] to any item, ask Question 10a. If no noises are heard, skip to Q. 31.)

10a. How loud is the noise from *(source)* compared to normal conversation? *(Show Card # 4.)*

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
Much more.	1 13.4	1 7.5	1 13.1	1 17.7	1 6.6	1 6.8	1 .1
More	2 16.5	2 12.2	2 16.7	2 18.0	2 10.3	2 7.3	2 1.0
About the same	3 14.7	3 9.0	3 12.7	3 12.5	3 10.2	3 3.6	3 .6
Less	4 12.1	4 6.7	4 6.6	4 6.5	4 7.6	4 1.8	4 .3
Much less.	5 3.4	5 2.3	5 1.7	5 1.8	5 3.9	5 .4	5
(Don't know)	8 .3	8 .1	8 .2	8 .2	8 .2	8	8

b. How often do you hear *(source of noise)*? *(Show Card # 5.)*

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
Everyday	1 43.3	1 24.2	1 23.2	1 21.8	1 24.0	1 6.9	1 .6
How many times?	___ 73	___ 78	___ 11	___ 16	___ 21	___ 26	___ 31
Several times a week . .	2 16.0	2 8.5	2 16.5	2 20.5	2 10.1	2 7.5	2 1.0
Several times a month.	3 22.4	3 2.7	3 8.2	3 9.7	3 2.6	3 3.6	3 .8
Once every few months	4 15.2	4 .8	4 2.2	4 3.3	4 .7	4 1.4	4 .1
Less often than that . .	5 1.6	5 1.1	5 .9	5 1.2	5 1.3	5 .8	5 .1
(Don't know)	8 .9	8 .6	8 .3	8 .3	8 .2	8 .2	8

79-80/02
1-6/DUP

CF 163 C

11. *Ask a through f for each noise source before going on to the next source.*

	Artillery	Street traffic	Airplanes
a. Do you hear *(source of noise)* more often during a certain time of the year?			
Yes	153.4	140.5	124.8
No *(Skip to part c)*	246.6	259.4	275.2

(If Yes)

	Artillery	Street traffic	Airplanes
b. What season of the year is that? *(Circle all that apply.)*			
Spring.	1 33	1 42	1 51
Summer	2 34	2 43	2 52
Fall.	3 35	3 44	3 53
Winter	4 36	4 45	4 54
Other *(Specify)*____	5 37	5 46	5 55

	Artillery	Street traffic	Airplanes
c. Do you hear them more often on some days than on others?			
Yes	137.6	150.8	130.5
No *(Skip to part e)*	262.4	249.2	269.5

(If Yes)

	Artillery	Street traffic	Airplanes
d. When is that?	________ 39	________ 48	________ 57
	________ 40	________ 49	________ 58

CF 163 D

Heli-copters	Children and dogs	Other	Other
127.5 272.5	152.6 247.4	135.1 261.9	137.9 262.1
1 [60] 2 [61] 3 [62] 4 [63] 5 [64]	1 [69] 2 [70] 3 [71] 4 [72] 5 [73]	1 [8] 2 [9] 3 [10] 4 [11] 5 [12]	1 [17] 2 [18] 3 [19] 4 [20] 5 [21]
134.3 265.6	129.3 270.7	148.2 251.8	141.4 258.6
______ [66]	______ [75]	______ [14]	______ [23]
______ [67]	______ [76]	______ [15]	______ [24]

77-78/BK
79-80/03
1-6/DUP

CF 163 D cont.

e. In general, taking everything into consideration, does the noise from *(source)* ever bother or annoy you?

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Yes	126.5	122.0	119.7	124.4	123.0	114.2	11.8
No *(Return to Q. 11a or skip to Q. 11g if finished with all sources. If "no" to all sources, skip to Q. 12a.)*	233.5	215.3	230.6	231.3	215.3	25.4	2 .7

(If Yes)

f. Overall, how annoyed are you by noise from *(source)*?

Extremely	54.4	54.1	52.8	54.5	54.9	53.0	5.3
Very much	45.3	45.5	45.0	46.0	45.8	44.0	4 .7
Moderately	310.1	37.8	37.8	39.3	37.2	34.5	3 .7
Slightly	26.7	24.3	23.7	24.2	24.7	22.6	2

(Return to Q. 11a or skip to Q. 11g if finished with all sources.)

g. *(If applicable)* Why does the noise from *(source most annoying)* annoy you?

____ 39-40

____ 41-42

(If applicable) Why does the noise from *(source second-most annoying)* annoy you?

____ 43-44

____ 45-46

(If applicable) Why does the noise from *(source third-most annoying)* annoy you?

____ 47-48

____ 49-50

CF 163 E

(Show cards # 3 and # 5 for Questions 12-17.)

12a. During the week Monday through Friday, are you usually home from around seven in the morning to six at night?

Yes. 35.8 1
No *(Skip to Q. 13a)* 48.1 2

(If Yes)

b. Do any of the noises we've been talking about bother or annoy you during the day from around seven in the morning to six at night?

Yes. 15.5 1
No *(Skip to Q. 13a)* 21.0 2

(If Yes)

c. What noises do that?

(Circle all that apply.)

Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
1 8.2	2 4.7	3 6.9	4 9.3	5 5.2	6 2.3	7 .1

d. How often does the noise from *(source)* bother or annoy you during the day? *(Card # 5)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Everyday	1 1.0	1 3.2	1 3.4	1 4.1	1 3.1	1 .9	1
How many times?	—	—	—	—	—	—	—
Several times a week . . .	2 3.0	2 1.4	2 2.4	2 3.7	2 1.4	2 .1	2
Several times a month	3 2.5	3 .1	3 .8	3 1.0	3 .3	3 .2	3
Once every few months	4 1.3	4	4 .1	4 .1	4	4 .1	4
Less often than that	5 .2	5	5	5	5 .2	5	5
(Don't know)	8 .1	8	8	8 .1	8	8	8

e. And in general and taking everything into consideration, how annoyed are you by noise from *(source)* during the day? *(Card # 3)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Extremely	5 1.6	5 1.0	5 1.1	5 1.5	5 1.2	5 .7	5
Very much	4 1.6	4 1.4	4 1.8	4 2.5	4 1.5	4 .7	4
Moderately	3 2.9	3 1.6	3 2.6	3 3.5	3 1.6	3 .4	3
Slightly	2 1.7	2 .6	2 1.2	2 1.5	2 .8	2 .4	2 .1
Not at all	1 92.0	1 95.2	1 93.2	1 90.8	1 94.7	1 97.7	1 99.8

CF 163 F

13a. Are you usually home during the day on weekends?

Yes	69.4	1
No *(Skip to Q. 14a)*	15.0	2

(If Yes)

b. Do any of the noises we've been talking about bother or annoy you during the day on weekends?

Yes	29.9	1	10
No *(Skip to Q. 14a)*	39.7	2	

(If Yes)

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
c. What noises do that? *(Circle all that apply.)*	1 9.2 [11]	2 10.7 [15]	3 8.5 [19]	4 4.8 [23]	5 10.0 [27]	6 5.4 [31]	7 .6 [35]

d. How often does the noise from *(source)* bother or annoy you during the day on weekends?

Every weekend	1 1.6 [12]	1 6.8 [16]	1 3.7 [20]	1 3.6 [24]	1 5.9 [28]	1 2.5 [32]	1 .2 [36]
How many times?	__ 13	__ 17	__ 21	__ 25	__ 29	__ 33	__ 37
Several weekends a month	2 3.9	2 3.0	2 3.7	2 4.3	2 2.8	2 2.0	2 .3
Once every few months	3 2.9	3 .5	3 .7	3 1.5	3 .8	3 .6	3
Less often than that	4 .5	4 .2	4 .3	4 .3	4 .2	4 .1	4
(Don't know)	8 .2	8 .2	8 .1	8 .1	8 .2	8 .2	8

e. And *(in general and taking everything into consideration)*, how annoyed are you by noise from *(source)* during the day on weekends?

Extremely	5 2.0 [14]	5 2.6 [18]	5 1.5 [22]	5 2.3 [26]	5 2.9 [30]	5 1.3 [34]	5 .1 [38]
Very much	4 2.0	4 3.3	4 2.1	4 2.6	4 3.0	4 1.5	4 .2
Moderately	3 3.3	3 3.4	3 3.2	3 3.4	3 2.9	3 1.7	3 .1
Slightly	2 1.7	2 1.2	2 1.4	2 1.4	2 1.5	2 .9	2 .2
Not at all	1 90.8	1 87.4	1 91.6	1 90.2	1 90.2	1 94.5	1 99.2

CF 163 G

14a. During the week Monday through Friday, are you usually home in the evenings from around 7 pm to 10 pm?

Yes. . . . . 77.8 . . . . 1 39
No *(Skip to Q. 15a)* 9.6 2

(If Yes)

b. Do any of the noises we've been talking about bother or annoy you during the evenings from around 7 pm to 10 pm?

Yes. . . . . 36.6 . . . . 1 40
No *(Skip to Q. 15a)* 41.2 2

(If Yes) c. What noises do that? *(Circle all that apply.)*	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
	1 11.2	2 11.1	3 10.5	4 11.1	5 16.9	6 5.9	7 .8

d. How often does the noise from *(source)* bother or annoy you during the evening?

Everyday	1 11.2	1 5.5	1 3.8	1 3.5	1 4.8	1 1.6	1 .3
How many times?	__ 43	__ 47	__ 51	__ 55	__ 59	__ 63	__ 67
Several times a week.	2 3.3	2 4.1	2 4.4	2 4.5	2 4.1	2 2.7	2 .3
Several times a month	3 4.3	3 1.1	3 1.8	3 2.4	3 1.3	3 1.1	3 .1
Once every few months.	4 2.1	4 .1	4 .3	4 .5	4 .2	4 .2	4
Less often than that	5 .1	5 .1	5 .2	5 .1	5 .1	5 .1	5 .1
(Don't know)	8 .2	8 .1	8	8 .1	8 .3	8 .1	8

e. And *(in general and taking everything into consideration)*, how annoyed are you by noise from *(source)* during the evening?

Extremely	5 2.0	5 2.8	5 1.9	5 2.6	5 2.5	5 1.5	5 .2
Very much	4 2.7	4 3.2	4 2.4	4 2.7	4 3.1	4 1.9	4 .3
Moderately	3 4.1	3 3.4	3 4.1	3 3.5	3 3.4	3 1.5	3 .3
Slightly	2 2.2	2 1.6	2 2.1	2 1.8	2 1.3	2 .5	2
Not at all	1 88.9	1 88.9	1 89.4	1 89.1	1 87.3	1 94.1	1 99.1

CF 163 H

15a. Are you usually home during the evening on weekends?

