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Reactions of Residents to Long-Term Sonic Boom Noise Environments

James M. Fields
Wyle Laboratories, El Segundo, California

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National Aeronautics and
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Langley Research Center
Hampton, Virginia 23681-0001

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ABBREVIATIONS, SYMBOLS AND IMPORTANT TERMS

Exact definitions of noise indices and scales for acoustical measurements can be found in general acoustical reference publications (e.g., Bennett and Pearsons, 1981).

ASEL Sound Exposure Level, A-weighted (dB)

B Partial regression coefficient for either sonic boom noise exposure (B_{LAeq}), region (B_{Region})or another explanatory variable (B_{Other})

CSEL Sound Exposure Level, C-weighted (dB)

dB Decibel

DNL Day-night Average Sound Level, dB(A)

L_{Aeq} Equivalent Continuous Sound Level (Average Sound Level), for 24 hours, dB(A)

L_{Ceq} Equivalent Continuous Sound Level (Average Sound Level), for 24 hours, dB(C)

L_{dn} Day-night Average Sound Level (DNL), dB(A)

Lpk (dB_{Peak}) Sound level of Pmax where Lpk = 20 Log10 (Pmax/Pref), where Pref is the reference pressure of 20μPa ($2.0*10^{-5}$Pascals) or (in psf) $0.417973*10^{-6}$psf

LPN Perceived Noise Level, dB

N Number of noise events

NEF Noise Exposure Forecast, dB

NNI Noise and Number Index, dB

PL Perceived Loudness Level (dB or PLdB) [Stevens Mark 7, 125 msec time constant]

Pmax (Δp_o) Maximum positive boom pressure over ambient pressure (psf, Pounds per square foot)

PNDB Perceived Noise Level, dB

$r_{AL \cdot R}$ Partial correlation of annoyance and noise level controlled for region

EXECUTIVE SUMMARY

A combined social survey and noise measurement program has been completed in a three-phase study in 14 communities drawn from two regions in the western United States. The 14 communities have been regularly exposed to sonic booms for many years. A total of 1,573 interviews were completed with 20 sets of community residents.

This is the first social survey with noise measurements that has analyzed the reactions of residents with long-term exposure to sonic booms. Residents were asked about sonic booms over the previous six months. The booms during that six-month period were measured in an acoustical survey. The sonic booms come from military training exercises and aircraft testing programs.

Although the communities differ somewhat in their exposures, their total exposure to sonic booms would be considered to be relatively low based on Day-night Average Sound Level (DNL) or other conventional aircraft noise metrics. The least exposed communities average about one measurable boom in 20 days and have less than one boom that is over 2.0 psf in 100 days. The most exposed communities average two booms per day with about one boom per week over 2.0 psf. For the six-month study periods, the least exposed communities had C-weighted exposures of about 40 $L_{Ceq24Hr}$ and A-weighted exposures of about 25 $L_{Aeq24Hr}$ (DNL 25). The most exposed communities had C-weighted exposures of about 55 L_{Ceq} and A-weighted exposures of about 40 L_{Aeq} (DNL 40). Acoustical measurements indicate that there were no booms at night during the study period.

Residents reported that three aspects of the sonic booms are most disturbing: being startled, noticing rattles or vibrations, and being concerned about the possibility of damage from the booms. Respondents report that the vibrations are not restricted to hearing rattles but also include noticing houses shake. A little over half of the startled respondents report that their startle reactions have not lessened from the time when they first heard the booms. More people fear the possibility of damage than believe that booms have thus far damaged their property.

The limited data from this survey suggest that the continuous equivalent noise level based on an A-weighting (DNL or $L_{Aeq24Hr}$) is equal or better at predicting reactions than are measures of average peak noise levels or metrics based on a C-weighting. In this particular data set the importance assigned to how often booms occur is, if anything, under-represented in the conventional metrics based on energy averaging.

Additional insight into reactions to sonic booms has been obtained by comparing the results from this survey with the results from 20 previous surveys of residents' reactions to aircraft noise and various types of impulse noise. The reactions to sonic booms in both of the western boom study regions appear to be more severe than would be expected for conventional aircraft at the same continuous equivalent noise levels (L_{Aeq}). However, the severity of the reactions to sonic booms is strikingly different in the two sonic boom study regions.

The 1,036 interviews conducted in the two survey phases in the first region (Region A) indicate that in the range of about 30 to 40 L_{Aeq} about 75 percent of the residents are at least a little annoyed by sonic booms and about 35 percent were "very" annoyed on a 4-point verbal annoyance scale. The 537 interviews in the second region (Region B) indicate that at the same range of noise levels about 50 percent were at least a little annoyed and about five percent were "very" annoyed.

This difference in reactions in the two regions also affects estimates of the difference between reactions to sonic booms and to conventional aircraft noise. On the basis of the lesser reactions in the second region (Region B), sonic boom environments appear to be subjectively equivalent to conventional aircraft environments that are approximately 10 decibels higher (L_{Aeq}). This estimate is only approximate because estimates range from 3 to 20 decibels depending upon the annoyance question and surveys to which the comparison is made. The more severe reactions in the first studied region (Region A) are, however, subjectively equivalent to being an additional 20 to 40 decibels higher than those in conventional aircraft noise environments.

The reactions in the less annoyed region (Region B) are roughly equivalent to the reactions found in the 1964 Oklahoma City study of residents' reactions to a six-month, temporary exposure to sonic booms. These lesser, Region B reactions are also similar to those found in most areas of a CEC impulse noise study of noise around light-arms firing ranges and a variety of other impulse noise sites. The weak evidence that is available also indicates some consistency between the Region B results and those from a study of noise from large artillery in the United States.

Although the less severe Region B reactions are more similar to those found in most other surveys. the more severe reactions in Region A cannot be dismissed. There is no indication that errors in social survey or acoustical survey procedures could be responsible for the difference in reactions in the two regions. In addition, equally high reactions were present in some locations in the Netherlands CEC study. After carefully examining many potential differences between the regions, a definite explanation for differences in reactions has not been found. The differences in reactions cannot be explained by any obvious differences in the respondents' demographic characteristics, the types of housing construction, or the characteristics of the individual communities. There is some tentative evidence that a limited part of the difference between the two regions might be traced to the low-altitude, subsonic combat training maneuvers that are more prevalent in Region A and, possibly, to a perception that pilots and flight planners in Region A are not doing all they could to reduce sonic booms. However, this evidence is not strong enough to definitely explain the differences between the two regions.

The conclusion from these studies is therefore that sonic boom annoyance is greater than that in a conventional aircraft environment with the same continuous equivalent noise exposure. With the present knowledge, however, it is not possible to predict the size of this difference. Most of the evidence suggests that sonic booms may cause reactions that are the equivalent of reactions to conventional aircraft noise environments of roughly 10 decibels greater exposure. The possibility that sonic booms may cause reactions that are the equivalent of a 20 to 40 decibels greater exposure cannot be ruled out.

1.0 INTRODUCTION

Considerable knowledge has been gained about reactions to the noise from aircraft, road traffic, and railways through community surveys that relate residents' responses in questionnaires to measured noise exposures. Several surveys of reactions to sonic booms have been conducted, but, with one exception, the noise exposures that generated those reactions have not been examined. That single exception, the 1964 Oklahoma City sonic boom survey, studied reactions to a short-term, temporary (six-month) sonic boom exposure, not to long-term exposures to sonic booms.

The Western USA Sonic Boom Survey described in this report surveyed residents' reactions to long-term exposures to sonic booms in two regions. The residents' reactions were obtained through personal interviews. The sonic boom exposure of the communities was measured with unattended instruments (Boom Event Analyzer Recorders) that continuously monitored the noise in each community and stored sonic boom events for later analysis. The interview survey obtained 1,573 interviews describing the residents' reactions to noise. The interviews were obtained in three study phases in 14 communities in two regions. The six communities in Region A were first surveyed in Phase I and then re-surveyed in Phase II for a total of 12 groups of study interviews. In Phase III interviews were only conducted in eight new communities in Region B.

The methods for gathering the social survey and acoustical data are described in Chapter 2. Much more detail about various aspects of the study methods is provided in the appendices to the report. Each community's sonic boom environment is described in Chapter 3.

The study is focused on two major issues; the dose/response relationship and the characteristics of sonic booms that affect residents' reactions.

The dose/response relationship in the western sonic boom survey is described in Chapter 4. When the dose/response relationship is examined it is found that the responses in Region B are much less severe than those found in Region A. This difference in reactions is one of the issues addressed in the following chapters. The Region A and Region B dose/response relationships are compared with dose/response relationships found in previous surveys in Chapter 6. Some of the non-noise factors that affect the dose/response relationships in the sonic boom survey are described in Chapter 5. Alternative explanations for the regional differences are examined in that chapter.

The characteristics of sonic booms that affect residents' reactions are explored in Chapter 7. Attention is primarily directed at the influence of residents' being startled, experiencing vibration, and believing that sonic booms can cause damage.

2.0 STUDY METHODS

The basic study procedures used in the western sonic boom survey are similar to those that have been used in high-quality noise annoyance surveys during the last thirty years. Noise levels are measured in the community to estimate residents' exposures. Residents are asked standardized questions in a social survey about their long-term reactions to the measured noise levels. The data are then analyzed to determine the amount of annoyance at specified noise levels and to identify noise and non-noise factors that affect the amount of annoyance with the measured noise source.

For this boom survey the conventional study methods have been augmented by study procedures that are adapted to four unusual characteristics of the study: 1) sonic booms as noise sources, 2) small numbers of noise events, 3) small numbers of exposed communities, and 4) the small sizes of those exposed communities. These characteristics affected the following four major components of the study methodology described in this chapter; 1) the definition of study areas, 2) the timing of the survey, 3) the social survey procedures, and 4) the noise measurement program.

2.1 Definition of study areas

Aircraft industry and military operations personnel were contacted to identify all areas in the United States that regularly experience sonic booms. Only two regions were identified that appeared to have the potential for regular, relatively frequent exposures to sonic boom exposures of at least moderate intensity. Both regions are in the Western United States. The present study included all 14 of the communities located in these regions. The sonic boom exposures in the first region, Region A, are predominantly from military training exercises operating from a single air base. Some of these sonic booms occurred when groups of aircraft maneuver during concentrated training periods. The aircraft that created sonic booms in the second region, Region B, appear to originate from several different locations and to include aircraft testing as well as military training operations.

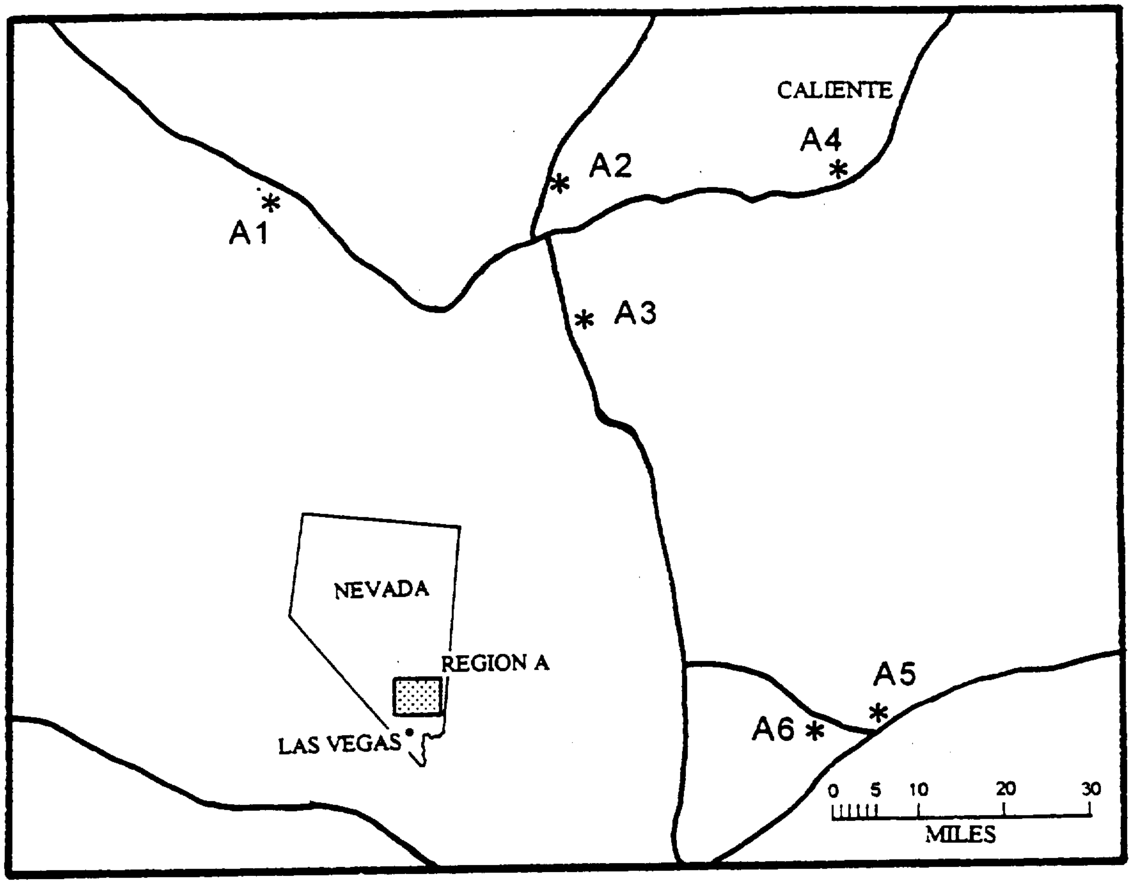

Figure 1 Location of Nevada study site (Region A) and of study communities within Region A

Region A contains several widely separated, small communities. The spatial relationship between the six communities in Region A is displayed in Figure 1. The communities are numbered in descending order by estimated noise exposure, with A-1 being the community with the greatest expected sonic boom noise exposure. The six Region-A communities are all within 100 miles of one another. Although communities A-5 and A-6 have the same name, the distance of more than one mile between them led to the decision to separate them for the noise measurement program and social survey analyses in this report. The base of operations for the sonic boom aircraft is more than 70 miles from the nearest community. The communities in Region A vary in size from less than 100 to about 1,000 residents. Although the communities are isolated, the respondents are not primarily on farms or ranches. Three percent are on farms or ranches. Another 7 percent have some livestock (e.g. horses, chickens). About 60% of the respondents' homes are within 50 feet of the nearest dwelling and 94% are within an estimated 500 feet of the nearest dwelling.

The spatial relationship between the eight communities in Region B is displayed in Figure 2. The eight communities are within approximately 100 miles of one another. Communities B-3 and B-4 are neighborhoods in the same community, but the separation of approximately 1.4 miles and differences in measured noise levels resulted in their being separated for the noise measurement and social survey analyses in this report. The smallest communities have populations of about 1,000. The largest community is over 40,000. These are not agricultural communities. One of the airbases from which sonic boom aircraft operate is included within the area shown in Figure 2. Although several communities are adjacent to the airbase property, none of the areas is within five miles of a runway. The study areas are not near enough to the airbase operations areas to regularly notice aircraft when they are landing or taking-off at the airbase.

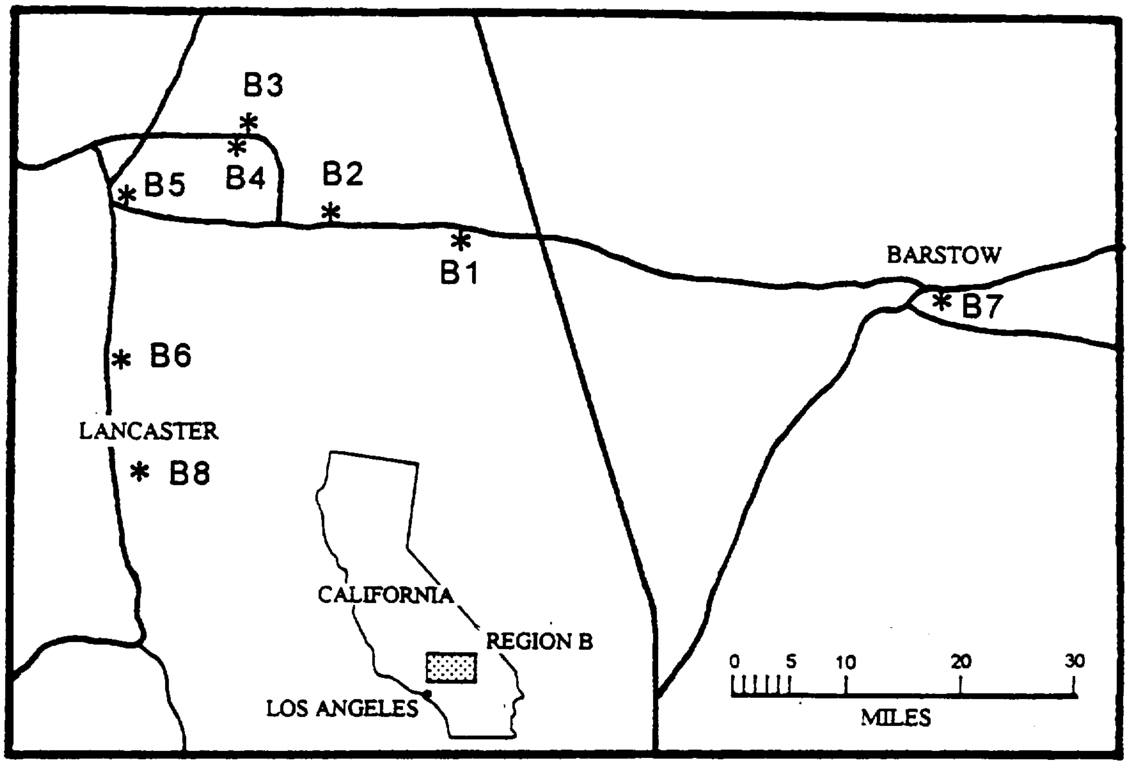

Figure 2 Location of California study site (Region B) and of study communities within Region B

The sonic boom exposure for each community was computed for one location and checked at one other location in eight of the study communities. Some characteristics of the sampled areas in each community are provided in Table 1. The interview homes are more tightly clustered around their respective microphone locations in Region B than in Region A. The very small numbers of households in three communities in Region A were considered in designing the sample. All adults from every household were included in the study sample in communities A-1 and A-2. One adult from every household was included in the sample in community A-3.

Table 1: Information about the 14 study areas

Characteristic	Region A communities						Region B communities								Total
	A-6	A-5	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4	B-3	B-2	B-1	
Size of study area (miles)															
Distance from noise measurement to furthest house	3	3	2	1	4	0.7	<0.5 (Only houses near the microphone position were included.)								
Households within study area	174		429	280	34	48	648	452	528	683	725		396	475	4872
Selected sample households	127		139	280	34	48	76	68	108	153	110		163	274	1580

2.2 Timing of survey and study phases

The data collection for this study has been conducted in three phases over approximately a three-year period. Phases I and II were conducted in Region A. Phase I started in October 1992 when noise measurement data began to be accumulated at some sites in Region A and concluded with the final interviews in early May of 1993. Phase II immediately followed Phase I in Region A and concluded with final interviews in December 1993. Phase III was conducted entirely in Region B. Phase III started with the uniform calibration and checking of the noise measurement equipment on location in early April of 1995 and concluded with the final interviews in mid November 1995. A more detailed listing of the survey dates is provided in Table 11 (page 77).

The same questionnaire was used with all respondents, except for the 217 respondents in Phase II (Region A) who had been previously interviewed in Phase I and were not again asked some of the demographic and most detailed reaction questions from the standard questionnaire. Respondents were asked about the previous six-month's exposure in every survey. There are only minor technical differences between the survey procedures used in the three phases.

The same noise measurement strategy was followed for each phase. In each phase the intent was to measure the sonic boom environment in the six months preceding the interviews. For Phase I, however, some microphones were not in place until less than six months before interviewing began. Unattended but frequently monitored noise measurement equipment (Boom Event Analyzer Recorders, BEARs) was used to accumulate data about each noise event in each phase. Some difficulties experienced in noise measurements during the first two phases were overcome when revised procedures were introduced for the noise measurements in Region B (Phase III).

2.3 Social survey procedures

Most of the social survey procedures followed are typical of high quality, interviewer-administered community surveys. Some new procedures had to be adapted to the unusual aspects of this study that are described in this paragraph. Only a small number of residences were available at the highest noise levels available for this study. Some communities were small and isolated so that residents were expected to frequently communicate, especially about local events. The study was designed to facilitate comparisons with a previously conducted sonic boom survey in Oklahoma City (Borsky, 1965) and a wide range of aircraft noise studies. When the survey was initially planned and implemented in Phase I, the questionnaire and survey procedures were designed to be compatible with multiple follow-up interviews that could be conducted by telephone.

2.3.1 Questionnaire design

The questionnaire was developed during three rounds of pretests in areas that occasionally experience sonic booms. The last round of pretests was conducted in Region B, in March 1992, some 32 months before the final interviews were conducted in the area. The two previous rounds were conducted in other regions of the United States that have only very occasional sonic booms (Farbry, et al., 1990; HBRS, 1994a)

In addition to performing their normal functions of uncovering questionnaire weaknesses, the pretests determined that the phrase "sonic booms from jets" was understood by the population. The pretests were especially helpful in developing procedures that allowed both interviewers and respondents to be comfortable with the administration of several, similarly-worded sonic boom annoyance questions and closely-related activity interference questions. The pretests also served to develop a set of questions that measured the magnitude of the respondents' annoyance with sonic booms relative to their annoyance with 16 other life experiences.

Residents' responses were gathered by interviewers who orally administered a questionnaire in respondents' homes. The primary questionnaire (FORM A), accounting for 86 percent of the interviews, included 51 questions with various subsections that averaged about 30 minutes to complete. The followup questionnaire (FORM B), used in the remaining 16 percent of the interviews included 27 questions with associated component parts that averaged 18 minutes to complete. The followup questionnaire was used in Phase II with respondents who had been previously interviewed in Phase I. The primary questionnaire is reproduced in Appendix K.

The survey questionnaire followed standard community noise survey procedures in that the initial questions gathered general information on "advantages and problems of living in different areas." The initial measurement of reactions to sonic booms was imbedded in a series of questions about neighborhood problems and noise concerns. At that point the respondent was not aware that the primary focus of the questionnaire would be sonic booms. The remaining sections of the questionnaire consisted of more than 19 primary sets of questions about reactions to sonic booms, seven of which had been directly taken from previous aircraft noise and sonic boom surveys for the purpose of facilitating comparisons with those surveys. Other sections measured reactions to the following components of sonic boom impact: loudness, rattle, startle, speech interference, sleep interference, and concern with the possibility of damage. Background information about housing, activities, and opinions was gathered that might help to explain sonic boom reactions. A number of questions were designed to help to understand the impact on respondents that is associated with the low-frequency components of the sonic boom.

Comparability with most questions on previous surveys was simply achieved by asking all respondents the previously used questions. For two sets of questions, however, only a subset of the respondents were asked the previously-used questions. The first such set of questions consists of a list of activity interferences that had been presented in three different ways in previous surveys. All respondents could not be asked all three versions of these activity interference questions. The second set of questions that could not be asked of all respondents were needed to address issues raised by a filter question used in the Oklahoma City sonic boom data publications that was difficult to interpret. In this second case, a new version of the Oklahoma City question needed to be compared to the previous version. To examine these issues, two sets of questions were varied in the FORM A questionnaire. This resulted in four versions that differed only in the two questions. The four versions were randomly assigned to households for Phases I and II. Slightly greater control over confounding factors was attempted in Phase III by having each of the four versions systematically assigned to every fourth household.

2.3.2 Population definition and respondent selection

The survey population is defined as all permanent (year-round), adult residents (age 18 and over) in the specified areas with sufficient command of English to complete an oral interview. Students who are visiting their home but are normally resident elsewhere are not eligible for the survey at home.

Respondents were selected from among all eligible residents in the household using the Troldale-Carter method (Lavrakas, 1987: 89-93) in Phases I and II and the Kish selection grid (Kish, 1965) in Phase III. Both methods eliminate the possibility of either the interviewer's preferences or the respondent's availability biasing the selection of sample members. The two methods would be expected to yield very similar samples for this population. This Kish selection grid follows strict probability sampling methods for selecting from among all adults in the household.

The standard procedure was to select one eligible resident from each household. In the two highest noise exposure communities in Region A (A-1 and A-2), however, all eligible household members were interviewed. During Phase II In Region A the practice of interviewing multiple respondents in households was extended to selected households in the remaining communities (A-3, A-4, A-5, or A-6) to obtain 139 interviews that followed an interview with someone else in the same household. In 35 instances these were repeated interviews with someone previously interviewed in Phase I (see Table 13).

Phase II sample selection procedures were modified because an attempt had already been made in Phase I to interview all of the residents in the two smallest, highest noise communities. As in Phase I, an attempt was made to interview all eligible adults in the two smallest, highest noise level communities (A-1 and A-2). The selection strategy in the remaining communities was designed to yield interviews under conditions found in the two smallest, high noise communities. Only households that were selected into the sample in Phase I were visited. Every previously identified respondent and non-respondent was again contacted for an interview. In multiple member households, in Phase II, an attempt was made to obtain an additional interview with one other randomly-selected member of the household. When there were more than two eligible adults, the Troldahl-Carter method used in Phase I was used to select the second adult within the household. Table 13 shows that of the total 1,573 responses in the survey 1187 were obtained in a conventional manner as either the only person from a household or as the first of several people from a household. Of the remaining interviews, 217 came from people who were interviewed a second time (i.e. in Phase II after having been interviewed in Phase I) and an additional 169 came from respondents who were interviewed for the first time after another member of their household had been interviewed.

2.3.3 Interview fieldwork organization

The study areas were mapped, dwellings were identified and interview assignments were specified before the field work began. On-site interviewer supervision was provided by senior staff from the social survey organization during the entire interview period.

Steps were taken to maintain a high quality of field interviewing. The experienced interviewers received a one-day, study-specific training session at the beginning of the interview period and were accompanied by supervisors for their initial interviews. The two inexperienced interviewers received special training, conducted extensive practice interviews until they firmly grasped interviewing techniques, and were accompanied by supervisors on at least the first three field interviews. Supervisors accompanied all interviewers at random times during the interview period. Verification telephone calls, audio recordings, or supervisor observation was used on approximately 20 percent of the interviews. Of the fifteen interviewers, the eight who participated in more than one phase completed 73 percent of the interviews.

Several steps were taken to heighten the likelihood of cooperation and reduce the possibility that the entire survey effort might be biased through low levels of cooperation or extensive, biased communication in close-knit, rural communities. Community residents were not routinely mailed a pre-interview letter. The first knowledge that most respondents had of the survey was when they were contacted at their home. To further reduce the possibility of advance communication about the survey, a major attempt was made to complete as many interviews on the first day in each community. On the first few days in each community most of the interviewing staff were concentrated in the community. Eleven previously-identified influential leaders of the communities in Region A were contacted in advance to gain their cooperation. These leaders received a letter from NASA before the interviewing period. At the start of the Phase I interviewing period the leaders were contacted and interviewed in their home by one of the survey organization supervisors. At the end of the interview the community leader was debriefed about the purpose of the survey and asked to not discuss the survey with other community members. The community leaders were cooperative and no difficulties were encountered in administering questionnaires. The same leaders were sent a letter before the beginning of Phase II and were later interviewed following the standard interviewing procedures. The questionnaires from those community leaders who live within the study areas are included in the analysis.

2.3.4 Sample disposition and response

A total of 2,475 sampling units were issued to the field staff during the three phases of the study. After excluding the ineligible units, mostly because of vacant homes, the sample yielded a total of 2,082 eligible selections of which 1,578 responded for a response rate of 76 percent. After excluding five specially selected community leaders who would not have otherwise been included in the survey, a total of 1,573 responses were included in the analyses in this report. Since 217 people were interviewed a second time in Phase II, these 1,573 responses came from 1,356 people. In most places in the report the 1,573 responses are referred to as 1,573 "respondents." More details about the sample disposition are given in Table 12 and in Appendix B.

2.4 Noise measurement program

The objective of the noise measurement program was to measure the sonic boom exposure at the residences for the six months preceding the survey interviews so as to provide an objective acoustical measurement of the sonic boom noise environment that would match the exposure about which respondents were asked in the questionnaire. The estimates of the sonic boom exposure were obtained from one unattended noise monitor in each community. The objective was to have the noise monitor operational for as much of the preceding six-month period as possible. The estimates at the primary measurement position were checked against one other noise measurement position in each of the eight communities in Region B.

2.4.1 Data acquisition

The noise measurements were made with Boom Event Analyzer Recorders (BEARs) (Lee, et al., 1989). The BEAR is a 16-bit microprocessor-based instrument equipped with a special pressure transducer. The BEAR continuously samples the background noise and then captures and stores the wave form of loud impulsive sounds along with other identifying information. The stored events were later downloaded and examined to eliminate events that did not have acoustical profiles that are characteristic of sonic booms. The BEAR also monitors the power supply every 15 minutes and saves these data in a voltage file. These voltage data could be examined to help identify periods during which the BEARs were not operating.

The incoming data, covering a frequency range of a few tenths of a Hertz to over 5 kHz, are digitized at a rate of 8,000 samples per second. The computer program stored events which met nine signal-level and timing requirements. The BEARs in Region A were operated by Firmware Version 5.0, the BEARs in Region B by Firmware Version 5.4. Several other changes were made in the configuration of the BEARs between the Region A and Region B measurements. The BEARs were designed with a memory capacity for about 50 booms.

The BEARs were located in weatherproof boxes on a cooperative resident's property or on government property in each community. Some communities had two BEARs. All BEARs in Region B and most BEARs in Region A were connected to the local power supply and a telephone line so that they could be remotely accessed. The BEAR microphones were installed in a foam hemisphere windscreen/holder and placed on a steel plate on the ground at a distance of at least 10 feet from any obstruction. A silk cone windscreen was placed over this assembly.

The BEARs were contacted during the measurement period to download data and check on their condition. These contacts occurred on an irregular basis in Region A. BEARs were sometimes found to not be operating satisfactorily. At other times the memories were found to be filled and thus to have been unable to measure additional noise events for at least some of the period. The memories filled with events that were later judged to have not been sonic booms. For Region B, the contacts with the BEARs were initially made two times a week and then increased to every weekday. The daily contacts were needed because some BEARs were found with full memories when only contacted on a twice weekly basis.

2.4.2 Boom identification through individual noise event analysis

The data from the BEARs were downloaded and analyzed to calculate the noise event parameters, identify booms, and monitor the up and down time at each site. A detailed description of these analysis procedures is available in study reports for Region A (Wyle, 1996b) and Region B (Wyle, 1996a).

The following metrics were calculated for each noise event: Pmax (maximum pressure in psf), Pmin (minimum pressure in psf), SEL-E (unweighted Sound Exposure Level in dB), SEL-A (A-Weighted SEL in dB), SEL-C (C-weighted SEL in dB), and PL (Perceived Loudness in dB [Stevens Mark 7, 125 msec time constant, according to Shepherd and Sullivan (1991)]). All of these metrics except SEL-E and Pmin were included in indices prepared for the social survey analysis.

Each noise event was graphically reproduced in a plot of amplitude (in psf) by time. An engineer examined these plots together with other information to score each event from 0 to 5 where zero represented a definite non-boom and 5 represented a definite boom. For Region B data the correlations between noise events at different noise measurement sites were also considered for scoring booms. For Region B, events that were originally scored as zero (non-booms) were reclassified as booms and given the lowest score of "1", if they were found to be correlated between sites. For both regions, events that were scored zero were dropped from further analysis. Alternative estimates of the residents' sonic boom environments were later created by including all booms, or by including only booms with the higher certainty scores.

The ultimate decision as to the rating of the noise event (including whether or not it was excluded from analysis as a non-boom) was made by an engineer not by a mechanically applied algorithm. The engineer was aided by computer-generated warning codes for five unlikely boom event characteristics. Each boom was also classified into one of eight shape categories ranging from "Distinct N wave with sharp corners and well-defined slope" to "Rumble, may or may not be boom related"(Wyle, 1996a: 4-5). The final 0-5 boom scoring considered the scoring of the booms on nine characteristics (see the guidelines in Appendix E, Table 17).

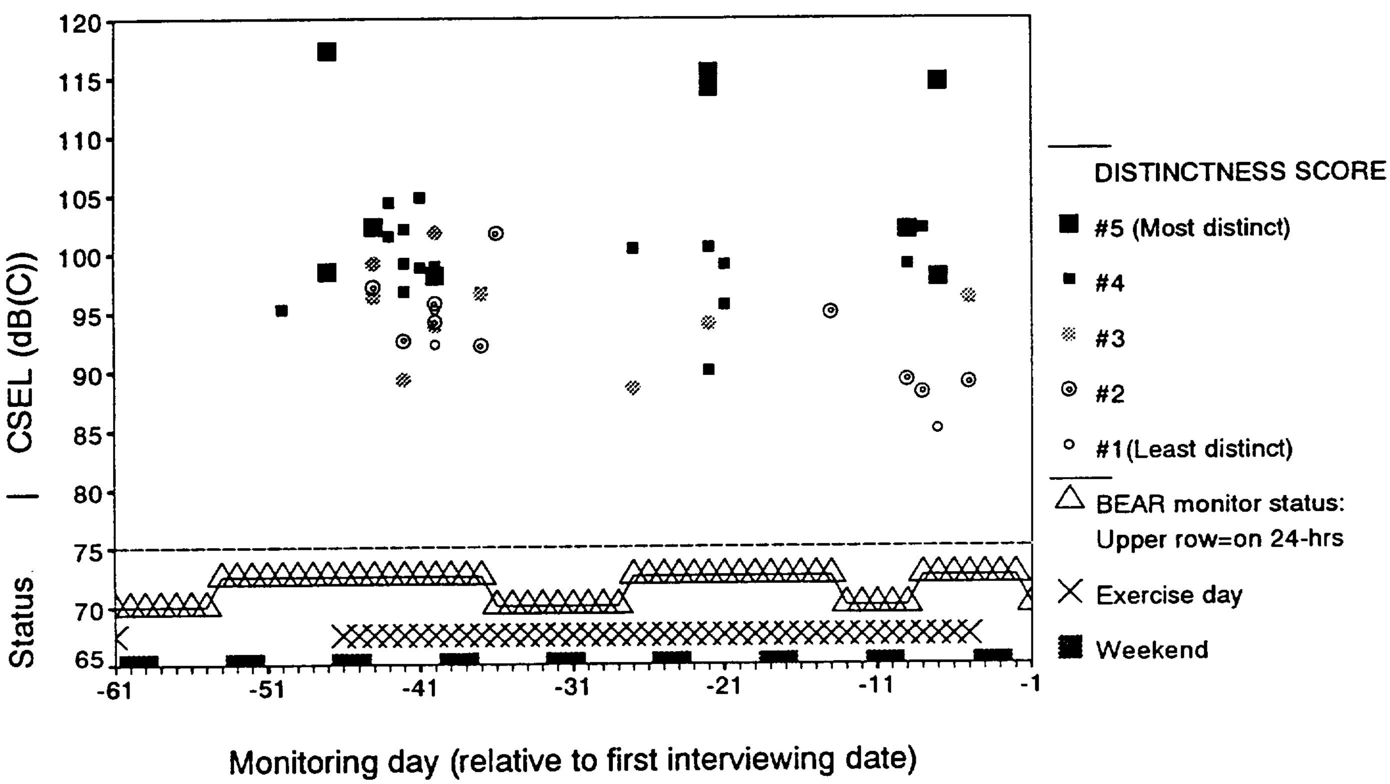

Figure 3 Sound exposure and distinctness of all measured booms in community A-1 in the 61 days preceding the first interview period

Examples of the sonic boom exposures and the accompanying noise measurement programs are presented graphically in Figures 3 and 4 for the last sixty days preceding the interviewing periods in two study communities. The points in the figures represent every measured sonic boom during the period. Figure 3 shows that even in community A-1, the highest sonic boom exposure community, only a small number of booms occurred on even the most highly exposed days. At this site the highest sonic boom events are seen to exceed a Sound Exposure Level (SEL) of 110 dB(C). The data in Figure 4 are for community B-5, a community with a lower sonic boom exposure. Both the noise level of the individual booms and the numbers of booms are seen to be less in this community. In fact, the previous months in community B-5 had exposures that were similar to the first half of the period in Figure 4 in which only four booms were observed. Both figures display the general tendency for the highest noise level flights to have been given the higher scores as distinctive booms by the acoustical engineers.

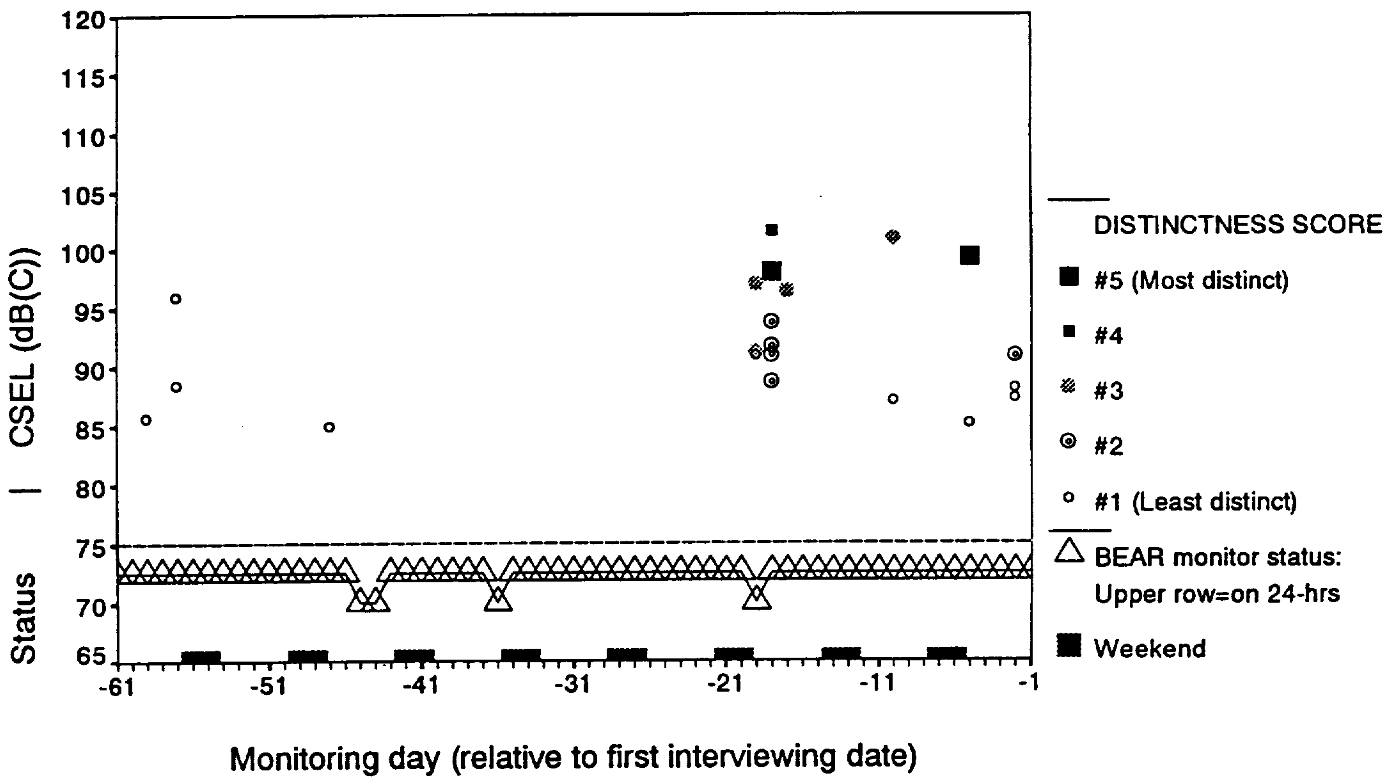

Figure 4 Sound exposure and distinctness of all measured booms in community B-5 in the 61 days preceding the interviews

The figures also show the very uneven distribution of sonic booms during this period. The weekend days, as indicated by the dark rectangles at the bottom of the figure, are seen to be days on which there were no sonic booms. The sonic boom activity in the Region A community is also seen to be much greater on the military training exercise days (indicated by the crossed "XX"), than on other days. No such exercise days existed in Region B. The two-level strings of joined triangles in the figures trace the noise measurement program. In the Region A community in Figure 3, three multi-day gaps in the noise measurement program are shown by the strings of joined triangles on the lower tier. As was typical of Region B, however, Figure 4 shows that there were only four days during the 60 day period when the BEAR was not operating the entire 24 hours.