Yes 70.7 1
No *(Skip to Q. 16a)* 16.8 2

(If Yes)

b. Do any of the noises we've been talking about bother or annoy you during the evening on weekends?

Yes 28.6 1
No *(Skip to Q. 16a)* 42.3 2

(If Yes)

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
c. What noises do that? *(Circle all that apply.)*	1 7.4	2 10.6	3 6.6	4 7.1	5 9.3	6 5.6	7 .7

d. How often does the noise from *(source)* bother or annoy you during the evening on weekends?

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Every weekend	1 1.1	1 5.9	1 2.5	1 2.9	1 4.8	1 2.7	1 .5
How many times?	___	___	___	___	___	___	___
Several weekends a month?	2 3.6	2 3.7	2 3.2	2 3.4	2 3.7	2 2.3	2 .2
Once every few months	3 2.2	3 .7	3 .8	3 .6	3 .4	3 .4	3
Less often than that	4 .2	4 .1	4 .1	4 .1	4 .1	4 .1	4
(Don't know)	8 .3	8 .2	8 .1	8 .1	8 .2	8	8

e. And *(in general and taking everything into consideration)*, how annoyed are you by noise from *(source)* during the evening on weekends?

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Extremely	5 1.5	5 2.4	5 1.2	5 2.0	5 2.5	5 1.5	5 .3
Very much	4 2.0	4 3.4	4 1.9	4 1.8	4 2.9	4 1.7	4 .2
Moderately	3 2.2	3 2.9	3 2.4	3 2.2	3 2.7	3 1.6	3 .2
Slightly	2 1.5	2 1.8	2 1.2	2 1.1	2 1.1	2 .6	2
Not at all	1 92.7	1 87.3	1 93.3	1 92.8	1 90.7	1 94.4	1 99.1

CF 1631

16a. During the week Monday through Friday, are you usually home at night from around 10 pm to 7 am?

Yes	84.0	1
No *(Skip to Q. 17a)*	3.5	2

(If Yes)

b. Do any of the noises we've been talking about bother or annoy you during the night from around 10 pm to 7 am?

Yes	36.3	1
No *(Skip to Q. 17a)*	47.6	2

(If Yes)

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
c. What noises do that? *(Circle all that apply.)*	1 10.9	2 8.8	3 8.0	4 7.3	5 12.5	6 6.8	7 .6

d. How often does the noise from *(source)* bother or annoy you during the night on weekdays? *(Card # 5)*

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
Everyday	1 .7	1 2.5	1 1.9	1 1.9	1 3.5	1 1.6	1 .1
How many times?	__ 31	__ 35	__ 39	__ 43	__ 47	__ 51	__ 55
Several times a week	2 2.6	2 3.8	2 3.2	2 2.7	2 5.4	2 2.5	2 .3
Several times a month	3 3.5	3 1.6	3 1.7	3 1.6	3 2.4	3 1.7	3 .1
Once every few months	4 3.1	4 .4	4 .8	4 .5	4 .7	4 .5	4
Less often than that	5 .7	5 .1	5 .3	5 .3	5 .2	5 .1	5
(Don't know)	8 .2	8	8	8	8 .1	8	8

e. And *(in general and taking everything into consideration)*, how annoyed are you by noise from *(source)* during the night? *(Card # 3)*

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
Extremely	5 2.3	5 2.1	5 1.9	5 3.1	5 4.2	5 1.9	5 .2
Very much	4 2.7	4 2.7	4 2.2	4 1.5	4 3.5	4 2.2	4 .2
Moderately	3 3.4	3 2.3	3 2.2	3 2.3	3 3.4	3 1.8	3 .1
Slightly	2 2.2	2 1.4	2 1.4	2 1.2	2 1.4	2 .5	2
Not at all	1 84.3	1 91.2	1 92.1	1 92.8	1 87.3	1 93.2	1 99.3

CF 1631

17a. Are you usually home during the night on weekends?

Yes	79.4	1
No *(Skip to Q. 18)*	8.0	2

(If Yes)

b. Do any of the noises we've been talking about bother or annoy you during the night on weekends?

Yes	31.1	1
No *(Skip to Q. 18)*	48.0	2

(If Yes)

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
c. What noises do that? *(Circle all that apply.)*	1 8.4	2 9.6	3 5.9	4 5.9	5 11.6	6 6.8	7 .7

d. How often does the noise from *(source)* bother or annoy you during the night on weekends?

Every weekend	1 .8	1 3.8	1 2.3	1 1.9	1 5.1	1 2.5	1 .4
How many times?	__	__	__	__	__	__	__
Several weekends a month	2 3.4	2 4.7	2 2.5	2 2.8	2 4.7	2 3.3	2 .2
Once every few months	3 3.4	3 1.0	3 .9	3 1.0	3 1.4	3 .8	3 .1
Less often than that	4 .6	4	4 .1	4 .1	4 .3	4 .3	4
(Don't know)	8 .3	8 .2	8 .1	8 .1	8 .1	8 .1	8

e. And *(in general and taking everything into consideration)*, how annoyed are you by noise from *(source)* during the night on weekends?

Extremely	5 1.9	5 2.3	5 1.4	5 1.5	5 3.9	5 2.0	5 .3
Very much	4 2.0	4 3.1	4 1.6	4 1.6	4 3.0	4 2.1	4 .2
Moderately	3 3.0	3 2.4	3 2.0	3 1.5	3 3.2	3 1.8	3 .2
Slightly	2 1.4	2 1.3	2 .8	2 .8	2 1.4	2 .7	2
Not at all	1 91.5	1 90.3	1 94.0	1 94.1	1 88.4	1 93.2	1 99.2

79-80 06

1-6 DUP

CF 163 K

D.07

18. During what hours of the night (or day) do you usually sleep?

From: __________ AM / PM [15-18]   To: __________ AM / PM [19-22]

(Show Cards # 5 and # 6 for Questions 19-23.)

19a. Does noise ever wake you up or prevent you from falling asleep?

Yes. . . . . 38.1 . . . . 1 [23]
No *(Skip to Q. 20a)* 48.6 2

(If Yes)

b. What noises wake you up or prevent you from falling asleep? *(Circle all that apply.)*

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
all that apply.)	1 10.1	2 9.4	3 7.5	4 6.4	5 13.6	6 9.4	7 1.1

c. How often does the noise from *(source)* wake you up or prevent you from falling asleep? *(Card # 5)*

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
Everyday	1 .6	1 1.1	1 .9	1 .9	1 2.6	1 1.0	1 .2
How many times?	__ 26	__ 30	__ 34	__ 38	__ 42	__ 46	__ 50
Several times a week. . . .	2 1.6	2 3.4	2 2.4	2 1.7	2 5.0	2 3.0	2 .3
Several times a month . .	3 3.4	3 3.1	3 2.2	3 2.1	3 3.7	3 2.7	3 .3
Once every few months . .	4 3.5	4 1.3	4 1.7	4 1.4	4 1.7	4 1.7	4 .2
Less often than that	5 .8	5 .4	5 .3	5 .2	5 .6	5 .9	5 .1
(Don't know)	8 .1	8	8	8	8	8	8

d. How annoyed are you by *(source)* interfering with your sleep *(repeat answer to "c" above)*? *(Card # 6)*

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
Extremely	5 3.1	5 2.9	5 2.9	5 2.3	5 5.6	5 3.4	5 .5
	4 1.8	4 2.6	4 1.9	4 1.4	4 2.8	4 2.0	4 .2
	3 3.4	3 2.2	3 1.9	3 1.6	3 3.3	3 2.3	3 .1
	2 1.4	2 1.0	2 .5	2 .8	2 1.2	2 .9	2 .2
Not at all	1 90.2	1 91.2	1 92.9	1 93.8	1 87.0	1 91.2	1 98.8

CF 163 L

20a. Does noise ever interfere with your listening to radio or TV?

Yes	38.2	1	52
No *(Skip to Q. 21a)*	48.8	2	

(If Yes)

b. What noises interfere with your listening to radio or TV? *(Circle all that apply.)*

	Artillery		Street traffic		Air-planes		Heli-copters		Children and dogs		Other		Other	
all that apply	1	6.2	2	7.0	3	14.4	4	16.9	5	3.1	6	5.0	7	.5

78 BK
79-80 07
1-6 DUP

c. How often does the noise from *(source)* interfere with your listening to radio or TV? *(Card #5)*

Everyday	1	.4	1	2.3	1	3.4	1	4.3	1	1.1	1	1.7	1	.2
How many times?	___ 55		___ 59		___ 63		___ 67		___ 71		___ 75		___ 8	
Several times a week	2	1.6	2	2.5	2	5.2	2	6.3	2	1.1	2	2.7	2	.2
Several times a month	3	2.7	3	1.4	3	3.9	3	4.3	3	.7	3	2.0	3	
Once every few months	4	1.2	4	.3	4	1.3	4	1.4	4	.1	4	1.1	4	.1
Less often than that	5	.2	5	.2	5	.6	5	.6	5	.1	5	.4	5	
(Don't know)	8	.1	8		8		8		8		8	.1	8	

d. How annoyed are you by noise from *(source)* interfering with listening to radio or TV *(repeat answer to "c" above)*? *(Card #6)*

Extremely	5	1.3	5	1.5	5	3.5	5	3.9	5	1.2	5	2.4	5	.3
	4	1.4	4	2.0	4	2.9	4	3.9	4	.6	4	1.7	4	.1
	3	2.4	3	2.0	3	4.8	3	5.5	3	.9	3	2.5	3	.1
	2	1.1	2	.9	2	3.4	2	2.7	2	.4	2	1.3	2	
Not at all	1	93.9	1	93.3	1	86.3	1	83.9	1	96.9	1	92.1	1	99.5

CF 163 M

21a. Does noise ever interfere with conversation? Either face-to-face or over the phone?

Yes 38.2 1   10
No *(Skip to Q. 22a)* 59.2 2

b. What noises interfere with conversation?

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
What noises interfere with conversation?	1 4.4	2 5.6	3 10.2	4 12.2	5 3.7	6 4.0	7 .3

c. How often does the noise from *(source)* interfere with conversation? *(Card # 5)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Everyday	1 .2	1 1.5	1 1.6	1 2.3	1 .9	1 1.4	1 .1
How many times?	__ 13	__ 17	__ 21	__ 25	__ 29	__ 33	__ 37
Several times a week	2 1.1	2 2.0	2 3.4	2 4.2	2 1.3	2 1.0	2 .1
Several times a month . .	3 1.3	3 1.4	3 3.1	3 3.3	3 .5	3 1.0	3
Once every few months . .	4 1.4	4 .6	4 1.6	4 1.6	4 .3	4 .5	4
Less often than that	5	5	5 .5	5 .7	5 .1	5 .2	5
(Don't know)	8	8	8	8	8	8 .1	8

d. How annoyed are you by *(source)* interfering with conversation *(repeat answer to "c" above)*? *(Card # 6)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Extremely	5 1.2	5 1.3	5 2.5	5 2.8	5 1.9	5 1.4	5 .2
	4 .7	4 1.5	4 1.9	4 3.0	4 .7	4 1.0	4
	3 1.5	3 1.8	3 3.1	3 3.6	3 .8	3 1.0	3 .1
	2 .6	2 .8	2 1.8	2 1.8	2 .4	2 .3	2
Not at all	1 96.0	1 94.6	1 90.8	1 88.8	1 96.9	1 96.3	1 99.7

22a. Does noise ever interfere with your activities out-of-doors around your home apartment?

Yes 10.3 1   39
No *(Skip to Q. 23a)* 76.3 2

CF 163N

D.08

b. What noises interfere with your outdoor activities around your home/apartment? *(Circle all that apply.)*

	Artillery	Street traffic	Air-planes
(Circle all that apply.) . . .	1 1.3	2 3.0	3 2.0

c. What outdoor activities does noise from *(source)* interfere with?

Artillery	Street traffic	Air-planes
______ 41	______ 47	______ 53
______ 42	______ 48	______ 54
______	______	______

d. Taking everything into consideration, how often does the noise from *(source)* interfere with your activities out-of-doors? *(Card # 5)*

	Artillery	Street traffic	Air-planes
Everyday	1 43	1 .4	1 .4
How many times?	__ 44	__ 50	__ 56
Several times a week	2 .3	2 1.3	2 .4
Several times a month . .	3 .2	3 .8	3 .6
Once every few months . .	4 .6	4 .5	4 .5
Less often than that	5	5	5
(Don't know)	*8*	*8*	*8*

e. How annoyed are you by *(source)* interfering with your outdoor activities *(repeat answer to "d" above)*? *(Card # 6)*

	Artillery	Street traffic	Air-planes
Extremely	5 .3	5 .9	5 .6
	4 .1	4 .7	4 .2
	3 .7	3 1.2	3 .7
	2 .1	2 .2	2 .3
Not at all	1 98.8	1 97.0	1 98.2

CF 163 O

Helicopters	Children and dogs	Other	Other
4 3.8	53.0	6 1.9	7 .4

1	.8	1	.5	1	.1	1	
2	1.1	2	1.0	2	.6	2	.2
3	.9	3	.9	3	.8	3	.1
4	.9	4	.5	4	.3	4	
5		5	.1	5	.1	5	
8		8		8		8	

5	1.4	5	1.1	5	.5	5	.2
4	.7	4	.5	4	.7	4	
3	.9	3	.7	3	.6	3	.1
2	.6	2	.5	2	.1	2	
196.5		197.1		198.1		199.6	

CF 163 O cont.

23a. Does noise or vibration ever make your house rattle or shake?

Yes	71.0	1
No *(Skip to Q. 24a)*	16.1	2

b. What noises make your house rattle or shake? *(Circle all that apply.)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
all that apply.)	1 63.4	2 1.0	3 11.1	4 12.1	5 .1	6 2.5	7 .2

c. How often does the noise from *(source)* make your house rattle or shake? *(Card # 5)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Everyday	1 1.6	1 .1	1 1.9	1 2.4	1	1 .6	1
How many times?	__	__	__	__	__	__	__
Several times a week	2 10.1	2 .4	2 2.8	2 3.7	2	2 .7	2 .1
Several times a month	3 21.3	3 .2	3 3.4	3 3.7	3	3 .5	3
Once every few months	4 24.3	4 .1	4 2.3	4 1.8	4	4 .3	4
Less often than that	5 4.9	5 .1	5 .7	5 .5	5	5 .3	5 .1
(Don't know)	8 1.0	8	8	8	8	8 .1	8

d. How annoyed are you by *(source)* making your house rattle or shake *(repeat answer to "c" above)*? *(Card # 6)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Extremely	5 5.9	5 .9	5 2.1	5 2.8	5	5 .7	5 .1
	4 7.4	4 .4	4 2.0	4 2.1	4 .1	4 .1	4
	3 16.8	3 .3	3 2.9	3 3.6	3 .1	3 .4	3
	2 14.8	2	2 2.4	2 1.9	2	2 .7	2
Not at all	1 55.5	1 99.0	1 90.4	1 89.3	1 99.7	1 97.9	1 99.8

CF 163 P

D.09

24a. As far as you know, has noise or vibration ever hurt or damaged anything in your house?

Yes. . . . . 8.4 . . . . 1 39
No *(Skip to Q. 25)* . . . 78.8 2

(If Yes)

b. What noise (or vibration) did this? ______________________________ 40-41

____

____

c. What sorts of damage do you think it did? *(Anything else?)* ______________________________ 42-43

______________________________ 44-45

______________________________ 46-47

d. About when did that happen? ______________________________ 48-49

____

CF 163 Q

(Show Cards # 5 and # 6 for Questions 25-28.)

25a. Does noise ever startle you?

Yes. 35.9 1
No *(Skip to Q. 26a)* 51.4 2

b. What noises startle you? *(Circle all that apply.)*

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
that apply.)	1 24.1	2 4.2	3 4.7	4 3.8	5 1.9	6 5.3	7 .6

c. How often does the noise from *(source)* startle you? *(Card # 5)*

d. How annoyed are you at being startled by *(source) (repeat answer to "c" above)? (Card # 6)*

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
Everyday	1 .6	1 .4	1 .2	1 .6	1 .3	1 .2	1 .1
How many times?	___ 53	___ 57	___ 61	___ 65	___ 69	___ 73	___ 77
Several times a week	2 2.5	2 1.1	2 1.0	2 1.0	2 .7	2 1.2	2
Several times a month . .	3 7.7	3 1.1	3 1.0	3 .9	3 .4	3 1.6	3 .1
Once every few months . .	4 9.1	4 .9	4 1.3	4 .9	4 .4	4 1.0	4 .1
Less often than that	5 3.9	5 .7	5 1.1	5 .3	5 .1	5 1.7	5 .2
(Don't know)	8 .3	8 .1	8	8	8	8 .1	8
Extremely	5 5.9	5 1.3	5 1.3	5 1.5	5 .9	5 1.6	5 .1
	4 3.4	4 1.3	4 .7	4 .6	4 .3	4 .9	4
	3 7.9	3 .7	3 1.4	3 1.0	3 .5	3 1.2	3 .2
	2 4.9	2 .6	2 .9	2 .5	2 .2	2 .5	2 .1
Not at all	1 77.8	1 96.1	1 95.7	1 96.4	1 98.3	1 95.5	1 99.4

CF 163 R

26a. Does noise ever frighten you?

Yes 19.6 1
No *(Skip to Q. 27a)* 67.8 2

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
b. What noises frighten you? *Circle all that apply.)*	1 9.2	2 2.7	3 2.9	4 2.6	5 1.2	6 5.4	7 .2

c. How often does the noise from *(source)* frighten you? *(Card # 5)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Everyday	1 .4	1 .3	1 .1	1 .3	1 .2	1 .1	1
How many times?	__	__	__	__	__	__	__
Several times a week	2 1.0	2 .7	2 .7	2 .7	2 .2	2 .5	2
Several times a month . .	3 2.9	3 .7	3 .6	3 .7	3 .2	3 1.6	3
Once every few months . .	4 3.7	4 .7	4 .8	4 .5	4 .3	4 1.2	4
Less often than that	5 1.1	5 .3	5 .6	5 .3	5 .2	5 1.7	5 .2
(Don't know)	8	8	8	8	8	8 .2	8

d. How annoyed are you at being frightened by *(source) (repeat answer to "c" above)*? *(Card # 6)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Extremely	5 3.3	5 1.0	5 1.0	5 1.2	5 .5	5 1.7	5
	4 2.0	4 .8	4 .8	4 .5	4 .2	4 1.2	4
	3 1.9	3 .4	3 .4	3 .5	3 .2	3 1.1	3
	2 1.4	2 .3	2 .5	2 .2	2 .1	2 .7	2 .1
Not at all	1 91.5	1 97.4	1 97.2	1 97.5	1 98.9	1 95.3	1 99.8

CF 163 S

27a. Does noise ever interfere with activities that require your care or concentration?

Yes	17.6	1
No *(Skip to Q. 28a)*	69.8	2

(If Yes)

b. What sorts of activities? ______________________________

____

c. What noises interfere with activities that require your care or concentration? *(Circle all that apply.)*

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
	1 6.8	2 4.5	3 5.4	4 6.1	5 3.4	6 2.9	7 .3

d. How often does the noise from *(source)* interfere with activities that require your care or concentration? *(Card #5)*

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
Everyday	1 .3	1 1.0	1 .7	1 1.2	1 1.6	1 .5	1 66
How many times?	___ 43	___ 47	___ 51	___ 55	___ 59	___ 63	___ 67
Several times a week	2 1.4	2 1.5	2 1.9	2 2.1	2 .2	2 1.0	2 .1
Several times a month	3 2.5	3 1.2	3 1.8	3 1.8	3 1.0	3 .7	3 .1
Once every few months	4 2.3	4 .6	4 .8	4 .7	4 .4	4 .5	4
Less often than that	5 .3	5 .2	5 .2	5 .1	5 .1	5 .2	5
(Don't know)	8	8	8	8	8	8	8

e. How annoyed are you by *(source)* interfering with activities requiring your care and contration *(repeat answer to "d" above)*? *(Card #6)*

	Artillery	Street traffic	Airplanes	Helicopters	Children and dogs	Other	Other
Extremely	5 2.3	5 1.4	5 1.8	5 2.1	5 1.2	5 .9	5 .1
	4 1.7	4 1.2	4 1.7	4 1.7	4 1.0	4 .7	4 .1
	3 1.8	3 1.4	3 1.4	3 2.0	3 .8	3 1.0	3 .1
	2 .8	2 .4	2 .5	2 .2	2 .3	2 .3	2
Not at all	1 93.2	1 95.3	1 94.6	1 93.9	1 96.6	1 97.0	1 99.6

CF 163 I

28a. Does noise ever disturb **your** rest and relaxation here at home?