The noise monitoring program is concisely summarized for each community in Table 2. Of the 4,392 total possible monitoring hours in the 183-day (six-month) period preceding each interviewing round, the number of hours monitored varied from 492 hours (18 percent) at one site to 4,392 hours (100%) at several sites. The numbers of days monitored at sites varied from 33 days to 183 days. These are rather large numbers of monitoring days for standard aircraft noise surveys. The effects of large numbers of days is partially offset, however, by the relatively small numbers of booms that occurred during the monitoring periods. The last row of Table 2 indicates that the number of booms observed in the communities varied greatly from two booms in community A-5 in Phase II to 259 booms in community A-2 in Phase I. More details about the accumulated noise data are given in Appendix D.

Table 2: Sonic boom noise data accumulated in each social survey community

Sample strata	Phase I: Region A						Phase II: Region A						Phase III: Region B							
	A-6	A-5	A-4	A-3	A-2	A-1	A-6	A-5	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4	B-3	B-2	B-1
Hours of noise monitoring in the six-month pre-survey period (6 months = 183 days = 4,392 hours)																				
Total (3 strata)	840	792	2784	1368	2400	2544	1344	1344	1176	1368	2760	3912	4344	4392	4255	4114	3264	4160	4314	4392
Percentage of hours monitored in six-month pre-survey period																				
Total (3 strata)	19%	18%	63%	31%	55%	58%	31%	31%	27%	31%	63%	89%	99%	100%	97%	94%	74%	95%	98%	100%
Number of days upon which monitoring occurred in the six-month pre-survey period																				
Total (3 strata)	35	33	117	57	100	107	56	56	49	57	115	163	182	183	179	177	159	178	181	183
Number of sonic booms measured during monitoring periods in the six-month, pre-survey period																				
Total of 3 strata(%)	17	8	88	64	259	207	4	2	16	17	69	237	10	51	30	39	56	47	126	248

NOTE: The six-month period in this table ends the day before the first interview. The noise data used for the social survey was individualized for each respondent's previous six-month period and thus is slightly different.

2.4.3 Calculation of noise metrics for social survey respondents

The sonic boom exposures for each respondent were calculated based on the noise measurements from all sites, the timing of the booms, some limited knowledge about training exercises at four of the Region A sites, and the date that each respondent was interviewed. A total of 104 noise metrics were merged with each respondent's social survey data. These 104 noise metrics were made for a total of 190 situations defined by the date on which the interviews occurred and the study site.

Noise metrics: The 104 noise metrics that were merged on each respondent's record are derived from the seven basic metrics shown in the first column of Table 3. The primary metrics for this report are the A-weighted continuous equivalent noise level (L_{Aeq}) and the C-weighted continuous equivalent noise level (L_{Ceq}) that appear in the first two rows of Table 3. The A-weighting is the most often used weighting for environmental noises. For the present data set the A-weighting appears to be at least as reliable as the C-weighting that is often used for impulsive noise events (Committee..., 1981). The 24-hour equivalent continuous noise level (L_{Aeq} (24-hour)) is equivalent to DNL (Day/Night Average Sound Level) for this data set. No booms were identified at any site during the measurement period between the hours of 22:00 and 06:30. Three of the four highest noise sites in Region A had from 1 to 9 booms measured at the end of the DNL "night" period between 6:32 A.M. and 6:57 A.M. A separate DNL metric was not calculated since all these booms were within 30 minutes of the end of the DNL nighttime period at 7:00 A.M..

The third column in the first row of Table 3 indicates that for both of the equivalent continuous noise level measures (L_{Aeq}, L_{Ceq}), all sonic booms, regardless of noise level, are included in the calculations. The next column shows that separate exposure estimates are formed for all metrics (1) using only the measurements made in the 6 months previous to the survey and (2) using all earlier measurements (even if they were before the 6-month survey period). The dates in Table 11 show that in a few instances this second definition extended the measurement period by approximately one month. The last column indicates four versions of each metric were generated based on the acoustical engineers' ratings of the distinctness of the booms. These ratings consider the nine characteristics of the booms that are defined in Table 17 in Appendix E. The combination of factors considered in the last two columns, thus generated eight different estimates of each of the previously specified metrics. L_{Ceq}, for example, is thus represented by 8 metrics. A similar approach was taken to the other metrics. Three times as many versions (24) were created for the arithmetic average of the maximum overpressures, because, as the third column indicates, separate averages were calculated for all booms, those over 0.5 psf, and those above 1.0 psf. Similarly 40 different counts of the number of booms were generated based on five different psf cut-off points for two time periods for four levels of ratings of distinctness of the booms.

Table 3: Definition of sonic boom noise metrics

<table>
<tr><th>Basic metric</th><th>Individual event data</th><th>Levels (psf) of booms included</th><th>Period for estimates</th><th>Rating of distinctness of boom</th></tr>
<tr><td colspan="3">Summation of exposure per unit time
{10*Log[(10^(SEL/10))/seconds in period]}</td><td rowspan="10">●6 Months (previous 6 months)

●All months (as many months as were measured)</td><td rowspan="10">● All
● 2+ rating
● 3+ rating
● 4+ rating</td></tr>
<tr><td>L_{Ceq}(24 hr)</td><td>SEL-C (dB)</td><td>All</td></tr>
<tr><td>L_{Aeq}(24 hr)</td><td>SEL-A (dB)</td><td>All</td></tr>
<tr><td colspan="3">Average noise event levels</td></tr>
<tr><td>SELC</td><td>Log average of SEL-C</td><td>All</td></tr>
<tr><td>SELA</td><td>Log average of SEL-A</td><td>All</td></tr>
<tr><td>PL</td><td>Log average of PL (dB)</td><td>All</td></tr>
<tr><td>Pmax</td><td>Arithmetic average of maximum pressures (psf)</td><td>●All
●>0.5 psf
●>1.0 psf</td></tr>
<tr><td colspan="3">Number of booms per day (Total number of booms/ total days in period)</td></tr>
<tr><td>Nboom</td><td>N/days</td><td>●All
●>0.5 psf
●>1.0 psf
●>2.0 psf
●>3.0 psf</td></tr>
</table>

● NOTE: A separate set of metrics has been calculated for each alternative that is preceded by a solid circle ("●").

Accounting for booms during the measurement period: At some sites sonic booms occurred infrequently, less than once a week. At all sites the levels of the individual booms varied considerably. So as to include all booms that might be relevant for each respondent, all metrics were recalculated for as many time periods as were needed to ensure that each respondent's measured noise environment included the booms that had occurred up to the minute at which the interview ended. For Phase I interviews, the correspondence between the timing of the booms and interviews at the six sites resulted in calculating the metrics for four periods. For Phase II, five periods were required. For Phase III, the eight sites required a total of 17 periods.

Adjusting for unmeasured periods: The data in Table 2 indicated that the BEARs were operating during more than 74 percent of the 6-month, pre-survey period at every site in Region B and at more than 30 percent of the time in five of the sites in Round II and four of the sites in Round I. At the lowest coverage site, a BEAR was operating about 18 percent of the time. Although such coverage exceeds that found in conventional aircraft noise measurement programs, the lower rates deserve attention in these sonic boom environments. To partially reduce the impact of unmeasured times, information about the exposure during particular types of measured periods was used to estimate the exposure during unmeasured periods of the same type. In effect, the measured periods were assumed to be a stratified probability sample of all periods.

Information about flight operations indicated that the frequency with which booms occur would vary by the type of day in Region A. The data confirmed these patterns. The estimates of the 6-month noise levels in Region A therefore divided the observed noise data into three periods before weighting the period results to estimate the total exposure for the 6 month rating periods. The three weighting periods for four of the six sites were as follows: weekend (52 days for both Phase I and Phase II), military-exercise weekdays (94 days for Phase I and 59 days for Phase II), and non-exercise weekdays (36 days for Phase I and 72 days for Phase II). For sites A-6 and A-5, information about exercises was not available and thus a simple weekend (52 days) and weekday (111 days) division was created.

In Region B three weighting periods were also formed, even though the high numbers of measurement hours made them less important. In Region B the high exposure period was all weekday, daytime hours. The next highest period was the weekday, nighttime period. The lowest exposure period was, as in Region A, the weekend.

The information about exposures during the weighting periods at each site was used to estimate the exposure for the entire six-month period that was asked about in the questionnaire. The total amount of time in each weighting period was determined for each site. The total exposure was then estimated by assuming that the unmeasured times during the weighted period had the same exposure as did the measured times during the period.

3.0 THE SONIC BOOM NOISE ENVIRONMENT

This chapter describes the sonic boom noise environment to which the study communities are estimated to be exposed. As the sonic booms could not be measured at all respondents' houses in all communities during the entire study period, the noise exposures used for the analysis in this report are estimates of the sonic boom noise environments. The exposure that is estimated is the exposure outside of respondents' homes up to the time of each respondent's interview. Although differences between inside and outside reactions are considered, no attempt is made to estimate indoor sonic boom exposures. Accurate estimates of this type cannot be made for a social survey study because of the large room-to-room and dwelling-to-dwelling differences. Similarly, although the total amount of time that respondents are at home is analyzed, no attempt has been made to estimate the sonic boom exposure at each individual's ear during the study period. Any such estimates would be very inaccurate because of the small number of booms, the considerable variations in boom exposure over small areas, and the impossibility of determining the location of respondents during the instants at which sonic booms occurred.

3.1 Estimated sonic boom environments

The average noise environment at each site is presented for each of the 20 combinations of study round and study site in Table 4. As was explained in a previous section the noise environment was individualized for respondents at the same site to account for sonic booms that occurred at different times in the interviewing period. Although these variations are rather small, the noise indices presented in the table are averages for respondents interviewed after slightly different exposures. The values in the first part of the table are for all booms in the six months immediately preceding an interview. The values in the second part exclude some of the less distinct booms. The last part of the table provides the noise exposures that extend back before the six month period by an additional one to seven months. The last part also provides exposures that excluded some of the less distinct booms.

Table 4: Sonic boom environment metrics for the 20 study situations

	Stage of Data Collection																			
	Region A: Phase I						Region A: Phase II						Region B: Phase III							
	Community						Community						Community							
	A-6	A-5	A-4	A-3	A-2	A-1	A-6	A-5	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4	B-3	B-2	B-1
LEQ(A)	22.60	26.73	31.66	27.50	37.46	41.88	22.02	27.24	25.10	28.00	39.26	41.67	28.77	32.12	29.11	29.51	34.11	40.12	37.54	40.33
LEQ(C)	40.78	47.91	46.47	46.32	54.15	57.15	40.36	40.53	38.86	45.27	52.35	55.88	32.91	41.05	40.73	41.87	46.27	48.59	51.64	54.52
SEL(A) Lg Avr	74.99	82.90	83.05	76.63	83.31	88.74	79.16	87.60	83.66	84.59	90.45	89.69	90.27	86.73	85.80	85.38	87.61	95.27	88.39	88.35
SEL(C) Lg Avr	93.17	104.07	97.86	95.45	100.00	104.01	97.49	100.89	97.42	101.86	103.54	103.90	94.41	95.67	97.41	97.74	99.77	103.74	102.49	102.54
PL Lg Avr	87.57	99.85	96.24	89.83	97.76	103.61	92.08	98.88	95.81	99.40	104.67	103.84	100.36	96.25	96.42	96.56	98.84	106.01	100.78	101.54
PMax Arith Mean All psf	.37	1.12	.54	.46	.57	.82	.62	.96	.59	.81	.83	.87	.49	.42	.53	.44	.64	.95	.93	.88
PMax Ar. Mean >0.5 psf	.82	1.76	1.07	1.09	1.21	1.51	.94	.96	.76	1.31	1.43	1.50	.63	.73	.87	.87	.99	1.14	1.28	1.30
PMax Ar. Mean >1.0 psf	1.09	4.85	1.69	1.84	1.98	2.25	1.13	1.17	1.35	1.66	2.66	2.23	.00	1.59	1.25	1.49	1.73	1.73	1.62	1.71
Num./day All psf	.50	.21	.63	1.06	2.25	1.78	.17	.08	.12	.19	.66	1.36	.06	.30	.19	.22	.39	.26	.71	1.36
Num./day >0.5 psf	.09	.12	.20	.20	.74	.80	.08	.08	.08	.09	.32	.66	.03	.09	.08	.08	.19	.20	.45	.80
Num./day >1.0 psf	.03	.03	.06	.07	.30	.40	.02	.04	.01	.05	.12	.34	.00	.01	.02	.02	.06	.08	.28	.47
Num./day >2.0 psf	.00	.03	.01	.03	.09	.16	.00	.00	.00	.02	.05	.12	.00	.00	.00	.00	.01	.02	.06	.11
Num./day >3.0 psf	.00	.03	.00	.00	.03	.08	.00	.00	.00	.00	.03	.06	.00	.00	.00	.00	.01	.01	.01	.01
Boom min./ day	.31	.15	.43	.64	.87	.91	.17	.08	.12	.15	.34	.77	.06	.27	.17	.19	.32	.22	.56	1.05

Table 4: CONTINUED)

	Wave of Data Collection																			
	Region A: Phase I						Region A: Phase II						Region B: Phase III							
	Community						Community						Community							
	A-6	A-5	A-4	A-3	A-2	A-1	A-6	A-5	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4	B-3	B-2	B-1
Noise environments (LAeq) for more distinct booms (2+ = grades 2, 3, 4, 5: 3+ grades 3,4,5; 4+ = grades 4, 5)[See Appendix 16 for definitions of grades.]																				
LEQ(A): Gr=2+	22.05	26.73	31.47	27.50	36.90	41.83	22.02	27.24	18.96	28.00	39.21	41.60	26.86	28.13	27.46	27.10	33.00	39.07	36.86	39.91
LEQ(A): Gr=3+	21.26	26.73	31.07	26.40	36.32	41.77	21.14	27.24	18.96	28.00	39.16	41.41	26.07	25.90	26.87	26.28	32.08	38.32	36.39	39.48
LEQ(A): Gr=4+	18.82	26.52	30.63	25.12	34.56	41.17	21.14	27.24	17.39	27.71	39.13	41.29	24.68	23.75	25.72	24.33	30.31	36.39	35.54	38.48
Noise environments (LAeq) for the longest available measurement period for all booms and relatively distinct booms. [See Appendix 16 for definitions of grades.]																				
LEQ(A) Gr=All(Mo>6)	22.60	26.73	31.66	27.50	37.46	41.88	23.02	28.89	29.33	28.39	37.86	41.37	28.30	32.15	29.83	29.90	33.85	40.22	37.70	40.63
LEQ(A) Gr=2+ (Mo>6)	22.05	26.73	31.47	27.50	36.90	41.83	22.81	28.89	28.80	28.39	37.57	41.30	26.16	27.72	27.89	27.66	32.72	38.78	36.84	40.11
LEQ(A) Gr=3+ (Mo>6)	21.26	26.73	31.07	26.40	36.32	41.77	21.89	28.89	28.35	28.09	37.29	41.17	25.37	25.50	27.03	27.05	31.77	37.83	36.31	39.68
LEQ(A) Gr=4+ (Mo>6)	18.82	26.52	30.63	25.12	34.56	41.17	21.12	28.82	27.85	27.62	36.68	40.77	23.98	23.10	25.73	25.73	29.77	35.90	35.54	38.62

3.2 Summary of information about the accuracy of the estimates of noise environments

The accuracy of the estimates of the long-term noise environment has been carefully assessed. It has been concluded that although there is considerable imprecision in the estimates there is no basis for assuming that the sonic boom estimates are likely to systematically either underestimate or overestimate the sonic boom environments in the study areas. This conclusion was reached after examining calibration information, evaluating the reasons for equipment downtime, comparing the BEAR and observer counts of booms during limited test periods, considering the possibility of systematic noise-exposure gradients across the communities, and examining the differences in measured levels between nearby BEARs (Appendix F)

The estimate of the noise exposure in any one location in a community can be seen as subject to sampling errors because not all booms are measured, there are random variations between the noise levels at different points in communities for the same booms, and individuals are not always present in the community. To evaluate these random sampling errors, the standard errors of the estimates of the six-month noise metrics (for example L_{Aeq}) have been estimated in Appendix G. These analyses did not indicate that the spectral frequency weighting (A or C) affected the accuracy of the estimates. The sampling errors reduce the correlation between noise level and responses, just as do errors in the measurement of the responses. However, these errors in the independent variable also lead to underestimates of the slope of the dose/response relationship.

The impact of errors in measuring the noise environment is affected both by the sizes of the errors and the amount of true variance in the noise exposures. If the noise exposures extend over a very large range, then the same sizes of measurement errors will have less impact than if there is a much smaller range in the variation of noise exposures. The range of noise exposures, expressed in L_{Aeq} (from 22 to 42) is provided in Table 4. The accompanying standard deviation of L_{Aeq} across respondents in the survey as a whole is approximately 5.9 dB (L_{Aeq}). The standard errors for estimates of the noise exposures (L_{Aeq}) at individual sites vary but are as high as half of this value. These relatively large confidence intervals suggest that errors in estimating noise environments have almost certainly reduced the slope of the dose/response relationship. This is one reason that the analysis in the remainder of this report focuses on the reactions in the communities and does not attempt to exactly specify the shape or slope of the dose/response relationship.

4.0 DOSE/RESPONSE RELATIONSHIPS

The relationship between the sonic boom environment and residents' responses is explored in this section graphically and through multivariate regression analyses. This analysis indicates the degree of reaction in different noise exposure environments and considers several alternative metrics for characterizing sonic boom environments.

4.1 Introduction to the graphical display

The first question residents were directly asked about sonic booms was presented in a series of parallel questions about possible noise sources. Respondents were first asked whether they heard each of seven community noises, the fourth of which was sonic booms:

```
Q.8.iv      In the last six months, have you ever heard the noise from
            sonic booms from jets when you were here at home?
```

Respondents hearing a source were then were asked an additional question about that source. For sonic booms they were asked:

```
Q.8.iv      Here is an "AMOUNT" card for choosing your answer for the
            next question.  During the last six-months has the noise
            from sonic booms from jets bothered or annoyed you very
            much, moderately, a little or not at all?
```

The percentages answering "very much annoyed" to this question are presented in Figure 5. The six solid diamonds in the figure represent the responses at each of six communities in Region A at the first round of interviewing in Phase I. The six open squares represent the responses at the same six locations in Phase II. The six solid circles represent the responses at the eight communities in Region B in Phase III. The noise levels are the arithmetic means of the values of L_{Aeq} of the individualized environments for each of the 20 groups of interviews. The numbers of interviews that provide the data for points vary from 29 to 207. Three other similar, overall sonic boom annoyance questions are included at later points in the questionnaire. The distributions of the responses for all four questions are given for each of the 20 groups in Appendix A.

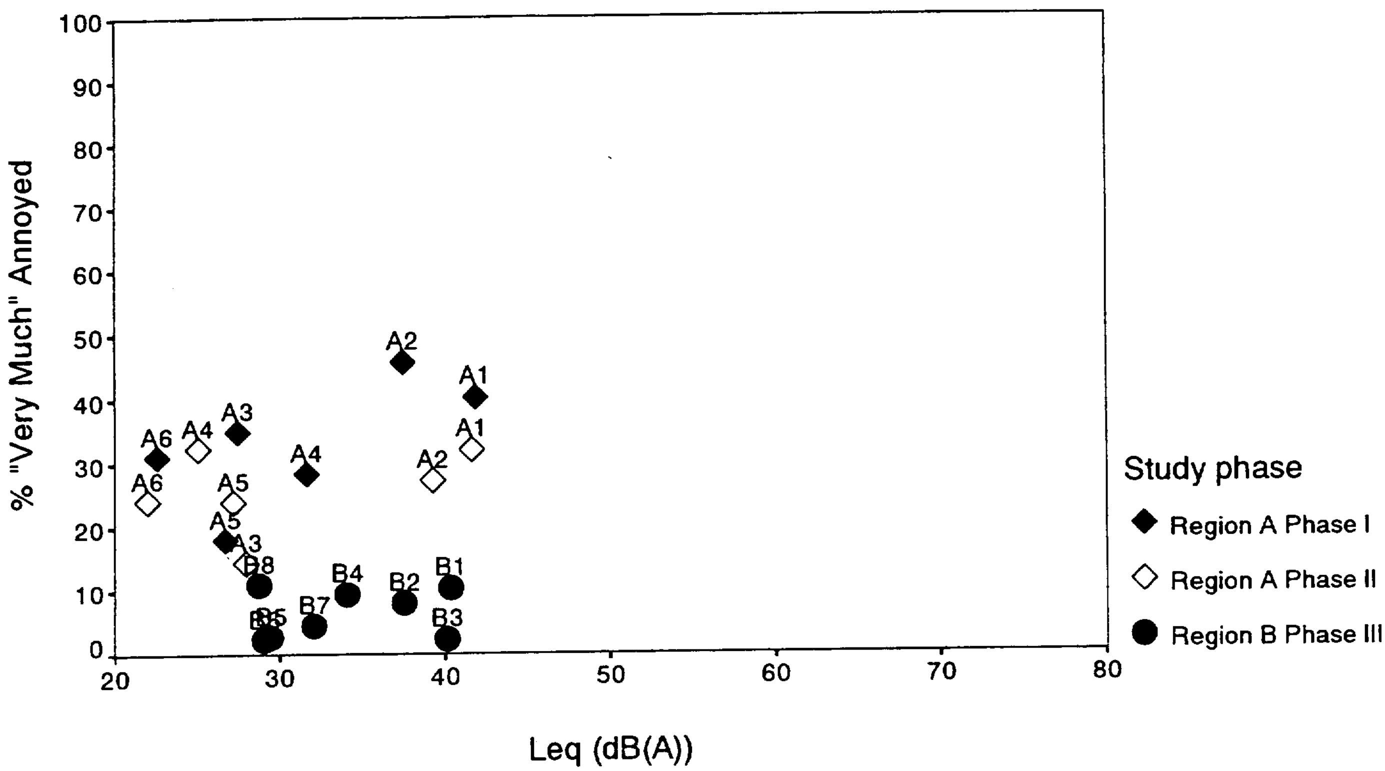

Figure 5 Dose/response relationship for "very much annoyed" (4-point verbal scale) and L_{Aeq}

One pattern is clear in Figure 5: the reaction in Region B is lower than that in either of the rounds of interviewing in Region A. Other patterns are more difficult to discern, partly because, as will be indicated later, the annoyance scale is a simple, relatively unreliable 2-category scale and partly because some site estimates with relatively small numbers of interviews provide relatively imprecise estimates.

Figure 6 presents a clearer view of the relationships. In this figure the four answers representing the four degrees of annoyance for Question 8 are assumed to be equally spaced and are simply scored from 0 to 3 (0=not at all annoyed, 1=at least a little annoyed, 2=moderately annoyed, 3=very annoyed). The two smallest communities' responses in Figure 5 have been combined with the adjacent communities for the presentation in Figure 6. The points in the figure each represent the average annoyance score for each group. The same distinctly lower annoyance score is apparent for Region B. There is also a slight trend toward higher annoyance at higher noise levels within each of the two regions.

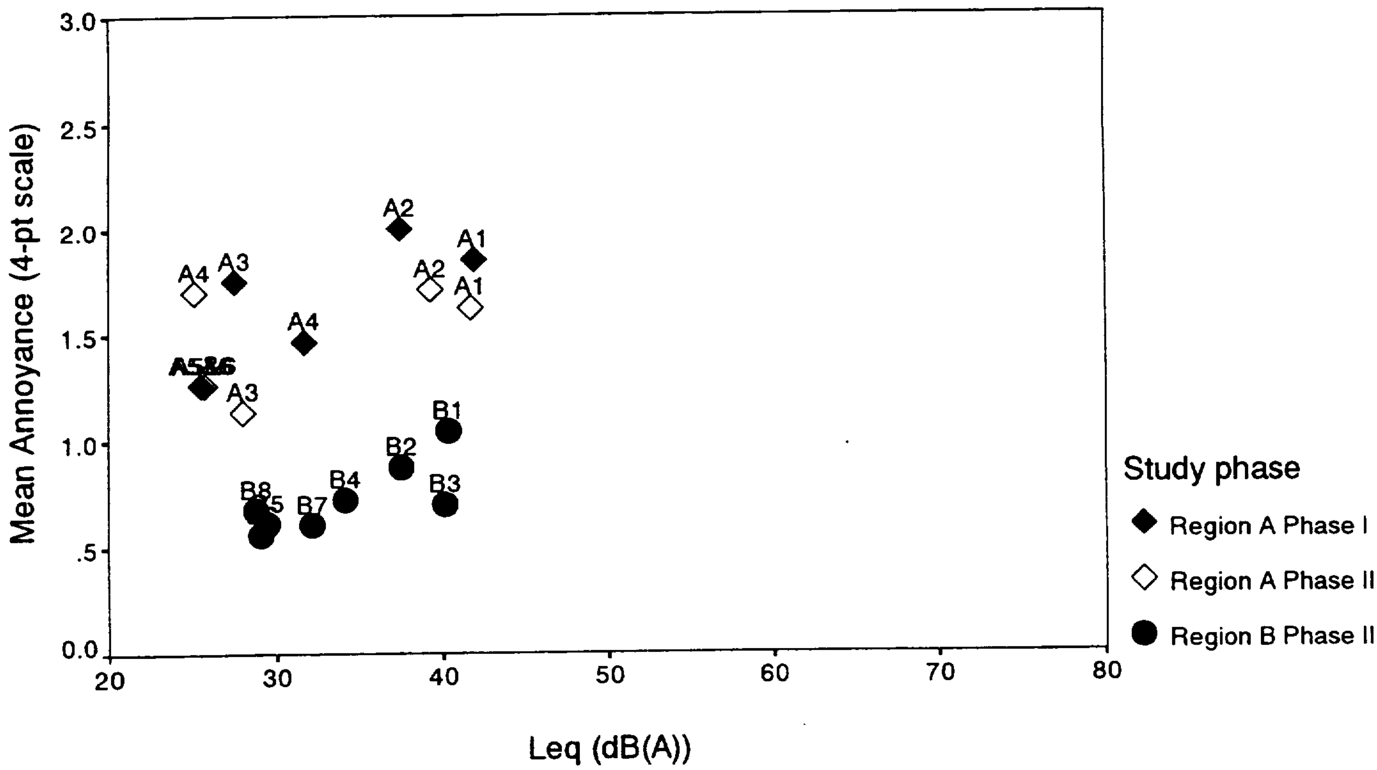

Figure 6 Dose/response relationship for average score on 4-point verbal scale by L_{Aeq}

The difference between reactions in the two regions is large and will be shown to be statistically significant in later analyses. The reactions in Region A are seen to be higher than those in Region B for three different degrees of annoyance in Figure 7 and Figure 8. In Region A (Figure 7) at the highest noise exposures about half of the population is at least "a little" annoyed. In Region B (Figure 8) over 80 percent are at least "a little" annoyed. The regional difference must therefore be considered in the analyses of these data.

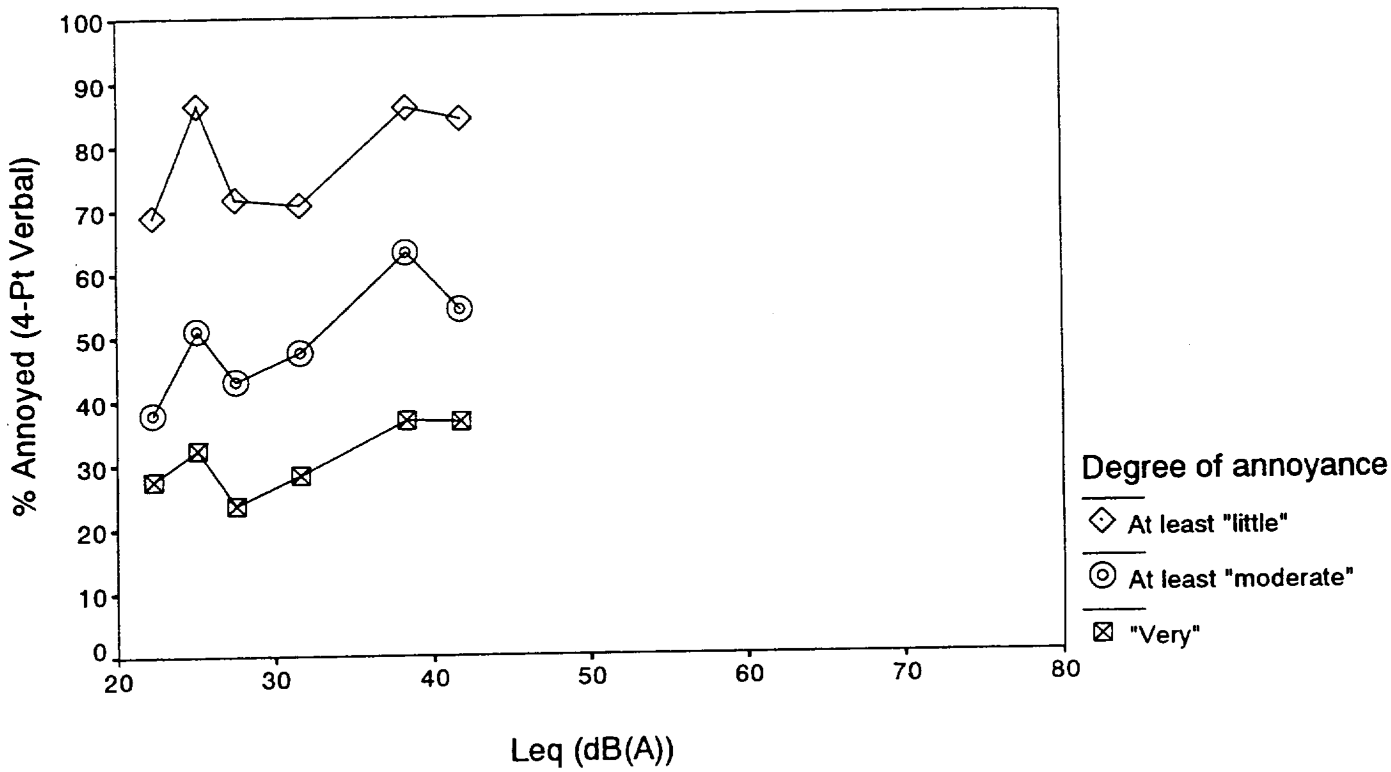

Figure 7 Dose/response relationship for 4-point verbal scale in Region A by L_{Aeq}

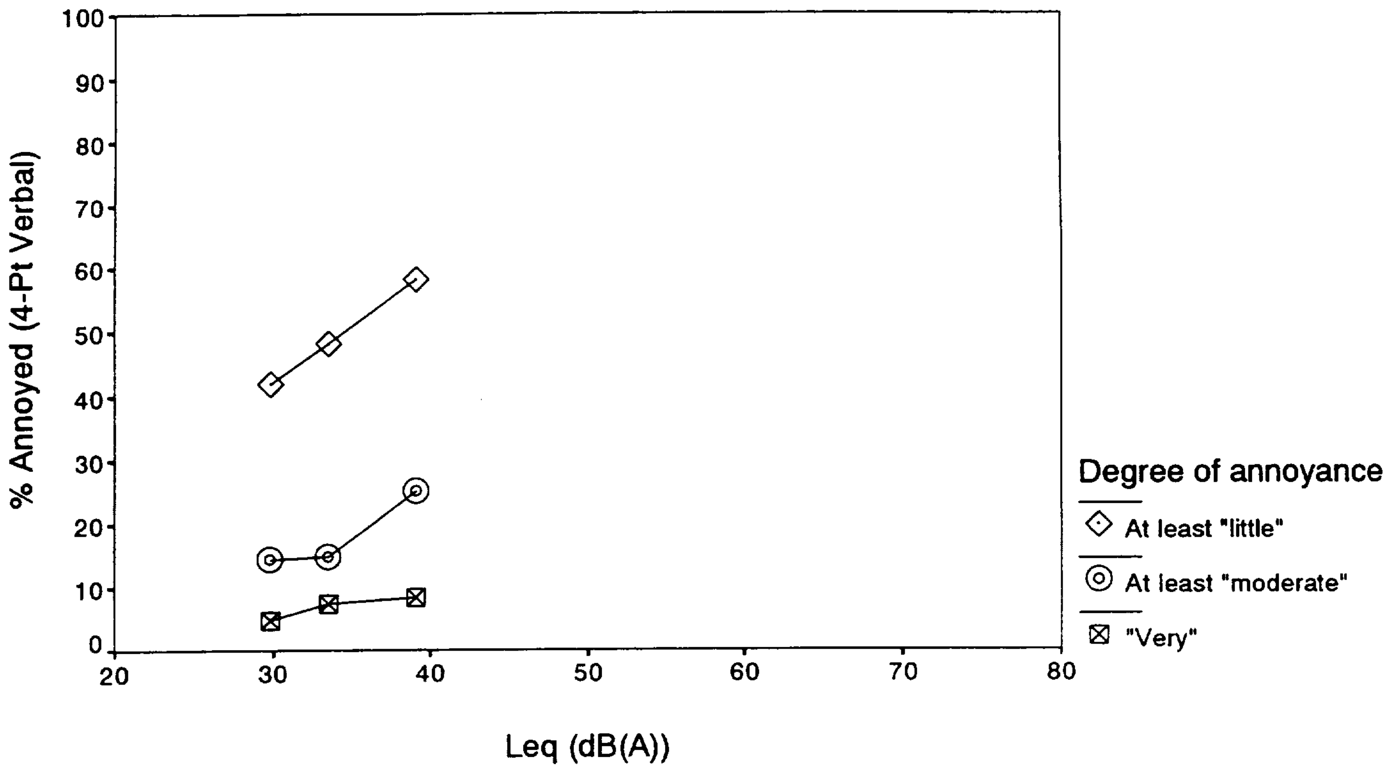

Figure 8 Dose/response relationship for 4-point verbal scale in Region B by L_{Aeq}

4.2 Comparisons of sonic booms and other nuisances with a magnitude estimation scale

Residents who reported any annoyance with sonic booms were asked to compare their feelings about sonic booms with their feelings about 16 nuisances. The relative degrees of annoyance were measured with a magnitude estimation scale when respondents were asked to give numeric annoyance scores to each of the 16 other nuisances relative to the sonic booms. The sonic booms were assigned a constant, arbitrary score of 100. Respondents were instructed to use the scale as a ratio scale so that a score of, for example, 200 would indicate twice as much annoyance as would a score of 100 (see Question 36 in Appendix K).

The data have been transformed to provide a sonic boom annoyance measure that is normalized relative to the feelings toward the 16 common, hypothetical nuisances that all respondents are assumed to evaluate similarly. Extensive research in both psychophysics and opinion polling has determined that people use these magnitude scales as ratio scales (Lodge, 1981; Stevens, 1974; Wegener, 1982). The analysis therefore proceeds by analyzing the common logarithms (base 10) of the judgments and calculating geometric means of the magnitude scores. A more detailed description and assessment of the analysis procedures followed for the sonic boom scale is available (Fields, 1996a).

Figure 9 succinctly summarizes the degree of annoyance with sonic booms in the two regions relative to the baseline provided by the 16 hypothetical nuisances. As is explained later, the scale is arbitrarily anchored at the noisy truck annoyance with a score of 100. The data points represent the geometric means of the sonic boom ratings relative to the 16 nuisances for those residents who were annoyed by sonic booms. Figure 9 includes only the annoyed respondents and thus should by interpreted together with the knowledge that an additional 7 to 47 percent of the respondents in each community did not express any annoyance.