Yes. 32.5 1

No *(Skip to Q. 29a)* . . 54.7 2

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
b. What noises disturb your rest and relaxation? *(Circle all that apply.)*	1 11.4	2 5.2	3 8.2	4 9.4	5 9.4	6 6.4	7 .6

79-80 10
1-6 DUP

c. How often does the noise from *(source)* disturb your rest and relaxation? *(Card #5)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Everyday	1 .4	1 1.6	1 1.4	1 1.5	1 2.0	1 .7	1
How many times?	72	76	8	12	16	20	24
Several times a week. . . .	2 2.2	2 3.3	2 2.7	2 3.5	2 3.6	2 2.2	2 .3
Several times a month . .	3 4.4	3 2.1	3 2.9	3 2.3	3 2.5	3 2.1	2
Once every few months . .	4 3.6	4 .9	4 1.0	4 1.3	4 1.1	4 1.0	4 .1
Less often than that	5 .6	5 .3	5 .1	5 .4	5 .3	5 .3	5
(Don't know)	*8* .1	*8*	*8*	*8*	*8*	*8*	*8*

d. How annoyed are you by *(source)* disturbing your rest and relaxation *(repeat answer to "c" above)*? *(Card #6)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Extremely	5 3.9	5 2.8	5 2.5	5 3.2	5 3.1	5 2.5	5 .1
	4 2.2	4 2.2	4 2.2	4 2.5	4 2.4	4 1.4	4 .1
	3 4.0	3 2.5	3 2.3	3 2.7	3 2.7	3 1.9	3 .2
	2 1.0	2 .5	2 1.1	2 .9	2 1.0	2 .4	2
Not at all	188.8	191.9	191.8	196.7	196.7	193.7	199.4

CF 163 C

29a. *(If applicable)* Does noise ever bother or disturb anyone else in the household?

Yes. 35.5 1 26
No *(Skip to Q. 30a)* 42.8 2
One person household *(Skip to Q. 30a)* . . . 7.7 3

	Artillery	Street traffic	Air-planes
b. What noises bother or disturb other members of the household? *(Circle all that apply.)*	1 17.9	2 8.4	3 9.9
c. Who does noise from *(source)* bother or disturb?	28	35	42
	29	36	43
d. In what sorts of ways does noise from *(source)* bother or disturb them?	30-31	37-38	44-45
	32-33	39-40	46-47

CF 163 V

Heli-copters	Children and dogs	Other	Other
4 [illegible]	5 [illegible]	6 [illegible]	7 [illegible]
49	56	63	70
50	57	64	71
51-52	58-59	65-66	72-73
53-54	60-61	67-68	74-75

CF 163 V cont.

e. How often does the noise from *(source)* bother or disturb other members of the household? *(Card # 5)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Everyday	1 .9	1 1.9	1 2.1	1 2.4	1 2.7	1 1.2	1 .1
How many times?	__ 77	__ 8	__ 11	__ 14	__ 17	__ 20	__ 23
Several times a week	2 3.6	2 3.4	2 3.3	2 3.9	2 4.2	2 2.5	2 .4
Several times a month	3 7.4	3 1.9	3 2.7	3 2.7	3 2.0	3 2.4	3 .5
Once every few months	4 4.3	4 .3	4 .8	4 1.4	4 .6	4 .9	4 .1
Less often than that	5 .5	5 .2	5 .2	5 .1	5 .3	5 .6	5
(Don't know)	8 .2	8	8	8	8	8 .2	8

f. How annoyed are **you** by *(source)* disturbing other members of your household *(repeat answer to "e" above)*? *(Card # 6)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Extremely	5 5.1	5 2.0	5 2.4	5 3.4	5 3.4	5 2.1	5 .3
	4 2.9	4 2.2	4 2.3	4 2.0	4 2.4	4 1.6	4 .2
	3 5.1	3 2.1	3 2.8	3 3.4	3 2.5	3 2.0	3 .2
	2 2.9	2 .9	2 1.2	2 1.4	2 .8	2 1.2	2 .1
Not at all	1 83.5	1 92.4	1 91.1	1 89.6	1 90.4	1 92.8	1 99.0
	79-80 11 1-6 DUP						25 BK

CF 163 W

30a. How much would you say **could** be done to reduce the noise from *(source)*? *(Show Card # 7. Read categories and circle answer code.)* What about *(next source)*?

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
A great deal	1 3.5	1 7.1	1 2.6	1 4.4	1 7.4	1 3.1	1 .5
Quite a bit	2 4.6	2 9.7	2 5.5	2 6.4	2 9.2	2 2.0	2 .6
A fair amount	3 8.3	3 16.3	3 8.7	3 9.4	3 18.2	3 1.4	3 .2
Not very much	4 25.4	4 18.9	4 23.2	4 23.2	4 15.8	4 1.6	4 .1
Nothing at all	5 30.7	5 24.2	5 31.7	5 30.6	5 25.5	5 3.6	5 .7
(Don't know)	8 13.6	8 12.1	8 12.2	8 11.0	8 12.1	8 1.0	8 .1

b. *(As far as you know . . .)* Right now **is** there anything being done to reduce the noise from *(source)*?

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
Yes	1 1.9	1 5.5	1 2.3	1 2.3	1 6.1	1 2.7	1 .1
No	2 63.6	2 61.1	2 61.2	2 63.0	2 61.0	17.9	2 1.7
(Don't know)	8 20.4	8 15.0	8 19.7	8 19.4	8 12.9	8 1.5	8 .2

(If Yes)

c. **How much** would you say is being done to reduce the noise from *(source)*? *(Show Card # 7)*

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
A great deal	1 .2	1 1.1	1 .6	1 .3	1 .7	1 .1	1 **
Quite a bit	2 .5	2 1.4	2 .5	2 .6	2 1.4	2 .1	2
A fair amount	3 1.0	3 2.1	3 .9	3 1.0	3 3.0	3 .1	3
Not very much	4 .1	4 .7	4 .3	4 .3	4 .6	4 .1	4
Nothing at all	5	5 .1	5	5	5	5	5
(Don't know)	8 .1	8	8	8 .1	8	8	8

CF 163 X

31. Compared to most people, how sensitive do you think you are to noise? *(Card #4) (Read categories and circle answer code.)*

Much more	6.0	1	47
More	10.1	2	
About the same	49.8	3	
Less	24.1	4	
Much less	8.4	5	
(Don't know)	.6	8	

32. Now here's a different kind of question. I have a list of noises which sometimes annoy people. Do these ever annoy you when you hear them? *(Read list.)*

	Annoy Yes	Annoy No	*Never hear*	
a. The noise of a lawn mower	1 22.2	2 77.0	3 .6	48
b. A dripping faucet	1 68.2	2 30.8	3 .9	49
c. A dog barking continuously	1 83.7	2 15.6	3 .5	50
d. The sound of a knife scraping on a plate	1 40.7	2 56.5	3 2.6	51
e. Somebody whistling out of tune	1 23.4	2 74.1	3 2.4	52
f. Chalk scraping a blackboard	1 59.6	2 36.9	3 3.2	53
g. A pneumatic drill or air hammer	1 45.1	2 44.9	3 9.5	54
h. A banging door	1 58.9	2 34.2	3 1.7	55
i. Musical instruments in practice	1 23.3	2 71.0	3 5.6	56
j. Typewriters	1 4.1	2 92.6	3 3.2	57

CF 163 Y

33. How important do you think the activities at *(location)* are to this community? What about *(next location)*?

		58		60		62
		99.1		99.1		99.0
Very important	1	75.0	1	67.6	1	61.0
Somewhat important, or	2	15.3	2	16.6	2	17.1
Not at all important	3	5.0	3	5.9	3	5.9
(Don't know)	8	4.1	8	9.1	8	15.2

34a. Do you think people around here ought to complain about the noise from government facilities or operations, if they find it annoying? 64

Yes 60.7 1

No 38.7 2

b. Why is that? ______________________ 65-66

______________________ 67-68

______________________ 69-70

CF 163 Z

35a. Have you ever felt like doing something about noises coming from any source?

Yes. . . . . 38.4 . . . . 1 [71]
No *(Skip to Q. 36a)* 61.2 2

(If Yes)

b. *What noises?*

______________________________ [72]

Ask c through f for each noise source before going on to the next source.

c. Have you ever actually done anything about noise from *(source)*? What about *(next source)*?

[73]
Yes . . . . 16.3 . . 1
No *(Skip to next source or Q. 36a if finished with all sources)* . . . 22.1 . . 2

(If Yes)

d. What did you do?

______________________________ [74-75]

______________________________ [76-77]

78 BK
79 80 12
1-6 DUP

e. And when was that?

______________________________ [7-8]

____

f. What was the outcome?

______________________________ [9-10]

______________________________ [11-12]

CF 163 AA

D.12

______________________ 13 ______________________ 25

Yes . . . . 3.4 . . . 1
No *(Skip to next source or Q. 36a if finished with all sources)* . . . 5.9 . . . 2

Yes 7 1
No *(Skip to Q. 36a)* 1.6 2

______________________ 15-16 ______________________ 27-28

______________________ 17-18 ______________________ 29-30

______________________ 19-20 ______________________ 31-32

______________________ ______________________

______________________ 21-22 ______________________ 33-34

______________________ 23-24 ______________________ 35-36

CF 163 AA cont.

36a. Are you ever concerned that any source of noise we've been talking about might cause damage in this neighborhood?

Yes. 34.9 1

No *(Skip to Q. 37a)* 64.6 2

(If Yes)

	Artillery	Street traffic	Air-planes	Heli-copters	Children and dogs	Other	Other
b. What do you think might do this? *(Circle all that apply.)*	1 [illegible]	2 9.3	3 9.8	4 5.7	5 3.6	6 3.3	7 .2

c. What do you think the chances are that *(source)* might cause damage in this neighborhood in the next few years? *(Card # 8) (Read categories and circle answer code.)*

Very likely	1 42.1	1 5.5	1 2.4	1 2.5	1 1.5	1 1.3	1
Likely	2 7.3	2 3.2	2 4.9	2 3.5	2 1.6	2 1.4	2 .1
Unlikely.	3 1.8	3 .2	3 1.2	3 1.2	3 .3	3 .4	3
Very unlikely	4 1.3	4 .2	4 .7	4 1.0	4	4 .2	4
Almost no chance at all .	5 .6	5 .1	5 .5	5 .4	5 .1	5	5

If R lives on post, skip to Q. 39

CF 163 BB

37a. Are there any members of the household including yourself who work for, or at, any government facilities or government operations?