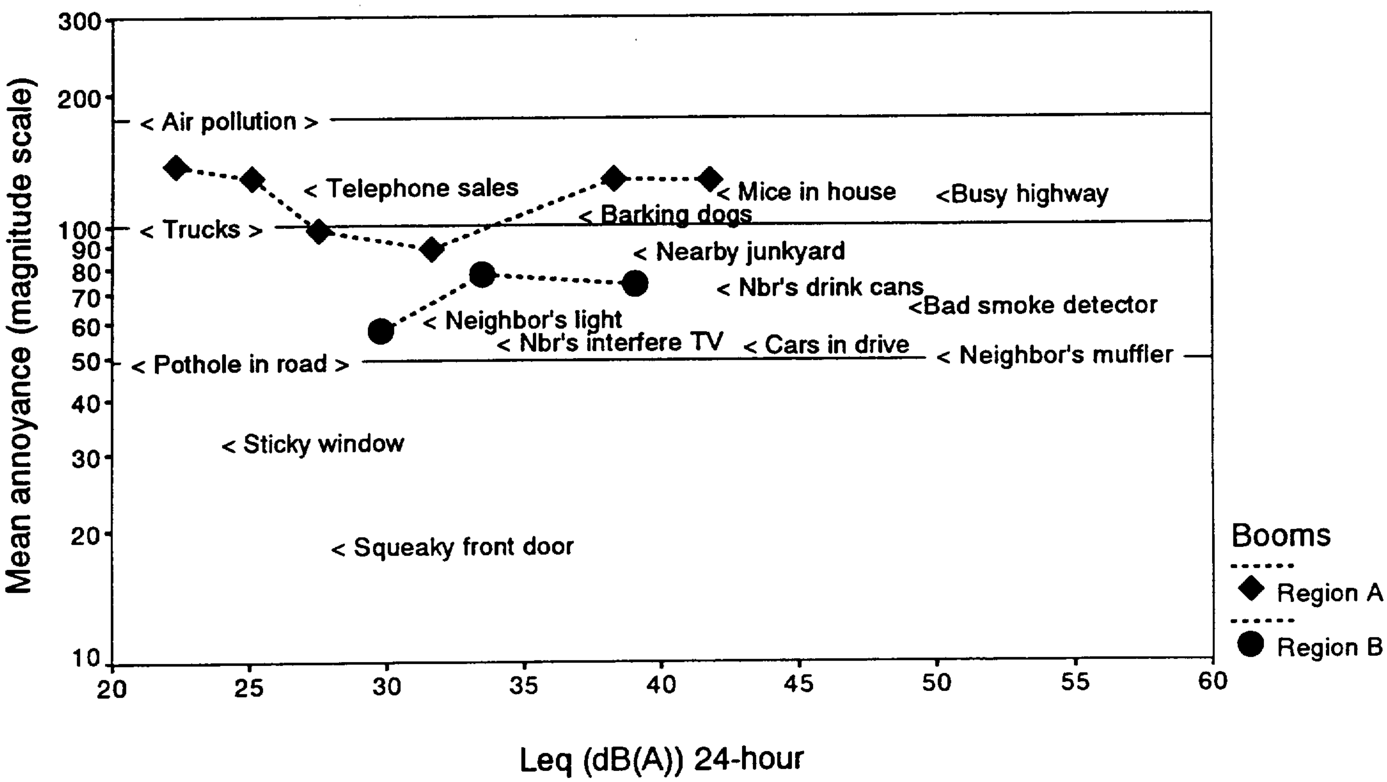

Figure 9 Annoyance scores for sonic booms in two regions by L_{Aeq} relative to 16 common nuisances

Extremely high and low magnitude scores were truncated at the scale's limits of 1,000 and 1 respectively. Distances between the 16 nuisances are the geometric mean distances calculated for respondents who rated all 16 nuisances. These distances are unaffected by the varying (sonic boom) reference point. First the 16 nuisances' values are expressed relative to the score for "hearing big noisy trucks if you lived at a busy intersection" which is set at 100. Each respondent's sonic boom score is then the geometric mean of the respondent's scores calculated from the respondent's sonic boom-to-nuisance ratios.

The scores in Figure 9 provide readers with a basis for understanding survey residents' feelings about sonic booms relative to their feelings about types of hypothetical or real situations that it is assumed both the readers and respondents would evaluate similarly. Figure 9 indicates that the average degree of annoyance with sonic booms increases only slightly over the 20-decibel range represented in this study. In the figure the phrases for the 16 non-boom nuisances are placed at their mean annoyance scores on the ordinate. When these nuisances are compared to the two sets of sonic boom data points, it is seen that the average sonic boom annoyance score lies between the annoyance with "having unhealthy air pollution in the area" (top reference line in Figure 9) and the annoyance with "having a pothole in the street near your house" (bottom reference line in Figure 9). The annoyance in Region A is generally rather similar to that felt toward "the telephone calls you get from salespeople at home", "having mice in your house", or "having a dog next door that regularly barks in the middle of the night." The annoyance in Region B is more similar to that expressed toward "having a neighbor whose drink cans get onto your property", "having a smoke detector that goes off at least once a week when someone is cooking", or "having a neighbor's security light that shines into your bedroom."

4.3 Examination of alternative summary annoyance measures

An answer to a single question by a single respondent can be subject to response errors that can be partially removed by combining the respondent's answers on several questions into an annoyance index. Such a 4-item overall sonic boom annoyance index has been prepared for this report from the answers to four questions, the 4-point verbal question (Q.8.iv, presented above) and the following three questions:

Q12 *[Note: Respondents used this 0-10 opinion thermometer to rate road traffic noise on the immediately preceding question.]* How much have you been bothered or annoyed by the sonic booms here, around home, during the last six months?

00	01	02	03	04	05	06	07	08	09	10
NOT AT ALL ANNOYED										EXTREMELY ANNOYED

Q35 Please look at CARD I to choose your next answer. [HAND CARD I TO RESPONDENT] Considering everything about the sonic booms in the last six months, would you say that you have been not at all annoyed by sonic booms, slightly annoyed by sonic booms, moderately annoyed by sonic booms, very annoyed by sonic booms or extremely annoyed by the sonic booms?

1. NOT AT ALL ANNOYED→ [SKIP TO Q37]
2. SLIGHTLY ANNOYED
3. MODERATELY ANNOYED
4. VERY ANNOYED
5. EXTREMELY ANNOYED

Q37 In 1969, people in nine cities looked at this next thermometer to tell us about noise. [HAND CARD J TO RESPONDENT] Now you can use it for the sonic booms here. On this thermometer, zero means "not at all annoyed" and four means "extremely annoyed". Considering everything about the sonic booms in the last six months, what number shows how much you are bothered or annoyed by the sonic booms?

0	1	2	3	4
NOT AT ALL ANNOYED				EXTREMELY ANNOYED

The 4-item boom index was formed by scoring each question from 0 to 10 (for the most extreme answers) while maintaining equal distances between the remaining answers and then averaging the scores on the four questions. All 1,573 survey interviews receive a score on this index. Respondents who did not report hearing sonic booms on Q.8.iv (above) were not asked the questions and received a score of zero. This 4-item boom index has been selected because it summarizes the overall annoyance reactions, avoids some of the errors implicit in relying on a single annoyance question, can be easily understood, and is constructed with procedures that can be easily adopted in other annoyance surveys. The four general annoyance items are all highly correlated with Pearson Product Moment correlations of $r>0.67$.

This 4-item boom index has been adopted after briefly examining the correlations between respondents' answers to these four general annoyance questions, five activity interference questions (Q.14, in Appendix K), and 16 magnitude estimation questions (Q.36, in Appendix K). A principle components factor analysis with varimax rotation was conducted for those 25 reaction questions. The four general annoyance questions load more highly than any other questions on the first rotated factor from that analysis.

The partial correlations between the 112 noise indices and 10 reaction indices, controlled for region-of-study were examined. Due to the strong effect of region-of-study on annoyance response, all conclusions are based on partial correlations in which the region of the survey is represented by a dichotomous dummy variable. These partial correlations are presented in Appendix C. The 4-item boom index is always more highly correlated with total boom environment noise exposure than is the highly-annoyed dichotomous scale (Q.8, see Figure 6). The 4-item boom index is somewhat less highly correlated with noise exposure than are a 5-item activity interference index and a speech interference annoyance question that is included in that activity interference index. For the primary noise index used in this analysis (L_{Aeq}), the partial correlation with the 4-item general boom index of $r_{AL \cdot R}=0.13$ is slightly less than that with the 4-item activity interference index of $r_{AL \cdot R}=0.16$. For some other noise indices the difference is even greater (see the correlation matrix in Appendix C).

Although the correlations with the speech interference questions are of potential interest, two other weaknesses led to the decision to use the 4-item general annoyance index for the analyses in this report. The activity interference items do not necessarily capture the respondents' overall, considered reaction to all aspects of the sonic booms. In addition, as explained in the questionnaire design section, three slightly different versions of these particular activity interference questions were used in different questionnaires. Although these differences in question versions are not correlated with noise exposure, they do mean that the measure could not be expected to be reproduced in another study and that some of the unusual aspects of some of the versions (e.g. asking about all family members rather than only the respondent) could be introducing methodological uncertainties that are difficult to evaluate.

4.4 Examination of alternative noise metrics

Most of the analyses in the report use an A-weighted measure of the 24-hour equivalent noise level (L_{Aeq}) to represent the sonic boom noise environment. This decision was made after examining the partial correlations between alternative annoyance measures and 112 sonic boom environment measures controlled for region. The examination of partial correlations with a control for region was again needed because without the control for region, the relations between reactions and noise level were quite weak or even negative. For example, the partial correlation between boom exposure (L_{Aeq}) and the 4-item boom annoyance index, controlled for region, is $r_{AL \cdot R}$ =0.13 while the simple bivariate correlation between the same two variables of $r_{AL \cdot R}$ =-0.01 does not show any relationship between exposure and annoyance.

All analyses are based on the most precise, individualized noise data that were available. Noise metrics have been calculated, as explained earlier, by calculating the estimated exposure in the area up to the minute of the interview. Annoyance responses are also separately calculated for each individual.

The partial correlations between the 4-item boom annoyance index and the alternative noise metrics can be summarized in terms of the effects of five factors. The actual partial correlations are presented in Appendix C. In each case the primary issue is whether some index other than the A-weighted equivalent continuous noise level might better represent reactions to sonic booms. One factor concerns the length of time period for which sonic booms are accumulated. The remaining factors consider the metric used for individual booms. Three of the factors are loosely related to the possibility that the equivalent continuous noise level (L_{Aeq}) may not adequately capture the effect of especially distinct, high intensity booms. The effect of the time of day of booms was not evaluated since the only events classified as booms outside of the standard day-time noise period (07:00 to 22:00) were within one hour of that period and were, even then, confined to a small number of booms at a few sites. As a result, DNL (Day/Night Average Noise Level) would have the same values as those presented here for L_{Aeq}. The remainder of this section considers each of the five factors in turn.

<u>Factor #1: Distinctness of booms</u> Every noise index considered in this analysis was calculated for all booms as well as for three subsets of booms that are defined by the increasingly stringent boom distinctness criteria that were discussed previously and are presented in Appendix E. In every case in which there was even a moderate partial correlation (r>.08) the partial correlation between the 4-item boom index was greater with the noise index based on all measured sonic booms than on any of the noise indices based on a lesser subset of booms that the acousticians had judged to be more distinct. For L_{Aeq} , for example, the partial correlation of $r_{AL \cdot R}$ =0.13 that included all booms, no matter how indistinct, exceeded the partial correlations of $r_{AL \cdot R}$ =0.12, $r_{AL \cdot R}$ =0.11, and $r_{AL \cdot R}$ =0.10 that eliminated less distinct booms in three successive steps.

Factor #2: Intensity of booms There is also no evidence that *only* the most intense booms affect annoyance. Separate indices of numbers of booms and average peak overpressures (arithmetic averages) were calculated for all booms and only those exceeding 0.5 psf (pounds per square foot), 1.0 psf (for both indices), and 2.0 psf and 3.0 psf (for the number of boom indices). In-as-much-as any pattern occurred it was for the correlation with annoyance to be higher for the indices that included all booms than for otherwise comparable indices that included only the smaller number of booms exceeding the successively more stringent peak overpressure criteria.

Factor #3: Numbers of booms A comparison of indices based on only boom intensities with indices based on either only the numbers of booms or on a combination of numbers and intensities of booms gives no support to the theory that reactions are determined by only the most intense booms. Sonic boom annoyance is more highly related to the equivalent continuous noise level (L_{Aeq} and L_{Ceq}) than it is to the logarithmic average intensity of the booms as measured by the value of SEL (SEL(A) or SEL(C)). The weak evidence from these data suggest that if the equivalent continuous noise level (L_{Aeq}) misrepresents noise exposure, it is through overemphasizing the impact of the intensity of the booms and underestimating the impact of the number of booms. The partial correlations between annoyance and simple counts of the total numbers of booms (controlled for region of study) are higher than those between annoyance and the logarithmic average intensity of the booms or between annoyance and the equivalent continuous noise level.

Two regression analyses were conducted to determine whether this strong effect of numbers of events was likely to be due to sampling variation. The 4-item boom annoyance index was regressed on the dichotomous region variable and the total number of noise events in the previous six months. In the first analysis L_{Aeq} was also included. In the second analysis L_{Aeq} was replaced by the logarithmic average SEL value. In both cases the effect of both region-of-study and number of booms is statistically significant ($p<.05$) while the effect of the indicator incorporating noise level is small or negative and not statistically significant. As for all analyses in this report the sampling errors were calculated using a sampling error calculation technique (in this case a jackknife replication technique) that accounts for the clustering of respondents into study areas. Although this analysis could be pursued further, the methodological considerations introduced at the end of this section suggest that these analyses should not by themselves be accepted as strong evidence on the relative impact of the intensity and numbers of booms.

In the preceding analyses each boom was counted separately even when several booms occurred within a single minute. The possibility that the number of boom episodes, rather than simply the number of booms, is important was considered by counting the number of minutes in which there were any booms. This measure of sonic boom exposure was found to have almost the same partial correlation with response as did the count of total number of booms. The partial correlation with annoyance was no more than $r_{AL \cdot R}=0.02$ greater for the simple count of number of events than for the count of number of minutes containing any booms.

Factor #4: Length of noise accumulation period Respondents were asked about the previous six-months and thus the noise indices used in the final analyses are also based on this strictly-defined, six-month period. To consider the possibility that respondents might be integrating their exposure over a longer period every noise index was also calculated for the longest period for which noise data were available. As shown in Table 11 this extended the noise integration period by approximately one month for the Phase I in Region A, and Phase III in Region B. For Phase II in Region A, the integration period was extended by about seven months so that it included the time covered by both the Phase I and Phase II questionnaire items. The partial correlations with the 4-item boom index are similar for the two time periods. None of the correlations exceeding $r_{AL \cdot R}=0.10$ differ by even $r_{AL \cdot R}=0.02$ for noise indices that are based on booms of all levels of distinctness.

Factor #5: Spectral frequency weighting The final factor considered in evaluating the boom indices was the spectral frequency weighting for the individual event metric. Average SEL(A), SEL(C), PL, and psf were all examined, but these metrics that ignored numbers of booms were always less closely related to annoyance than simple counts of number of events or metrics that considered both numbers and levels of events (for example, L_{Aeq}). Both A-weighted and C-weighted measures of the continuous equivalent noise level were positively related to each of the annoyance indices. The A-weighted index was slightly more closely related to each of the general annoyance indices, the percentage highly annoyed, the activity interference index, the startle annoyance scale and the vibration annoyance scale. The differences are not great and probably not significantly different. The A-weighted and C-weighted indices are highly correlated (r=0.83) for the social survey respondents. Most of the remainder of this analysis is conducted with the A-weighted measure (L_{Aeq}). This index is probably the most widely internationally shared index. As a result, a large number of data sets are available for direct comparisons based on L_{Aeq}.

4.5 Considering the form of the dose/response relationship

The relationship between noise exposure and reactions is assumed to be linear for the limited range of noise conditions examined in the sonic boom survey. The scatterplots in Figures 5 and 6 do not suggest an alternative shape. A regression analysis of the 4-item boom index on Region, L_{Aeq} and L^2_{Aeq} found that the squared term was not statistically significant. In addition the total proportion of explained variance in annoyance reactions increased by less than one percent.

Of course some more complex form might be appropriate for a dose/response relationship that extended beyond these noise exposures Nothing in the present analyses gives insight into the form that might be expected.

The data do not accurately specify the slope of the dose/response relationship. When the 4-item boom index is regressed on region and L_{Aeq} the regression coefficient of B=0.08 for L_{Aeq} is surrounded by a 95 percent confidence interval of $\pm$ 0.05 that indicates that the true slope could vary from almost zero (B=0.03) to a slope that is almost twice that found in the study (B=0.13). With so little precision in these estimates, the present analysis should not be considered to have precisely specified the slope of the dose/response relationship for sonic boom noise.

The uncertainty about the dose/response relationship can be traced to several factors. The uncertainty in the estimation of the long-term noise environments is a major factor, as is discussed in Appendix F. Information about the dose/response relationship is also limited by the fact that the exposures are all rather low, not more than 42 dB (L_{Aeq}), and thus cover a limited range of exposures. The very small number of sonic boom events during the six-month study period for most of the 20 study groups can be expected to reduce the accuracy. As was seen in Table 2, four of the 20 groups' noise estimates are based on 10 or fewer measured booms and an additional three of the 20 groups are based on less than 20 measured booms. With a small number of boom measurements there is less opportunity for a stable average exposure to emerge from the differences in the exposures to the same flights at different houses within a site. Small numbers of flights also mean that variations in the times that residents were at home could affect their knowledge about the sonic boom exposures during the six-month study periods.

5.0 NON-NOISE FACTORS RELATED TO SONIC BOOM RESPONSES

This section examines 34 non-acoustic factors that have sometimes been hypothesized to affect residents' reactions to noise. Both demographic and attitudinal factors are considered. Major attention is focused on an attempt to understand the source of the different reactions that were noticed in the previous section between reactions in Region A and Region B.

5.1 Method for examining factors

Multiple linear regression analyses are performed to examine the relationship between annoyance, sonic boom exposure, and other non-noise variables. A linear relationship is accepted because the relationship in Figures 5 and 6 appears to be approximately linear and, as was explained in the preceding section, a regression analysis found no support for a more complex curvilinear relationship.

The region-of-study variable has such a strong effect on the dose/response relationship that it is included as a dummy variable in all analyses. Without controlling for region, there does not appear to be a significant relationship between sonic boom exposure and reactions. The possibility that the first and second interviewing phases in Region A might have created different annoyance reactions was considered but rejected. In a regression of the 4-item boom annoyance index on dummy variables representing the study phases it was found that the Phase I scores on the 0-10 annoyance scale exceeded those in Phase II by approximately 0.6 points, but that this estimate of 0.6 points was surrounded by a 95% confidence interval of approximately ± 1.3 annoyance points and thus was not statistically significant at even a $p<0.10$ level.

Tables 5, 6 and 7 present the partial regression coefficients from the regression of the 4-item boom annoyance index on the sonic boom environment (B_{LAeq}), region-of-study (B_{Region}), and various alternative non-noise explanatory variables (B_{Other}). In each table the unstandardized partial regression coefficients for each factor are presented together with indicators of the statistical significance of the effects of region and the various non-noise explanatory variables.

5.2 Demographic factors

The regression analyses in Table 5 indicate that none of the demographic variables affect sonic boom reactions or can explain the differences in reactions between the regions. The evidence for these conclusions comes from the values of the partial regression coefficients and the outcome from the statistical tests. An examination of the effect of the first "Personal connection" variable in Table 5 serves to show the type of information that is presented for all of the variables in Tables 5 to 7.

The possibility that a personal connection to the noise source could affect reactions is examined for the two analyses under the "Personal connection" category in the table. It was thought that personal connections might be important since the residents in Region B were relatively close to the air base and may have included employees or others associated with military affairs. The first line in this section evaluates the effect of working for the noise source on the basis of the answers to Q.40.a in which, as the middle column indicates, respondents were asked whether anyone living in the house worked for the airfield or a business associated with the airfield. The three partial regression coefficients in this row indicate that a respondent's score on the 0 to 10 annoyance scale is predicted to increase by 0.08 points for each decibel (L_{Aeq}), by 2.68 points for living in Region A, and by 0.54 points for having an employment connection with the airfield. The asterisk (*) in the B_{Region} column indicates that the effect of region is statistically significant. The absence of an asterisk with the coefficient for airfield employment (B_{Other} column) indicates that the effect of airfield employment (B_{Other}=0.54)is not statistically significant. The following column contains the standard error for the partial regression coefficient for airfield employment (σ_{BOther}) and provides additional information about the precision with which the effect of this variable has been specified. The 95 percent confidence interval for estimate of the partial regression coefficient is approximately twice (1.96) the value of the standard deviation. For the airfield employment effect of B_{Other}=0.54, the 95 percent confidence interval extends from 1.07 to -0.07 (0.54 $\pm$ (0.31*1.96)). Thus, although the analysis suggests that the estimate that airfield employment increases annoyance is not statistically significant, the analysis also cannot rule out the possibility, at a 95 percent confidence level, that airfield employment might decrease the annoyance score by -0.07 points. The extent to which important effects could be missed by such a large confidence interval is clear if the regression coefficient for noise level is also considered. With the regression coefficient for noise level of B_{LAeq}=0.08, the positive regression coefficient of B_{Other}=0.54 (7≈ 0.54/0.08)for airfield employment implies that employment by the airfield increases annoyance by approximately the same as a 7-decibel (7≈ 0.54/0.08) increase in noise exposure. Thus, although these data do not support an effect of business associations with an airfield, the possibility of potentially important effects cannot be eliminated.

The remainder of Table 5 indicates that there is not a statistically significant relationship for indicators of relationship to the noise source, living in a mobile home, the type of property, the length of residence (linear or logarithmically transformed), or plans to move from the community. There is a statistically significant tendency for annoyance to decrease with the amount of time that is spent away from home (linear or logarithmic transformation). There is also a significant relationship with months lived in the community, but not with the logarithmic transformation of months lived in the community. The first line in the table shows the coefficients for the simple regression without any of these non-noise explanatory variables. The small impact that any of these demographic variables has on the amount of annoyance in these areas is evident from the finding that in no case does the proportion of variance explained by the total model increase by more than R^2=0.02 over the value of R^2=0.124 (last data column) for the baseline equation in the first row. The demographic variables also do not otherwise impact the dose/response relationship. In no case does the regression coefficient for noise level (B_{LAeq}) change by more than 0.01 points from the baseline coefficient of B_{LAeq} = 0.08). The comparison of the baseline estimate for the effect of region (B_{Region} = 2.63) with the same regression coefficients for the remaining models (low of B_{Region} = 2.53) indicates that none of these variables is able to explain the large difference between reactions in the two regions.

5.3 Attitudinal factors

Table 6 provides the results of regression analyses relating to attitudinal factors that might be considered to affect reactions to sonic booms. For the five environmental issues that appear first in the table, the positive, statistically-significant partial regression coefficients show that in every case perceptions of environmental problems are positively related to annoyance with sonic booms. Similarly each of the four attitudes toward various aspects of sonic booms and military aircraft are related to sonic boom annoyance in the direction that would be expected. Each relationship is statistically significant. Those with favorable attitudes toward supersonic aircraft generally or military aircraft in the area are less likely to be annoyed by the aircraft.

While the attitudinal factors are related to sonic boom annoyance in the way that is expected, the interpretation of the causal implications of these relationships is uncertain. It is not clear, for example, whether a resident's belief that it is important to develop supersonic commercial aircraft reduces annoyance or whether a resident who find himself or herself to be more annoyed by booms may be led to conclude that developing supersonic commercial aircraft would not be valuable.

Table 5: Regression analysis of the effect of demographic factors on reactions

Regression ID #	Regression equation (* = p<0.05): Intercept	B_{LAeq}	B_{Region}	Demographic variable: Description	B_{Other}	σB_{Other}	R^2 (proportion of variance explained by equation)	(Variable name)
Baseline equation (no additional variable)								
	-0.46	0.08	2.63*	(None)			0.124	
Personal connection to noise source								
1.	-1.09	0.08	2.68*	Q40a Anyone in household works for business or airfield associated with the booms	0.54	0.310	0.129	R40AZ
2.	-0.16	0.07	2.63*	Q47a Respondent ever worked for military service	-0.35	0.244	0.127	R47AZ
Characteristics of location								
3.	-0.91	0.08	2.67*	Farm/ Ranch property	0.32	0.615	0.125	VAGZ
4.	-0.92	0.09	2.76*	Distance to nearest house (feet)	-0.00033	0.000	0.127	VDISTZ
5.	-0.54	0.09	2.74*	Log_{10} Distance to next house (feet)	-0.17	0.252	0.126	VDISTZL
Other								
6.	-0.28	0.08	2.57*	Live in mobile home	-0.14	0.365	0.125	R59Z
7.	0.00	0.08	2.53*	Q45 Minutes away from home per day	-0.0018*	0.000	0.149	R45Z
8.	0.83	0.08	2.54*	Log_{10} Minutes away per day	-0.65*	0.241	0.139	R45ZL
9.	-0.56	0.08	2.68*	Q5d Months lived in community	0.00085*	0.000	0.134	S05Z
10.	-0.98	0.09	2.74*	Log_{10} Months lived in community	0.11	0.122	0.133	S05ZL
11.	-0.65	0.08	2.62*	Q49 Plans to move from community	0.22	0.195	0.125	S49Z

Table 6: Regression analysis of relations between general attitudes and reactions

Regression ID #	Regression equation (* = p<0.05)						R^2 (proportion of variance explained by equation)	(Variable name)
	Inter-cept	B_{LAeq}	B_{Region}	Attitude				
				Description	B_{Other}	σB_{Other}		
Baseline equation (no additional variable)								
	-0.46	0.08	2.63*	(None)			0.124	
General environmental opinions								
12.	-0.85	0.07	2.80*	Q.43 Extent identify self as "environmentalist"	0.17*	0.050	0.149	V43Z
13.	-1.64	0.07	2.62*	Q.42.a Extent "air pollution" is threat to environment overall	0.27*	0.025	0.158	V42AZ
14.	-1.57	0.07	2.61*	Q.42.b Extent "lake and stream" pollution is threat to environment	0.25*	0.034	0.150	V42BZ
15.	-1.58	0.07	2.71*	Q.42.d Extent "global warming" is threat to environment	0.29*	0.040	0.173	V42dZ
16.	-2.31	0.08	2.77*	Q.42.e Extent "additives and pesticides in food" are threat	0.35*	0.047	0.176	V42eZ
Attitudes toward aircraft importance								
17.	1.38	0.06	2.42*	Q.41.d Importance of developing supersonic commercial aircraft	-0.26*	0.051	0.154	S41d
18.	1.41	0.06	2.43*	Q.41.e Extent supersonic commercial aircraft should be supported	-0.26*	0.050	0.153	S41e
19.	3.23	0.07	2.47*	Q.41.c Importance of boom aircraft in area for defense	-0.55*	0.071	0.177	S41CZ
20.	3.39	0.08	2.38*	Q.41.b Importance of military flights in area	-0.62*	0.120	0.193	S41BZ
Strength of attitudes toward other local noises								
21.	-1.28	0.06	2.50*	Q.10 Annoyance with noise in general around home	0.65*	0.042	0.383	V10Z
22.	-1.67	0.09	2.90*	Q.11 Annoyance with road traffic noise around home	0.37*	0.050	0.181	V11Z
23.	-0.97	0.08	2.76*	Q.8.v Annoyance with any other impulsive noise in area	0.92*	0.147	0.160	S085CZ

5.4 Understanding the differences between reactions in the two regions

A clear, unambiguous explanation for the differences in reactions to sonic booms in the two regions cannot be extracted from these data. The demographic variables that were examined previously did not explain the differences. The remaining variables either are attitudinal variables, for which the causal direction is not clear, or are correlated characteristics of the entire region whose effects cannot be disentangled. An initial examination of the answers that were volunteered to open questions about area problems also did not identify widely shared problems that would explain the differences between regions. It is possible to eliminate some possible attitudinal explanations and to develop a list of characteristics that are possible candidates for explaining the differences between the two regions.

Several attitudinal factors are eliminated as explanations by the analyses in Table 6. Environmental attitudes do not reduce the regional difference. Attitudes toward the importance of the boom aircraft or military flights do not explain differences in reactions. It may also be of some importance that attitudes toward the development of a commercial supersonic aircraft are also unimportant. Even attitudes toward other non-aircraft noise sources in the area do not explain the differences in reactions to sonic-booms in the two areas. This suggests that any differences in ambient noise sources in the two areas do not explain the differences between the reactions in the two areas.

Table 7: Regression analysis of ambiguous causal connections between perceptions of sonic boom conditions and reactions

Regression ID #	Regression equation						R^2 (proportion of variance explained by equation)	(Variable name)
	Intercept	B_{LAeq}	B_{Region}	Other variable				
				Description	B_{Other} (* = $p<0.05$)	$\sigma_{B_{Other}}$		
Baseline equation (no additional variable)								
	-0.46	0.08	2.63*	(None)			0.124	
Attitudes toward low-flying aircraft								
24.	-0.73	0.06	2.36*	Q.8vi Hear low-flying jet aircraft in area (2 categories)	1.29*	0.239	0.149	S086AZ
25.	0.79	0.01	1.24*	Q.8vi Annoyance with low-flying jet aircraft in area	2.00*	0.097	0.500	S086CZ
Attitudes toward the aircraft operators								
26.	-1.48	0.04	1.75*	Q.41f Agree pilots could do something more to reduce booms here (2 category)	1.95*	0.230	0.218	S41FZA
27.	-1.00	0.03	1.36*	Q.41f Extent pilots could do more to reduce booms here	0.61*	0.088	0.264	S41FZ
28.	-1.97	0.04	1.97*	Q.41g Agree officials planning flights could do something more to reduce booms here (2 category)	1.92*	0.188	0.216	S41GZA
29.	-1.80	0.05	1.65*	Q.41g Extent officials planning flights could do more to reduce booms here	0.63*	0.063	0.267	S41GZ
Reported presence of types of sonic boom impact								
30.	-0.75	0.04	1.91*	Q.13vii Startled by sonic booms	2.72*	0.194	0.270	D1407Z
31.	-1.98	0.05	2.26*	Q.21 Any danger from sonic boom aircraft crashing	2.05*	0.251	0.223	R21ZA
32.	-2.05	0.05	2.33*	Q.13xi Vibration from sonic booms	2.86*	0.368	0.201	D1411Z
33.	-0.67	0.08	2.73*	Q.17 Notice damage from booms	0.90*	0.306	0.153	R17

Table 7 examines attitudes for which the causal relationship with boom annoyance are especially uncertain. Some are related to sonic boom exposure as well as to sonic boom annoyance. As previously noted, it is not clear whether these types of attitudinal variables cause sonic boom annoyance or, the reverse, are caused by sonic boom annoyance. From examining the values of the partial regression coefficient for area (B_{Region}) it is clear that the simple report of noticing any damage from booms (last line) does not account for the regional differences. Reporting being startled, perceiving danger, or being aware of vibration is seen to be associated with some reduction in the regional difference. The findings for attitudes toward aircraft operators and attitudes toward low-level flights provide some clear information about differences between regions, even if the causal interpretation of those differences is uncertain. Figure 10 shows that the percentage who report hearing low altitude aircraft is somewhat higher in Region A than in Region B and that the percentage increases with sonic boom exposure. Simply perceiving that respondents have "heard noise from low-flying jet aircraft" in the last six months is associated with a rather modest reduction in the regional difference in boom annoyance responses (from B_{Region}=2.63 to B_{Region}=2.36 in Table 7). However, when the extent of annoyance with those aircraft is considered in the third line of Table 7, the partial regression coefficient for the regional difference is cut in half to about B_{Region}=1.24.

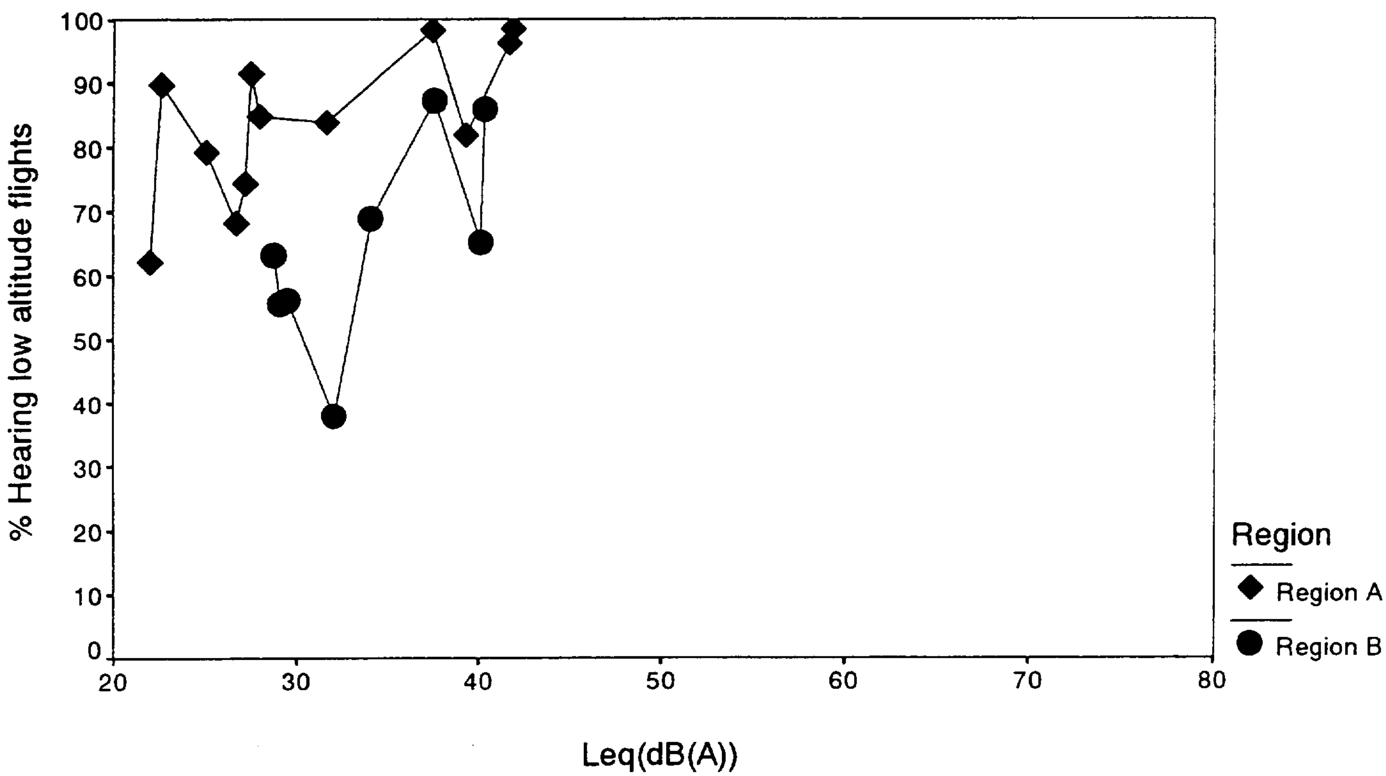

Figure 10 Percentage "hearing low-altitude flights" by sonic boom exposure (L_{Aeq})

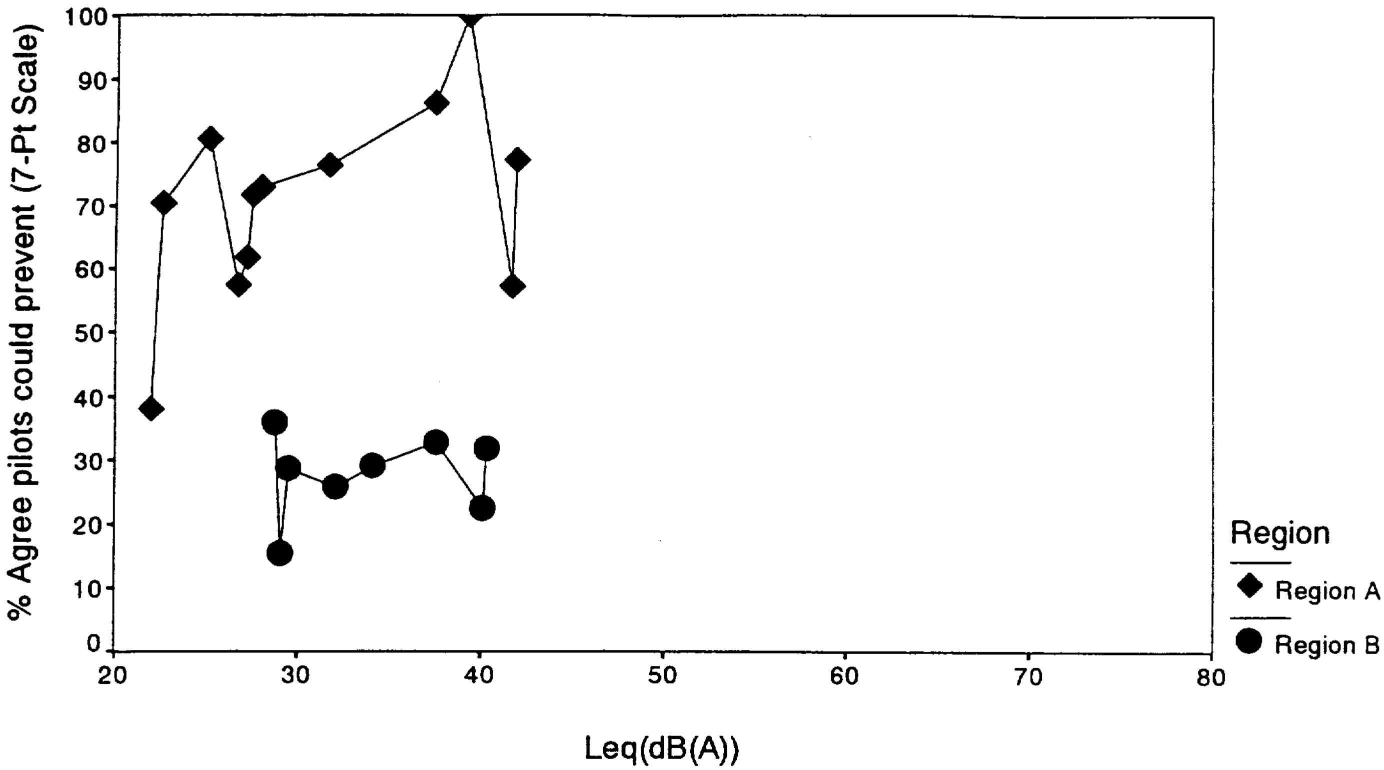

Figure 11 Percentage believing pilots can "do more to reduce booms" by sonic boom exposure (L_{Aeq})

A similar though somewhat weaker pattern is evident for the attitudes about the extent to which sonic booms could be prevented by both pilots and "officials planning flights." The percentage believing that pilots can do more to reduce booms is strikingly higher in Region A than Region B and is also slightly related to sonic boom exposure (Figure 11). For perceptions of both pilots and officials the regional difference coefficient is greatly reduced by considering only the simple division of respondents into those who think that the official could or could not prevent booms (B_{Region} =1.8 for pilots and B_{Region} = 2.0 for officials). The regional difference coefficient is further reduced when a more finely-graded 7-point scale of "extent of preventability" is considered (B_{Region} =1.4 for pilots and B_{Region} = 1.7 for officials). The ambiguity in these apparent "explanations" for boom annoyance is clear from the striking, accompanying reduction in the partial regression coefficient for noise level from the controlled value of B_{LAeq}=0.08 at the top of the table to as low as B_{LAeq}=0.01 when some of the associated variables are considered.