Yes . . . . 36.0 . . . . 1 52
No *(Skip to Q. 38)* 47.0 2

(If Yes)

b. Who, in this household? ______________________________ 53-54

c. Where does he/she work? ______________________________ 55-56

57-58

38. Do you own or rent this dwelling unit?

Own . . . . 52.9 . . . . 1 59
Rent 28.8 2

39. Now, a few background items about yourself to help us analyze the results of this survey. Remember at no time will any of this information be used to identify anyone.

a. Are you currently employed?

Yes . . . . 60.5 . . . . 1 60
No *(Skip to Q. 40)* 35.9 2

(If Yes)

b. What is your job title?

______________________________ 61-63

c. What kind of work do you do?

____

____

____

d. Are you employed full or part time?

Full time . . . . 54.2 . . . . 1 64
Part time 5.9 2

CF 163 CC

40. **What is the last grade you completed in school?**

Did not finish high school	19.3	01
High school graduate	45.1	02
College through		
freshman	7.7	03
sophomore	6.9	04
(two year college graduate, A.A., A.S.)	3.5	05
junior	3.2	06
College graduate	8.2	07
Some post graduate work	1.6	08
Master's degree	2.2	09
Ph.D. or other doctorate degree	.2	10
Professional degree (M.D., L.L.D., etc.)	.4	11
Other *(Specify)*	1.7	12

41. **Was your total family income before taxes last year (1977) . . .**

More than $3,000?	No	5.7	0
More than $5,000?	No	5.6	1
More than $7,500?	No	13.4	2
More than $10,000?	No	17.7	3
More than $15,000?	No	19.8	4
More than $25,000?	No	14.6	5
	Yes	5.4	6
(Don't know)		11.2	8
(Refused)		6.6	9

Coder________ 68-70

Check Coder________ 71-73

Keypunch________ 74-76

Thank you very much for your cooperation.

CF 163 DD

APPENDIX D:

DESCRIPTION OF MONITORING SITES AT FORT BRAGG

Site 1

Location: Western border of Fort Bragg and Chicken Road

Name: Chicken Road

Specific Location: 50 m east of western border along fire break; 100 m south of Chicken Road

Grid Coordinates: 506,823

Directions: From installation cantonment area take Plank Road west to junction of King Road. King Road north 3.1 k to Chicken Road; west 0.8 k on Chicken Road to fire break; 100 m south on fire break. Monitor will be located on east side of fire break.

Site 2

Location: Aberdeen Antenna Farm

Name: Antenna Farm

Specific Location: 500 m east of Antenna Farm along road to Antenna Farm

Grid Coordnates: 490,873

Directions: From installation cantonment area, take Plank Road west to King Road; King Road north 8 k to dirt road; 2 k west on dirt road.

Comments: No power, no buildings nearby other than Antenna Farm

Site 3

Location: Southern boundary of Fort Bragg and Raeford and Vass Road

Specific Location: About 500 m west of Raeford and Vass Road along military reservation boundary on fire break

Grid Coordinates: PH 606,789

Directions: From installation cantonment area to Plank Road east to Ranger Station 1; south Raeford and Vass Road to installation boundary; west 500 m on fire break. Unit located just north of fire break.

Comments: No power or building nearby

Site 4

Location: North of trailer park along Plank Road

Name: Trailer Park

Grid Coordinates: PJ 699,800

Directions: From installation cantonment area, take Plank Road west past St. Mereglise drop zone to unnamed road leading south to trailer park; turn north along dirt road 200 m past Burm. Unit is located in trees beside road.

Comments: No power or buildings nearby

Site 5

Location: Town of Aberdeen

Name: Aberdeen

Specific Location: 110 Montford Road, Aberdeen, NC. Blue box located in storage shed next to carport in backyard. Cabling will be run through vent near top of roof; No. 4921 will be located along fence 100 m east of carport.

Grid Coordinates: 436,894

Directions: From installation take State Route 211 west; at junction of State 211 and US 501 and US 15 turn north; at junction of US 1 continue north; turn right on Montford Road. First Baptist Church will be on the right side of street. Go 1 block east; house is yellow with white trim.

Comments: None

Site 6

Location: Town of Southern Pines

Name: Southern Pines

Specific Location: 385 E. New Jersey, Southern Pines. Monitoring unit will be placed in the garage; No. 4921 will be placed outside of garage with cable running through window in garage.

Grid Coordinates: 473,935

Directions: From installation take Southern Pines Road to Morgantown Road to Southern Pines; at Southern Pines take May Street northeast until New Jersey; southeast on New Jersey 1 block. House located on the corner of New Jersey.

Site 7

Location: Southern installation boundary and Merchison Road near Simmons Army Airfield

Name: Merchison Road

Specific Location: 200 m north northeast of installation marker along Atlantic coast line at Merchison Road

Grid Coordinates: PJ 881,885

Directions: From Fayetteville, take Merchison Road to installation boundary; continue northwest to first paved road leading northeast; follow road over railroad tracks; take dirt boundary road along train tracks to installation marker corner; site is 200 m northeast.

Comments: This is a helicoper site; no power or buildings nearyby

Site 8

Location: Town of Pinehurst

Name: Pinehurst

Grid Coordinates: PH 400,960

Directions: From circle northeast of Pinehurst, take State Route 2 west to Pinehurst; take right at second paved road (short road) -- may be located by fire hydrant in median; go northwest 2 blocks to Everett Road; left on Everett Road to third house on right. House is white with green shutters. Monitor lorated in garage in backyard. No. 4921 located in yard.

Comments: The power switch was taped to prevent accidental turning off of light which will be used to receive power.

Site 9

Location: Town of Raeford

Name: Raeford

Grid Coordinates: PJ 605,717

Directions: From the installation, take State Route 211 west; turn north at junction of State Route 211 and U.S. 501 and U.S. 15; continue north at junction of U.S. 1; turn right on Mumford Road. First Baptist Church will be on the right side of the street. Go 1 block east; house is yellow with white trim.

Comments: None

Site 10

Location: Clifoale Road

Grid Coordinates: PJ 767,788

Comments: Power

Site 11

Location: 673 Wiltshire Road

Grid Coordinates: PJ 866,797

Comments: Power

Site 12

Location: Fort Bragg

Name: Brown

Grid coordinates: 911,823

Comments: Power

Site 13

Location: 7 Normandy Dr., Fort Bragg

Name: Normandy

Grid Coordinates: PJ 810,889

Comments: Power

Site 14

Location: 205 Soufer, Fort Bragg

Name: Santos

Grid Coordinates: PJ 845,914

Comments: Power

Site 15

Location: Pope Air Force Base

Name: Pope Air Force Base

Specific Location: Just off main runway

Grid Coordinates: PJ 823,952

Comments: No power

Site 16

Location: 5413 Sanstone

Name: College Lake

Grid Coordinates: 912,901

Comments: Power

Site 17

Location: 925 Sunburt Ave.

Name: Warren Lake

Grid Coordinates: 905,885

Comments: Power

APPENNDIX E:

NOISE MONITOR OPERATION*

STARTING MONITOR PROCEDURE

1. Set up system according to block diagram.

2. 4921 Set Up

a. Set power switch to Ext
b. Set polarization switch to 200
c. Set direct, A-weighted switch to direct
d. Set gain switch to 0 dB
e. Set calibration + 10 dB pot to max gain position

3. Abbreviated Calibration Summary

a. LEQ-SEL switch set to LEQ
b. Obtain corrected calibrator level from the 4921 to be used with this station
c. Put function switch to calibration level and enter this value into calibration level Ch #1 & Ch #2
d. Put function switch to mode of operation and select Ch #1 cal (Mode 0)
e. Allow 5 to 10 sec and then press sample switch
f. Repeat procedure for Ch #2 calibration (Mode 1)
g. Change function to gain constants and read Ch #1 and Ch #2 values -- should be close to 40 dB
h. Put function switch to mode of operation and select sound-level meter (mode 2)
i. Change function switch to most recent value
j. While holding down reset switch, verify that Ch #1 & Ch #2 read 90.0 or 89.9 dB

4. Abbreviated Set Up Summary

a. Do not set up at night from 10 pm to 7 am
b. Set Ch #1 signal input to C
c. Set Ch #2 signal input to A
d. Set analog input selector to Ch #1 (goes to both Ch #1 and Ch #2)
e. Set function switch to mode of operation -- and select mode 6
f. Set function switch to peak detector and enter in Ch #1
g. Enter 105 dB in Ch #1 threshold
h. Change function switch to accumulation time and enter 6 min
i. Move function switch to storage format and enter 7757 (octal)
j. Set function switch to days (present time) enter day (Julian date)
k. Set function switch to hours; enter present time in hours (military time 5:00 pm = 17 hr)
l. Set function switch to minutes; enter in minutes
m. Set wind speed detector to 18 kph

* Wiring diagrams are given in Figures E1 and E2.