The effects when simultaneously considering the low-flying jets and two preventability measures display a similar pattern. These results do not appear in a table. When the three simple dichotomous measures are considered (hearing low jets, agreeing that pilots could reduce noise, agreeing that officials could reduce noise) then the regional difference is strikingly reduced to B_{Region} =1.5 ($p<0.05$) but the coefficient for noise level, though still positive, is reduced (B_{LAeq}=0.03) and no longer statistically significant. When the multi-point scales for extent of low-flying jet annoyance and extent of pilot or official prevention are considered then the regional difference is reduced by a further dramatic amount (B_{Region} =0.67, $p<0.05$), but the coefficient for noise level completely disappears.

The data have not been able to explain the difference between the two regions, although they do suggest one partial explanation that is consistent with the types of operations that are known to occur in the two areas. The operations in Region A consist largely of training exercises including combat training. Pilots are expected to engage in a large variety of unpredictable maneuvers at many locations as part of the simulated combat operations. The flights in Region B are more often a part of programmed aircraft testing programs. The flights in Region B are also closer to the airbase where the flight operations may be more tightly controlled than in the operations areas in Region A. It may be that part of the difference in sonic boom reactions in the two regions is due to the differences in operations. The operational flights may have led people in Region A to perceive that pilots and officials could do more to control their aircraft in a way that minimized their impact on the local population. Some support for this explanation comes from an examination of the few answers volunteered to open questions. On a question about the purposes of military flights (Q.39) respondents in Region A were more likely to volunteer the belief that the pilots were performing maneuvers that were not related to their military missions.

An additional possibility is that people's feelings about low altitude flights may carry over to their feelings about sonic booms. Perceptions of connections between sonic booms and low altitude flights were not explored in the questionnaire. However, it seems quite possible that residents in Region A believed that the same aircraft were responsible for both phenomena and allowed negative experiences with low altitude portions of flights to affect their feelings about sonic booms.

5.5 An examination of methodological issues and the differences between reactions in the two regions

The possibility that the differences between the regional reactions are methodological artifacts has been considered and rejected. The methodological issues that have been considered can be loosely grouped under four headings: social survey data collection conditions, social survey data processing procedures, noise measurement methods, and noise measurement analyses.

The social survey contractor's data collection and data processing methods appear to have been virtually identical in both regions. All of the standard social survey data collection methods were followed in both regions. Households and respondents within households were chosen with objective probability methods. The same rigidly structured interview was administered in both regions. The same survey organization followed its standard procedures for both regions. Most of the personnel were the same, with most of the same interviewers and supervisory and training staff conducting the field work. The survey organization also prepared the data using the same computer programs and procedures for both regions. All data analyses were conducted on a single data set that contained all of the interviews from all rounds.

Other social survey conditions appear to have been almost identical. Climatic conditions and the timing of the surveys were similar. The first interviews in Region A and the interviews in Region B were conducted at almost the same time of year (early November and early December). Both were conducted in desert areas. A further indication that the difference was due to the region and not the timing comes from the finding in Region A that the December 1993 interviews (Phase II) gave results that were not statistically different from those from the May 1993 interviews (Phase I). The evidence does not suggest that unusual aspects of the previous six months' sonic boom exposure could explain the difference in reactions. A regression analysis that included a variable for the perception that sonic boom noise had increased was associated with a small reduction in the regional difference (B_{Region}=2.38). The causal implications of even this small difference are not clear.

The acoustical data collection contractor followed the same basic noise measurement strategy and used the same types of instruments (Boom Event Analyzer Recorders). There were, however, changes in personnel, the specific measurement equipment units, and many aspects of the noise data accumulation methods. The changes were all designed to result in more accurate estimates of the sonic boom environment in Region B. Many aspects of the noise measurement methodology were examined to determine whether errors or changes in the noise measurement methodology could have caused the difference in the dose/response relationships. From this examination it appears that the differences in noise measurement procedures in the two regions could not have led to systematic differences in the estimates of the noise environments in the two regions. For noise measurement errors to explain the very large differences in reactions there would need to have been very large noise measurement errors of perhaps 20 decibels or more. Ancillary information from the knowledge of aircraft operations and measurements at nearby locations in other periods are consistent with the measured exposures and not consistent with the types of exposures that would have been needed to explain the differences in the social survey reactions.

The noise data analysis and accumulation methods also would not seem to have offered any opportunities for introducing such large systematic differences. The data that had been downloaded from the BEARs were analyzed in batches by several different people and not in single blocks by region. In addition, much of the data were analyzed several times using different instruments. The final calculation of the noise metrics were carefully checked. As an additional check, several of the noise exposures were independently calculated by the data collection contractor as well as the social survey computer programmer. Detailed analyses of matched booms and the total boom environment at nearby, independently analyzed noise measurement sites also provided checks on the consistency of the noise measurement process.

6.0 COMPARISONS OF WESTERN SONIC BOOM SURVEY WITH OTHER NOISE REACTION SURVEYS

The sonic boom survey questionnaire includes questions that provide a direct link to 20 other noise surveys of conventional aircraft or impulsive noise sources. Four annoyance questions provide all but two of these linkages. The identification number that is associated with each survey in this report comes from a catalog of community noise surveys (Fields, 1991). The surveys are listed by catalog number in Appendix H. The questions that were asked in the previous surveys are also given in Appendix H. Identically matched activity interference questions allow comparisons with the 1964 Oklahoma City sonic boom survey (USA-012). Other aspects of the surveys' methods were similarly examined. A 30-item study methods data sheet was completed for every matching study, usually with the cooperation of the previous study's investigator. The methods followed in this comparison and the adjustments, if any, that were made to many of these studies are summarized in Tables 21 and 22 (Appendix H) and have also been described in an earlier report (Fields, 1996b). A detailed description of the methods used to extract data from the 1964 Oklahoma City study are given in a separate appendix (Appendix I).

6.1 Comparisons with conventional aircraft surveys

The four general sonic boom annoyance questions matched the annoyance questions used in 13 conventional aircraft surveys. The comparisons of the reactions for the high-annoyance dichotomy are presented for each of the four sets of matched annoyance questions in Figures 12 to 15. Comparisons were made with this limited number of surveys rather than with the well-known Schultz curve in either its original (Schultz, 1978) or updated form (Fidell, Barber, Schultz, 1991). The analysis producing that curve was judged to not be adequate for the present purpose because of errors in recording and classifying data for some studies (Fields, 1994) and because the overall curve includes sources other than aircraft noise.

Figure 12 presents the comparison of the two sonic boom survey study regions with surveys conducted at Fornebu (Oslo) airport in 1989 (NOR-311), around Heathrow (London) airport in three separate surveys (UKD-024 in 1967, UKD-130 in 1976, and UKD-242 in 1982), around Glasgow in 1984 (UKD-238), in France in 1984 (FRA-239) and around Schiphol in 1984 (NET-240). The three latter studies were part of a coordinated CEC data collection effort. Figure 12 shows that the sonic boom survey noise exposures are lower than those included in most of the six conventional surveys. The reactions in Region A are much greater than those that would be expected in conventional aircraft noise environments.

The estimates of the differences between the average reactions in the different surveys are subject to considerable sampling error and cannot be precisely quantified. As a supplement to the figures in this chapter, however, a best estimate of the differences between the surveys is expressed as the number of decibels that separate the displacement of the western boom survey dose/response relationships and the dose/response relationships found in the other surveys. This displacement is estimated from a logistic regression in which each of the surveys in a figure is represented by a dummy variable and a single average slope is calculated for the dose/response relationship for all surveys in the figure. The displacement between the various surveys' dose/response relationships is then directly estimated as the ratio of the partial regression coefficient for the survey dummy variable divided by the logistic regression coefficient for noise level. Two estimates have been formed for each comparison. One is based on the "high" annoyance dichotomy that is presented in the figures. A second estimate comes from the dose/response relationship from the regression of the "any"/"no annoyance" dichotomy on noise level.

For the dose/response relationship in Figure 12 the logistic regression analysis estimates that annoyance would be greater to sonic booms than to aircraft noise at the same noise level. The very large difference between Region A and the conventional aircraft surveys are obvious in the figure. The smaller difference between Region B and the conventional aircraft surveys is estimated to be the equivalent of from 8 decibels (for UKD-238) to 16 decibels (UKD-130). For the "any" annoyance dichotomy the difference is estimated to be the equivalent of from 12 to 21 decibels. The displacement for Region A is estimated to be from 30 to 48 dB for "high" annoyance and from 30 to 39 decibels for "any" annoyance. Sampling errors have not been calculated for these estimates. If they were available they would extend the range of estimates considerably further.

Figure 13 compares the survey in the two sonic boom regions with surveys conducted in the three phases of the TRACOR studies in the late 1960's at nine USA airports (USA-022 in 1967 at Chicago, Dallas, Denver, Los Angeles; USA-032 in 1969 at Boston, Miami, New York; USA-044 in 1970 at Chattanooga, Reno). The three studies used the same primary aircraft noise annoyance questions (Question 37 in the sonic boom survey) even though their questionnaires differed in some other respects. For these data there is some overlap in the exposures when expressed in L_{Aeq}. From the logistic regression analysis Region B reactions are estimated to exceed the conventional aircraft estimates by the equivalent of 3 to 8 decibels for the high annoyance relationship in Figure 13. High annoyance is defined as the top two points on a five-point numeric scale. Region B reactions are estimated to be the equivalent of 2 to 15 decibels higher for the "any" annoyance dichotomy. Region A reactions are again seen to be much higher and to represent approximately a 20 to 30 dB gap in noise exposure.

Figure 14 presents a comparison with a Swiss survey conducted around three Swiss airports in 1971 (SWI-053). Estimates are only available for the "high" annoyance dichotomy for this survey. The logistic regression estimates give a displacement of only one decibel for Region B and 21 decibels for Region A. The more severe labels for the 11th point on the Swiss annoyance scale may, however, have resulted in an underestimate of the difference of the reactions in the two populations. The extreme end of the sonic boom 11-point scale is labeled "Extremely annoyed" whereas the extreme end of the Swiss 11-point scale is labeled unacceptably disturbing ("Unerträgliche Störung").

Figure 15 presents the comparison with aircraft surveys conducted in the United States in 1973 around Los Angeles International Airport (USA-082) and in 1979 around Burbank airport (USA-203). While the complete Burbank study included several rounds of interviewing, only the first round, conducted before any changes were made at the airport, is reported here. The limited ranges of exposures and very disparate reactions at the various study sites for these two studies preclude clear comparisons with the sonic boom results.

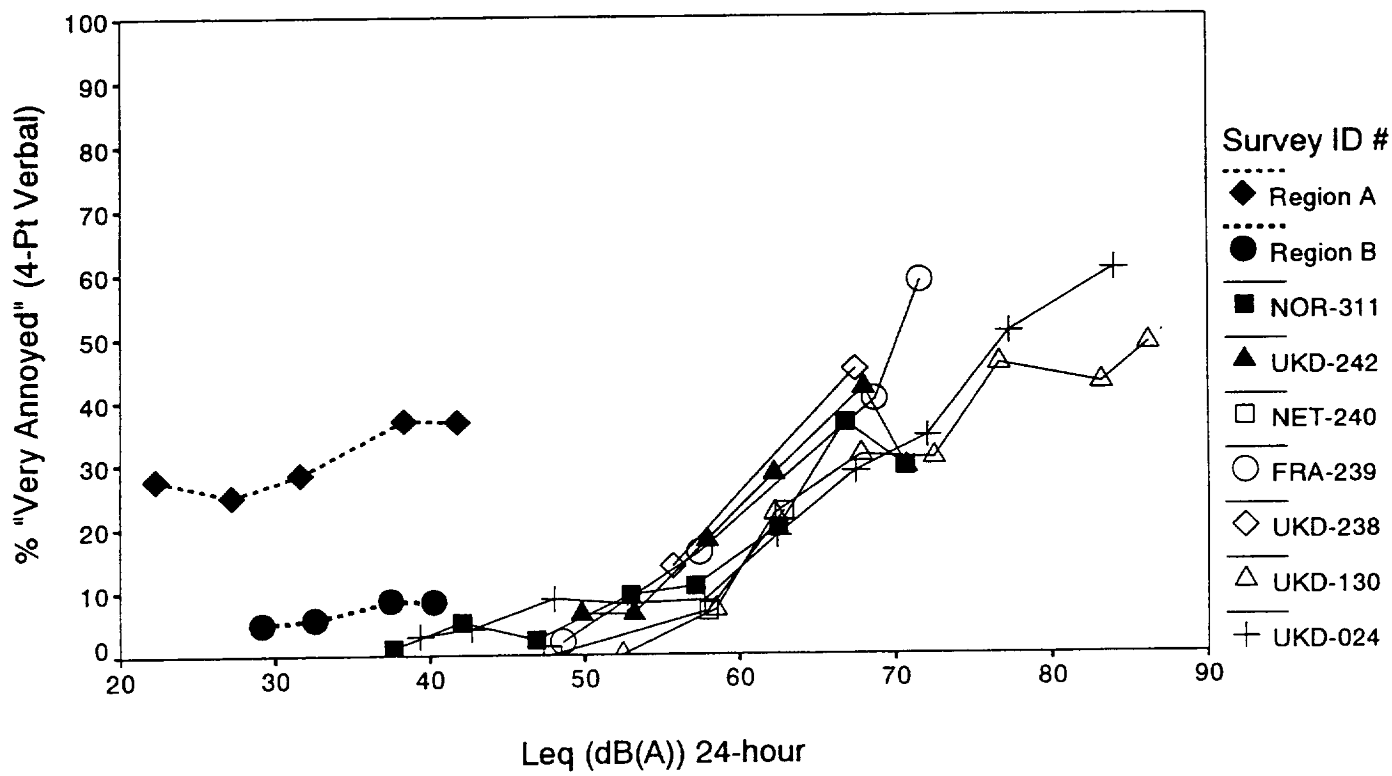

Figure 12 Percent "very annoyed" on 4-point verbal scale in seven conventional aircraft studies and Regions A & B (Q.8,iv)

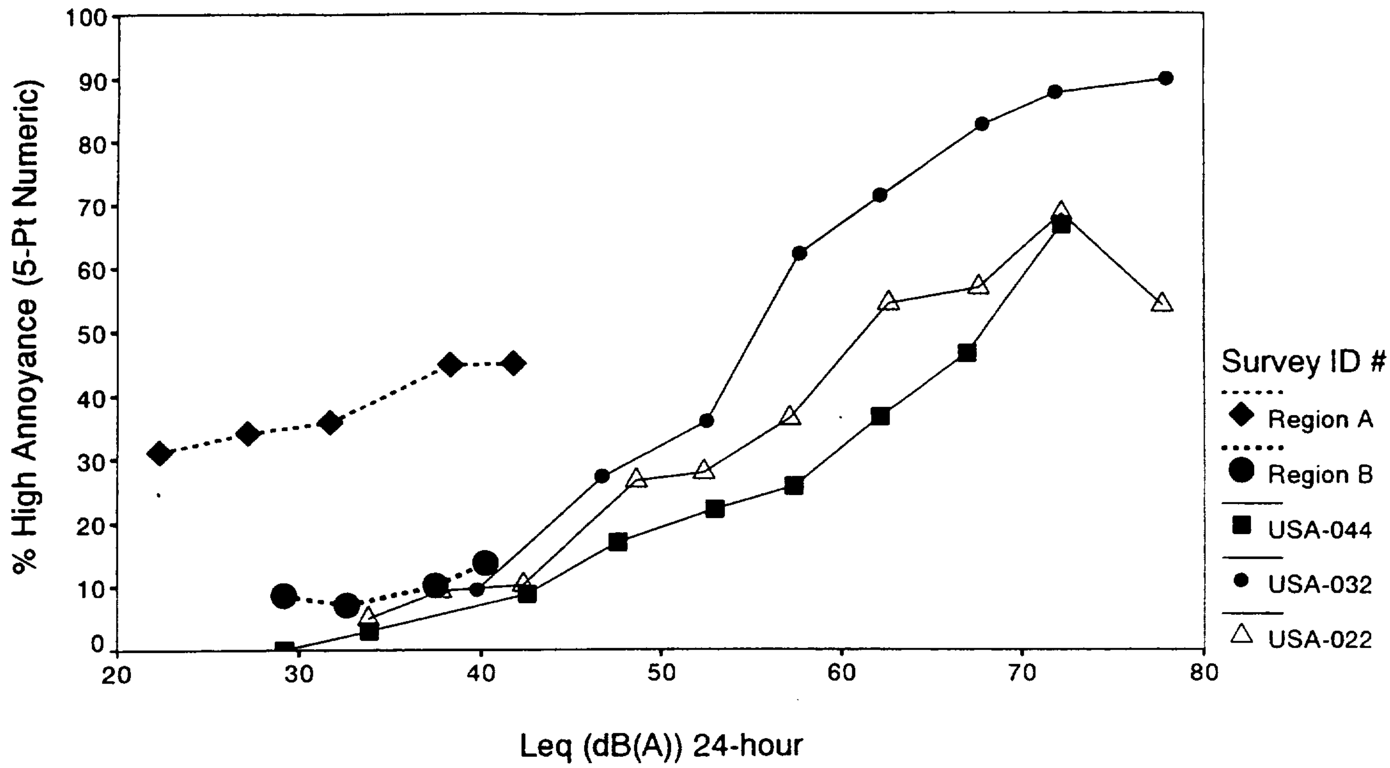

Figure 13 Percent in the top two scale points on a 5-point numeric scale (Q.37) in three conventional aircraft studies and Regions A & B

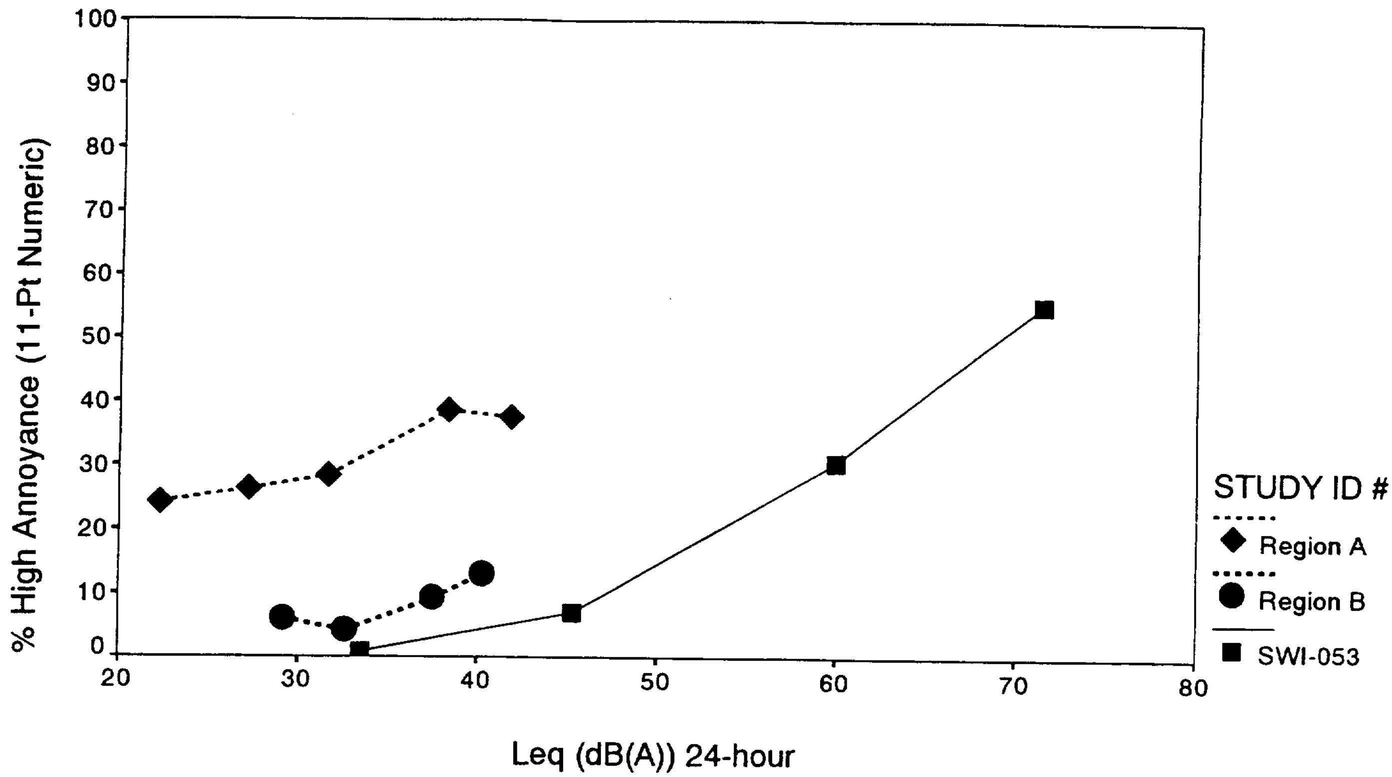

Figure 14 Percent in the top three categories on an 11-point numeric scale in the 4-city Swiss aircraft survey and Regions A & B

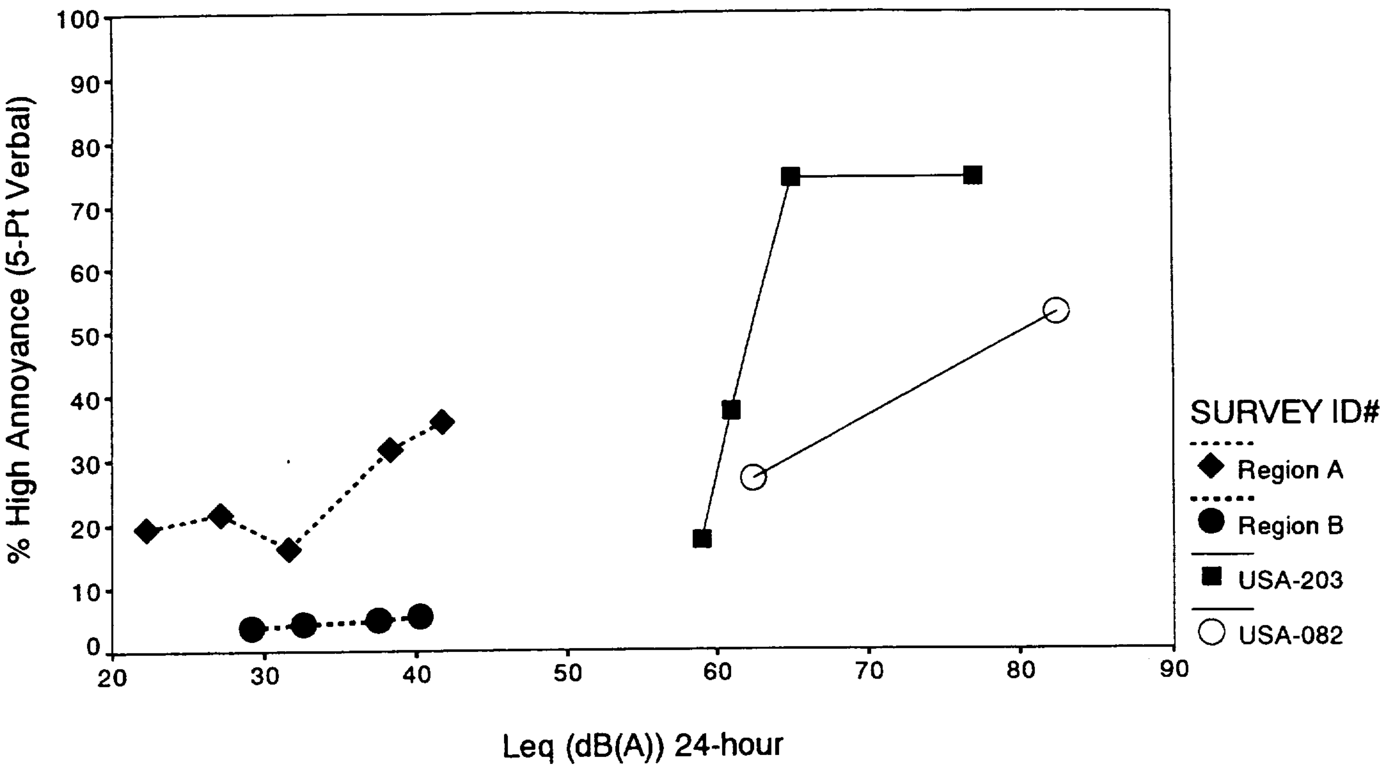

Figure 15 Percent in the top two categories ("very" & "extremely") on a 5-point numeric scale in two USA aircraft surveys and Regions A & B

6.2 Comparisons with other non-boom impulse noise surveys

Figure 16 compares reactions in four coordinated CEC surveys with Regions A and B. All of the surveys used the same 4-point verbal annoyance scale with the top point being labeled "very much" annoyed (Q.8.iv in the sonic boom questionnaire). Although most of the CEC survey sites were near small-arms firing ranges, other sites had impulsive noise coming from railway shunting yard, building construction, shipyard, dairy, and metal working sites. In Figure 16 the four CEC impulse noise reactions span the range of reactions reported for Region B. For the "very" annoyed dichotomy the CEC impulse surveys vary from an estimate of more annoyance, equivalent to a 14 decibel displacement, to less annoyance (-2 dB) relative to Region B. The "any" annoyance dichotomy spans the range from 16 to -4 dB. Although the overall estimates from the CEC surveys are all for less annoyance than is found in Region A, the Netherlands impulse survey noise categories centered around about 40 and 45 decibels did measure annoyance equivalent to that in Region A. No attempt has yet been made to analyze the combination of impulse noise sites in the Netherlands that are represented in those two noise categories.

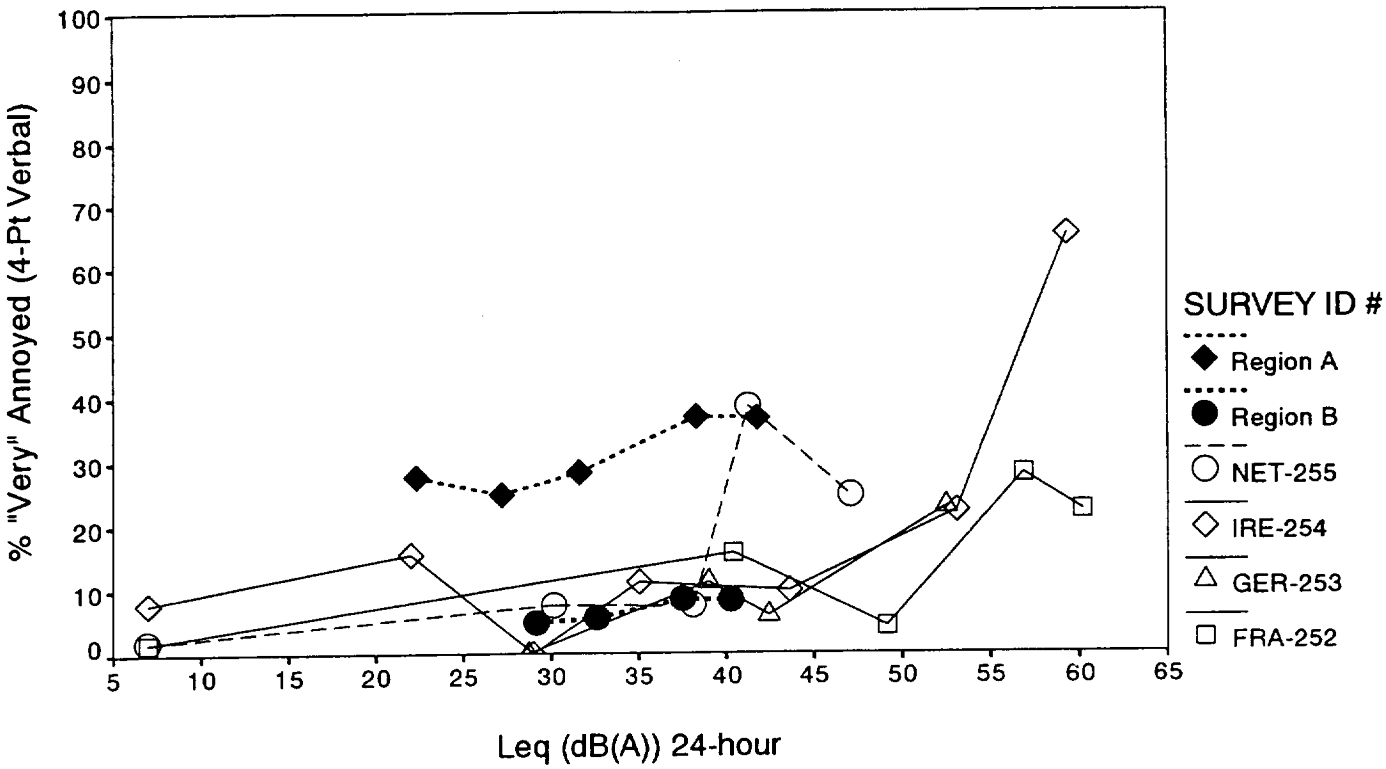

Figure 16 Percent "very" annoyed in four CEC impulse noise studies and Regions A & B

An attempt was also made to compare the reactions in Regions A and B with those from a study of reactions to artillery noise around an army base in the United States (Schomer, 1982). These comparisons are, however, more uncertain due to differences in the reaction question wording. Figure 17 indicates that the different measures of high annoyance estimate that the reactions to artillery noise are above or about the same as those in Region B. However, a similar analysis for the "any" annoyance dichotomy placed the reactions to artillery noise as being considerably below those at Region B. The estimates from the logistic regression analysis are that artillery noise is the equivalent of 10 decibels more annoying than in Region B using the "high" annoyance measure, but are the equivalent of 24 decibels *less* annoying using the "any" annoyance measure.

The inconsistent estimates of survey differences are probably an artifact of the differences in the way that annoyance was measured. Although both surveys derived 5-point scales with the same labels, the surveys differed in how the questions were presented. The sonic boom survey presented one annoyance question with five alternatives (Q.35). The artillery questionnaire used a two-part questioning approach (page 109, Appendix H). The first part was a dichotomous question asking if there was "any" annoyance. Those expressing annoyance were asked the second part, a 4-point annoyance question. In interpreting the answers it is important to recognize that the number of scale points as well as the wording of questions has generally been found to affect answers to survey questions (Schwartz, 1990).

In this instance it seems likely that the initial two-point annoyance question in the artillery questionnaire depressed the reports of annoyance below those expected if respondents could choose from five points on the sonic boom questionnaire. Similarly, it is likely that the follow-up, four-point annoyance question in the artillery questionnaire inflated the reports of annoyance above those found when respondents could choose from five points in the sonic boom questionnaire.

In view of the differences in the annoyance questions, an exact comparison cannot be drawn between the two studies. The artillery noise response can only be said to be less than that in Region A. No conclusions can be drawn about the comparisons with Region B.

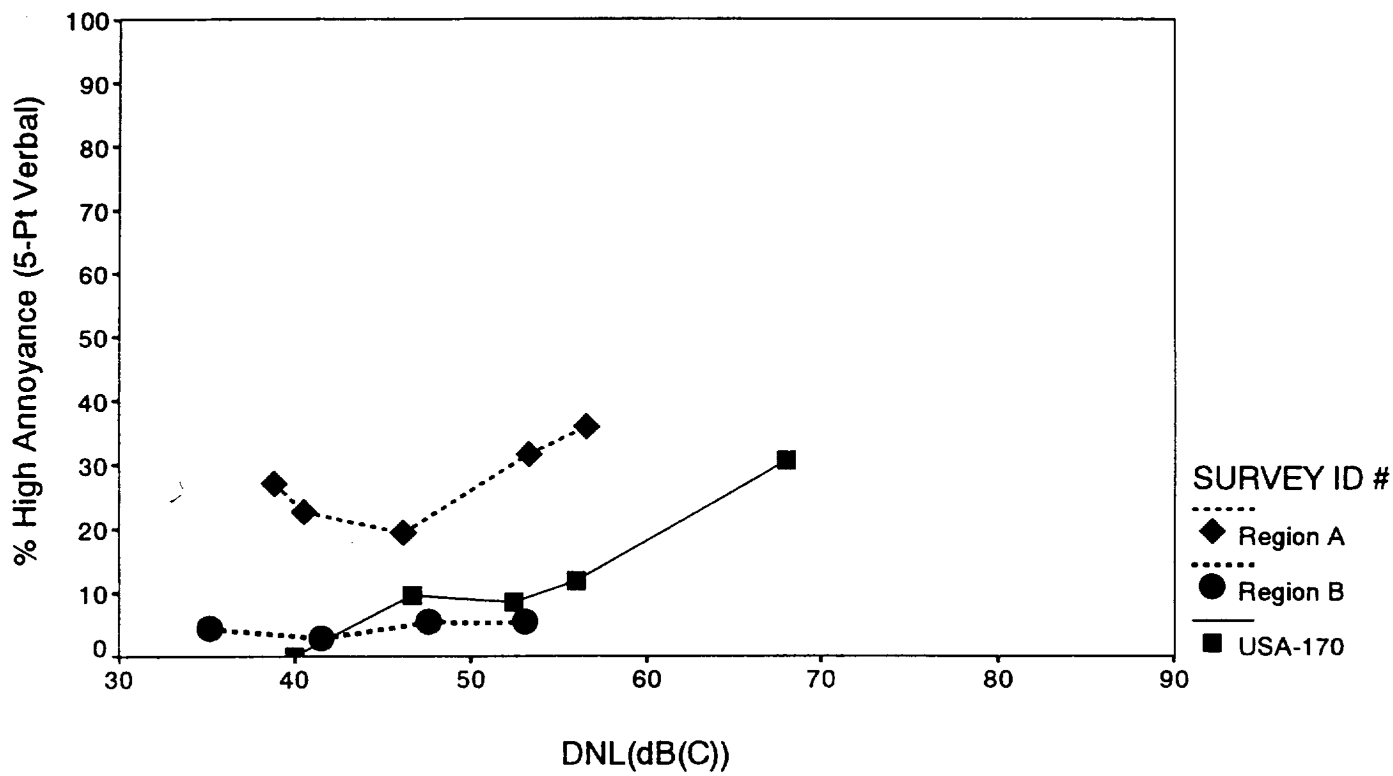

Figure 17 Percent "very" or "extremely" annoyed in an artillery noise survey and Regions A & B for dissimilar annoyance questions

6.3 Comparisons with one sonic boom survey

Only one previous sonic boom survey (USA-012) has been conducted with noise measurements that are linked to survey responses. This 1964 survey was conducted in Oklahoma City as part of a publicized trial of sonic boom flights during a six-month period. The population was informed that they would be only temporarily exposed to sonic booms. Some officials stated that it was the community residents' patriotic duty to not complain about these military flights. The flights were planned to follow rigid flight plans so that the noise measurements for every flight would be able to accurately characterize the exposure of the residents over large areas. Residents were interviewed at three periods during the flights. The original Oklahoma City report (Borsky, 1965) does not present results for the entire sample for an overall sonic boom annoyance question. The most complete results are reported for the responses to the amount of annoyance on activity interference questions. These activity interference questions were exactly reproduced in half of the western boom questionnaires. Only this half of the questionnaires is used for the Oklahoma City comparison presented in this section. The other half of the western boom questionnaires used versions of the activity interference questions that had been used in other studies. The two versions of the activity interference questions can be found in Question 14 (Appendix K, Page 123)

Both the noise and social survey data from the Oklahoma City survey were carefully examined before the western boom survey was conducted to ensure that the western boom studies would provide comparable definitions of the noise and annoyance reaction variables. The 24-hour noise environment (L_{Aeq} and L_{Ceq}) for each of the Oklahoma City noise measurement sites was calculated directly from a reanalysis that is described in Appendix I of the entire data base of approximately 1,225 measured flights (Hilton, Huckel, Steiner, Maglieri, 1964; Maglieri Sothcott, 1990)

The two studies are compared in Figure 18. The noise levels are seen to overlap by about 10 decibels (L_{Aeq}) of the more than 30 decibels covered by the two surveys. Figure 18 compares the percentages that are at least "moderately" annoyed ("moderately" or "very") on a 4-point verbal annoyance scale for each of three phenomena associated with sonic booms: vibration ("house rattle and shake"), startle ("startle or frighten anyone in your family"), and conversation interference ("interfere with your conversation"). The division between noticing and not noticing each of the phenomena is also presented in the report, but is not graphed here. The report does not give the percentage of the total sample that was "very" annoyed on each of these questions. The only parts of the sample with reports of "very annoyed" are for the subsample that excluded respondents who believed that people should not complain about sonic boom annoyance.

The rank order of the three annoyance responses is the same in the western boom and Oklahoma City studies. "House rattle and shake" is the most annoying followed by "startle or frighten anyone in your family" and finally by "interfere with your conversation." The reactions in Region A are clearly well above either the Region B or the Oklahoma City reactions. The logistic regression analysis estimates the gap with the Oklahoma City reactions to be the equivalent of a 24 to 36 decibel shift in exposure. The reactions in Region B, on the other hand, are similar to those in the Oklahoma City survey. The regression analysis estimates that Oklahoma City Region B reactions are the equivalent of one decibel higher for the vibration question, but the equivalent of five or six decibels lower for the startle and conversation reactions. Although sampling errors have not been calculated for these estimates, the estimates are even less precise than those for other data from the western boom survey because only half of the sample were asked these Oklahoma-City-comparable versions of the questions.