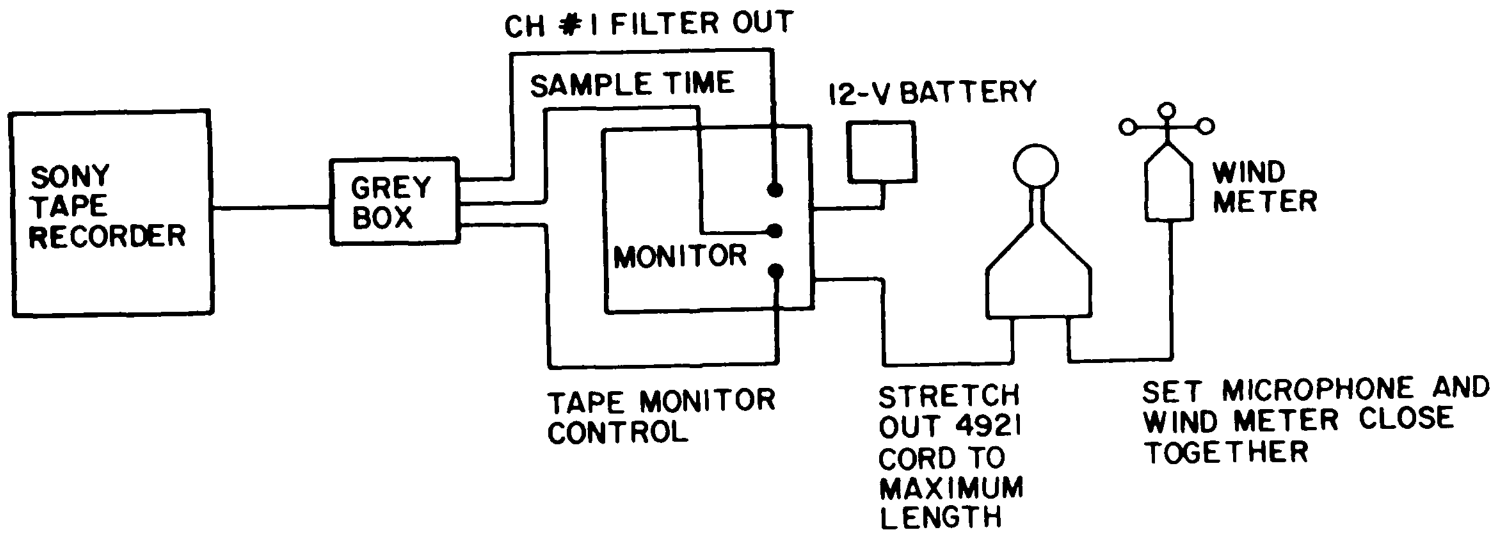
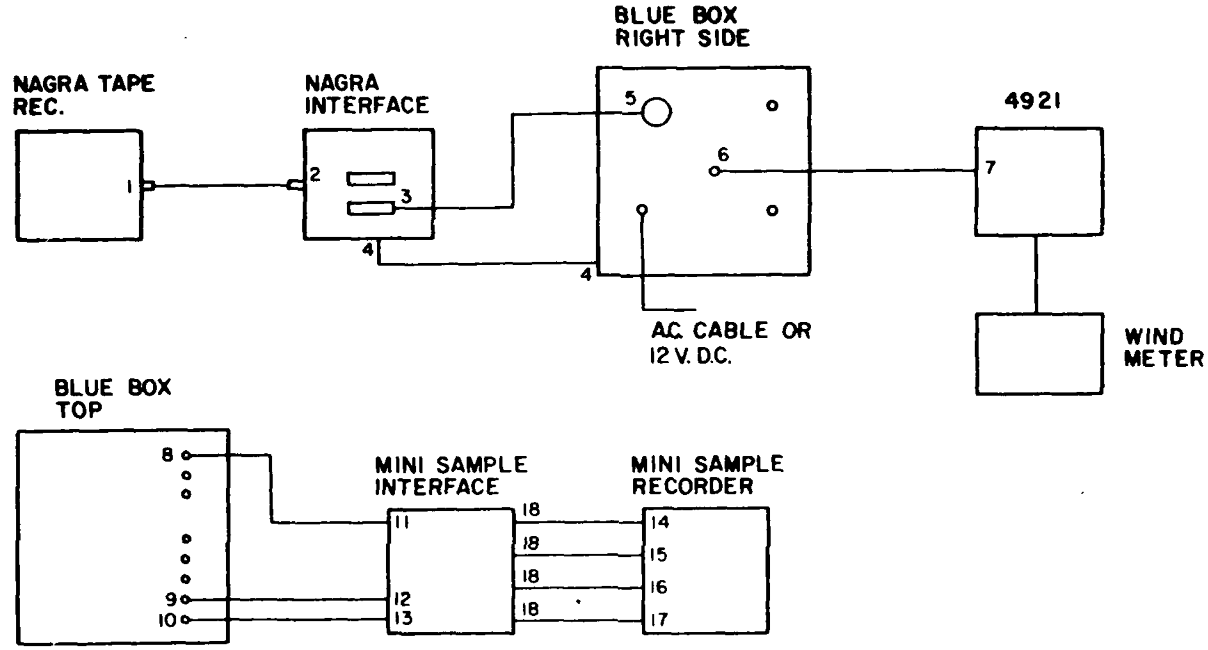


Figure E1. Monitor hookup.



1. 7 PIN MIXER INPUT
2. BNC OUTPUT
3. 50 PIN CONN.
4. GROUND CABLE
5. 50 PIN CONN.
6. 12 PIN CABLE TO 4921 (CH # 1 IN)
7. 4921 OUTPUT CABLE
8. ANALOG INPUT BNC TO A ON MINI SAMPLE INTERFACE SAMPLE TIME
9. BNC TO ST ON MINI SAMPLE INTERFACE
10. TAPE MONITOR CONTROL CABLE TO MINI SAMPLE INTERFACE
11. A INPUT
12. ST INPUT
13. CABLE INPUT NEW MARKING
14. DC 6V
15. REMOTE
16. RT. CH IN
17. LT. CH IN
18. CABLES FROM INTERFACE ALL ARE LABELED AS TO WHERE THEY GO

Figure E2. Monitor wiring diagram.

n. Unit is now ready for taking data in 6 min blocks, with the minisample triggering on sound levels over 105 dB

o. Set start time and check next storage block location to determine that the unit has taken a block of data

p. Turn function switch to minutes and check that the clock is working properly

5. Tape Recorder Set Up

Minisample

a. Mic line switch set to line (right side of tape recorder)
b. Mono stereo switch set to stereo
c. Tape selector switch set to normal
d. Tape recorder operational switches set to forward rec
e. Load cassette
   (1) Load cassette into cassette recorder
   (2) Set tape recorder on record
   (3) Check record level; it should be at midpoint
   (4) Clear tape counter
   (5) Advance tape to a count of 2

6. Checking Start Up

a. When start time occurs:
   (1) Check that display clears
   (2) Standby light goes out
   (3) Start light turns on

b. Clap loudly near microphone for 3 sec; while clapping yell "start, start, ..."

c. Check tape recorder counter to see if tape advanced

d. Close up blue box and 4921 and wire both shut

7. Monitor Daily Operating Procedure

Caution Note: Do not change 12-V battery (if used) until after dumping data.

1a. Approach system; yell "Dump-Dump-Dump" loudly and make sure the minisample tape recorder is taking data (the yells have to be spaced to cause the unit to take a long block which is over 2.5 sec); if the blue box is placed some distance from the 4921 microphone, the minisample tape counter will have to be used to ascertain that the unit is working properly

b. Attach ground wire from interface to blue box

c. Attach interface cable to blue box

d. Set function switch to next storage block location and read the value

e. Change function switch to "visual data display starting location"; enter a value that is about "X # of blocks" less than the value obtained in reading the storage block location; to find "X # of blocks," subtract 5:00 from present time and multiply by 6; the block #'s wrap around at 292, so the operator may have to go through the cross-over point to obtain the correct block #; after the block # is entered; observe visual display for the Ch #1 and Ch #2 LEQ values, peak, and dB time; the reason for this test is to check the noise level of the system; the operator should expect levels between 50 and 60 dB; if the levels are high, further checks should be made to determine if there are problems with the system; record levels on the data sheet

f. Set Nagra tape recorder speed to 7.5 ips

g. Open lever (tape drive switch) and place the record playback switch to record; observe midscale or higher reading on the VU meter

h. Start the tape recorder and allow recording of about 10 sec of tone before pushing the dump switch on the interface box; monitor the data by either (or both) plugging headphones into Nagra phone jack or observing external data output starting location (blue box) increment as each block is passed

2. After dump:

a. Remove Nagra interface and ground wire

b. Reload minisample recorder with new cassette

c. Press forward and record switches on minisample

d. Yell into microphone "start, start, start," (the yells have to be spaced long enough to create a long block which is over 2.5 sec); observe correct operation of minisample recorder

e. Wait at least 6 min and observe next storage block location for the incremented block #

8. Dumping Data

1. Check minisample

a. Open blue box up and note tape counter on minisample tape

b. Clap loudly near microphone and yell "Dump-Dump" for 3 sec or more

c. Check minisample tape to see if it has advanced

2. Dump Data

a. Set function switch to next storage block location; read value and record on data sheet

b. Set function switch to external data output start location; read both black and DNL values; record on data sheet

c. Attach ground wire from tape interface to blue box

d. Attach interface to blue box; look at blue box data connector; line up cables carefully; do not force

e. Check Nagra tape recorder

(1) Record speed at 7.5 ips standard

(2) While recorder is set in test mode, check VU meter to see if at midrange or higher

f. Record Data

(1) Start tape recorder

(2) Record tone for 10 sec

(3) Press dump switch on interface

(4) Note that external data output starting location for block data advances

(5) When external data output starting location for block stops increasing, i.e. when it reaches next storage block location, wait 30 sec and then turn off tape recorder

g. Remove Nagra interface cable and ground wire

h. If using 12-V battery, change battery NOW; amp meter should read between 0.7 and 1.5 amps

i. Load cassette

(1) Load cassette into cassette recorder
(2) Set recorder to record
(3) Check recorder level
(4) Clear tape counter
(5) Advance tape counter to 2

j. Test minisample

(1) Clap loudly near microphone for 3 sec; while clapping, yell "start-start, ..."
(2) Check minisample counter to see if tape has advanced

k. Close up blue box and wire shut

START UP OF UNIT

1. Power On

Turn power switch to AC/power.
Check following items:

a. Display should show 6414
b. Standby light is on
c. All other lights off
d. 4921 power meter is in the green
e. If battery powered, then amp meter should read between 0.7 and 1.5 amps

2. Set Front Panel Switches

Set Front Panel switches to the following settings:

a. LEQ/SEL to LEQ
b. Ch #1 Weighting to C
c. Ch #2 Weighting to A
d. Analog Input
e. Volume Control to CCW-OFF
f. Wind Speed to 18 kph
g. Master Slave to Master