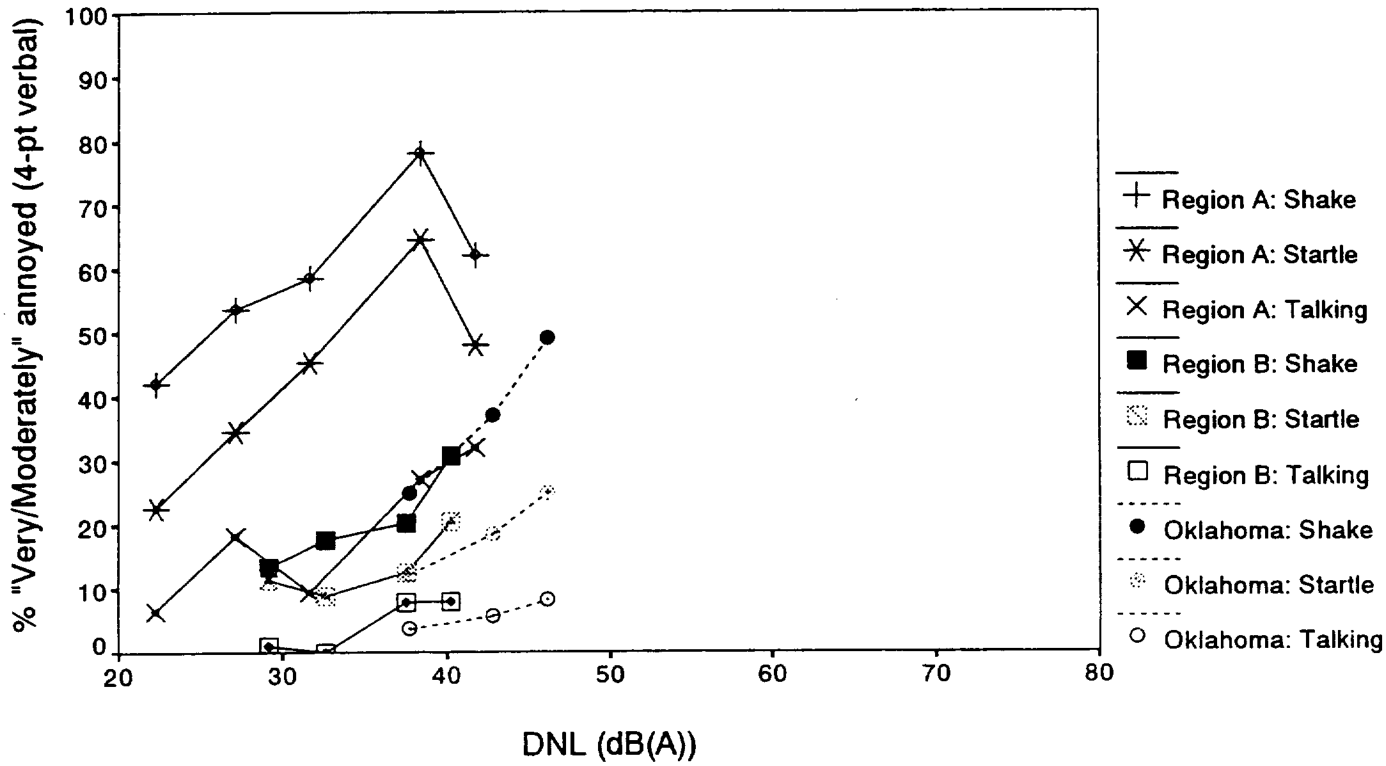

Figure 18 Percent "moderately" or "very" annoyed by three sonic boom impacts in the Oklahoma City survey and Regions A & B (Q.14)

6.4 Comparisons with an impulse noise standard

Figure 19 compares reactions in the Region A and Region B with the curve recommended in a CHABA report (CHABA, 1981:15). In this figure the acoustical measure is C-weighted DNL. The reactions in Regions A and B are represented by lines that are the best fit to the individual level data for the same shape curve (a logistic regression curve) as is used in the CHABA analysis. The reactions in Region B are seen to be very similar to those prescribed in the impulse noise standard. The reactions in Region A are seen to be much higher than are suggested in the standard.

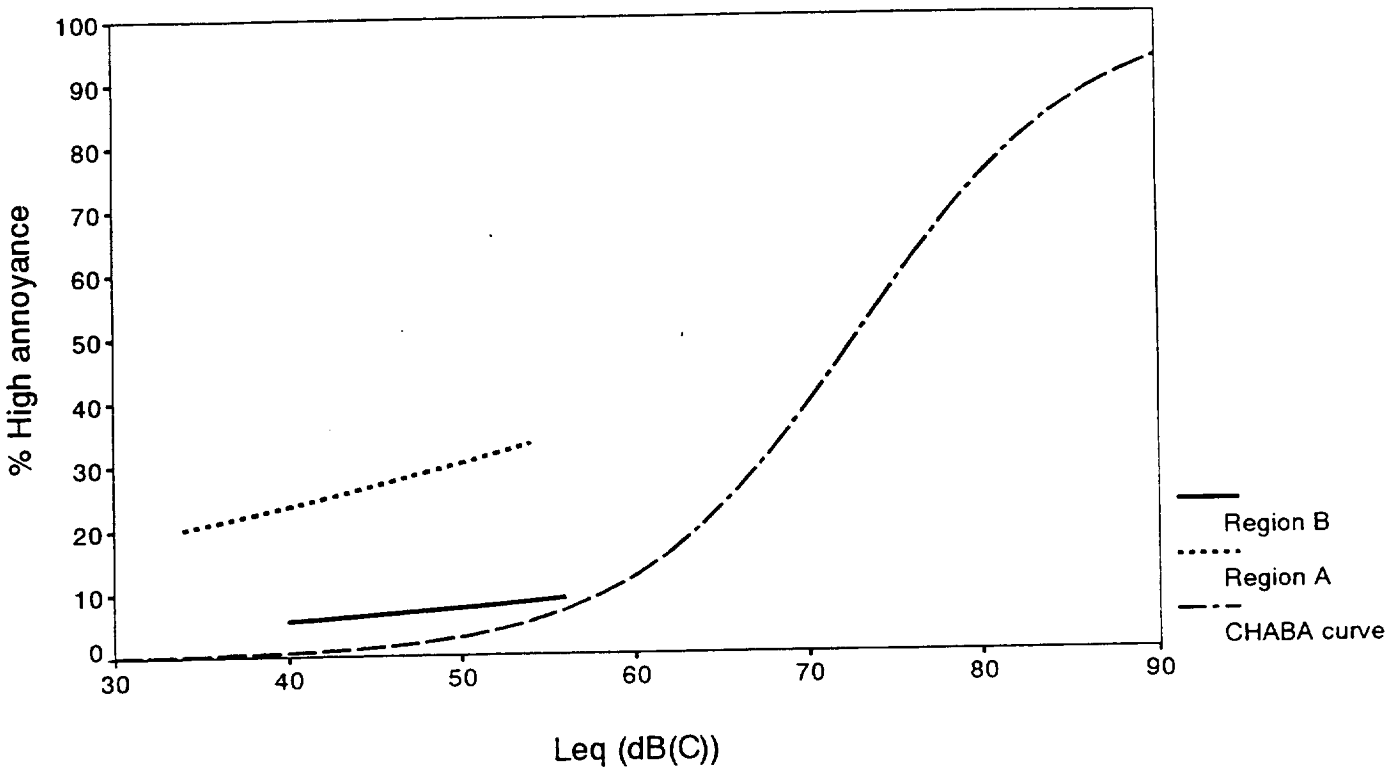

Figure 19 Percent saying "very much annoyed" in Regions A & B compared to the CHABA recommendation for a high-energy, impulse dose/response curve

6.5 Conclusion

Exact comparisons between reactions in the western boom survey and the reactions in other surveys are difficult because of differences in noise exposure, a lack of precision in the western boom survey estimates, and the considerable differences between the reactions in Region A and Region B. In general, however, the reactions in Region A are considerably higher than those observed in any of the studies with the possible exception of some areas in the Dutch CEC impulse noise study. On the basis of the lesser reactions in the second region (Region B) sonic boom environments appear to be subjectively equivalent to conventional aircraft environments that are approximately 10 decibels higher (L_{Aeq}). This estimate is only approximate since estimates range from 3 to 20 decibels depending upon the annoyance question and surveys to which the comparison is made. The more severe reactions in the first studied region (Region A) are, however, subjectively equivalent to being an additional 20 to 40 decibels higher than those in conventional aircraft noise environments.

The reactions in the less annoyed region (Region B) are roughly equivalent to the reactions found in the 1964 Oklahoma City study of residents' reactions to a six-month, temporary exposure to sonic booms. The lesser Region B reactions are also similar to those found in most areas of a CEC impulse noise study of noise around light-arms firing ranges and a variety of other impulse noise sites. The weak evidence that is available also indicates some consistency between the Region B results and those from a study of noise from large artillery in the United States.

Although the less severe Region B reactions are more similar to those found in most other surveys, the more severe reactions in Region A cannot be dismissed. There is no indication that errors in social survey or acoustical survey procedures could be responsible for the difference in reactions in the two regions. In addition, equally high reactions were present in some locations in the Netherlands CEC study. After carefully examining many potential differences between the regions, a definite explanation for differences in reactions has not been found. The differences in reactions cannot be explained by any obvious differences in the respondents' demographic characteristics, the types of housing construction, or the characteristics of the individual communities. There is some tentative evidence that a limited part of the difference between the two regions might be traced to the low-altitude, subsonic combat training maneuvers that are more prevalent in Region A and, possibly, to a perception that pilots and flight planners in Region A are not doing all they could to reduce sonic booms. However, this evidence is not strong enough to definitely explain the differences between the two regions.

The conclusion from these studies is therefore that sonic boom annoyance is greater than that in a conventional aircraft environment with the same continuous equivalent noise exposure. With the present knowledge, however, it is not possible to predict the size of this difference. Most of the evidence suggests that sonic booms may cause reactions that are the equivalent of reactions to conventional aircraft noise environments of roughly 10 decibels greater exposure. The possibility that sonic booms may cause reactions that are the equivalent of a 20 to 40 decibels greater exposure cannot be ruled out.

7.0 COMPONENTS OF SONIC BOOM REACTIONS

This section examines the aspects of sonic booms that residents identify as being annoying. Respondents are asked to choose the most annoying aspects of booms as well as to rate the amount of annoyance with several aspects of booms. The extent to which each of seven aspects of sonic booms are reported as occurring are given in Figure 20 for Region A and Figure 21 for Region B. The three major aspects that are most carefully considered are startle effects, vibration and concern about possible damage. These characteristics can be traced to the rapid rise times and strong low-frequency spectral content of sonic booms. The effect of sonic booms on sleep could not be studied in these regions because of the absence of measured nighttime booms during the study period.

7.1 Results from a direct question

Toward the end of the questionnaire, after detailed questions about each aspect of the booms, respondents were asked:

```
Please look at the disturbances on CARD G. [HAND CARD G TO RESPONDENT]
Q34. Please choose the one thing, if any, that is the most disturbing about
     sonic booms for you.  Is the most disturbing thing for you the rattles
     and vibrations, being startled or surprised, the possibility of damage,
     the noisiness of the sounds, something else, or nothing at all?

     1.    THE RATTLES AND VIBRATIONS
     2.    BEING STARTLED OR SURPRISED
     3.    THE POSSIBILITY OF DAMAGE
     4.    THE NOISINESS OF THE SOUNDS
     5.    SOMETHING ELSE (What is that?)____________
     6.    NOTHING AT ALL
```

The answers are summarized in Table 8. No single aspect is chosen by a majority of the respondents. Being "startled or surprised" is, however, more often chosen than vibration or damage concerns. When those who do not report being disturbed by any aspect are removed from the base in the last column, the same pattern remains with no single source gaining a majority of the respondents' answers.

Several steps were taken to determine whether some other aspects of the sonic booms might be more important. During the pretesting process, interviewers probed for other aspects. The answers of the two percent who answered "something else" to the "most disturbing" question (above) were examined carefully. About one-quarter of the answers referred to combinations of the offered alternatives. No other single alternative was mentioned by more than three people. In an earlier part of the questionnaire residents were also asked about interference with conversation, radio or television, resting, and sleeping. All of these types of interferences were noticed but none were as frequently mentioned or caused as much annoyance as vibration, startle or damage. At the same point in the questionnaire respondents were given the opportunity to mention other impacts from sonic booms. No impact was mentioned by more than seven residents. From five to seven residents mentioned scaring babies or children, interference with concentration, almost being thrown from horses and disturbances of other animals.

Table 8: Most disturbing aspect of sonic booms (Q.30)

Type of disturbance	Percentage choosing aspect as the "most disturbing"			Total	Total (excluding "Nothing")
	Region A: Phase I	Region A: Phase II	Region B		
Rattles and vibrations	20.5	19.5	19.4	19.8	24.2
Being startled or surprised	36.2	33.1	33.5	34.3	42.0
Possibility of damage	20.5	20.8	10.2	17.1	21.0
Noisiness of the sounds	11.1	6.6	7.6	8.5	10.4
Something else	1.0	4.3	0.9	2.0	2.5
Nothing at all	10.7	15.8	28.3	18.4	.
Total	100.0% (522)	100.1% (514)	99.9% (537)	100.1% (1573)	100.1% (1284)

7.2 Information from detailed questions

The direct questions about the amount of annoyance with various aspects of the sonic booms provide another direct comparison between vibration and startle effects, but not damage effects (a damage question was not included in the same format). In Table 9 respondents again express somewhat similar degrees of annoyance with the two sources of annoyance. In this case, however, vibration is rated as more annoying than startle effects whereas on the direct question, startle was reported as more important than vibration effects. This difference in ordering may be due to nuances in the wording in the question stem ("disturbing" or "annoying"), to subtle differences in the wording of the alternatives ("rattle and vibrate" or "vibrate and shake"), or to other methodological or substantive aspects of the questions. The interpretation is also complicated by the use of the two somewhat different forms of these questions in the questionnaire (Question 14 in Appendix K). The primary finding is, however, consistent from these detailed rating questions and the previous direct ranking question. The three major aspects of sonic boom reactions are startle, vibration, and concern about damage.

The remainder of this section provides some additional information about the nature of these reactions.

Table 9: Extent of annoyance with two aspects of sonic booms (Q.14)

Extent of annoyance	Percentage with this degree of annoyance in:			Total
	Region A: Phase I	Region A: Phase II	Region B	
Annoyance with vibration and rattle				
Very much	38.1	34.8	7.1	26.4
Moderately	23.5	18.5	14.7	18.8
A little	17.5	20.7	30.9	23.1
Not at all	12.9	15.4	31.7	20.1
Not occur/not hear	8.1	10.6	15.6	11.5
Total	100.1% (520)	100.0% (508)	100.0% (537)	99.9% (1565)
Annoyance with startle (or frighten)				
Very much	26.2	26.3	7.3	19.8
Moderately	21.5	15.2	8.6	15.0
A little	19.5	19.3	23.1	20.7
Not at all	10.5	9.5	14.7	11.6
Not occur/not hear	22.2	29.8	46.4	32.9
Total	99.9% (522)	101.1% (514)	101.1% (537)	100.0% (1573)

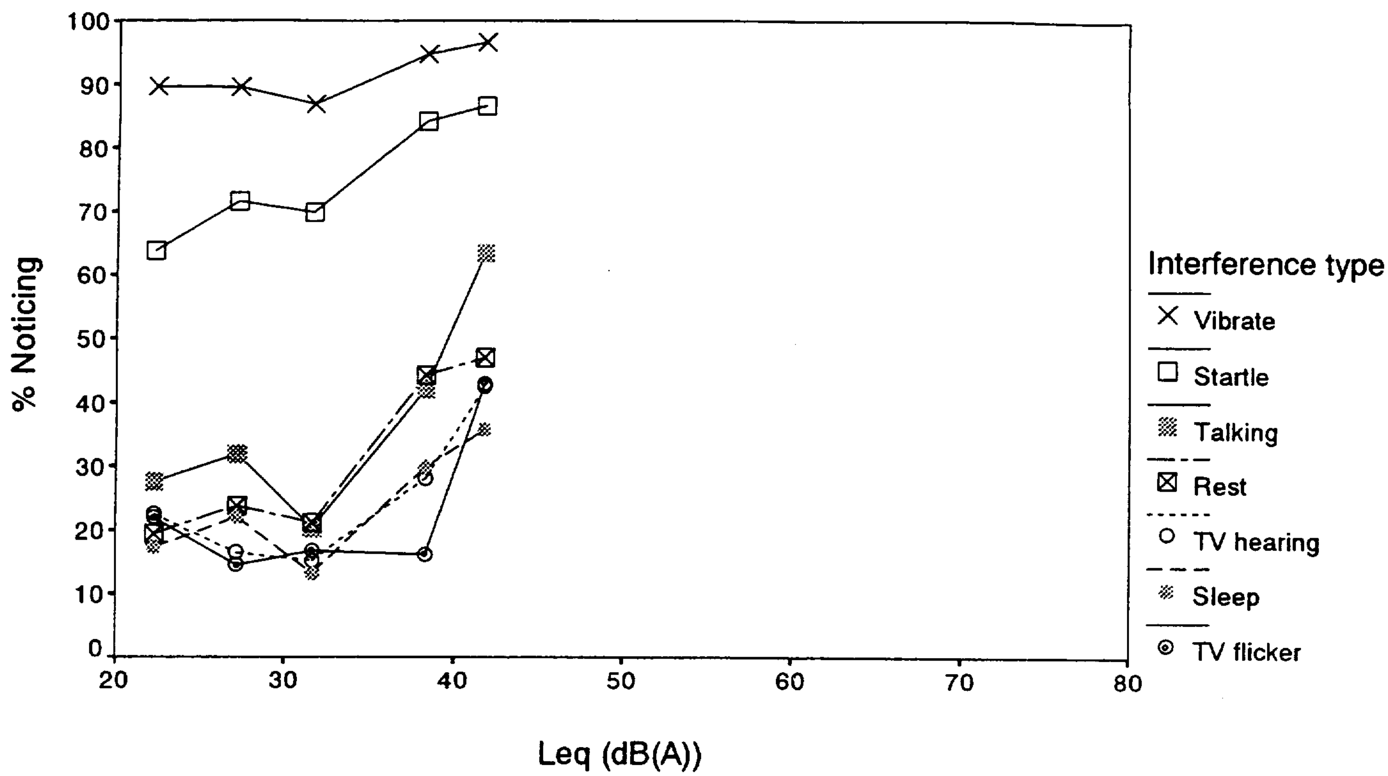

Figure 20 Region A interference: percentages who report noticing each of seven aspects of sonic booms (Q.14)

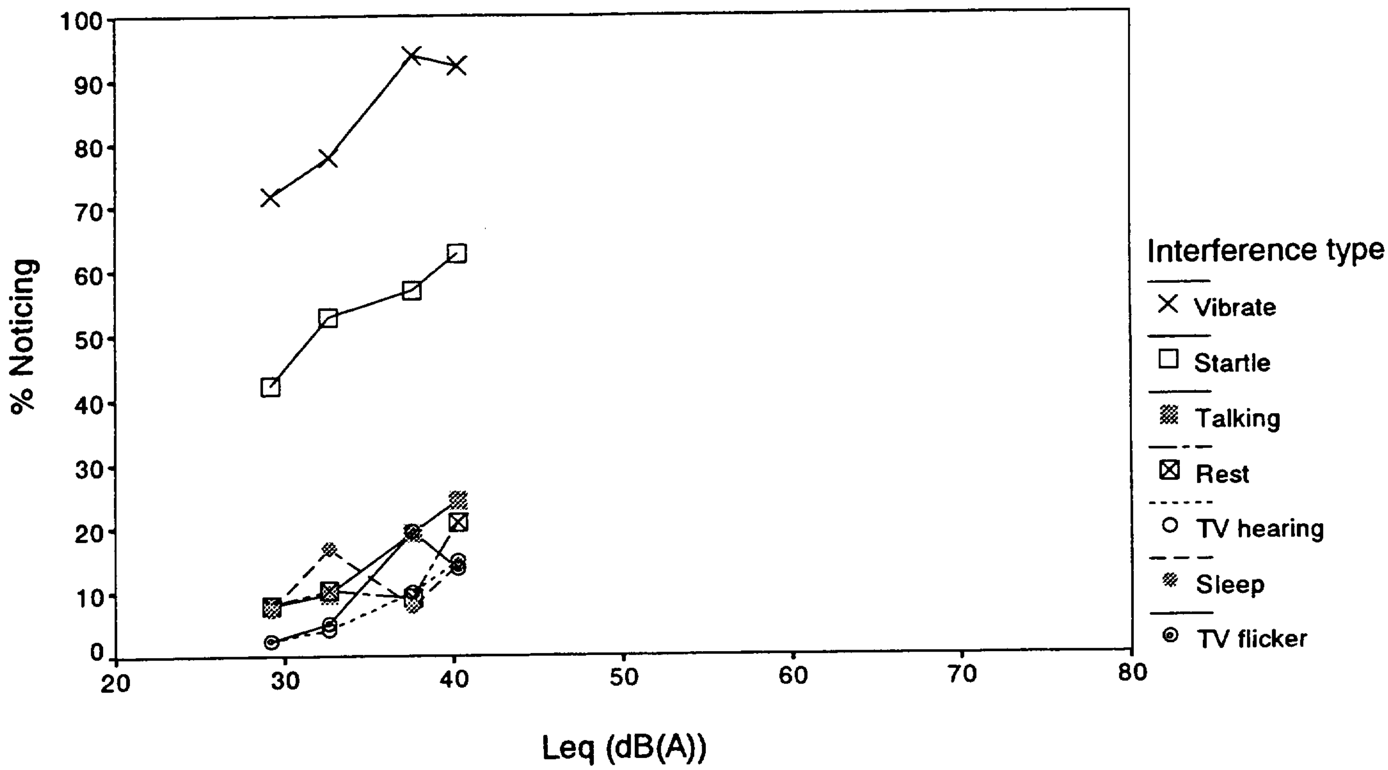

Figure 21 Region B interference: percentages who report noticing each of seven aspects of sonic booms (Q.14)

7.3 The startle reaction

The percentage of the residents reporting being startled varies from approximately 40 to 80 percent depending upon the site. Although the extent and severity of the startle reaction varied between sites, some insight into the type of reaction can be gained from the average over these diverse sites. An examination of the more severe reactions indicates that although simply being startled is not synonymous with having a severe startle experience, there are significant numbers of the population who do have severe reactions. Most who reported being startled did not report being so startled that they were "frightened or scared." However about 20 percent of the startled residents reported that the booms had actually "frightened or scared" them. About 15 percent reported that they had actually "flinched or jumped or made a sudden movement." About 10 percent reported that a sonic boom had made them "drop something or fall."

While about 40 percent of the residents who reported being startled said that they were less startled by the booms now than they were the "first few times you heard them", about 50 percent reported that it had "always been about the same" and an additional 10 percent reported that they were "more startled now." Most of those who had been startled had not, therefore, totally adapted to them.

7.4 The vibration reaction

The percentage of the residents reporting noticing rattles or vibrations associated with sonic booms varies from approximately 75 to 95 percent depending upon the site. The percentage at least a little annoyed varies from approximately 40 to 90 percent. The percentage "very" annoyed from vibration varies from about 5 to 40 percent from site to site. The most often noticed vibration is from the rattling of windows. About 80 to 100 percent of those residents who noticed vibration went on to report such rattles. Approximately 40 to 100 percent of those noticing vibration answered that they had noticed "pictures or other things on shelves or the walls rattle or move." The vibration reaction was not limited to seeing or hearing movement. From about 40 to 100 percent of those reporting vibration state that they actually "<u>feel</u> the furniture or the house shake or vibrate." Feeling vibration was more often reported in mobile homes. However, the reports of vibration in other structures also concerned perceptions of "<u>feel</u> the furniture or the house shake or vibrate" for a range of 40 to over 90 percent of the vibration reports. The perception of vibration is therefore not limited to hearing rattles, but encompasses feeling movement.

7.5 Reports of damage

Residents were asked about their perceptions of whether sonic booms might have "had anything to do with any things being broken or damaged." The questionnaire therefore measured perceptions of damage, rather than actual damage. No independent attempt was made to verify the accuracy of the respondents' perceptions. Approximately 10 to 50 percent of the respondents at the various sites reported a perception that some damage on their property might have been related to the sonic booms. For most of these reports, residents felt at least "moderately certain" that the damage was caused by the sonic booms. The most frequent reports were of walls, plaster, windows, or window frames that had been broken, cracked or loosened. The other most frequent reports concerned items on walls such as pictures or items on shelves such as knickknacks, glasses, or dishes.

Concern about possibility of damage is more widespread than the actual perception that something has, in the past, been damaged by a sonic boom. For the sample as a whole, about 30 percent reported that they thought that booms might have been related to damage in their home over the "past few years." However, a much larger percentage, about 55 percent, reported that in just the last six months they had heard sonic booms and then "felt that the booms might break or damage or hurt" something around their home.

7.6 Contrasting reactions indoors and outdoors

Some additional insight into differences between reactions to sonic booms and conventional aircraft noise can be gained by considering respondents' feelings about the relative annoyance indoors and outdoors. The sonic boom survey included a matched pair of questions about indoor and outdoor annoyance that had been previously used in a survey of reactions to aircraft and road traffic noise around the Toronto, Canada airport (CAN-168 in Birnie, Taylor and Hall, 1980; Hall, et. al., 1981). The questions were the following:

"These next few questions are especially important because you'll be informing us about some special situations. First we will compare the sonic booms when you are outdoors and indoors. Please look at this DISTURBANCE SCALE. [HAND CARD E TO RESPONDENT] It goes from zero for "not at all disturbed" to ten for "unbearably disturbed".

Q35. How do you rate the sonic booms when you are <u>out-of-doors</u> around your house in the daytime?

0	1	2	3	4	5	6	7	8	9	10	[OUTSIDE]
NOT AT ALL DISTURBED										UNBEARABLY DISTURBED	

Q36. How do you rate the sonic booms when you are <u>inside</u> your house in the daytime?"

0	1	2	3	4	5	6	7	8	9	10	[INSIDE]
NOT AT ALL DISTURBED										UNBEARABLY DISTURBED	

Residents were found to be disturbed by sonic booms both indoors and outdoors. The annoyance with sonic booms is not restricted to the indoor environment. The average score on the indoor scale was, however, higher than that on the outdoor scale. This is the opposite of the pattern found for the Toronto aircraft and road traffic responses where there was greater annoyance outdoors than indoors.

This difference in indoor/outdoor reactions might be expected on the basis of any of the three major aspects of the sonic boom impact. Although it is clearest that vibration would be noticed less often outdoors, it also appears that the other aspects could also be noticed less often. Booms heard indoors may cause greater fear of danger or damage because the respondents are in a structure surrounded by things that could fall or be damaged. Booms heard indoors may be more startling because residents relax more and expect the indoor environment to generally be a more predictable noise environment or because the booms heard indoors are more likely to be associated with the possibility of danger from nearby objects.

8.0 CONCLUSIONS AND DISCUSSION

This survey has provided the first information about reactions to long-term exposure to sonic booms when sonic boom exposures have been measured. The sonic booms in the study areas come from military training exercises and aircraft testing programs.

Although the communities differ somewhat in their exposures, their total exposure to sonic booms would be considered to be relatively low based on Day-night Average Sound Level (DNL) or other conventional aircraft noise metrics. The least exposed communities average about one measurable boom in 20 days and have less than one boom that is over 2.0 psf in 100 days. The most exposed communities average two booms per day with about one boom per week over 2.0 psf. For the six-month study periods, the least exposed communities had C-weighted exposures of about 40 $L_{Ceq24Hr}$ and A-weighted exposures of about 25 $L_{Aeq24Hr}$ and DNL 25. The most exposed communities had C-weighted exposures of about 55 L_{Ceq} and A-weighted exposures of about 40 L_{Aeq} and DNL 40. Although no booms were classified as having occurred at night during the study period, it should be noted that the boom scoring method described in Appendix E would tend to underreport indistinct nighttime and weekend sonic booms.

Residents reported that three aspects of the sonic booms are most disturbing: being startled, noticing rattles or vibrations, and being concerned about the possibility of damage from the booms. Respondents report that the vibrations are not restricted to hearing rattles but also include noticing houses shake. A little over half of the startled respondents report that their startle reactions have not lessened from the time when they first heard the booms. More people fear the possibility of damage than believe that booms have thus far damaged their property.

The limited data from this survey suggest that the continuous equivalent noise level based on an A-weighting (DNL or $L_{Aeq24Hr}$) is equal or better at predicting reactions than are measures of average peak noise levels or metrics based on a C-weighting. In this particular data set the importance assigned to how often booms occur is, if anything, under-represented in the conventional metrics based on energy averaging.

Additional insight into reactions to sonic booms has been obtained by comparing the results from this survey with the results from 20 previous surveys of residents' reactions to aircraft noise and various types of impulse noise. The reactions to sonic booms in both of the western boom study regions appear to be more severe than would be expected for conventional aircraft at the same continuous equivalent noise levels (L_{Aeq}). However, the severity of the reactions to sonic booms is strikingly different in the two sonic boom study regions.

The 1,036 interviews conducted in the two survey phases in the first region (Region A) indicate that in the range of about 30 to 40 L_{Aeq} about 75 percent of the residents are at least a little annoyed by sonic booms and about 35 percent were "very" annoyed on a 4-point verbal annoyance scale. The 537 interviews in the second region (Region B) indicate that at the same range of noise levels about 50 percent were at least a little annoyed and about five percent were "very" annoyed.

This difference in reactions in the two regions also affects estimates of the difference between reactions to sonic booms and to conventional aircraft noise. On the basis of the lesser reactions in the second region (Region B), sonic boom environments appear to be subjectively equivalent to conventional aircraft environments that are approximately 10 decibels higher (L_{Aeq}). This estimate is only approximate because estimates range from 3 to 20 decibels depending upon the annoyance question and surveys to which the comparison is made. The more severe reactions in the first studied region (Region A) are, however, subjectively equivalent to being an additional 20 to 40 decibels higher than those in conventional aircraft noise environments.

The reactions in the less annoyed region (Region B) are roughly equivalent to the reactions found in the 1964 Oklahoma City study of residents' reactions to a six-month, temporary exposure to sonic booms. These lesser, Region B reactions are also similar to those found in most areas of a CEC impulse noise study of noise around light-arms firing ranges and a variety of other impulse noise sites. The weak evidence that is available also indicates some consistency between the Region B results and those from a study of noise from large artillery in the United States.

Although the less severe Region B reactions are more similar to those found in most other surveys. the more severe reactions in Region A cannot be dismissed. There is no indication that errors in social survey or acoustical survey procedures could be responsible for the difference in reactions in the two regions. In addition, equally high reactions were present in some locations in the Netherlands CEC study. After carefully examining many potential differences between the regions, a definite explanation for differences in reactions has not been found. The differences in reactions cannot be explained by any obvious differences in the respondents' demographic characteristics, the types of housing construction, or the characteristics of the individual communities. There is some tentative evidence that a limited part of the difference between the two regions might be traced to the low-altitude, subsonic combat training maneuvers that are more prevalent in Region A and, possibly, to a perception that pilots and flight planners in Region A are not doing all they could to reduce sonic booms. However, this evidence is not strong enough to definitely explain the differences between the two regions.

The conclusion from these studies is therefore that sonic boom annoyance is greater than that in a conventional aircraft environment with the same continuous equivalent noise exposure. With the present knowledge, however, it is not possible to predict the size of this difference. Most of the evidence suggests that sonic booms may cause reactions that are the equivalent of reactions to conventional aircraft noise environments of roughly 10 decibels greater exposure. The possibility that sonic booms may cause reactions that are the equivalent of a 20 to 40 decibels greater exposure cannot be ruled out.

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APPENDIX A: FREQUENCIES FOR NOISE REACTION QUESTIONS BY STUDY SITE

The answers to the four primary annoyance questions are provided in Table 10 in this appendix. On every question, the "Not annoyed" category includes those who report not hearing sonic booms.

Table 10: Annoyance reactions on four general sonic boom annoyance questions

	Wave of Data Collection																	
	Region A: Phase I						Region A: Phase II						Region B: Phase III							
	Site (Noise L Order)						Site (Noise L Order)						Site (Noise L Order)							
	A-6	A-5	A-4	A-3	A-2	A-4	A-6	A-5	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4	B-3	B-2	B-1
Q8.iv Boom: 4-Pt Verbal Annoy																				
Not At All Annoyed %	17.2%	37.3%	29.3%	18.0%	15.3%	11.9%	44.8%	29.6%	13.5%	34.9%	12.7%	20.8%	58.7%	57.8%	55.6%	59.5%	53.1%	48.8%	42.4%	38.1%
N=	5	25	29	36	9	8	13	21	13	73	7	11	27	26	25	44	17	21	53	48
A Little Annoyed %	34.5%	32.8%	23.2%	24.0%	15.3%	31.3%	27.6%	31.0%	35.4%	31.1%	30.9%	28.3%	26.1%	28.9%	35.6%	23.0%	31.3%	34.9%	36.0%	30.2%
N=	10	22	23	48	9	21	8	22	34	65	17	15	12	13	16	17	10	15	45	38
Moderately Annoyed %	17.2%	11.9%	19.2%	23.0%	23.7%	16.4%	3.4%	15.5%	18.8%	19.6%	29.1%	18.9%	4.3%	8.9%	6.7%	14.9%	6.3%	14.0%	13.6%	21.4%
N=	5	8	19	46	14	11	1	11	18	41	16	10	2	4	3	11	2	6	17	27
Very Much Annoyed %	31.0%	17.9%	28.3%	35.0%	45.8%	40.3%	24.1%	23.9%	32.3%	14.4%	27.3%	32.1%	10.9%	4.4%	2.2%	2.7%	9.4%	2.3%	8.0%	10.3%
N=	9	12	28	70	27	27	7	17	31	30	15	17	5	2	1	2	3	1	10	13
Total %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
N=	29	67	99	200	59	67	29	71	96	209	55	53	46	45	45	74	32	43	125	126
Q35 Boom: 5-Pt Verbal Annoy																				
Not At All Annoyed %	21.4%	30.3%	29.0%	20.1%	13.6%	16.4%	44.8%	23.9%	15.6%	36.2%	14.5%	20.8%	60.9%	56.8%	55.6%	60.8%	65.6%	48.8%	54.9%	37.7%
N=	6	20	27	39	8	11	13	17	15	75	8	11	28	25	25	45	21	21	67	46
Slightly Annoyed %	21.4%	27.3%	33.3%	29.9%	30.5%	26.9%	27.6%	33.8%	35.4%	30.9%	23.6%	20.8%	21.7%	22.7%	24.4%	27.0%	18.8%	41.9%	31.1%	35.2%
N=	6	18	31	58	18	18	8	24	34	64	13	11	10	10	11	20	6	18	38	43
Moderately Annoyed %	32.1%	28.8%	21.5%	22.7%	25.4%	22.4%	13.8%	16.9%	21.9%	17.9%	29.1%	20.8%	13.0%	18.2%	15.6%	9.5%	6.3%	7.0%	9.8%	20.5%
N=	9	19	20	44	15	15	4	12	21	37	16	11	6	8	7	7	2	3	12	25
Very Annoyed %	14.3%	12.1%	9.7%	19.1%	22.0%	23.9%	10.3%	18.3%	15.6%	9.2%	21.8%	15.1%	2.2%		4.4%	2.7%	9.4%	2.3%	3.3%	3.3%
N=	4	8	9	37	13	16	3	13	15	19	12	8	1		2	2	3	1	4	4
Extremely Annoyed %	10.7%	1.5%	6.5%	8.2%	8.5%	10.4%	3.4%	7.0%	11.5%	5.8%	10.9%	22.6%	2.2%	2.3%					.8%	3.3%
N=	3	1	6	16	5	7	1	5	11	12	6	12	1	1					1	4
Total %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
N=	28	66	93	194	59	67	29	71	96	207	55	53	46	44	45	74	32	43	122	122

(continued)

	Wave of Data Collection																			
	Region A: Phase I						Region A: Phase II						Region B: Phase III							
	Site (Noise L Order)						Site (Noise L Order)						Site (Noise L Order)							
	A-6	A-5	A-4	A-3	A-2	A-4	A-6	A-5	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4	B-3	B-2	B-1
Q12 Boom: 11-Pt Numeric Annoy																				
0 - Not At All Annoyed %	13.8%	35.3%	23.2%	14.1%	10.2%	10.4%	34.5%	23.9%	15.6%	33.3%	10.9%	22.6%	54.3%	53.3%	42.2%	54.7%	40.6%	37.2%	41.6%	30.2%
N=	4	24	23	28	6	7	10	17	15	70	6	12	25	24	19	41	13	16	52	38
1 %	10.3%	10.3%	8.1%	8.0%	3.4%	11.9%	17.2%	11.3%	12.5%	11.0%	9.1%	1.9%	8.7%	15.6%	13.3%	14.7%	18.8%	9.3%	15.2%	11.1%
N=	3	7	8	16	2	8	5	8	12	23	5	1	4	7	6	11	6	4	19	14
2 %	13.8%	4.4%	9.1%	7.5%	13.6%	13.4%	10.3%	8.5%	6.3%	9.0%	10.9%	7.5%	10.9%	8.9%	6.7%	9.3%	15.6%	11.6%	15.2%	11.1%
N=	4	3	9	15	8	9	3	6	6	19	6	4	5	4	3	7	5	5	19	14
3 %	3.4%	13.2%	7.1%	7.5%	1.7%	7.5%	6.9%	9.9%	14.6%	8.1%	3.6%	11.3%	8.7%	4.4%	13.3%	1.3%	6.3%	16.3%	8.0%	7.9%
N=	1	9	7	15	1	5	2	7	14	17	2	6	4	2	6	1	2	7	10	10
4 %	3.4%	5.9%	7.1%	6.5%	3.4%	3.0%		7.0%	3.1%	7.1%	7.3%	7.5%	2.2%	6.7%	11.1%	2.7%	3.1%	7.0%	1.6%	8.7%
N=	1	4	7	13	2	2		5	3	15	4	4	1	3	5	2	1	3	2	11
5 %	20.7%	7.4%	6.1%	11.6%	10.2%	7.5%	10.3%	4.2%	4.2%	5.7%	7.3%	3.8%	4.3%	2.2%	4.4%	9.3%	6.3%	7.0%	5.6%	3.2%
N=	6	5	6	23	6	5	3	3	4	12	4	2	2	1	2	7	2	3	7	4
6 %	3.4%		5.1%	3.0%	3.4%	4.5%		5.6%	4.2%	4.8%	7.3%	1.9%	2.2%	6.7%	2.2%			4.7%	1.6%	5.6%
N=	1		5	6	2	3		4	4	10	4	1	1	3	1			2	2	7
7 %	3.4%	8.8%	6.1%	5.0%	11.9%	6.0%		7.0%	6.3%	2.9%	9.1%	3.8%	2.2%		2.2%	1.3%		4.7%	2.4%	5.6%
N=	1	6	6	10	7	4		5	6	6	5	2	1		1	1		2	3	7
8 %	3.4%	1.5%	10.1%	8.5%	16.9%	9.0%	3.4%	7.0%	7.3%	4.3%	14.5%	1.9%	4.3%	2.2%		2.7%			4.0%	6.3%
N=	1	1	10	17	10	6	1	5	7	9	8	1	2	1		2			5	8
9 %	6.9%	1.5%	3.0%	6.0%	5.1%	4.5%	6.9%	2.8%	4.2%	1.9%	7.3%	7.5%			2.2%	4.0%	3.1%		1.6%	2.4%
N=	2	1	3	12	3	3	2	2	4	4	4	4			1	3	1		2	3
10 - Extremely Annoyed %	17.2%	11.8%	15.2%	22.1%	20.3%	22.4%	10.3%	12.7%	21.9%	11.9%	12.7%	30.2%	2.2%		2.2%		6.3%	2.3%	3.2%	7.9%
N=	5	8	15	44	12	15	3	9	21	25	7	16	1		1		2	1	4	10
Total %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
N=	29	68	99	199	59	67	29	71	96	210	55	53	46	45	45	75	32	43	125	126

(continued)

	Wave of Data Collection																			
	Region A: Phase I						Region A: Phase II						Region B: Phase III							
	Site (Noise L Order)						Site (Noise L Order)						Site (Noise L Order)							
	A-6	A-5	A-4	A-3	A-2	A-4	A-6	A-5	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4	B-3	B-2	B-1
Q37 Boom: 5-Pt Numeric Annoy																				
0 - Not At All Annoyed																				
%	13.8%	30.9%	28.6%	21.6%	13.6%	14.9%	48.3%	22.5%	20.8%	36.4%	14.5%	20.8%	56.5%	54.5%	51.1%	60.0%	59.4%	46.5%	50.4%	32.8%
N=	4	21	28	43	8	10	14	16	20	76	8	11	26	24	23	45	19	20	63	41
1																				
%	20.7%	17.6%	22.4%	18.6%	18.6%	17.9%	13.8%	23.9%	18.8%	22.5%	21.8%	28.3%	17.4%	27.3%	26.7%	20.0%	18.8%	25.6%	28.0%	24.8%
N=	6	12	22	37	11	12	4	17	18	47	12	15	8	12	12	15	6	11	35	31
2																				
%	24.1%	25.0%	13.3%	19.1%	20.3%	23.9%	17.2%	19.7%	18.8%	14.4%	21.8%	3.8%	17.4%	9.1%	8.9%	14.7%	15.6%	20.9%	12.0%	26.4%
N=	7	17	13	38	12	16	5	14	18	30	12	2	8	4	4	11	5	9	15	33
3																				
%	20.7%	20.6%	20.4%	18.6%	27.1%	20.9%	6.9%	18.3%	21.9%	14.4%	20.0%	18.9%	6.5%	6.8%	8.9%	4.0%	6.3%	7.0%	7.2%	9.6%
N=	6	14	20	37	16	14	2	13	21	30	11	10	3	3	4	3	2	3	9	12
5 - -Extremely Annoyed																				
%	20.7%	5.9%	15.3%	22.1%	20.3%	22.4%	13.8%	15.5%	19.8%	12.4%	21.8%	28.3%	2.2%	2.3%	4.4%	1.3%			2.4%	6.4%
N=	6	4	15	44	12	15	4	11	19	26	12	15	1	1	2	1			3	8
Total																				
%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
N=	29	68	98	199	59	67	29	71	96	209	55	53	46	44	45	75	32	43	125	125

APPENDIX B: STUDY DESIGN AND SAMPLE DISPOSITION

B.1 The timing of study phases and noise measurement programs

The three phases of the study were executed over a three-year period. Table 11 provides the basic dates for the study. The beginning and ending dates of the social survey program are provided at the beginning of the table. The noise measurement study dates are provided in the remainder of the table.