3. Calibration and Check of Calibration

a. Obtain calibrator level from 4921
b. Place this value into calibration level from Ch #1 and Ch #2
c. Set mode of operation to mode 0 (calibration Ch #1)
d. When it is quiet press start; wait 5 sec; press sample
e. Display gain constant for Ch #1
f. Repeat d and e until gain constant stops varying
g. Repeat d, e, and f for Ch #2
h. Set mode of operation to mode 2 (SLM)
i. Check most recent values of Ch #1, Ch #2, and peak; they should vary as the sound received by the microphone varies; sample length should read -10.0
j. Hold down reset switch which should activate calibrator; check most recent values; Ch #1 and Ch #2 should read the calibration level; peak should be 3.0 to 4.0 dB above calibrator level; sample length should be -10.0; these values should not change as long as you hold the switch down and there are no loud sounds occurring
k. Release reset switch which deactivates the calibrator; the most recent values should return to the levels noted in step i
l. Hold down wind test switch; test light should light; check most recent values; Ch #1 and Ch #2 should be set to their gain constant as seen in parts f and g; peak should be unaffected; sample length should go to -44.0
m. Set function switch to peak detector channel/channel 1 threshold; set peak detector channel to 1; set threshold to 102
n. Look at most recent value Ch #1; it should have the same values as seen in step i; press start switch and release; the value for Ch #1 should go

to zero if there are no loud sounds present; standby light should go out; start light should go on

o. Set function switch to mode of operation; set mode to 6; do this twice; mode 6 light and standby light should go on; all others should be off

p. Load in 6 min for accumulation time by setting function switch to accumulation time; set function shift to black and load 6 into accumulation time

q. Set storage format to 7757

r. Set present and start time

(1) Set present day and start day to the current day of the year (Jan 1 is #1); use sheet attached to top of lid to obtain current day of year

(2) Set present hour to the current hour in military time format (2 pm is 1400)

(3) Set present minutes to the current minutes (0 to 59); when you load it by pressing execute, the unit will start counting from that point

(4) Set start hour to the hour you want the unit to start; the start minute should be a multiple of 6 minutes; i.e. (00, 12, 24, 36, 48); therefore if the present time is greater than 48, your start time will be the next hour; if present time is 1350, your start time would be 1400 thus making the start hour 14

(5) Set the start minute which you determine in subsection 4

s. Insure unit was setup correctly by rechecking values loaded in and switch settings

APPENDIX F:

OBTAINING OPERATIONAL DATA FOR THE FORT BRAGG SURVEY

Fort Bragg operation data were collected as described in CERL Technical Report N-82/ADA080424, Compilation of Operational Blast Noise Data, by J. McBryan. Data were collected at Fort Bragg for three reasons:

1. To compare blast noise contours for a 1-year period with the responses to the CAS.

2. To compare the results of a "point" routine with the data obtained by the noise contours at Fort Bragg.

3. To obtain data to be used for a time series analysis.

To obtain the data needed for 1 above, it was necessary to create a data base for the year before the community attitudinal survey. This was done simply by deleting the M198 howitzer data and by increasing the number of rounds to the right number of operations for each gun type.

The data needed for 2 above were obtained by determining correct, accurate data for the time period that the monitors were operating at Fort Bragg.

The data handled for 3 above used all collected data; however, some "smoothing" of the data ocurred as choices were made when distributing rounds totals throughout the year.

Fort Bragg operational data were taken from five sources:

Data Base 1: Range personnel provided a yearly summary of operations (Table F1).

Data Base 2: Ammunition issue records for the year during and after the survey (1 August 1978 to 31 July 1979) were broken down by unit and by day (Table F2).

Data Base 3: Daily activity logs of the unit, day, location of the operation, and the time of the operations were collected.

Data Base 4: Range request forms were transcribed by CERL personnel.

Data Base 5: Fort Bragg Forms 1954 (Acquisition of Operational Blast-Noise Data) were collected (Figure F1; summarized in Table F3).

Table F4 summarizes the type of information contained in the above data bases.

Using these five sources of information, the following things were done:

1. Data Base 5 -- Form 1954 (developed jointly by Range and CERL personnel) -- was used to identify units in Data Base 4 that had not turned in Form

Table F1

Data Base 1 --
Range Personnel Data Base (5 November 1979)

Gun Type	Description	No. of Rounds per Year FY78	FY79
1	105-mm howitzer	50,298	62,918
3,7	8-in. howitzer	10,625	4,501
4	175-mm gun	500*	1,950
6,5,2	155-mm howitzer	19,448	23,756
8	155-mm howitzer (M198)	NA	20,459
10	Small TNT		
11	Large TNT		
20	60-mm mortar	9,880	6,564
22	81-mm mortar	65,581	66,419
23	4.2-in. mortar	32,264	18,209
50	2.75-in. rocket		
53	LAW		
54	TOW		
90	105-mm tank gun	6,017	4,518
92	152-mm tank gun	9,426	8,173

*Only one time period, number of 175-mm gun rounds; usually two 1/2 weeks (March, April) and (September, October).

Table F2

Summary of Data Base 2 (Obtained During Field Trip, 30 November 1979)

Gun Type	Description	Rounds Issued 1 August 1978 - 31 July 1979 HE	ILLUM	WP	TPT (Inert)
1	105-mm howitzer	48,684	1,564	3,156	562
3,7	8-in. howitzer	2,145			
4	175-mm gun*				
6,5,2	155-mm howitzer	15,094	709	826	
8	155-mm howitzer (M198)*				
10	Small TNT				
11	Large TNT				
20	60-mm mortar	6,609	235	330	
22	81-mm mortar	38,189	14,059		99
23	4.2-in. mortar	9,375	3,020	6,274	
50	2.75-in. rocket	9,766			
53	LAW	14,716			
54	TOW	55		33	
90	105-mm tank gun				4,506
92	152-mm tank gun				7,285

*Marines bring their own rounds.

ACQUISITION OF OPERATIONAL BLAST NOISE DATA

UNIT DESIGNATION: IMA DATE: 14 May 78

OIC NAME: Cpt Payne RANK: Cpt TEL NO: 60614

FUZE FUNCTION
G=Ground Burst; A=Air Burst
NB=Non-Blast (WP, Illum, ICM, etc.)

COLUMN NUMBER	WEAPON POSITION	TYPE WEAPON	NUMBER OF TUBES	CHG/ ~~INCS~~	TARGET LOCATION	ROUNDS FIRED BY TIME PERIOD/FUZE FUNCTION: 0001-Sunrise			Sunrise-0700			0700-1000			1000-Sunset-1Hr			Sunset-1Hr-2200			2200-2400		
						G	A	NB	G	A	NB	G	A	NB	G	A	NB	G	A	NB	G	A	NB
102	724858	60mm Mort	7	4	Macridge										216								
103	725860 724858	106	1		"										6								
"	"	57mm RR	2		"										38								
"	"	90mm RR	2		"										38								
"	"	M72 LAW	38		"										38								

FB Form 1954

Figure F1. Fort Bragg Form 1954.

Table F3

Date Base 5
(Form 1954 -- 10 January 1980)

Gun Type	Description	No. of Rounds
1	105-mm howitzer	36,949
3,7	8-in. howitzer	2,588
4	175-mm gun	38
6,5,2	155-mm howitzer	26,124*
8	155-mm howitzer (M198)	20,166
10	Small TNT	803
11	Large TNT	4
20	60-mm mortar	3,546
22	81-mm mortar	6,989
23	4.2-in. mortar	1,050
50	2.75-in. rocket	1,810
53	LAW	2,169
54	TOW	17
90	105-mm tank gun	None
92	152-mm tank gun	608

*Some should be Code 8, but were coded as Code 6.

Table F4

Summary of Sources of Information

Data Base Code	Data Base Descriptor	Units Covered in Data Base	Information Covered
1	Range Operations Yearly Summary	All units FB, NG, R, ROTC, MAR*	Weapon, no. of rounds
2	Ammunition Issue Records	All units except Marines	Weapon (unit, no. of rounds, date)
3	Range Daily Activity Logs	All units	Unit, weapon, problem no., XY FP,** target area, day, time of day
4	Range Request Forms, Daily Bulletin	All units	Unit, weapon, problem no., day
5	Form 1954	All units except 105-mm gun and 152-mm Sheridan tank gun; few 81-mm mortar, 175-mm gun; Demolition+	Unit, weapon, column no., XY FP,** XYT,** time of day, day, no. of rounds

* FB = Fort Bragg Units
NG = National Guard
MAR = Marines
R = Reserves
ROTC = Reserve Officer Training College

**XY FP = location of firing point
XYT = location of target
+DEMO = demolition activities and Air Force bombs

1954 data sheets. This was done so units would not have to rely on their memory to reconstruct their blasting activities.

2. Data Base 1 was used to indicate how accurate Data Base 5 was.

3. The installation's ammunition issue point was visited to obtain Data Base 2 and to collect more detailed unit records.

4. Range operations information was collected and used to create Data Base 3 for a time period of at least 2 months.

5. Data Base 3 was cross-checked against Data Base 5; a very bad correlation was found for the 105-mm, 155-mm, and M198 howitzer gun types. (For the test case of March, only one-half of the data on the daily activity logs had a corresponding Form 1954.)

6. After cross-checking Data Base 5 vs Data Base 3 (to determine units) and Data Base 5 vs Data Base 2 (to determine number of rounds), Data Base 5 was set aside as being correct, complete information for those days and those units reporting, but incomplete for the entire year. (Whatever was turned in was assumed to be correct.)

Units actually completing Form 1954 were cross-checked against the units listed in the daily activity logs. In this manner, units in the daily activity log were separated into two groups: those that turned in Form 1954 and those that did not submit the form. The units which turned in the form were checked off in the daily activity logs as needing no further consideration in terms of determining data for all the units listed in the daily activity log.

The ammunition issue is recorded by unit, but the unit may keep the records several days or weeks. The data on rounds fired by type (e.g., HE, WP, illumination, etc.) were subtracted from a unit's totals of ammunition for that period of time. In this manner, the ammunition supply point data totals were divided into two categories: those accounted for on Form 1954 and those unaccounted for on Form 1954.

7. Data categories in Data Base 2 (the ammunition issue date) for units not completing Form 1954 were cross-checked against daily range activity logs.

Data Base 2 was cross-checked against Data Base 2. The unit, number of rounds, and time period that the unit had the rounds were taken from Data Base 2. The unit and the exact times of operation were obtained from Data Base 2. The rounds were split up from Data Base 2 based on the unit that used the rounds and the total number of hours (proportionately) that the unit was in the field during the time period of interest (Figure F2).

After completing Steps 6 and 7, the results were combined to form a basic 1-year set of firing point and target cards for the Blast Noise Prediction computer program.

Total actual yearly rounds expended by weapon and type (e.g., HE, WP, etc.) were developed from the ammunition point records augmented by the 175-mm rounds fired by the Marines and the 500-lb bombs dropped by the Air Force.

4.2-IN. HE M329A1 (WITH FUSE PD)

DATE	UNIT	⊖	+	FP	T	
12 SEP 78	1/505		100			
21 SEP	1/505	50				
28 SEP	2/508		100			
5 OCT	2/504		300			
11 OCT	2/505		75			
19 OCT	1/120		30			
26 OCT	2/508		150			
27 OCT	3/325		80			
31 OCT	1/504		175			
31 OCT	1/504		225			
2 NOV	1/119		20			
7 NOV	2/325		250			
9 NOV	2/325	20				
13 NOV	1/504	175				
13 NOV	1/504	165				

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Figure F2. Data Base 2 information.

Tables F1, F2, and F3 compare the range data with the ammunition point data and the initial totals developed from the raw data base. From these tables, the following decisions were made as to how to alter the totals in the raw data base so as to correctly portray the following: the year before the survey was administered, the monitored period, and the entire year for which the data were gathered:

a. The yearly total data base for the year before the attitudinal survey had as its criteria: to get the total number of rounds expended correct and to get a correct mix of firing points and targets and weapons, etc. Little attempt was made to get the right firing at the right location on the correct day since the DNL model uses the total energy for the year. Thus, the raw data base was used with multipliers on number of operations in order to achieve the correct totals as given in Table F1, Column 3. It should be pointed out that this table completely deletes the XM-198, as this gun was only tested during the latter part of 1979. Also, it must be noted that the daily operations in this data base are essentially correct, except for the last 2 months during the year, during which the raw data base is much less complete than for the other 10 months of the year.

b. The total data for the most recent year was again formed out of the raw data base. Because the last 2 months of this year are less complete than the other 10 months, this raw data had to be split into two groups such that, as a final result, the following was achieved: (1) the yearly totals agreed with the ammunition point yearly totals as given in Table F1, Column 4 and Table F2, and (2) the operations during the last 2 months of the year were on a par with the other 10 months of the year.

c. The daily data during the time during which monitoring was performed at Fort Bragg (August 1978 to February 1979) was formed out of the total yearly data base described above and summarized in Table F5.

Additional notes:

1. 81-mm mortar data were coded for just HE rounds since the ILLUM or WP rounds make little noise at target or firing point.

2. 175-mm gun and 8-in. howitzer charge ranges were determined from distance fired and firing tables for each gun.

3. The 105-mm tank and 152-mm Sheridan guns were relatively easy to reconstruct since few units used each gun. (However, the 105-mm tank gun was entered as a 105-mm gun on the daily activity logs and could be separated from the 105-mm howitzer only by looking at the unit information.)

4. Demolition activities were coded as found in the daily activity log. The number of rounds was set to 1, except for the 500-lb bomb, which was set to 6 (per conversations with Range personnel).

Table F5

Data Base X
(Used for Time Series and Monitor Comparison)

Gun Type	Description	No. of Rounds
1	105-mm howitzer	50,212
3,7	8-in. howitzer	10,393
4	175-mm gun	274
6,5,2	155-mm howitzer	23,574
8	155-mm howitzer (M198)	20,136
10	Small TNT	1,029
11	Large TNT	357
20	60-mm mortar	6,596
22	81-mm mortar	34,808
23	4.2-in. mortar	9,370
50	2.75-in. rocket	1,810
53	LAW	1,469
54	TOW	17
90	105-mm tank gun	1,811
92	152-mm tank gun	7,779

APPENDIX G:

ESTIMATION OF PERCENT "HIGHLY ANNOYED" AS A FUNCTION OF CDNL FOR THE OKLAHOMA CITY DATA

The author of this report has previously shown that for sonic booms from transport size aircraft (B56/XB70) at high altitudes[35]

$$\text{CSEL} = (10/8.5)(\text{Peak Level}) - 50.35 \qquad \text{[Eq G1]}$$

This equation is used herein to convert the Oklahoma City data (Table 84 of the Borsky study)[36] from peak levels to CSEL. Essentially, the lower the peak level, the more rounded (lower frequency) the boom, and the more energy the C-weighting eliminates.

At Oklahoma City, there were eight booms per day. So, total daily CSEL equal the CSEL per boom plus 9 dB, and

$$\text{CLDN} = \text{CSEL} + 9 - 49.4 \qquad \text{[Eq G2]}$$

Using Eqs G1 and G2, the Oklahoma City data for (energy) average pounds per square foot (PSF) and percent "highly annoyed" by time period yield the results summarized in Table G1.

Using linear regression, the percent of respondents "highly annoyed" as a function of CDNL is found ($r^2 = 0.93$) as:

$$\%\ \text{Highly Annoyed} = (3.09)(\text{CLDN}) - 164.0 \qquad \text{[Eq G3]}$$

Table G2 data are used to establish the "impulse correction factor" equations given in the main text of this report.

[35] Paul D. Schomer, "Growth Function for Human Response to Large-Amplitude Impulse Noise," Journal of the Acoustical Society of America, Vol. 64, No. 6 (1978).

[36] P. N. Borsky, Community Reactions to Sonic Booms in the Oklahoma City Area, Vol II: Data on Community Reactions and Interpretations, TR-65-37 (AMRL, 1965).

Table G1

Oklahoma City Data

Borsky Measurement Period	Peak PSF	Peak Level (dB)	CDNL	% Highly Annoyed
March 2 to April 19	1.13	128.1	59.9	16.6
	0.8	125.1	56.4	12.5
	0.65	123.3	54.3	5.1
April 20 to June 14	1.23	128.8	60.8	25.9
	1.10	127.8	59.6	19.4
	0.85	125.6	57.0	11.0
June 15 to July 25	1.60	131.1	63.5	35.3
	1.35	129.6	61.7	25.4
	1.00	127.0	58.7	16.9

Table G2

Impluse "Correction" Factors

CDNL	% Highly Annoyed	ADNL	Difference ADNL-CDNL
80	83.3	87.6	7.6
75	67.8	84.1	9.1
70	52.4	80.0	10.0
65	36.9	75.0	10.0
60	21.5	68.5	8.5
55	6.0	57.5	2.5

APPENDIX H:

COMBINED FACTORS WHICH CORRELATE WITH ANNOYANCE

Table H1

Question 30 or 36 or 31*

	Yes			No		
	Number % Highly Annoyed	Highly Annoyed	Total	% Highly Annoyed	Number Highly Annoyed	Total
Blast	22.7	154	678	3.6	51	1469
Street Traffic	24.1	179	742	1.9	27	1405
Airplane	18.9	118	626	3.3	50	1521
Helicopter	25.2	162	643	4.2	64	1504
Children/Pets	23.4	160	683	4.7	70	1464

*Misfeasance or damage or sensitivity to noise.

Table H2

Questions 30 or 36 or 31 and 34*

	Yes			No		
	% Highly Annoyed	Number Highly Annoyed	Total	% Highly Annoyed	Number Highly Annoyed	Total
Blast	27.1	140	517	4.1	67	1630
Street Traffic	22.8	120	525	5.3	86	1622
Airplane	20.9	100	477	4.1	68	1670
Helicopter	29.5	145	491	4.9	81	1656
Children/Pets	22.6	108	4778	7.3	122	1669

*Misfeasance or damage or sensitivity to noise and willingness to complain.

Table H3

Question 30 or 36*

	Yes			No		
	% Highly Annoyed	Number Highly Annoyed	Total	% Highly Annoyed	Number Highly Annoyed	Total
Blast	28.4	123	433	4.9	84	1714
Street Traffic	31.6	163	516	2.7	43	1631
Airplane	26.5	96	362	4.1	72	1785
Helicopter	36.4	142	390	4.8	84	1757
Children/Pets	33.6	148	441	4.8	82	1706

*"A great deal," "quite a bit," or "a fair amount" can be done but "nothing at all," <u>or</u> "not very much" is being done or damage from a noise source in this neighborhood is "very likely" or "likely."

Table H4

Questions 30 and 34 and 36

	Yes			No		
	% Highly Annoyed	Number Highly Annoyed	Total	% Highly Annoyed	Number Highly Annoyed	Total
Blast Noise	54.8	40	73	8.0	167	2074
Street Traffic	47.4	37	78	8.2	169	2069
Airplanes	53.5	23	43	6.9	145	2104
Helicopters	62.8	32	51	9.3	194	2096
Children/Pets	62.5	20	32	9.9	210	2115

*"A great deal," "quite a bit," or "a fair amount" can be done, but "nothing at all" or "not very much" is being done and damage from a noise source in this neighborhood is "very likely" or "likely" <u>and</u> respondents feel they should complain.

Table H5

Questions 30 and 36*

	Yes			No		
	% Highly Annoyed	Number Highly Annoyed	Total	% Highly Annoyed	Number Highly Annoyed	Total
Blast Noise	50.7	40	79	8.0	167	2068
Street Traffic	53.8	64	119	7.0	142	2028
Airplanes	46.9	23	49	6.9	145	2098
Helicopters	59.6	34	57	9.2	192	2090
Children/Pets	64.0	32	50	9.4	198	2097

*"A great deal," "quite a bit," or "a fair amount" can be done, but "nothing at all" or "not very much" is being done and damage to the neighborhood from a noise source is "very likely" or "likely".

Table H6

Questions 30 and 34*

	Yes			No		
	% Highly Annoyed	Number Highly Annoyed	Total	% Highly Annoyed	Number Highly Annoyed	Total
Blast Noise	31.3	70	223	7.1	137	1924
Street Traffic	29.6	92	311	6.2	114	1836
Airplanes	25.9	54	208	5.9	114	1939
Helicopters	37.9	96	253	6.9	130	1894
Children/Pets	33.1	96	290	7.2	134	1857

*"A great deal," "quite a bit," or "a fair amount" can be done, but "nothing at all" or "not very much" is being done and respondents feel they should complain.

Table H7

Questions 34 and 36*

	Yes			No			
	% Highly Annoyed	Number Highly Annoyed	Total	% Highly Annoyed	Number Highly Annoyed	Total	Ratio of % Highly Annoyed
Blast Noise	41.6	82	197	6.4	125	1950	6.5
Street Traffic	44.1	56	127	7.4	150	2020	6.0
Airplanes	41.3	52	126	5.7	116	2021	7.2
Helicopters	58.7	67	114	7.8	159	2033	7.5
Children/Pets	59.5	25	42	9.7	205	2105	6.1

*Damage caused by a noise source and respondents feel they should complain.

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