Table 11: Key social survey and noise measurement study dates

Event	Phase I: Region A Sites(1993)[1] (Month/day)						Phase II: Region A(1993)[1] (Month/day)						Phase III: Region B (1995) (Month/day) (All are 1995)							
	A-6	A-5	A-4	A-3	A-2	A-1	A-6	A-5	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4	B-3	B-2	B-1
Social Survey dates																				
First interview	4/21	4/21	4/27	4/23	4/22	4/22	12/09	12/09	12/03	12/06	12/04	12/04	11/11	11/11	11/11	11/04	11/09	11/09	11/05	11/08
Last interview	4/28	4/28	4/29	05/01	05/01	05/02	12/12	12/12	12/09	12/10	12/07	12/07	11/18	11/14	11/17	11/15	11/16	11/15	11/11	11/16
Noise measurement program dates																				
BEAR device installed	3/3	2/2	4/9/92	1/25	4/1/92	3/31/92	3/3	2/2	4/9/92	1/25	4/1/92	3/31/92	3/1	2/16	2/15	2/16	2/16	2/16	3/1	2/21
1st pre-six-month day used in analysis	(Pre-six-month exposure not calculated)						3/4	2/3	10/20/92	1/26	10/20/92		4/08							
Start 6-month period	10/20/92						06/03						05/04							
Late start date	3/4	2/3		1/26			06/09	06/09		7/16										
End of 6-months for first respondents	4/20						12/2						11/3							

[1] All dates in Region A are for 1993, except for some start dates at sites A-1, A-2 and A-5 that are noted.

B.2 Sample disposition

The distribution of the sample across the communities and phases is shown in Table 12. The upper half shows the disposition of addresses between eligible and non-eligible addresses. The largest category of ineligible addresses is vacant homes. Some of these may have been the homes of temporary or seasonal residents, but many, especially in Region B, arose from a reduction in the population in the area.

The lower half of Table 12 gives the distribution of the eligible, selected residents. Of the 2082 selected, eligible residents, 1578 provided interviews for an overall response rate of 76 percent. Of the 1,578 interviews, 217 were obtained from a respondent in Phase II who had been previously interviewed in Phase I. The generally lower response rates in Phase II and Phase III are believed to have been at least partially caused by low contact rates that may have been due to unverified seasonal or vacant residences, an apartment complex in one community (B-6) to which access was denied, a local flu outbreak in two communities in Phase II (A-3, A-4), and the less favorable timing just before the Christmas holiday (Phase II) and Thanksgiving holiday (Phase III) when some residents of these remote communities were making shopping trips to distant cities.

Table 12: Sample disposition and response rates by community and study phase

Disposition	Phase I: Region A sites(1993)						Phase II: Region A sites(1993)						Phase III: Region B sites(1995)								Total
	A-6[3]	A-5 (&6)	A-4	A-3	A-2	A-1	A-6[3]	A-5 (&6)	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4[3]	B-3 (&4)	B-2	B-1	
Disposition of sample selections (Note: The number of households is less than the number of eligible residents in some communities in which multiple respondents were selected from households.)																					
Issued sample points (Dwelling/residents)		127	139	280	34	48		196	192	360	62	85	76	68	108	153		110	163	274	2475
Vacant		12	10	51	5	8		11	26	34	6	16	12	2	13	37		16	7	108	374
Temporary/Seasonal residence		2	7	15	0	0		0	2	2	0	6	0	0	2	2		2	0	3	43
No English speaker		1	0	0	0	0		5	0	1	0	0	0	1	1	3		0	0	2	14
Miscellaneous		0	0	1	1	0		1	8	10	0	1	0	0	0	0		0	1	3	26
Disposition of selected residents																					
Selected residents		112	122	211	59	75		179	156	313	56	62	64	65	92	111		92	155	158	2082
Refusal[1]		8	5	7	0	1		21	19	15	0	5	7	10	34	12		8	3	17	172
No contact with designated respondent		7	16	3	0	5		58	39	88	1	4	11	10	13	24		9	27	15	330
Completed interviews		97	101	201	59	67		100	98	210	55	53	46	45	45	75		75	125	126	1578[2]
Response rate (% of eligible sample)		87%	83%	95%	100%	89%		56%	60%	67%	98%	85%	72%	69%	49%	68%		82%	81%	80%	76%
Probability sample analyzed in report (Excludes 6 interviews with specially selected community members.)																					
Completed interviews	29	68	99	200	59	67		100	96	210	55	53	46	45	45	75		75	125	126	1573

1. A large number of refusals came from two sites where property managers denied access to many or all residents at a trailer park (site B-1) or an apartment house (Site B-6).
2. One additional interview was completed with a community leader living outside of the study area. This interview was on the original data tape, but has not been included in the study analysis or the sample disposition statistics.
3. Sample disposition information, except for number of completed interviews, was not separately maintained. The disposition information is combined with the column to the right.

B.3 Household interviewing patterns

Most interviews were conducted following procedures used in most cross-sectional surveys in which one respondent is selected from each household and interviewed only one time. In order to gain as much data as possible from the small numbers of residents in the highest exposure areas in Region A, however, multiple interviews were taken from the same household and household members were reinterviewed after approximately an eight-month period. Table 13 shows the numbers of interviews of each that were conducted.

Table 13: Division of respondents by type of household interviewing pattern in three study phases

The first person interviewed in the particular phase is:	Phase I: Region A sites(1993)						Phase II: Region A sites(1993)						Phase III: Region B sites(1995)								Total
	A-6	A-5	A-4	A-3	A-2	A-1	A-6	A-5	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4	B-3	B-2	B-1	
First time this respondent is interviewed																					
The respondent	29	67	99	200	28	42	17	42	48	64	3	11	46	45	45	75	32	43	125	126	1187
Another household member		1			31	25	7	19	25	53	2	6									169
Second time this respondent has been interviewed (only occurs in Phase II)																					
The respondent							4	7	20	65	24	25									145
Another household member							1	3	3	28	26	11									72
Total	29	68	99	200	59	67	29	71	96	210	55	53	46	45	45	75	32	43	125	126	1573

Note: The Phase II, repeat interviews all used the shorter, Form B, version of the questionnaire. All but two of the initial interviews were conducted with the longer (Form A) questionnaire. Two of the initial interviews in Phase II, Site A-4 were mistakenly interviewed with Form B. These later two interviews are included in the analysis with missing data for the main interview questions that were not included in Form B.

APPENDIX C: PARTIAL CORRELATIONS FOR DOSE/RESPONSE MEASURES

This appendix first lists alternative noise exposure (dose) and noise reaction (response) measures and then presents the partial correlation between 112 measures of sonic boom exposure and 10 measures of residents' responses controlled for region-of-study. Region-of-study is represented by a dichotomous dummy variable that is coded 0 or 1. The variables are identified with names of 8 or fewer characters. As there are no missing data for the noise exposure variables, the number of interviews for each partial correlation is the number with valid data on the reaction variable.

C.1 Definition of annoyance variables

The means, ranges of values, valid numbers of responses, and labels for the 10 annoyance scales are:

Variable	Mean	Minimum	Maximum	Valid N	Label (Question #)
[------------------------------			ANNOYANCE VARIABLES		--------------------------------]
MANNOYB	3.72	.00	10.00	1573	Annoyance: 4-Quest. Avr. score index (Q8 12 35 37)
S084CZ	1.26	0	3	1570	Annoyance: 4-Point Verbal scale (Q.8.iv)
M35Z	1.25	0	4	1546	Annoyance: 5-Point Verbal scale (Q.35)
V12Z	3.70	0	10	1572	Annoyance: 11-Point Numeric scale (Q.12)
V37Z	1.52	0	4	1568	Annoyance: 5-Point Numeric scale (.37)
FACTOR_4	.00	-1.13	1.98	1530	Annoyance: 4-Quest. Factor score (See 1st scale)
FACTOR_9	.00	-1.24	2.41	1530	Annoyance: 9-Quest. Factor score(Above+ Q14)
R36U	1.27	.00	3.59	1463	Annoyance: 16-Quest. Magnitude Est scale (Q.36[1])
S084CZH	.21	.00	1.00	1570	Annoyance: "Very" (Top of 4-Pt. scale)(Q8.iv)
R14GAS	1.35	0	5	795	Annoyance: 6-Quest. Guttman scale (Q.14)

C.2 Definition of noise exposure variables

The noise exposure variables are listed below. The labels on the right side of the list are, for the most part, self-explanatory. The seven character variable names, on the left side of the list, are coded into four parts. If the seven character variable is represented as

AAA#B@

then the four components can be decoded as follows:

AAA = Noise metric where:

```
LQA = LAeq(24 hr)
LQC = LCeq(24 hr)
MSA = Mean (Logarithmic) SEL(dB(A))
```

---

[1] The 16-item magnitude estimation measurement procedure is described in Chapter 4. The scale used in the correlation matrix includes respondents who are not annoyed. This scale has been documented in a previous publication where the scale is described as the magnitude scale with "All interviews [Impute not annoy]" (Fields, 1996a: 2385).

MSC = Mean (Logarithmic) SEL(dB(C))
MPL = Mean (logarithmic) Perceived Loudness (PL)
MPF = Arithmetic mean maximum overpressure (psf)
NUE = Number of minutes per day (average) during which a boom event occurred
NUM = Number of booms per day (average)

# = Minimum level for the maximum overpressure (in psf) where the minimum psf included in the index is:
0 = all (no values excluded)
5 = 0.5 psf
1 = 1.0 psf
2 = 2.0 psf
3 = 3.0 psf

B = The length of the period over which the noise is integrated where:
S = Six months before interview
A = All of measured period before the interview (greater than 6 months)

@= Lowest boom distinctness grade where:
1 = all booms, including the least distinct are included
......
4 = only the booms graded in the two highest distinctness categories (4 & 5) are included

Table 14: Means, ranges of values, valid numbers of cases and labels for 112 noise exposure indices

Variable	Mean	Minimum	Maximum	Valid N	Label
LQA0S1	31.94	22.02	41.97	1573	LEQ(A): Grade=1+ (Mo=6)
LQA0S2	31.04	18.91	41.92	1573	LEQ(A): Grade=2+ (Mo=6)
LQA0S3	30.56	18.91	41.86	1573	LEQ(A): Grade=3+ (Mo=6)
LQA0S4	29.62	17.32	41.42	1573	LEQ(A): Grade=4+ (Mo=6)
LQA0A1	32.34	22.60	41.97	1573	LEQ(A): Grade=1+ (Mo>6)
LQA0A2	31.72	22.05	41.92	1573	LEQ(A): Grade=2+ (Mo>6)
LQA0A3	31.16	21.26	41.86	1573	LEQ(A): Grade=3+ (Mo>6)
LQA0A4	30.23	18.82	41.26	1573	LEQ(A): Grade=4+ (Mo>6)
LQC0S1	46.84	32.89	57.24	1573	LEQ(C): Grade=1+ (Mo=6)
LQC0S2	46.47	32.15	57.20	1573	LEQ(C): Grade=2+ (Mo=6)
LQC0S3	46.23	31.85	57.15	1573	LEQ(C): Grade=3+ (Mo=6)
LQC0S4	45.57	30.78	56.63	1573	LEQ(C): Grade=4+ (Mo=6)
LQC0A1	47.79	32.32	57.24	1573	LEQ(C): Grade=1+ (Mo>6)
LQC0A2	47.58	31.46	57.20	1573	LEQ(C): Grade=2+ (Mo>6)
LQC0A3	47.27	31.15	57.15	1573	LEQ(C): Grade=3+ (Mo>6)
LQC0A4	46.66	30.08	56.63	1573	LEQ(C): Grade=4+ (Mo>6)
MSA0S1	84.97	74.99	95.28	1573	SEL (A) Logarithmic Mean: Grade=1+ (Mo=6)
MSA0S2	85.07	74.72	95.15	1573	SEL (A) Logarithmic Mean: Grade=2+ (Mo=6)
MSA0S3	85.53	74.90	95.16	1573	SEL (A) Logarithmic Mean: Grade=3+ (Mo=6)
MSA0S4	86.47	75.47	95.07	1573	SEL (A) Logarithmic Mean: Grade=4+ (Mo=6)
MSA0A1	84.06	74.99	95.43	1573	SEL (A) Log Mean: Grade=1+ (Mo>6)
MSA0A2	84.43	74.72	95.25	1573	SEL (A) Log Mean: Grade=2+ (Mo>6)
MSA0A3	85.06	74.90	95.16	1573	SEL (A) Log Mean: Grade=3+ (Mo>6)
MSA0A4	86.26	75.47	95.07	1573	SEL (A) Log Mean: Grade=4+ (Mo>6)
MSC0S1	99.88	93.17	104.07	1573	SEL (C) Logarithmic Mean: Grade=1+ (Mo=6)
MSC0S2	100.49	92.82	104.85	1573	SEL (C) Logarithmic Mean: Grade=2+ (Mo=6)
MSC0S3	101.20	93.30	105.89	1573	SEL (C) Logarithmic Mean: Grade=3+ (Mo=6)
MSC0S4	102.43	94.08	107.40	1573	SEL (C) Logarithmic Mean: Grade=4+ (Mo=6)
MSC0A1	99.52	93.17	104.07	1573	SEL (C) Log Mean: Grade=1+ (Mo>6)
MSC0A2	100.29	92.82	104.72	1573	SEL (C) Log Mean: Grade=2+ (Mo>6)
MSC0A3	101.18	93.30	105.89	1573	SEL (C) Log Mean: Grade=3+ (Mo>6)

Variable	Mean	Minimum	Maximum	Valid N	Label
MSCOA4	102.69	94.08	107.40	1573	SEL (C) Log Mean: Grade=4+ (Mo>6)
MPLOS1	98.03	87.57	106.02	1573	PL Logarithmic Mean: Grade=1+ (Mo=6)
MPLOS2	98.36	87.35	106.30	1573	PL Logarithmic Mean: Grade=2+ (Mo=6)
MPLOS3	99.01	87.80	107.05	1573	PL Logarithmic Mean: Grade=3+ (Mo=6)
MPLOS4	100.19	88.81	108.16	1573	PL Logarithmic Mean: Grade=4+ (Mo=6)
MPLOA1	97.32	87.57	106.01	1573	PL Logarithmic Mean: Grade=1+ (Mo>6)
MPLOA2	97.92	87.35	106.34	1573	PL Logarithmic Mean: Grade=2+ (Mo>6)
MPLOA3	98.77	87.80	106.57	1573	PL Logarithmic Mean: Grade=3+ (Mo>6)
MPLOA4	100.25	88.81	108.16	1573	PL Logarithmic Mean: Grade=4+ (Mo>6)
MPF0S1	.71	.37	1.12	1573	PMax Ar. Mean: (All psf) Grade=1+ (Mo=6)
MPF0S2	.80	.36	1.12	1573	PMax Ar. Mean: (All psf) Grade=2+ (Mo=6)
MPF0S3	.89	.40	1.27	1573	PMax Ar. Mean: (All psf) Grade=3+ (Mo=6)
MPF0S4	1.07	.41	1.55	1573	PMax Ar. Mean: (All psf) Grade=4+ (Mo=6)
MPF0A1	.67	.37	1.12	1573	PMax Ar. Mean: (All psf) Grade=1+ (Mo>6)
MPF0A2	.77	.36	1.16	1573	PMax Ar. Mean: (All psf) Grade=2+ (Mo>6)
MPF0A3	.88	.40	1.31	1573	PMax Ar. Mean: (All psf) Grade=3+ (Mo>6)
MPF0A4	1.09	.41	1.56	1573	PMax Ar. Mean: (All psf) Grade=4+ (Mo>6)
MPF1S1	1.79	.00	4.85	1573	PMax Ar. Mean: (>1.0 psf) Grade=1+ (Mo=6)
MPF1S2	1.71	.00	4.85	1573	PMax Ar. Mean: (>1.0 psf) Grade=2+ (Mo=6)
MPF1S3	1.71	.00	4.85	1573	PMax Ar. Mean: (>1.0 psf) Grade=3+ (Mo=6)
MPF1S4	1.71	.00	4.85	1573	PMax Ar. Mean: (>1.0 psf) Grade=4+ (Mo=6)
MPF1A1	1.87	.00	4.85	1573	PMax Ar. Mean: (>1.0 psf) Grade=1+ (Mo>6)
MPF1A2	1.88	.00	4.85	1573	PMax Ar. Mean: (>1.0 psf) Grade=2+ (Mo>6)
MPF1A3	1.89	.00	4.85	1573	PMax Ar. Mean: (>1.0 psf) Grade=3+ (Mo>6)
MPF1A4	1.89	.00	4.85	1573	PMax Ar. Mean: (>1.0 psf) Grade=4+ (Mo>6)
MPF5S1	1.15	.63	1.76	1573	PMax Ar. Mean: (>0.5 psf) Grade=1+ (Mo=6)
MPF5S2	1.15	.63	1.76	1573	PMax Ar. Mean: (>0.5 psf) Grade=2+ (Mo=6)
MPF5S3	1.17	.63	1.76	1573	PMax Ar. Mean: (>0.5 psf) Grade=3+ (Mo=6)
MPF5S4	1.24	.66	1.76	1573	PMax Ar. Mean: (>0.5 psf) Grade=4+ (Mo=6)
MPF5A1	1.17	.63	1.76	1573	PMax Ar. Mean: (>0.5 psf) Grade=1+ (Mo>6)
MPF5A2	1.18	.63	1.76	1573	PMax Ar. Mean: (>0.5 psf) Grade=2+ (Mo>6)
MPF5A3	1.20	.63	1.76	1573	PMax Ar. Mean: (>0.5 psf) Grade=3+ (Mo>6)
MPF5A4	1.28	.66	1.76	1573	PMax Ar. Mean: (>0.5 psf) Grade=4+ (Mo>6)
NUE0S1	.43	.06	1.06	1573	Minutes of booms/day: Grade=1+ (Mo=6)
NUE0S2	.37	.04	.88	1573	Minutes of booms/day: Grade=2+ (Mo=6)
NUE0S3	.32	.04	.79	1573	Minutes of booms/day: Grade=3+ (Mo=6)
NUE0S4	.22	.03	.59	1573	Minutes of booms/day: Grade=4+ (Mo=6)
NUE0A1	.48	.06	1.05	1573	Minutes of booms/day: Grade=1+ (Mo>6)
NUE0A2	.43	.04	.88	1573	Minutes of booms/day: Grade=2+ (Mo>6)
NUE0A3	.36	.03	.79	1573	Minutes of booms/day: Grade=3+ (Mo>6)
NUE0A4	.24	.02	.59	1573	Minutes of booms/day: Grade=4+ (Mo>6)
NUM0S1	.67	.06	2.51	1573	Number/day: (All psf) Grade=1+ (Mo=6)
NUM0S2	.55	.04	1.80	1573	Number/day: (All psf) Grade=2+ (Mo=6)
NUM0S3	.42	.04	1.22	1573	Number/day: (All psf) Grade=3+ (Mo=6)
NUM0S4	.26	.03	.73	1573	Number/day: (All psf) Grade=4+ (Mo=6)
NUM0A1	.77	.06	2.51	1573	Number/day: (All psf) Grade=1+ (Mo>6)
NUM0A2	.64	.04	1.80	1573	Number/day: (All psf) Grade=2+ (Mo>6)
NUM0A3	.48	.03	1.22	1573	Number/day: (All psf) Grade=3+ (Mo>6)
NUM0A4	.29	.02	.73	1573	Number/day: (All psf) Grade=4+ (Mo>6)
NUM1S1	.13	.00	.47	1573	Number/day: (>1.0 psf) Grade=1+ (Mo=6)
NUM1S2	.13	.00	.47	1573	Number/day: (>1.0 psf) Grade=2+ (Mo=6)
NUM1S3	.13	.00	.47	1573	Number/day: (>1.0 psf) Grade=3+ (Mo=6)
NUM1S4	.12	.00	.43	1573	Number/day: (>1.0 psf) Grade=4+ (Mo=6)
NUM1A1	.15	.00	.50	1573	Number/day: (>1.0 psf) Grade=1+ (Mo>6)
NUM1A2	.14	.00	.49	1573	Number/day: (>1.0 psf) Grade=2+ (Mo>6)
NUM1A3	.14	.00	.48	1573	Number/day: (>1.0 psf) Grade=3+ (Mo>6)
NUM1A4	.12	.00	.43	1573	Number/day: (>1.0 psf) Grade=4+ (Mo>6)
NUM2S1	.04	.00	.16	1573	Number/day: (>2.0 psf) Grade=1+ (Mo=6)
NUM2S2	.04	.00	.16	1573	Number/day: (>2.0 psf) Grade=2+ (Mo=6)
NUM2S3	.04	.00	.16	1573	Number/day: (>2.0 psf) Grade=3+ (Mo=6)
NUM2S4	.04	.00	.14	1573	Number/day: (>2.0 psf) Grade=4+ (Mo=6)
NUM2A1	.04	.00	.16	1573	Number/day: (>2.0 psf) Grade=1+ (Mo>6)
NUM2A2	.04	.00	.16	1573	Number/day: (>2.0 psf) Grade=2+ (Mo>6)
NUM2A3	.04	.00	.16	1573	Number/day: (>2.0 psf) Grade=3+ (Mo>6)
NUM2A4	.04	.00	.14	1573	Number/day: (>2.0 psf) Grade=4+ (Mo>6)
NUM3S1	.01	.00	.08	1573	Number/day: (>3.0 psf) Grade=1+ (Mo=6)
NUM3S2	.01	.00	.08	1573	Number/day: (>3.0 psf) Grade=2+ (Mo=6)
NUM3S3	.01	.00	.08	1573	Number/day: (>3.0 psf) Grade=3+ (Mo=6)
NUM3S4	.01	.00	.07	1573	Number/day: (>3.0 psf) Grade=4+ (Mo=6)
NUM3A1	.01	.00	.08	1573	Number/day: (>3.0 psf) Grade=1+ (Mo>6)
NUM3A2	.01	.00	.08	1573	Number/day: (>3.0 psf) Grade=2+ (Mo>6)
NUM3A3	.01	.00	.08	1573	Number/day: (>3.0 psf) Grade=3+ (Mo>6)
NUM3A4	.01	.00	.07	1573	Number/day: (>3.0 psf) Grade=4+ (Mo>6)
NUM5S1	.28	.03	.84	1573	Number/day: (>0.5 psf) Grade=1+ (Mo=6)

Variable	Mean	Minimum	Maximum	Valid N	Label
NUM5S2	.27	.03	.81	1573	Number/day: (>0.5 psf) Grade=2+ (Mo=6)
NUM5S3	.25	.03	.79	1573	Number/day: (>0.5 psf) Grade=3+ (Mo=6)
NUM5S4	.20	.02	.66	1573	Number/day: (>0.5 psf) Grade=4+ (Mo=6)
NUM5A1	.31	.02	.84	1573	Number/day: (>0.5 psf) Grade=1+ (Mo>6)
NUM5A2	.30	.02	.81	1573	Number/day: (>0.5 psf) Grade=2+ (Mo>6)
NUM5A3	.28	.02	.79	1573	Number/day: (>0.5 psf) Grade=3+ (Mo>6)
NUM5A4	.22	.02	.66	1573	Number/day: (>0.5 psf) Grade=4+ (Mo>6)

C.3 Partial correlation coefficients

The matrix of partial correlation coefficients between annoyance (column headings) and noise exposure (row headings) begins on the next page.

Table 15: Partial correlation coefficients between annoyance and noise exposure controlled for region

Noise	MANNOYB	S084CZ	M35Z	V12Z	V37Z	FACTOR 4	FACTOR 9	R36U	S084CZH	R14GAS
LQAOS1	.1348**	.1292**	.1301**	.1322**	.1122**	.1403**	.1729**	.1180**	.0811**	.1568**
LQAOS2	.1150**	.1085**	.1070**	.1161**	.0953**	.1173**	.1477**	.0912**	.0656**	.1482**
LQAOS3	.1103**	.1028**	.1039**	.1108**	.0921**	.1126**	.1427**	.0901**	.0593*	.1406**
LQAOS4	.0983**	.0895**	.0944**	.0987**	.0823**	.0999**	.1288**	.0800**	.0481	.1269**
LQAOA1	.1425**	.1374**	.1388**	.1380**	.1199**	.1497**	.1828**	.1344**	.0857**	.1540**
LQAOA2	.1414**	.1363**	.1345**	.1385**	.1187**	.1472**	.1799**	.1331**	.0821**	.1505**
LQAOA3	.1351**	.1291**	.1296**	.1317**	.1141**	.1406**	.1725**	.1293**	.0758**	.1437**
LQAOA4	.1249**	.1181**	.1216**	.1211**	.1057**	.1298**	.1603**	.1221**	.0660**	.1300**
LQCOS1	.1211**	.1200**	.1050**	.1232**	.0985**	.1210**	.1521**	.1083**	.0672**	.1535**
LQCOS2	.1090**	.1071**	.0921**	.1132**	.0882**	.1077**	.1372**	.0920**	.0584*	.1469**
LQCOS3	.1059**	.1036**	.0898**	.1099**	.0858**	.1046**	.1341**	.0906**	.0549*	.1435**
LQCOS4	.0921**	.0890**	.0782**	.0969**	.0741**	.0904**	.1190**	.0764**	.0440	.1327**
LQCOA1	.1204**	.1161**	.1112**	.1194**	.1012**	.1230**	.1550**	.1221**	.0564*	.1362**
LQCOA2	.1175**	.1131**	.1068**	.1177**	.0985**	.1195**	.1507**	.1184**	.0535*	.1326**
LQCOA3	.1128**	.1083**	.1029**	.1130**	.0948**	.1147**	.1457**	.1146**	.0497*	.1291**
LQCOA4	.1034**	.0993**	.0947**	.1036**	.0863**	.1050**	.1355**	.1071**	.0420	.1192**
MSAOS1	-.0035	-.0217	.0331	-.0166	.0053	.0043	.0232	.0237	-.0325	-.0040
MSAOS2	-.0032	-.0223	.0298	-.0128	.0041	.0029	.0223	.0124	-.0317	.0088
MSAOS3	.0105	-.0073	.0395	.0021	.0147	.0167	.0361	.0224	-.0193	.0219
MSAOS4	.0320	.0150	.0561*	.0248	.0315	.0379	.0582*	.0391	-.0015	.0412
MSAOA1	.0496*	.0344	.0751**	.0360	.0492	.0566*	.0779**	.0636*	.0244	.0765*
MSAOA2	.0569*	.0418	.0812**	.0440	.0543*	.0641*	.0847**	.0692**	.0300	.0789*
MSAOA3	.0650**	.0511*	.0868**	.0530*	.0601*	.0724**	.0929**	.0766**	.0353	.0794*
MSAOA4	.0752**	.0620*	.0943**	.0646*	.0675**	.0828**	.1032**	.0859**	.0419	.0803*
MSCOS1	-.0116	-.0261	.0122	-.0189	-.0038	-.0093	.0148	.0272	-.0535*	.0060
MSCOS2	-.0112	-.0260	.0130	-.0170	-.0051	-.0087	.0144	.0209	-.0499*	.0106
MSCOS3	.0056	-.0070	.0244	.0019	.0072	.0084	.0319	.0308	-.0323	.0311
MSCOS4	.0279	.0182	.0382	.0278	.0232	.0301	.0546*	.0426	-.0094	.0593
MSCOA1	.0263	.0104	.0466	.0169	.0305	.0293	.0533*	.0575*	-.0166	.0576
MSCOA2	.0292	.0130	.0517*	.0198	.0317	.0333	.0560*	.0589*	-.0116	.0579
MSCOA3	.0396	.0254	.0590*	.0317	.0388	.0444	.0679**	.0672*	-.0032	.0629
MSCOA4	.0517*	.0406	.0663**	.0464	.0463	.0571*	.0820**	.0769**	.0072	.0688
MPLOS1	-.0057	-.0235	.0272	-.0173	.0029	-.0003	.0207	.0260	-.0404	.0000
MPLOS2	-.0068	-.0250	.0236	-.0154	.0005	-.0025	.0181	.0147	-.0392	.0093
MPLOS3	.0071	-.0098	.0332	-.0001	.0109	.0114	.0323	.0240	-.0261	.0239
MPLOS4	.0258	.0107	.0464	.0208	.0247	.0300	.0519*	.0364	-.0087	.0450
MPLOA1	.0407	.0238	.0665**	.0271	.0429	.0461	.0684**	.0631*	.0080	.0680
MPLOA2	.0454	.0287	.0712**	.0324	.0458	.0513*	.0726**	.0665*	.0127	.0688
MPLOA3	.0541*	.0387	.0774**	.0423	.0520*	.0605*	.0821**	.0741**	.0189	.0710*
MPLOA4	.0645*	.0505*	.0846**	.0545*	.0588*	.0714**	.0936**	.0831**	.0268	.0745*

Noise	MANNOYB	S084CZ	M35Z	V12Z	V37Z	FACTOR 4	FACTOR 9	R36U	S084CZH	R14GAS
MPF0S1	-.0383	-.0547*	-.0126	-.0482	-.0220	-.0394	-.0217	.0065	-.0726**	-.0146
MPF0S2	-.0134	-.0306	.0143	-.0242	-.0027	-.0126	.0081	.0295	-.0558*	.0070
MPF0S3	.0264	.0140	.0432	.0178	.0278	.0282	.0517*	.0573*	-.0168	.0559
MPF0S4	.0609*	.0512*	.0668**	.0563*	.0543*	.0621*	.0874**	.0803**	.0174	.0990**
MPF0A1	.0051	-.0103	.0232	-.0064	.0155	.0034	.0209	.0359	-.0272	.0478
MPF0A2	.0227	.0066	.0427	.0108	.0288	.0227	.0416	.0524*	-.0140	.0658
MPF0A3	.0508*	.0383	.0649*	.0402	.0496*	.0526*	.0754**	.0753**	.0071	.0876*
MPF0A4	.0671**	.0558*	.0776**	.0594*	.0616*	.0703**	.0947**	.0893**	.0199	.0985**
MPF5S1	.0080	-.0025	.0166	.0059	.0087	.0041	.0265	.0222	-.0308	.0463
MPF5S2	.0082	-.0018	.0147	.0079	.0084	.0041	.0263	.0186	-.0282	.0512
MPF5S3	.0124	.0027	.0171	.0124	.0122	.0082	.0300	.0237	-.0257	.0538
MPF5S4	.0363	.0273	.0381	.0382	.0309	.0344	.0585*	.0481	-.0062	.0717*
MPF5A1	.0287	.0160	.0419	.0209	.0305	.0275	.0499	.0507	-.0121	.0684
MPF5A2	.0329	.0205	.0448	.0262	.0335	.0322	.0552*	.0553*	-.0092	.0727*
MPF5A3	.0377	.0253	.0481	.0314	.0377	.0371	.0597*	.0608*	-.0071	.0757*
MPF5A4	.0596*	.0486	.0665**	.0560*	.0538*	.0612*	.0858**	.0825**	.0091	.0860*
MPF1S1	-.0050	-.0181	.0102	-.0087	-.0006	-.0088	.0012	.0225	-.0253	.0229
MPF1S2	-.0179	-.0315	-.0069	-.0174	-.0125	-.0244	-.0148	-.0094	-.0314	.0334
MPF1S3	-.0174	-.0309	-.0068	-.0168	-.0121	-.0241	-.0149	-.0091	-.0313	.0318
MPF1S4	-.0174	-.0286	-.0073	-.0147	-.0150	-.0230	-.0124	-.0094	-.0279	.0261
MPF1A1	-.0358	-.0518*	-.0132	-.0419	-.0226	-.0391	-.0321	.0018	-.0498*	-.0065
MPF1A2	-.0344	-.0503*	-.0119	-.0406	-.0215	-.0375	-.0304	.0035	-.0488	-.0058
MPF1A3	-.0341	-.0499*	-.0122	-.0402	-.0212	-.0375	-.0310	.0041	-.0485	-.0078
MPF1A4	-.0310	-.0431	-.0107	-.0345	-.0228	-.0331	-.0246	.0057	-.0417	-.0127
NUE0S1	.1829**	.1872**	.1463**	.1886**	.1515**	.1840**	.2074**	.1418**	.1355**	.2036**
NUE0S2	.1808**	.1862**	.1426**	.1873**	.1494**	.1816**	.2053**	.1362**	.1361**	.2083**
NUE0S3	.1780**	.1847**	.1409**	.1833**	.1463**	.1788**	.2041**	.1328**	.1354**	.2124**
NUE0S4	.1611**	.1627**	.1364**	.1613**	.1343**	.1623**	.1912**	.1245**	.1137**	.2048**
NUE0A1	.1712**	.1737**	.1399**	.1764**	.1425**	.1741**	.1995**	.1412**	.1115**	.1683**
NUE0A2	.1677**	.1713**	.1352**	.1739**	.1390**	.1705**	.1966**	.1346**	.1101**	.1722**
NUE0A3	.1649**	.1688**	.1343**	.1697**	.1365**	.1677**	.1954**	.1312**	.1084**	.1767**
NUE0A4	.1443**	.1447**	.1250**	.1434**	.1217**	.1470**	.1768**	.1199**	.0883**	.1689**
NUM0S1	.1847**	.1930**	.1494**	.1892**	.1512**	.1881**	.2142**	.1404**	.1507**	.2185**
NUM0S2	.1836**	.1923**	.1465**	.1894**	.1498**	.1864**	.2120**	.1338**	.1499**	.2222**
NUM0S3	.1794**	.1856**	.1474**	.1835**	.1468**	.1822**	.2109**	.1322**	.1413**	.2252**
NUM0S4	.1606**	.1607**	.1411**	.1612**	.1324**	.1633**	.1951**	.1201**	.1136**	.2097**
NUM0A1	.1809**	.1861**	.1530**	.1843**	.1486**	.1868**	.2156**	.1465**	.1314**	.1917**
NUM0A2	.1775**	.1835**	.1473**	.1826**	.1450**	.1827**	.2119**	.1373**	.1281**	.1937**
NUM0A3	.1713**	.1749**	.1458**	.1744**	.1409**	.1763**	.2077**	.1345**	.1183**	.1947**
NUM0A4	.1465**	.1460**	.1309**	.1458**	.1220**	.1504**	.1830**	.1172**	.0906**	.1764**

Noise	MANNOYB	S084CZ	M35Z	V12Z	V37Z	FACTOR 4	FACTOR 9	R36U	S084CZH	R14GAS
NUM5S1	.1650**	.1646**	.1455**	.1626**	.1403**	.1697**	.1997**	.1451**	.1150**	.1954**
NUM5S2	.1632**	.1623**	.1446**	.1604**	.1389**	.1676**	.1977**	.1423**	.1126**	.1951**
NUM5S3	.1610**	.1605**	.1437**	.1575**	.1366**	.1654**	.1964**	.1383**	.1127**	.1990**
NUM5S4	.1507**	.1484**	.1384**	.1464**	.1273**	.1547**	.1866**	.1243**	.1026**	.1964**
NUM5A1	.1591**	.1555**	.1457**	.1556**	.1368**	.1654**	.1962**	.1463**	.0990**	.1741**
NUM5A2	.1570**	.1531**	.1445**	.1531**	.1352**	.1631**	.1938**	.1433**	.0971**	.1739**
NUM5A3	.1538**	.1502**	.1425**	.1493**	.1321**	.1598**	.1915**	.1383**	.0961**	.1767**
NUM5A4	.1396**	.1357**	.1322**	.1339**	.1196**	.1448**	.1772**	.1220**	.0844**	.1707**
NUM1S1	.1484**	.1464**	.1318**	.1448**	.1280**	.1522**	.1814**	.1337**	.0934**	.1762**
NUM1S2	.1467**	.1448**	.1301**	.1431**	.1265**	.1502**	.1794**	.1313**	.0922**	.1759**
NUM1S3	.1436**	.1414**	.1276**	.1397**	.1243**	.1469**	.1759**	.1286**	.0892**	.1741**
NUM1S4	.1395**	.1352**	.1257**	.1360**	.1211**	.1426**	.1715**	.1242**	.0817**	.1668**
NUM1A1	.1483**	.1439**	.1356**	.1438**	.1291**	.1532**	.1826**	.1383**	.0852**	.1634**
NUM1A2	.1477**	.1432**	.1352**	.1431**	.1285**	.1525**	.1820**	.1373**	.0848**	.1637**
NUM1A3	.1446**	.1397**	.1329**	.1398**	.1263**	.1493**	.1787**	.1343**	.0820**	.1627**
NUM1A4	.1384**	.1328**	.1278**	.1338**	.1210**	.1426**	.1716**	.1281**	.0739**	.1537**
NUM2S1	.1390**	.1364**	.1300**	.1328**	.1200**	.1442**	.1758**	.1232**	.0912**	.1809**
NUM2S2	.1390**	.1364**	.1300**	.1328**	.1200**	.1442**	.1758**	.1232**	.0912**	.1809**
NUM2S3	.1337**	.1310**	.1249**	.1271**	.1161**	.1382**	.1689**	.1183**	.0865**	.1761**
NUM2S4	.1327**	.1286**	.1254**	.1268**	.1148**	.1372**	.1687**	.1164**	.0836**	.1762**
NUM2A1	.1355**	.1301**	.1337**	.1278**	.1173**	.1423**	.1759**	.1228**	.0813**	.1729**
NUM2A2	.1355**	.1301**	.1337**	.1278**	.1173**	.1423**	.1759**	.1228**	.0813**	.1729**
NUM2A3	.1303**	.1245**	.1291**	.1222**	.1134**	.1366**	.1695**	.1179**	.0767**	.1689**
NUM2A4	.1285**	.1223**	.1271**	.1208**	.1118**	.1343**	.1672**	.1165**	.0731**	.1654**
NUM3S1	.0951**	.0840**	.1170**	.0794**	.0848**	.1041**	.1356**	.0872**	.0713**	.1675**
NUM3S2	.0951**	.0840**	.1170**	.0794**	.0848**	.1041**	.1356**	.0872**	.0713**	.1675**
NUM3S3	.0855**	.0751**	.1071**	.0690**	.0775**	.0935**	.1234**	.0783**	.0663**	.1613**
NUM3S4	.0786**	.0680**	.1034**	.0621*	.0702**	.0868**	.1176**	.0714**	.0626*	.1602**
NUM3A1	.0716**	.0583*	.0994**	.0544*	.0671**	.0809**	.1135**	.0695**	.0461	.1451**
NUM3A2	.0716**	.0583*	.0994**	.0544*	.0671**	.0809**	.1135**	.0695**	.0461	.1451**
NUM3A3	.0614*	.0480	.0898**	.0436	.0592*	.0697**	.1009**	.0600*	.0390	.1373**
NUM3A4	.0520*	.0392	.0828**	.0337	.0507*	.0605*	.0919**	.0527*	.0329	.1315**

Significance levels for overly liberal simple random sampling assumptions are:
* - Signif. LE .05   ** - Signif. LE .01   (2-tailed)

APPENDIX D: ACOUSTICAL SURVEY DATA

Table 16 summarizes the acoustical survey data that are available for estimating the noise indices used in the social survey analysis. The data are presented by site and, within site, by the stratum to which they belong. The three strata are defined by the expected frequency of booms with the lowest strata being weekend periods. The highest of the three strata is defined as the military exercise periods for four of the six sites in Region A and as the weekday, daytime periods for Region B.

The table does not include counts of noise events that were accumulated by the BEAR but later judged to not be boom events. The number of boom and non-boom entries were reported for test measurements made over an approximately one-month test period for four types of BEARs. For the BEAR that was most similar to the BEARs used in Region B, there were approximately twice as many non-boom events as boom events accumulated by the BEAR (Wyle, 1996b; Appendix B results for BEAR 4004).

The voltage files, times at which noise events were recorded, and logs of contacts with the BEARs were examined to determine when the BEARs were operating. For Region A it was concluded that it was possible to accurately determine when a BEAR had been operating for complete 24-hour periods, but it was not possible to make accurate determinations as to the number of hours of operation on days when there were less than 24-hours of operation. For Region B, determinations could be made to the closest hour.

Table 16 gives the number of hours in the six months preceding the beginning of the social survey during which the BEARs were judged to be operational. As indicated above, Region A sites are only considered to be operational when they were up for complete 24-hour periods. The percent of the six-month period that was measured is given in the next line. The relatively low percentages for some sites in Phase I are partially due to the fact that the BEARs were not installed at the sites until part way through the six-month period (see Table 11 for installation dates).

Table 16: Sonic boom noise data accumulated in each social survey community

Sample strata	Phase I: Region A						Phase II: Region A						Phase III: Region B							
	A-6	A-5	A-4	A-3	A-2	A-1	A-6	A-5	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4	B-3	B-2	B-1
Hours of noise monitoring in the six-month pre-survey period (each of the 6-month periods consists of 183 days (4,392 hours))																				
Strata 1:(Highest)			1752	888	1440	1344			648	552	696	1416	1677	1703	1665	1618	1411	1668	1658	1703
Strata 2: (Inter.)	600	576	288	96	264	480	1008	960	264	384	1296	1392	1419	1441	1407	1326	1047	1369	1408	1441
Strata 3: (Weekend)	240	216	768	384	696	720	336	384	264	432	768	1104	1248	1248	1183	1170	806	1123	1248	1248
Total (3 strata)	840	792	2784	1368	2400	2544	1344	1344	1176	1368	2760	3912	4344	4392	4255	4114	3264	4160	4314	4392
Percentage of hours monitored in six-month pre-survey period																				
Strata 1:(Highest)			77.66	39.36	63.83	59.57			45.76	38.98	49.15	100	98.47	100	97.77	95.01	82.85	97.94	97.36	100
Strata 2: (Inter.)	19.08	18	32.43	10.81	29.73	54.05	32.06	30.53	15.28	22.22	75	80.56	98.47	100	97.64	92.02	72.66	95	97.71	100
Strata 3: (Weekend)	19.23	17	61.54	30.77	55.77	57.69	26.92	30.77	21.15	34.62	61.54	88.46	100	100	94.79	93.75	64.58	89.98	100	100
Total (3 strata)	19.13	18	63.39	31.15	54.64	57.92	30.6	30.6	26.78	31.15	62.84	89.07	98.91	100	96.88	93.67	74.32	94.72	98.22	100
Number of days upon which monitoring occurred in the six-month pre-survey period																				
Strata 1:(Highest)			73	37	60	57			27	23	29	59	130	131	129	126	119	131	129	131
Strata 2: (Inter.)	25	24	12	4	11	20	42	40	11	16	54	58	130	131	129	128	114	131	129	131
Strata 3: (Weekend)	10	9	32	16	29	30	14	16	11	18	32	46	52	52	50	49	37	47	52	52
Total (3 strata)	35	33	117	57	100	107	56	56	49	57	115	163	182	183	179	177	159	178	181	183
Number of sonic booms measured during monitoring periods in the six-month, pre-survey period																				
Strata 1:(Highest)			83	56	243	190			5	14	44	155	9	50	29	38	56	45	122	245
Strata 2: (Inter.)	17	8	4	8	16	14	4	2	11	3	25	77	0	1	0	1	0	0	0	2
Strata 3: (Weekend)	0	0	1	0	0	3	0	0	0	0	0	5	1	0	1	0	0	2	4	1
Total of 3 strata(%)	17	8	88	64	259	207	4	2	16	17	69	237	10	51	30	39	56	47	126	248
Hours measured before interviewing began (beginning before 6-month period but, for Phase II, after previous interviews concluded).																				
Total	840	792	6552	1368	4968	6576	1344	1344	1680	1464	3432	4656	4992	4927	4821	4756	3554	4611	4696	4987

NOTE: * The six-month period in this table ends the day before the first interview. The noise data used for the social survey was individualized for each respondent's previous six-month period and thus is slightly different.

* In Region A, Strata 1 is military exercise days. In Region B, Strata 1 is weekday daytime hours (06:00-19:00).

* In Region A, Strata 2 is non-exercise weekdays. In Region B, Stratum 2 is weekday night-time hours (19:00-06:00).

APPENDIX E: BOOM EVENT RATING METHOD

The BEAR measurement devices accumulated non-sonic boom events as well as sonic boom events. Each measured event was evaluated by an engineer who judged whether the event was a sonic boom. Events varied in the extent to which they resembled the shape that would be expected from a strong distinct sonic boom. Each noise event was scored from 0 to 5 by an acoustical engineer. The guidelines that were followed in scoring the booms have been previously described (Wyle, 1996a: 4-5) and are presented in Table 17. Events scored zero were assumed to not be sonic booms and were not included in further analyses. When booms were not given the same score for every characteristic the acoustical engineer's judgment was relied upon.

Although some booms were judged to have occurred on weekends, the scoring guidelines may have resulted in some otherwise similar noise events not being scored as booms because they occurred on weekends or during the 10-hour period that includes the night. These types of procedures could lead to an underestimation of the exposure from indistinct booms at these times.

Table 17: Sonic boom scoring guidelines

Characteristic	Range of scores to associate with values on characteristics		
	0 (Not boom)	1 to 3	4 and 5
Boom amplitude	< 0.2 psf	>0.2 - 0.5< psf	>0.5 psf
Duration	Unable to determine	> 120 to 180< msec	
Rise/fall	Very slow	Finite slope	Fast
Decay(from over to under pressure)	Ragged	Curved	Straight
Shape of signal	Irregular	Rounded (N or U)	Sharp (N or U)
Signal/noise ratio	Very low	Low	High
Symmetry of over and under pressures	None	Unequal	Equal
Time of day	20:00 to 06:00	06:00 to 20:00	
Time of week	Weekend	Weekday	

APPENDIX F: ANALYSES OF PAIRED ACOUSTICAL SURVEY SITES

Several different methods could be used to evaluate the accuracy of the noise estimates. Since measurements were not conducted on all days and since there is some random variation between houses within the same area, at least part of the measurement precision can be viewed as an exercise in estimating the sampling errors of the noise indices. This exercise is described in Appendix G. The other information on the accuracy of the noise data comes from two sources: (1) measurements of the same booms with co-located BEARs (i.e. with in a few feet of each other), (2) measurements of the same booms from nearby neighborhoods. These two sources could be analyzed to indicate the extent to which some BEARs were operating consistently and the extent to which normal field operating conditions in this study resulted in similar or different measurements at different locations within the same community.

As Table 18 indicates 14 pairs of BEAR measurements were available for analysis. Five of these were from co-located BEARs. Of the remaining 12, three come from study communities that could be paired with each other. One pair of Region A communities (A-5, A-6) that were located near each other generated two set of paired measurements. One set was produced during Phase I and one during Phase II. Six additional pairs came from the secondary microphone positions that were located near some of the primary microphones in Region B communities. For the Region B communities, only a small subarea within each community was included in the area from which respondents were sampled for the social survey.

Table 18: Information about noise measurements at paired sites

Information in row	Type of location													
	Nearby neighborhood/area sites									Co-located data sources				
Location	Region A (Phase)		Region B (Pair Identification #)							Regi on B	On-base test position			Obse rver
Comparison pair identifier>>	1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13	14
Description of pairs of noise measurement positions														
Primary position Identification	A-5	A-5	B-8	B-7	B-6	B-5	B-3	B-2	B-1	B-1	C-1 (#4004)			
Ancillary position identification	A-6	A-6	B-8a	B-7a	B-6a	B-5a	B-4	B-2a	B-1a	B-1b	C-2 4014	C-3 4021	C-4 2004	No mic.
Distance between positions (Miles)	7	7	1.5	1.5	1.2	1.1	1.4	0.6	2.6	one foot	one foot	one foot	one foot	20? feet
Type of ancillary position:	Std. Site	Std S.	Meas only	Meas only	Meas only	Meas only	Std. Site	Meas only	Meas only	Meas only	Meas only	Meas only	Meas only	Obse rver
Hours of simul-taneous measurement	360	1008	3622	1721	1976	3554	3535	2016	2107	3889	816	792	120	792

Information in row	Type of location													
	Nearby neighborhood/area sites									Co-located data sources				
Location	Region A (Phase)		Region B (Pair Identification #)							Regi on B	On-base test position			Obse rver
Comparison pair identifier>>	1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13	14
Number of booms measured at primary	3	1	12	41	19	31	50	55	114	188	22	22	8	19
Noise measurement results for Leq (Deviation of ancillary site from primary site (dB))														
Difference in LCeq	6.7	2.1	-3.4	-1.6	-1.2	0	0.4	0.2	0.8	0.3	-9.0	-2.6	0.8	-0.0
Difference in LAeq	3.2	0.1	-6.0	-2.1	-1.5	-0.2	3.8	1.5	-0.1	0.4				
Description of booms at primary site														
% of primary site booms at both sites	67	100	75	88	58	74	66	73	75	97	14	82	100	79
σ of all booms at primary(SELC)	4.6	-	3.2	4.9	7.1	7.4	7.0	6.4	7.2	6.4	7.4	7.0	4.9	7.2
σ of booms that match (SELC)	6.5	-	1.8	4.8	6.6	7.6	5.9	6.6	6.7	6.4	4.6	6.8	4.9	5.8
Results: Differences (Δ) between noise levels from individual events (SELC)														
σ (Std. Dev) of Δ	10.3	-	1.6	2.8	2.8	3.7	3.1	2.7	5.7	0.8	1.1	0.9	0.6	0.0
Mean Δ (difference)	6.3	3.0	-5	-1	-0	-0	-6	-1.2	-2	-1	1.1	0.9	-0.4	0.0
Mean absolute Δ	7.3	3.0	5.2	2.2	2	2.7	5.5	2.1	4.3	0.8	1.1	1.0	0.6	0.0
N matching booms	2	1	9	36	11	23	33	40	86	183	3	18	8	15
Results: Differences (Δ) between noise levels from individual events (SELA)														
σ (Std. Dev) of Δ	7.0	-	1.9	2.5	1.7	3.0	3.7	2.3	4.1	1.6	No A-weighted data			
Mean Δ (difference)	3.8	2.3	-6.5	2.5	0.4	-1.3	-9.3	-2.2	-1.4	-0.7				
Mean absolute Δ	4.9	2.3	6.5	2.7	1.5	2.7	9.3	2.7	3.5	1.3				
σ of all booms at primary	3.2	-	2.2	2.3	2.8	4.5	3.5	3.3	4.5	4.0				
σ of booms that match	4.1	-	2.0	2.5	2.6	4.0	4.3	3.0	4.5	4.1				

APPENDIX G: CALCULATION OF SAMPLING ERRORS FOR NOISE DATA

Other sections of this report have described the method for measuring and estimating the sonic boom exposure at each measurement site. This section considers the effect that measuring on a limited number of days has on the accuracy of the estimates of the sonic boom exposure at each measurement site. The sampling variability for estimating the noise exposure is especially important because it can strongly affect the strength of the relationship that is found in these data between residents' responses and measured noise exposure.

G.1 Overview of the structure of the noise measurement sample

The estimates of sampling errors are affected by the total number of hours of monitoring, the variability in the exposure over different days, and, for some assumptions, the percent of the hours measured during a defined period. The noise exposure was found to be very dissimilar in different time periods. In order to increase the precision of the estimates of noise exposure, three noise exposure strata are defined. The least exposure occurs in Stratum 3. Stratum 3 is defined as the 52 weekend days during the 6-month (183-day) pre-survey period. Stratum 1 has the highest exposure. For the sites in Region A for which aircraft exercise information was available, Stratum 1 is the days with exercises (94 during Phase I and 59 during Phase II). In Region B, Stratum 1 is the daytime weekday hours (06:00 to 19:00). Stratum 2, consists of the remaining weekday hours in both regions. The striking differences between the number of booms in each period are apparent from the distribution of the numbers of booms in different strata shown in the lower part of Table 16. For example, 16 of the twenty Stratum 3 (weekend) measurement periods recorded either one or no sonic boom during the weekend periods.

Table 16 summarizes the primary information about the amount of noise measurement at each site. The fourth line of Table 16 shows that the sites obtained between 792 and 4,392 hours of monitoring during the 4,392 hour (6-month) pre-survey period. The number of measurement hours in particular strata are shown in the table to vary from a low of 96 hours to a high of 1703 hours. The total numbers of sonic booms observed during these stratified measurement periods are, as previously noted, provided in the lower part of the table. Even during the highest exposure periods (Stratum 1), 8 of the 18 sites had 50 or less sonic boom events.

In the second panel of Table 16 the proportion of the target period that was sampled is seen to vary from 18% to 100% for sites as a whole and from 11% to 100% for individual sites/strata. It is not entirely clear whether the sampling errors should be calculated on the assumption that a 100% measurement program represents a sampling-error-free sample of the noise environment. If the respondent in fact averages exposures over a longer, but similar noise exposure period, then even the 6-month period should be considered as only a sample from a longer period. If respondents are very attentive to the six-month definition, then sampling errors should take into account not only the number of sampled hours but also the percentages of the hours that are shown in the table as being sampled. Even when the sampling errors have been calculated on the infinite noise period assumption here, the estimates for the fixed, 6-month period assumption would be reduced by only about 30% for sites where half of the time was measured and by about 38% at the sites where 62% of the time was measured.

One other factor needs to be considered in calculating sampling errors: the sampling units. The noise exposures during each hour of each day at a site in a particular stratum cannot be considered to be independent of each other. Especially during the daytime, sonic booms tend to cluster by days. The primary sample unit is thus considered to be days within each stratum. This results in the implicit assumption that the sonic boom activity is correlated only within days within strata but not between strata. Table 16 indicates that the noise exposure estimates are therefore based on measurements made on 33 to 183 study days at each site.

G.2 Calculation of sampling errors for noise data

The confidence intervals for the estimates of the noise environment at each site have been calculated with a technique that considers both the three strata for noise measurement periods and the observation that sonic boom events tend to be clustered by measurement day. The standard errors for this stratified clustered sample were calculated using the Taylor series expansion. Later estimates of sampling errors using the Jackknife technique yielded similar results for the two sites that were examined with the WESVAR sampling error computer program.

Standard errors have been calculated for the two equivalent noise level (L_{Ceq} and L_{Aeq}) metrics and for the six additional metrics that calculate the average noise level per sonic boom (SELA, SELC, PL(Peak), Pmax(all), Pmax(>0.5 psf), Pmax(>1.0 psf)). The standard errors were calculated for the four versions of each metric that are defined by the four levels of boom distinctiveness (described in Table 3). The confidence intervals were also calculated. For the Pmax-based measures the 95% confidence intervals were directly calculated, using the normal approximation, as the value of the standard error multiplied by 1.96. The remaining metrics are all based on logarithmic sums of the noise exposure data. For these metrics the standard errors of the antilogs of the noise exposure are calculated and expressed as confidence intervals in their antilogs, before being converted back to sound exposure expressed in decibels.

Table 19 presents the sampling errors for one noise metric, L_{Aeq}. The first panel expresses these sampling errors in antilogs. The second panel converts these standard errors and their associated confidence intervals into the familiar decibel units. The 95% confidence intervals for the estimates are less than 3 decibels in 2 instances, less than 5 decibels in a total of 6 instances, less than 13 decibels in 13 instances and cannot even be calculated under these assumptions in the remaining 7 instances. The confidence intervals in decibels show that the *upper* 95% confidence intervals are relatively small: within 2 decibels in 9 instances and within 4 decibels in 17 (all but 3) instances. The lower 95% percent confidence interval estimate is skewed by the large number of zero-exposure days that violate the assumptions of a normal distribution for the small numbers of cases observed here. The lower 95% confidence interval is so broad that it could not be estimated using this procedure in 7 of the 20 instances. The standard errors have also been converted into decibels and are labeled as 66% confidence intervals in the table.

The sizes of the sampling errors for the remaining noise metrics are represented by their coefficients of variation in Table 20. The coefficient of variation expresses the size of each standard error as a percentage of the quantity being estimated and thus gives an indication of the relative accuracy of the different estimates. Formally the coefficient of variation is the standard error of the estimate divided by the estimate (both expressed in antilogs). Each of the seven metrics is represented by four entries. The first includes all booms ("All"), the second, "2+" represents all booms with a rating of at least 2 on the distinctness scale (See Table 17), "3+" represents all booms with a rating of at least 3 on the distinctness scale, and "4+" includes only those booms with scores of 4 or 5 on the distinctness scale. An examination of these coefficients shows that there is no evidence that estimates are any more accurate for C-weighted than A-weighted indices. Estimates are slightly more precise for average values of SEL than for the values of Leq (A-weighted or C-weighted).

Table 19: Standard errors and confidence intervals for L_{Aeq} at each site/round

Statistic	Phase I: Region A (1993)						Phase II: Region A						Phase III: Region B							
	A-6	A-5	A-4	A-3	A-2	A-1	A-6	A-5	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4	B-3	B-2	B-1
Sampling estimates for LAeq expressed in antilogs																				
Estimate	167.38	471.46	1442.3	565.66	5542.9	15083	67.24	238.20	273.05	631.23	8713.6	14601	698.56	1505.3	676.82	895.92	2085.9	10266	5658.9	10921
Standard error	89.24	369.36	660.41	165.74	1362.2	5511.7	42.37	199.58	199.73	385.94	6796.4	6475.0	264.01	321.06	169.07	238.47	511.92	2748.2	907.80	1657.4
Estimated noise level and 95% confidence interval for LAeq expressed in decibels																				
Upper 95% confidence interval	25.34	30.78	34.37	29.50	39.14	44.13	21.77	27.99	28.23	31.42	43.43	44.36	30.85	33.29	30.04	31.35	34.90	41.95	38.71	41.51
Upper 66% confidence interval	24.09	29.25	33.23	28.64	38.39	43.14	20.40	26.41	26.75	30.07	41.91	43.24	29.83	32.62	29.27	30.55	34.15	41.14	38.17	41.00
Estimate of LAeq	22.24	26.73	31.59	27.53	37.44	41.78	18.28	23.77	24.36	28.00	39.40	41.64	28.44	31.78	28.30	29.52	33.19	40.11	37.53	40.38
Lower 66% confidence interval	18.93	20.09	28.93	26.02	36.21	39.81	13.96	15.87	18.65	23.90	32.83	39.10	26.38	30.73	27.06	28.18	31.97	38.76	36.77	39.67
Lower 95% confidence interval	.	.	21.70	23.82	34.58	36.31	.	.	.	.	.	32.81	22.58	29.42	25.38	26.32	30.34	36.88	35.89	38.85

Note: The noise data in this table are for the six months that end with the first day of the study period in each round. The individualized respondent exposures are slightly different. For example, at one very low exposure site (B6 in Phase II) the beginning study-period exposure of 18 (dB, L_{Aeq}) increased to 22 for the first respondent because of a strong boom in the first few days of the study period.

Table 20: Coefficients of variation for 7 noise metrics at 4 levels of distinctness at each site/round

Metric (Distinctness) [See Table 17)		Phase I: Region A						Phase II: Region A						Phase III: Region B							
		A-6	A-5	A-4	A-3	A-2	A-1	A-6	A-5	A-4	A-3	A-2	A-1	B-8	B-7	B-6	B-5	B-4	B-3	B-2	B-1
LAeq	All	.53	.78	.46	.29	.25	.37	.63	.84	.73	.61	.78	.44	.38	.21	.25	.27	.25	.27	.16	.15
	2+	.49	.78	.47	.29	.27	.37	.63	.84	.56	.61	.79	.45	.49	.24	.33	.38	.27	.30	.17	.16
	3+	.43	.78	.50	.31	.28	.37	.63	.84	.56	.61	.79	.47	.56	.30	.37	.39	.30	.30	.19	.17
	4&5	.45	.82	.52	.38	.34	.42	.63	.84	.70	.65	.82	.48	.51	.42	.48	.54	.39	.34	.21	.19
LCeq	All	.56	.88	.40	.34	.30	.32	.70	.72	.57	.70	.54	.27	.44	.37	.37	.44	.43	.38	.19	.15
	2+	.51	.88	.41	.34	.32	.32	.70	.72	.53	.70	.55	.28	.52	.29	.40	.47	.44	.40	.19	.16
	3+	.48	.88	.42	.36	.30	.32	.70	.72	.53	.70	.59	.28	.55	.37	.43	.50	.46	.41	.19	.16
	4&5	.54	.88	.45	.41	.38	.35	.70	.72	.59	.72	.61	.29	.51	.49	.49	.59	.55	.47	.21	.17
SEL(A)(Average)	All	.12	.75	.38	.19	.18	.36	.24	.47	.68	.38	.70	.41	.12	.06	.09	.14	.10	.06	.10	.10
	2+	.14	.75	.40	.19	.21	.36	.24	.47	.36	.38	.81	.41	.10	.08	.11	.24	.12	.06	.11	.11
	3+	.17	.75	.44	.23	.24	.34	.27	.47	.36	.38	.81	.42	.09	.09	.11	.18	.14	.07	.12	.12
	4&5	.25	.79	.45	.24	.29	.37	.27	.47	.40	.38	.84	.43	.13	.10	.12	.24	.21	.10	.14	.11
SEL(C)(Average)	All	.26	.87	.31	.30	.25	.30	.47	.21	.43	.47	.45	.23	.14	.24	.26	.37	.36	.33	.14	.11
	2+	.28	.87	.31	.30	.28	.29	.47	.21	.08	.47	.55	.22	.13	.20	.20	.41	.38	.34	.13	.10
	3+	.34	.87	.34	.33	.28	.28	.41	.21	.08	.47	.58	.22	.12	.24	.20	.35	.39	.34	.13	.10
	4&5	.44	.88	.37	.33	.32	.29	.41	.21	.10	.45	.61	.23	.14	.27	.19	.34	.45	.36	.14	.08
PL (average peak)	All	.24	.90	.42	.27	.26	.36	.34	.17	.67	.47	.69	.38	.08	.08	.18	.28	.24	.14	.17	.14
	2+	.27	.90	.42	.27	.30	.36	.34	.17	.20	.47	.79	.37	.05	.11	.17	.37	.27	.17	.18	.14
	3+	.31	.90	.46	.30	.31	.35	.34	.17	.20	.47	.79	.38	.05	.13	.18	.32	.30	.18	.18	.14
	4&5	.40	.91	.48	.29	.36	.36	.34	.17	.21	.45	.82	.38	.06	.17	.17	.36	.39	.23	.20	.11
Pmax with three different lower limits																					
All psf	All	.11	.55	.09	.13	.09	.12	.21	.15	.16	.25	.14	.09	.10	.07	.15	.14	.13	.14	.06	.06
	2+	.11	.55	.10	.13	.10	.12	.21	.15	.11	.25	.22	.09	.07	.08	.10	.19	.14	.15	.06	.05
	3+	.18	.55	.11	.16	.10	.11	.20	.15	.11	.25	.25	.08	.07	.09	.09	.15	.15	.14	.06	.05
	4&5	.22	.58	.12	.19	.13	.11	.20	.15	.12	.23	.28	.09	.10	.15	.09	.17	.19	.16	.06	.04
psf=> 0.5	All	.13	.62	.08	.17	.10	.10	.10	.15	.16	.09	.24	.08	.05	.07	.07	.14	.14	.13	.06	.05
	2+	.13	.62	.08	.17	.11	.10	.10	.15	.11	.09	.24	.08	.05	.07	.07	.13	.15	.14	.06	.05
	3+	.13	.62	.10	.17	.10	.10	.10	.15	.11	.09	.26	.08	.05	.09	.08	.14	.15	.14	.06	.04
	4&5	.00	.62	.13	.17	.13	.11	.10	.15	.12	.09	.28	.09	.03	.15	.09	.17	.19	.15	.06	.04
psf=> 1.0	All	.00	.00	.09	.17	.11	.11	.00	.00	.00	.16	.26	.08	.00	.00	.08	.12	.22	.14	.05	.03
	2+	.00	.00	.09	.17	.12	.11	.00	.00	.00	.16	.26	.08	.00	.00	.08	.12	.22	.14	.05	.04
	3+	.00	.00	.09	.17	.11	.11	.00	.00	.00	.16	.30	.09	.00	.00	.08	.12	.22	.14	.05	.04
	4&5	.00	.00	.10	.17	.13	.12	.00	.00	.00	.16	.30	.09	.00	.00	.08	.12	.26	.15	.05	.04

APPENDIX H: SURVEYS COMPARED TO WESTERN SONIC BOOM SURVEY

This appendix provides a guide to the data from 19 of the 20 social surveys that are compared with the western sonic boom survey. Most of these comparisons are made in Chapter 6. The remaining survey, the Oklahoma City sonic boom survey, is described in Appendix I.

The surveys are first listed. Next, basic information about each survey's social survey and noise measurement survey is presented in two tables. Finally, the wording of each social survey question and, in some cases, additional information is presented.

H.1 Listing of surveys

The 20 surveys that are compared to the western sonic boom survey are listed below together with a survey identification number. These survey identification numbers come from a catalog of social surveys (Fields, 1991). That catalog contains a more complete description of each survey. The list is ordered by the unique, three-digit serial number which forms the second part of the survey identification number. Most serial numbers from 001 to 187 were assigned in ascending order by year of the social survey.

USA-012	1964 Oklahoma City Sonic Boom Study
USA-022	1967 U.S.A. Four-Airport Survey (Phase I of Tracor Survey)
UKD-024	1967 Heathrow Aircraft Noise Study (Second Heathrow Survey)
USA-032	1969 U.S.A. Three-Airport Survey (Phase II Tracor Survey)
USA-044	1970 U.S.A. Small City Airports (Small City Tracor survey)
SWI-053	1971 Swiss Three-City Noise Survey
USA-082	1973 Los Angeles Airport Night Study
UKD-130	1976 Heathrow Concorde Noise Survey
CAN-168	1978 Canadian Four-Airport Survey
USA-170	1978 U.S. Army Impulse Noise Survey
USA-203	1979 Burbank Aircraft Noise Change Study
UKD-238	1984 Glasgow Combined Aircraft/Road Traffic Survey
FRA-239	1984-1986 French Combined Aircraft/Road Traffic Survey
NET-240	1984 Schiphol Combined Aircraft/Road Traffic Survey
UKD-242	1982 United Kingdom Aircraft Noise Index Study (ANIS study)
FRA-252	1982-83 CEC Impulse Noise Field Study (France)
GER-253	1982-83 CEC Impulse Noise Field Study (Germany)
IRE-254	1982-83 CEC Impulse Noise Field Study (Ireland)
NET-255	1982-83 CEC Impulse Noise Field Study (Netherlands)
NOR-311	1989 Oslo Airport Survey

H.2 Data for comparisons to the western boom survey

The dose/response curve comparisons in Chapter 6 are based on data that have been adjusted using the best available information to match the acoustical and social survey conditions present in the western boom survey. This process was considerably simplified for social survey questions by the fact that the sonic boom survey included four general annoyance questions as well as activity interference questions that had been drawn from these previous surveys. The noise metric comparisons were simplified by the fact that the sonic boom survey calculated several alternative noise metrics.

Table 21 describes the social survey data for 21 social survey data sets.. The 1978 Toronto survey provided both aircraft and road traffic noise reactions and therefore is counted as providing a second data set for the total of 21 data sets in the table. In the first columns of Table 21 each study is identified by a title as well as a unique study number drawn from a catalog of community noise reaction surveys (Fields, 1991). The "Unit of analysis" column shows that 18 of the 21 data sets consist of individual interviews ("I") while the remaining 6 have only summary scores for groups of interviews ("G"). Two indicators of the size of the survey are provided, numbers of interviews and numbers of study sites. There are a total of 39,928 interviews. The studies included a total of 775 study sites. Large numbers of study sites are preferable because they tend to increase the precision of estimates of relationships and reduce the likelihood that noise-level effects will be confounded with the effects of other study site characteristics.

The noise reaction question that is used for the comparisons is described in the next columns. The "Type of question" column indicates whether respondents were offered verbal ("Verb") or numeric ("Numb") labels for choosing between the specified number of alternative answers (from 2 to 11). The comparisons that are graphed in the text are based on the percentages of the respondents choosing relatively high annoyance categories. The definition of "high" annoyance in the next column is defined by the verbal label chosen by respondents as well as by the number of high-annoyance categories relative to all categories offered. The last column's "Comments" note unusual characteristics of the particular survey's questions or potentially important differences between the survey and the western boom survey characteristics.

Table 21: Descriptions of social survey data in 21 data sets

Identification				Data units			Noise reaction measure used in comparison in this report		Comments
#	Study title	Catalog ID#	Noise source	Unit of analysis I=Individual G=group	Number of interviews (Max)	Number of sites (approx)	Type of question	High annoyance definition	
1.	Oklahoma City	USA-012	Sonic boom	G	8556	3	Interferences Verb-4	2/4 "moderately, very"	Annoyance is measured by degree of reaction to each of 6 interferences.
2.	LAX Nighttime	USA-082	Aircraft	I	1411	2	Verb-5	2/5 "very, extremely"	
3.	Burbank Change	USA-203	Aircraft	I	953	4	Verb-5	2/5 "very, extremely"	
4.	US Army Impulse	USA-170	Artillery	G	1904	8	Verb-2+4	2/5 "very, extremely"	A two-part annoyance question starts with an "any annoyance" filter unlike all other questions.
5.	CEC/84 Glasgow	UKD-238	Aircraft	I	605	6	Verb-4	1/4 "Very much"	Annoyance question follows other aircraft noise annoyance questions.
6.	CEC/84 French	FRA-239	Aircraft	I	570	9	Verb-4	1/4 "beaucoup"	The questions used for the analysis are the same as in UKD-238.
7.	CEC/84 Schiphol	NET-240	Aircraft	I	581	9	Verb-4	1/4 "heel erg" "very much"	The questions used for the analysis are the same as in UKD-238.
8.	1982 Heathrow	UKD-242	Aircraft	I	413	10	Verb-4	1/4 "very much"	
9.	Swiss 3-Airport	SWI-053	Aircraft	G	3940	(25 categories)	Numb-11	3/11	The upper scale label is very strong (""Unerträgliche Störung" "unacceptably disturbing").
10.	1978 Toronto	CAN-168	Aircraft	I	617	53	Verb-5 (Bipolar-9)	2/5 "considerably, extremely"	One high-noise site with unusually low annoyance scores was not available for this analysis (Hall, Taylor, Birnie, and Palmer,1981: 1695)
11.	1978 Toronto	CAN-168	Road	I	597	53	Verb-5 (Bipolar-9)	2/5 "considerably, extremely"	
12.	1982 Fornebu	NOR-311	Aircraft	I	3322	15	Verb-4	1/4 "very" "svært"	The annoyance question specifies noise heard inside the house.
13.	1967 Heathrow	UKD-024	Aircraft	I	4650	251	Verb-4	1/4 "very much"	
14.	1976 Heathrow	UKD-130	Aircraft	I	2563	44	Verb-4	1/4 "very much"	
15.	USA-4-Airport	USA-022	Aircraft	I	3499	61	Numb-5	1/5 "extremely"	
16.	USA-3-Airport	USA-032	Aircraft	I	2899	187	Numb-5	1/5 "extremely"	
17.	USA 2-Airport	USA-044	Aircraft	I	1954	24	Numb-5	1/5 "extremely"	
18.	CEC/Imp French	FRA-252	Impulse	I	451	10	Verb-4	1/4"very" "très"	
19.	CEC/Imp German	GER-253	Impulse	I	248	18	Verb-4	1/4"very" "sehr"	
20.	CEC/Imp Dutch	NET-255	Impulse	I	338	18	Verb-4	1/4"very" "erg"	
21.	CEC/Imp Ireland	IRE-254	Impulse	I	454	18	Verb-4	1/4 "very"	

All acoustical data were adjusted to a standard nominal condition used for the western boom survey. Acoustical data are normalized for 24-hour periods at outdoor positions on the noisiest side of a dwelling away from reflecting surfaces. The noise metrics are either L_{Aeq}, L_{Ceq}, or DNL.

Table 22 describes the noise metrics that were available in the original data sets as well as any steps that were needed for manipulating those data to match the nominal noise conditions. The check in the column labeled "Best published data" indicates that most studies included estimates of L_{Aeq} or DNL in the original, published data set. The remaining columns indicate unusual characteristics of the noise data or steps that were required to convert the published noise data to estimates for the standard nominal conditions.

Table 22: Information about noise exposure indices for the noise environments in the 21 data sets

Identification				Best published data to estimate L_{Aeq24} or DNL_a	Additional notes on the original noise data set	Method for estimating L_{Aeq24} and DNL for nominal conditions from original noise data set
#	Study title	Catalog ID	Noise source	(✔=L_{Aeq} or DNL)		[Source of adjustment method: (S) Study-specific recommendation for this data set (G) General procedure not specifically cited for this data set]
1.	Oklahoma City	USA-012	Sonic boom	Distance & Δp_o for each flight	Flights were tightly restricted to a standard sonic boom test flight track.	See Appendix I
2.	LAX Nighttime	USA-082	Aircraft	✔	The method for estimating DNL is not described in publications.	
3.	Burbank Change	USA-203	Aircraft	✔	Unattended recordings of high noise events were screened for duration before summing SEL to estimate DNL.	No adjustments. It is assumed that the previous week is the same as the previous year.
4.	US Army Impulse	USA--170	Artillery	✔ L_{Ceq}	The estimates for the year are based on a prediction model and 4 to 67 days of monitoring with events screened for wind speed, duration (<2 sec) and listening to analog recordings.	
5.	CEC/84 Glasgow	UKD-238	Aircraft	✔	Events above 57 dB(A)were measured for about 10 days and identified as aircraft from tower logs.	✔
6.	CEC/84 French	FRA-239	Aircraft	✔	Attended measurements of types of aircraft and operations are combined with airport records for 3 previous months.	No adjustments are introduced even though measurements were made on both roofs and the ground.
7.	CEC/84 Schiphol	NET-240	Aircraft	✔	Measurements of aircraft types were combined with air traffic data from the previous 28 days.	✔
8.	Swiss 3-Airport	SWI-053	Aircraft	NNI is based on 15-dB PNL classes	Measurements made on railings of 2nd floor balconies. Data are reported in 4 (15-dB) categories of PNL were used to estimate NNI	NNI (16h) is estimated from PNL Ldn= NNI(16h) • 0.760 + 31.53 (S) Leq = Ldn - 1.8 (G)
9.	1978 Toronto	CAN-168	Aircraft	✔	Estimates come from the INM 1.2 noise prediction program.	✔
10.	1978 Toronto	CAN-168	Aircraft	✔		✔
11.	1982 Heathrow	UKD-242	Aircraft	✔	Measurements for different operating conditions were combined with airport records for the 3 summer months.	✔
12.	1982 Fornebu	NOR-311	Aircraft	EFN	The time-of-day weighted index EFN is predicted for the study period using INM-2 with tower logs and radar track data.	Leq=Ldn=EFN-0.8 (S)
13.	1967 Heathrow	UKD-024	Aircraft	N, L (mean peak, dB(A))	The undefined duration measure in the data set (not time above 80 PNdB) is not used in this analysis.	L= L(PNdB)-13 (G) D= 99.3 - 0.914 • L (G) Leq = 10 lg10 {[N• $0^{(L/10)}$ • (D/2)]/(24•60•60)}
14.	1976 Heathrow	UKD-130	Aircraft	Duration, N, L (mean peak, dB(A)) [All for 12-hour days]	Duration was estimated with a model developed with data collected at Heathrow. Ratios of day/night traffic come from another survey (UKD-024).	L= L(PNdB) - 13 (G) Ne/hr = .75 Nd/hr (12 hr day) Nn/hr = .25 Nd/hr (12 hr day) Leq (for each period t) = 10 lg10 {[Nt • $10^{(L/10)}$ • (D/2)]/(t•60•60)}
15.	USA-4-Airport	USA-022	Aircraft	N, L (mean peak, dB(A))	The duration estimation equation is the average of landing and take-off prediction equations from the first phase of this study.	L= L(PNdB)-13 (G) D = 73.1 - 0.646 • L Leq = 10 lg10 {[N•$10^{(L/10)}$ • (D/2)]/(24•60•60)}
16.	USA-3-airport	USA-032	Aircraft	N, L (mean peak, dB(A))	(See USA-022)	(See USA-022)
17.	USA 2-airport	USA-044	Aircraft	N, L (mean peak, dB(A))	(See USA-022)	(See USA-022)

Identification				Best published data to estimate L_{Aeq24} or DNL_h	Additional notes on the original noise data set	Method for estimating L_{Aeq24h} and DNL for nominal conditions from original noise data set [Source of adjustment method: (S) Study-specific recommendation for this data set (G) General procedure not specifically cited for this data set]
#	Study title	Catalog ID	Noise source	(✔=L_{Aeq} or DNL)		
18.	CEC/Imp French	FRA-252	Impulse	✔		$L = L_{(1\text{-meter-to facade})} - 3.0$ (G)
19.	CEC/Imp German	GER-253	Impulse	✔		$L = L_{(1\text{-meter-to facade})} - 3.0$ (G)
20.	CEC/Imp Dutch	NET-255	Impulse	✔		$L = L_{(1\text{-meter-to facade})} - 3.0$ (G)
21.	CEC/Imp Ireland	IRE-254	Impulse	✔		$L = L_{(1\text{-meter-to facade})} - 3.0$ (G)

H.3 Noise reaction questions and additional information for selected studies

This section quotes the questions used for the survey comparisons used in this report. No description beyond that already provided in Tables 21 and 22 is given for the surveys that have been described in a recent publication (Fields, 1996b) or for the Oklahoma City survey that is described in Appendix I. Additional information is available about other surveys in the noise survey catalog (Fields, 1991).

CEC-1984 CEC aircraft/road traffic surveys (UKD-238, FRA-239, NET-240)

UKD-238: Annoyance question:
"Q19a Taking all things into account, how much would you say the noise from aircraft around here bothers or annoys you? (SHOW CARD B)"
[Card B has four phrases: "Very much, Moderately, A little, Not at all."]

FRA-239: Annoyance question:
[IN FRENCH]
"Q19a Globalement, en prenant tout en compte à quel point diriez-vuos que le bruit du trafic aérien ici vous gène? *(MONTRER CARTE D)* (Beaucoup, Assez, Peu, Pas du tout)"
(For English translation see UKD-238)

NET-240: Annoyance question:
[IN DUTCH]
"Q26 ...Wanneer u alles tesamen neemt, in welke mate hindert vliegtuiglawaai u dan hier? Geeft u uw antwoord maar aan de hand van deze kaart. Heel erg, tamelijk, een beetje, helemaal niet."
(For English translation see UKD-238)

CEC-1984 CEC impulse noise surveys (FRA-252, GER-253, IRE-254, NET-255)

FRA-252: Annoyance question:

"Q20 ..could you say when you are indoors at home to what extent would you say the ..(name of impulse noise source).. noise is annoying? (Show card) very annoying, annoying, a little annoying, or not annoying. "

[IN FRENCH]

"Q20 Maintenant, pourriez-vous nous dire si, quand vous êtes chez vous, à l'intérieur, le bruit .... ast : *(Carta C)*

- très gênant, - gênant, - un peu gênant, - pas gênant, - sans objet, - ne sait pas, - non rêponse"

GER-253: Annoyance question:

[IN GERMAN]

"Q20.1 Können Sie mir nun sagen, wie stark Sie ...... belästigen, wenn Sie zu Hause in Ihrer Wohnung sind?...sehr belästigend, belästigend, ein wenig belästigend, nicht belästigend"

(For English translation see FRA-252)

NET-254: Annoyance question:

[IN DUTCH]

"Q.58.. Kunt u mij nu vertellen als u hier binnenshuis bent, hoe hinderlijk u dan het geluid vindt van... (Eng.: NOEM BRON AANWIJZING I)? Geeft u uw antwoord maar aan de hand van deze kaart. erg hinderlijk, hinderlijk, een beetje hinderlijk, niet hinderlijk."

(For English translation see FRA-252)

IRE-254: Annoyance question:

See FRA-252

USA TRACOR Airport studies

USA-022: Annoyance question:

"Q33 Now I will read a list of sounds and sources of sounds. For each one, please tell me whether it is a <u>kind</u> of sound you hear in this neighborhood; and if so, <u>how much</u> the sound annoys you and, if it annoys you, <u>how often</u> you find it annoying. Use the Opinion Thermometer to rate your feeling of annoyance and to rate how often you feel annoyed."

{Items rated included "Aircraft operations."}

{Respondents were shown a picture of a thermometer with the numbers "zero" to "4" and end points labeled "Extremely" and "Not at all or None."}

USA-032, USA-044: Annoyance question:

"Q13a I will now read a number of noises heard in different neighborhoods. Which ones do you hear in this neighborhood? (aircraft)

{Items rated included "Aircraft operations."}

Q13b Of those that you hear, how much are you bothered or annoyed? Use the opinion thermometer."

{Respondents were shown a picture of a thermometer with the numbers "zero" to "4" and end points labeled "Extremely" and "Not at all or None."}

{Items rated included "Aircraft operations."}

CAN-168: 1978 Toronto Airport Survey

Annoyance questions:

"Q 3a I would like to ask you more about your reactions to (aircraft/main road) noise and to the overall noise

"On this scale from 0 (not at all disturbed) to 10 (unbearably disturbed) how do you rate (source) noise:...

indoors day

outdoors day

NOR-311: 1982 Fornebu survey

Annoyance question:

"Q14C Do you hear noise from aircraft inside your home? [YES, NO]

[IF YES]

Do you consider this noise...very annoying, quite annoying, a little annoying, or not annoying?"

[IN NORWEGIAN]

"Q14C Hører du støy fra fly i boligen? [JA NEI]

Er denne støyen svært plagsom, ganske plagsom, litt plagsom eller ikke plagsom."

SWI-053: Swiss 3-airport survey

Annoyance questions:

"Q45 Let's assume that this would be a thermometer with which it is possible to measure how much street traffic noise disturbs you at home. The number 10 means that you find street traffic noise unbearable, the number 0 that it doesn't disturb you at all. Please tell me the number that applies to you.

(Not at all disturbing 0 1 2 3 4 5 6 7 8 9 10 Unbearably disturbing)

. . . . .

Q45D Now, lets apply the thermometer to airplane noise."

The questionnaire was also administered in French and Italian, but only the following German version has been published:

"45. NEHMEN WIR AN, DIES WAERE EIN THERMOMETER, MIT DEM MAN MESSEN KANN, WIE STARK SIE DAHEIM DURCH DEN STRASSENVERKEHRSLAERM GESTOERT WERDEN. DIE ZAHL 10 BEDEUTET, DASS DER STRASSENVERKEHRSLAERM SIE

UNERTRAEGLICH STOERT, DIE ZAHL 0, DASS ER SIE UEBERHAUPT KEIN BISSCHEN STOERT. SAGEN SIE MIR EINFACH DIE ZAHL, DIE AUF SIE ZUTRIFFT.

Überhaupt keine Störung 0 1 2 3 4 5 6 7 8 9 10 Unerträgliche Störung

. . . . .

45 D. JETZT NEHMEN WIR DAS THERMOMETER NOCH FUER DEN FLUGLAERN"

UKD-024: 1967 Heathrow survey, UKD-130: 1976 Heathrow survey:

Annoyance question:

Respondents who heard aircraft noise were asked:

"Q12a SHOW CARD A: Please look at this scale and tell me how much the noise of aircraft bothers or annoys you."

{Show Card A presented the following phrases: "VERY MUCH, MODERATELY, A LITTLE, NOT AT ALL".}

UKD-148: 1982 Heathrow survey:

Annoyance question:

"Q11A SHOW CARD A: Please look at this scale and tell me how much the noise of aircraft here bothers or annoys you.

Very much, Moderately, A little, Not at all"

USA-082: LAX Nighttime survey:

Annoyance question:

Original English Version

"1 Are you ever annoyed by aircraft noise in your neighborhood?

(ALLOW A FREE RESPONSE; DO NOT RECORD REPLY)

I see. Now I need an answer that I can compare with the answers that other people give me. Would you say you've been not at all annoyed, slightly annoyed, moderately annoyed, very annoyed or extremely annoyed?"

Some of the respondents in Los Angeles were interviewed in Spanish.

Spanish Version (Copy of questionnaire supplied by author)

"1. Se siente used molestado por el ruido de aviones en su vecindario?"

(ALLOW A FREE RESPONSE; DO NOT RECORD REPLY)

"Ya veo, ahora necesito una respuesta que yo pueda comparar con las respuestas de otras personas. Dirá usted que ... Definitivamente No, Un Poco, Moderadamente, Bastante, Extremamente."

Source of data for analysis:

The original social survey data set was reanalysed for this analysis.

USA-170: 1978 U.S. Army Impulse Noise Survey

Annoyance question:

"9 Do you ever hear noise from artillery around here?

11e In general, taking everything into consideration, does the noise from artillery ever bother or annoy you?

IF YES

11f. Overall, how annoyed are you by noise from artillery?

Extremely, very much, moderately, slightly"

Source of data for analysis:

The data for this analysis have been extracted from three tables in a publication (Schomer, 1982: Tables 2, 3 and 4).

USA-203: 1979 Burbank Aircraft Noise Change Study

Annoyance question:

(Respondents were first asked about annoyance during the past week with aircraft noise and road traffic noise.)

"Q4. While you've been at home over the past YEAR (since this time last year), would you say that you've been not at all annoyed by aircraft noise, slightly annoyed by aircraft noise, moderately annoyed by aircraft noise, very annoyed by aircraft noise, or extremely annoyed by aircraft noise?"

Source of data for analysis:

The original social survey data set was reanalysed for this analysis.

APPENDIX I: OKLAHOMA CITY SONIC BOOM SURVEY

Although several surveys have been conducted of residents' reactions to sonic booms, the 1964 Oklahoma City sonic boom study (USA-012) is the only survey for which a dose/response relationship can be estimated. The 1964 Oklahoma City study consisted of 8,997 interviews obtained during three waves of interviews with over 3,000 respondents. The waves of interviews all occurred during the last four months of a six-month period during which there were daily, carefully-controlled sonic boom flights. Noise measurements were conducted during the six-month periods, but the social survey report did not contain estimates of the sonic boom exposure (Borsky, 1965). This appendix describes the methods for estimating sonic boom exposures at the interview locations and linking these to the social survey response data.

I.1 Source of social survey response

The social survey data for the present analysis are the residents' responses as presented in tables of the original social survey report (Borsky, 1965). Although the Oklahoma City questionnaire contained questions about general sonic boom reactions, the report does not present the answers to an overall sonic boom annoyance question for different noise exposure groups. The best available annoyance information, reports of activity interference, is presented for nine noise exposure groups. The nine noise-exposure groups are defined by three distances from the flight tracks for each of the three study-phases. Respondents were asked about interference and four degrees of annoyance in the following questions:

> "Q.1 First, during the last few weeks, have you heard any booms from the jet flying near here? (Yes, No)
>
> Q.4. Did any of the recent booms ever ...(ask each item below)...?
> IF YES TO Q.4, ASK "A" BEFORE GOING ON TO NEXT ITEM
>
> A. And how annoyed did this make you feel-- Very annoyed, Moderately annoyed, Only a little annoyed, or Not at all Annoyed?
>
> 1) Interfere with your radio or TV?
> 2) Startle or frighten anyone in your family?
> 3) Disturb your family's sleep
> 4) Make your house rattle or shake?
> 5) Interfere with your family's rest or relaxation?
> 6) Interfere with your conversation."

Although there were some minor differences in wording, the same response scale was used for the same six interferences in each of the study phases. The analyses in this report are based on the 8556 responses from the 2852 respondents who were interviewed during all three study phases. These data have been constructed from information provided in four tables in the study report (Borsky, 1965). Table 7 in that report provides the total number of interviews. Table 9 provides the numbers who heard sonic booms and were therefore asked the activity interference questions. Table 67 gives the percentages reporting any interference. Table 68 gives the percentages reporting more than a little interference (i.e. "moderate or high" annoyance). Although some other tables give the percentages "very" annoyed, these percentages are only for such non-standard subsets of the respondents as those who said that it was appropriate to complain about sonic boom noise or those who lived in the middle distance groups and worked within certain distances of their homes. The reconstruction of the data was painstakingly undertaken after a thorough examination of the three questionnaires used in the study provided a basis for interpreting the tables in the report.

I.2 Estimation of ASEL and CSEL for 1,225 sonic boom flights

The acoustical data for the present analysis are derived from the noise levels for each of the 1,225 flights during the six-month Oklahoma City study period presented in a NASA report (Hilton, Huckel, Steiner and Maglieri: 1964). In 1994 acoustical engineers at the NASA Langley Research Center reanalyzed the acoustical data from the 1,225 flights to estimate the 24-hour Leq for the 30 days preceding the respondents' interviews for each of three study phases.

The A-weighted and C-weighted sound exposure levels (SEL) were estimated from the peak overpressures (Δp_o) and information about the lateral distance of the aircraft from the microphone position using the following equation:

$$SEL(dB) = 20 \times Log_{10}(\Delta p_o / \Delta P_{ref}) - C$$

where $\Delta P_{ref} = 0.417973 \times 10^{-6}$ psf or 2.0×10^{-5} Pa and C is a conversion factor that varies with the metric and the lateral distance from the ground track. The conversion factors for estimating CSEL are 26.2, 27.1, 28.0, 27.6, 28.6, and 29.5 at distances of 0, 5, 10, 8, 13 and 18 miles respectively (C=26.201663 + (3.42202e-05)×Distance in feet). The conversion factors for ASEL at the same distances are 44.5, 46.1, 47.7, 47.1, 48.7, and 50.3 (C=44.482635 + (6.17060e-05)×Distance in feet).

The conversion factors for estimating SEL were derived from analyses of the relationship between lateral distance and the difference between dB_{Peak} and SEL (A or C) for flights in the BOOMFILE data base (Lee and Downing, 1991). To match the conditions found in the Oklahoma City tests, this analysis was based on F-15 and F-16 flights at altitudes between 30,000 and 40,000 feet where the lateral distances were less than twice the altitude of the aircraft. Greater distances were excluded because conventional N-waves are customarily observed at distances up to 2.5 times the altitude.

The Oklahoma City data were also used to define dB_{Peak} in the following equation:

$dB_{Peak} = 20\times Log_{10}(\Delta p_o/\Delta P_{ref})$.

I.3 Estimation of L_{Aeq} and L_{Ceq} in respondents' study areas

Using the above procedures SEL (both A and C) was estimated for each of the 1,225 flights during the six-month trial period. In a few instances where data were missing for a flight the values for that flight were estimated from the averages of similar flights at the same location.

With the values for each individual flight available, a value of L_{eq} could be computed for whatever subsets of the days (within the six-month period) best matched the time period mentioned in the interview. After examining the vague questionnaire references to "the recent booms", booms "during the last few weeks", and "the last month or so", a 30-day period prior to the interview dates was selected as the basis for the calculation of the sonic boom exposure ($L_{eq24\text{-}hr}$). Since each wave of interviews lasted from 17 to 20 days, exposures were calculated for the 30-day period preceding each of those 17 to 20 days. These 30-day-based values of $L_{eq24\text{-}hr}$ were then arithmetically averaged over the 17 to 20 interview days to give the final exposure used in the analysis.

The decision to use a 30-day accumulation period and to evenly weight each interviewing day was somewhat arbitrary, but had only a minor effect on the calculations of L_{eq}. An analysis determined that the values of L_{eq} for an area were not very sensitive to the day of interview or the number of days that were included in the period preceding the interview. For a 30-day sonic boom accumulation period, it was found that there was less than a 1.9 dB (L_{Aeq} or L_{Ceq}) range from the highest L_{eq} interview date to the lowest interview date within an interviewing wave. For any given interview day there was less than a 1.4 dB(A) range in the values of L_{eq} for accumulation periods that ranged from the previous 17 to 61 days.

The flights were reported to have followed a tightly controlled ground track on all days but one during the six-month measurement period. Special estimates were developed for that day. The sonic boom measurement positions were established at 0, 5 and 10 miles from the standard ground track. The social survey results were reported for three distance groups: 0 - 8 miles, 8 to 12 miles and 12 to 16 miles from the standard ground track. The 0-8 mile social survey respondents were assigned the arithmetic average of the value of $L_{eq24\text{-}hr}$ at the noise measurement locations at 0 and 5 miles from the ground track. The 8 to 12 mile respondents were assigned the values from the 10 mile measurement position. The 12 to 16 mile respondents' values were estimated by first predicting the value for each of the 1,225 flights at 14 miles by reducing the 10 mile measurements by 1.94 dB (dB_{Peak}), 0.4 (CSEL), or 1.66 (ASEL). Lateral spread calculations based on the Carlson method (Carlson, 1978) determined that the lateral cutoff distance for some booms was less than 14 miles under standard atmospheric conditions. The calculations for the 14-mile position were repeated excluding those booms. These results were not used in the analysis after it was found that this adjustment for lateral attenuation only reduced the estimated values of Leq by 0.3 dB.

APPENDIX J: SUGGESTIONS FOR ADDITIONAL ANALYSES AND DOCUMENTATION OF THESE DATA

This report has extracted the basic dose/response relationship, confirmed that the differences between regions are not simply explained by the noise measurement programs or measured characteristics of respondents, and documented the general study methods. Additional analyses could address issues that are not addressed or have been only briefly discussed in the present report. Additional analyses could also give better indications of the precision and strength of the reported findings. Some aspects of the methods have not been documented in detail.

This appendix lists suggested additional analyses and documentation. The additional documentation and some detailed analyses are most relevant for the production of a supplement to this report or an expanded version of this report. Other suggestions are proposed that would be incorporated in more condensed presentations such as a professional journal article. The suggestions are loosely organized around the chapters in the present report. Within chapter headings, the most general items appear first.

J.1 Suggestions for reporting on study methods (Chapter 2 and appendices)

1. The report could contain a more thorough description of the possible threats to the validity of the noise measurements and of the extensive analyses that were conducted to evaluate each of these threats. At present there is only a brief discussion at the end of Chapter 3 (Page 18) and in Appendices E, F, and G.
2. The effect of noise environment estimation error variance on the slope of the dose/response relationship should be examined. The slope has almost certainly been reduced by noise estimation error variance, but more analysis would be needed to determine whether this is likely to be a small or large reduction.
3. The pattern of occurrence and frequency of booms would be better understood if the sonic booms' noise levels were graphed along a timeline for several more sites.
4. The precision of the noise environment estimates should be evaluated for variances based on decibel units as well as for the current approach that is based on variances of the anti-logs in Appendix G.
5. To more precisely estimate sampling errors and eliminate the possibility of small biases it would be useful to study the effects of reinterviewing and multiple interviews in the same household on responses.
6. Better information about the study areas could come from more careful estimations of the distance from the measurement positions to the interview locations in Table 1, Page 5.

J.2 Suggestions for dose/response relationship analyses (Chapter 4)

7. The analysis of the alternative noise indices' correlations with annoyance measures should be expanded. The present report statements are based almost entirely on the

correlations with the four-item response index. The analysis should be extended to other response scales. In addition, tests for the significance of the differences between the partial correlation coefficients in the table in Appendix C should be conducted to formally document the expected finding that there are not significant differences between different noise indices. Such tests would need to be based on the correct assumption that this is not a simple random sample.

8. Analyses of alternative response measures should be expanded to obtain an additional more reliable index than that provided by only the four-item index. This could provide somewhat more precise estimates in some analyses.
9. Best-fit logistic regression, dose/response curves for the two study regions could be calculated and displayed in figures together with 95 percent confidence intervals for the predicted mean reactions. It would be useful to have these for the percentage very annoyed as well as for a range of lesser reactions.
10. The experience with the magnitude estimation scale should be thoroughly documented. This is a potentially valuable method for measuring reactions to noise. The particular approach taken in the questionnaire was innovative. A short conference paper presented some findings but provided only an abbreviated description of the findings or analysis methods (Fields, 1996a).
11. A single, condensed table of important correlation matrices would be useful in the text of the report and any article in addition to the large matrix that is now in Appendix C.

J.3 Suggestions for non-noise factors' effects (Chapter 5)

12. The extent to which the environmental attitudes in these areas could lead to different sonic booms reactions than would be found in the United States as a whole should be tested. All of the "General environmental opinions" factors in Table 6 are related to sonic boom annoyance. The national results are available from a previous survey in which each of these questions was administered to the general population of the United States.
13. The extent to which these areas' residents' attitudes toward the noise source could lead to different sonic booms reactions should be tested. All of the "Attitudes toward aircraft importance" factors in Table 6 are related to sonic boom annoyance. The possible effect of less favorable attitudes, for example attitudes toward the military usage, could be assessed.
14. The possibility that alternative codings of some of the continuous variables would yield relationships should be examined. For example, time-away-from-home has been examined as a continuous measure of minutes away while it may be that some specific dichotomizations (e.g. 10 hours or more) might show a relationship.

J.4 Suggestions for survey comparisons (Chapter 6)

15. The differences between the western boom and other surveys that now appear in the text should be presented in a table with at least the following information: full regression equations, standard errors of regression parameters, decibel equivalents of

differences. The analyses should be presented for alternative codings for the reaction variables and not only for the high-annoyance dichotomy included in the present report. Tests for differences between the comparisons for different studies should be conducted.

16. Significance tests should be conducted to determine whether the dose/response curves for the western boom study are significantly different than the dose/response curves that have been derived from previous meta-analyses. Figure 19 provides one of those curves but does not include a significance test.
17. An attempt to create a single, best estimate of the difference between the western boom survey and conventional aircraft surveys should be made by creating a weighted mean of the estimates from the conventional aircraft surveys.
18. Additional analyses of the CEC Impulse noise studies graphed in Figure 16 should be conducted to determine whether the high reactions at some types of CEC impulse noise sites are related to the type of impulse noise source. These analyses might, in turn, provide additional insight into reasons for differences in reactions in Regions A and B of the western sonic boom survey.
19. Plots of the logistic regression curves for at least some studies would provide a clearer summary of the average difference and could be used to illustrate the meaning of the displacement parameter.
20. The possibility that the position of the annoyance question within the sonic boom questionnaire could have affected responses should be considered. Evidence on such effects should be reviewed.
21. Tests for the differences between reactions to the different forms of the activity interference questions should be conducted. If there are no differences, then the Oklahoma City comparisons in Chapters 6 and 7 could be improved by including more of the western boom questionnaires.
22. A complete table of responses for the Oklahoma City questionnaire should be presented to supplement the graphical presentation. These data were difficult to acquire and may be useful for future researchers.

J.5 Suggestions for understanding the components of sonic boom reactions (Chapters 7)

23. The prevalence of the various components of reactions should be reported for different noise levels. Basic tables on startle, vibration, damage, and speech interference could give this information. The information might be easily summarized by equations that relate extent of reaction to noise level. An analysis should determine if the ratio of different types of reactions remains relatively consistent over noise levels. The degrees of annoyance with specific reactions should be explored as well as the prevalence of different reactions
24. More details about the differences between indoor and outdoor reactions could be presented. The percentages offering particular explanations for differences in reactions could be reported. The extent of the difference at each noise level or site could be presented.

25. The contrasts between indoor/outdoor reactions in the western boom and the Toronto airport study should be graphed and described quantitatively. Significance tests should be conducted. Since the interest is in the within-person differences, these estimates might be relatively precise.

J.6 Other general suggestions

26. A review of the previous eight sonic boom surveys that did not have adequate noise measurements might yield some additional information about reactions to sonic booms, provide a convenient summary of all available information, and confirm or cast doubt upon some of the conclusions stated in this report.

27. The sampling errors and 95 percent confidence intervals for the social survey results should be further examined. The current estimates are all based on the assumption that there are 20 independently examined areas (PSU, Primary Sampling Units). None of the calculations examine the possibility that repeated interviews in Phases I and II may have increased the precision for testing the difference between reactions in Phases I and II. The number of PSUs is somewhat below the number that are usually recommended to obtain stable estimates. The effects of splitting the areas into neighborhoods for the purpose of variance estimation should be examined.

28. Most presentations of percentages and noise levels in tables should be rounded to whole numbers to reflect that fact that they are surrounded by relatively large confidence intervals.

APPENDIX K: SOCIAL SURVEY QUESTIONNAIRE

The questionnaire presented in this appendix has been modified to serve as a codebook for the survey. The codebook includes the standard, long form (Form A) of the questionnaire as it was read to respondents. The codebook augments the paper copy of the questionnaire used by interviewers in the following ways:

* Variable names are added in margins or in blank spaces
* Codes for missing data are added in bold face type
* The alternative versions of two questions (Question #14 and Question #24) are repeated in the codebook under a bold face heading that indicates the questionnaire version in which they appeared. In the original questionnaires, separate questionnaires with distinctively colored first pages were created for each version.

These additional notes lengthen the questionnaire document and thus change the page numbers on which questions appear.

The cards that are shown to respondents are at the end of this appendix.

A short form of this questionnaire (Form B) was used for respondents in Phase II who had been previously interviewed in Phase I. Form B was created by dropping the following questions from Form A: 15 to 21, 25 to 28, 38 to 44, 47, 48, 52 to 54, and 64 to end. Question 23 was also shortened slightly.

Interviewer manuals were prepared for each of the three phases and are included in the project manuals for each study phase (HBRS, 1994a; HBRS, 1994b; HBRS, 1996). These manuals provide detailed information about conducting the particular surveys. They include instructions on such topics as respondent selection and the probing and interpretation of particular questions.

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Expires: 3/31/96

FIRST LONG-TERM SURVEY (FORM A)-- CALIFORNIA

CONTACT **0** **No contact sheet attached**
1 **Contact sheet attached**

VERSION **1**
2
3
4

Questions apply to all survey versions unless otherwise indicated.

COMPLETE THE FOLLOWING ITEMS BEFORE BEGINNING THE INTERVIEW.

Q1. INTERVIEW ID HID (HOUSE) PID (PERSON) 03 (ROUND)

Q2. CONTACT DATE INTMO (MONTH) INTDAY (DAY) INTYR (YEAR)

Q3 Q3. INTERVIEWER ID ________

Q4 Q4. TYPE OF SELECTION HOUSEHOLD
1. TAKE ALL
2. RANDOM SELECTION [USE SUPPLEMENTARY SELECTION INSTRUCTIONS]

Hello. I am (first & last name) from HBRS. We are conducting an opinion survey about the advantages and problems of living in different areas and we would like to get your views. The survey is sponsored by the National Aeronautics and Space Administration. [SHOW NASA LETTER] You are not required to participate, but it will be very helpful if you do. It is important that we talk to different types of people and your household is one of a small number that has been selected from (state). Our results will be summarized so that the answers you provide cannot be associated with you or anyone in your household. Your name and address will be held in confidence in accordance with the Privacy Act and will only be released to others if required by Privacy Act implementing regulations. Would you have time now to answer a few questions, it should take about a half hour?

Q5. ASK ONLY ONCE PER HOUSEHOLD
a. First we need to know the number of adults, that is people 18 or over, who presently live in this house. We do not need to know their names just their relationship to you. [LIST ALL RELATIONSHIPS IN GRID]
b. RECORD SEX
c. In what month and year was that person born?
d. When did each of you move to ...(name of community)...?

For variables Q5A_1 - Q5A_5:
See Relationship List

For variables Q5D_1A - Q5D_5A and INTMO:

1	January	11	November
2	February	12	December
3	March	13	Spring
4	April	14	Summer
5	May	15	Fall
6	June	16	Winter
7	July	97	Always
8	August	98	Don't know
9	September	99	Missing
10	October		

Rank Order	a. RELATIONSHIP	b. SEX F(1) M(2) 9 Missing	c. DATE OF BIRTH month/year	d. DATE MOVED HERE (If always, enter "always") month/year
Q5r 1	1. **Q5A 1**	**Q5B 1** 1.F 2.M		**Q5D 1A** / **Q5D 1B**
Q5r 2	2. **Q5A 2**	**Q5B 2** 1.F 2.M		**Q5D 2A** / **Q5D 2B**
Q5r 3	3. **Q5A 3**	**Q5B 3** 1.F 2.M		**Q5D 3A** / **Q5D 3B**
Q5r 4	4. **Q5A 4**	**Q5B 4** 1.F 2.M		**Q5D 4A** / **Q5D 4B**
Q5r 5	5. **Q5A 5**	**Q5B 5** 1.F 2.M		**Q5D 5A** / **Q5D 5B**
Q5r 6	6. **Q5A 6**	**Q5B 6** 1.F 2.M		**Q5D 6A** / **Q5D 6B**
Q5r 7	7. **Q5A 7**	**Q5B 7** 1.F 2.M		**Q5D 7A** / **Q5D 7B**

KSHTABLE Kish Table Number

RESPOND CIRCLE NUMBER OF PERSON INTERVIEWED

BEGHR **99 Missing**

BEGMIN **99 Missing**

TIME START: **AMPM** 1. AM
2. PM
9 Missing

Q6. We want to learn how you feel about the neighborhood right around here and about any advantages that make you feel it is a good place to live. What are the one or two things you like most about this area?

Q6 1 **Response 1, See Like About Area List**

Q6 2 **Response 2**

Q6 3 **Response 3**

Q7. How about any things that are disadvantages. What are the one or two disadvantages that you dislike the most about this area?

Q7 1 **Response 1, See Dislike About Area List**

Q7 2 **Response 2**

Q7 3 **Response 3**

Q8. Now some questions about noises you might have heard when you have been at home. First we only want to know about noises in about the last six months.

IF MOVED TO COMMUNITY WITHIN LAST SIX MONTHS, REASSURE WITH "Since you moved here recently, please just tell me about noises since you moved here."

a. What are some of the different types of noises you have heard around here? (PROBE: Anything else?) [MARK "VOL" FOR VOLUNTEERED NOISES]

b. [ASK FOR ALL NOISES NOT VOLUNTEERED] In the last six months, have you ever heard the noise from ...(cars or trucks or other road traffic going by)... when you were here at home?

[STOP!!!: COMPLETE ENTIRE LIST WITH b BEFORE STARTING c]

c. Here is an "AMOUNT" card for choosing your answer for the next question. [HAND CARD A TO RESPONDENT] [ASK FOR EACH SOUND HEARD] During the last six months has the noise from ...(cars or trucks or other road traffic going by)...bothered or annoyed you very much, moderately, a little, or not at all?

For variables Q8 A:
9 Missing

For variables Q8 C:
9 Missing
● NA

	a,b HEARD	c. BOTHERED OR ANNOYED VERY MUCH (1)	MODER-ATELY (2)	A LITTLE (3)	NOT AT ALL (4)	DK (8)	
i. Cars or trucks or other road traffic going by	1 VOL.⬇ 2 YES ⬇	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8	
Q8I A	3 NO ⬇ 4 DK ⬇	**Q8I C**					
ii. Motorcycles	1 VOL.⬇ 2 YES ⬇	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8	
Q8II A	3 NO ⬇ 4 DK ⬇	**Q8II C**					
iii. Neighbors' tools or outdoor equipment	1 VOL.⬇ 2 YES ⬇	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8	
Q8III A	3 NO ⬇ 4 DK ⬇	**Q8III C**					
iv. [REPEAT FULL QUESTION] ..Sonic booms from jets **Q8IV A**	1 VOL.⬇ 2 YES ⬇	VERY 1	MODER 2	LITTLE 3	NOT 4 *[MARK Xs →]*	DK 8	*MARK X AT Q?, 12. & Q?, 31.*
	3 NO ⬇ 4 DK ⬇ FINISH THROUGH Q11.	**Q8IV C**					
v. Any other explosions or bangs or booms (besides the sonic booms)	1 VOL.⬇ 2 YES ⬇	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8	
Q8V A (DESCRIBE) **Q8DESC1** **See Other Explosions List**	3 NO ⬇ 4 DK ⬇	**Q8V C**					
vi. Low-flying jet aircraft	1 VOL.⬇ 2 YES ⬇	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8	
Q8VI A	3 NO ⬇ 4 DK ⬇	**Q8VI C**					
vii. Any other airplane s (besides the low-flying jets)	1 VOL.⬇ 2 YES ⬇	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8	
Q8VII A (DESCRIBE) **Q8DESC2** **See Other Airplanes List**	3 NO ⬇ 4 DK ⬇	**Q8VII C**					
viii. [DESCRIBE ANY OTHER VOLUNTEERED NOISES HERE] **Q8VIII A**	1 VOL.⬇	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8	
Q8DESC3 **See Other Noise List**	3 NO ⬇ 4 DK ⬇	**Q8VIII C**					

Q9. During the last six months have there been any particular noises which you think have been louder than usual or quieter than usual?

Q9 1. YES ↓ 2. NO [SKIP TO NEXT Q] 3. DO NOT KNOW [SKIP TO NEXT Q]

a. (PROMPT IF NEEDED: What noise is that?)

Q9A 1 Response 1, See What Noise Louder/Quieter Than Usual List

Q9A 2 Response 2

b. (PROMPT IF NEEDED: How has it been different?)

Q9B 1 Response 1, Refers to Q9A 1, See How Noise Different List

Q9B 2 Response 2, Refers to Q9A 1

Q9B 3 Response 3, Refers to Q9A 2

Q9B 4 Response 4, Refers to Q9A 2

Please look at this OPINION THERMOMETER [HAND CARD B TO RESPONDENT]

Q10. Using a number on the OPINION THERMOMETER how much have you been bothered or annoyed by the noise in general here around home during the last six months? Choose zero if you are not at all annoyed, ten if you are extremely annoyed, and a number from one to nine if you are somewhere in between.

Q10

00	01	02	03	04	05	06	07	08	09	10	**99**
NOT AT ALL ANNOYED										EXTREMELY ANNOYED	**Missing**

Q11. On the same OPINION THERMOMETER how much have you been bothered or annoyed by the noise from cars or trucks or other road traffic going by when you have been around home during the last six months?

Q11

00	01	02	03	04	05	06	07	08	09	10	**99**
NOT AT ALL ANNOYED										EXTREMELY ANNOYED	**Missing**

[IF SONIC BOOM WAS NOT HEARD AT Q#8.b.iv., SKIP TO Q#41.]

Q12. How much have you been bothered or annoyed by the sonic booms here, around home, during the last six months?

Q12

00	01	02	03	04	05	06	07	08	09	10	**99**
NOT AT ALL ANNOYED										EXTREMELY ANNOYED	**Missing**

↓

MARK X AT Q?, 12. & Q?, 31.

☐ ←"X" if Q#8.c.iv is "NOT"	READ IF BOTH BOXES ARE MARKED "X"
☐ ←"X" if Q#?, 12. is "NOT"	

Even if the sonic booms have not annoyed you during the last six months, we still need your views on particular aspects of the booms. If any specific aspects bother you, please say so. If you are not annoyed by any of these aspects, that's fine, too. Just keep telling me your views and we can move right along.

Q13. Here is a "How Often" card for choosing your answer to the next question. [HAND CARD C TO RESPONDENT] About how many times have you heard the sonic booms from jets here over the last six months; several times a week, several times a month, several times in the last six months, or only once in the last six months?

Q13
1. SEVERAL TIMES A WEEK
2. SEVERAL TIMES A MONTH
3. SEVERAL TIMES IN THE LAST 6 MONTHS
4. ONLY ONCE IN THE LAST 6 MONTHS
8. **DON'T KNOW**
9 **Missing**
● **NA**

VERSIONS 1 AND 2

Q14.g. Over the last six months have the sonic booms ever ...(startled you)..?

[IF YES, ASK a IMMEDIATELY, BEFORE GOING ON TO NEXT ITEM]

h. Please look at the AMOUNT CARD [HAND CARD A TO RESPONDENT] and tell me when they ..(startled you).. how annoyed does this make you feel: very much annoyed, moderately annoyed, a little annoyed or not at all annoyed?

For variables Q14 G:
9 **Missing**
● **NA**

For variables Q14 H:
9 **Missing**

	g. OCCUR	h. HOW ANNOYED VERY MUCH (1)	MODER-ATELY (2)	A LITTLE (3)	NOT AT ALL (4)	DK (8)
vii. Startled you	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
Q14VII G	2 NO ↓	**Q14VII H**				
viii. Waked you up	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
Q14VIIIG	2 NO ↓	**Q14VIIIH**				
ix. Interfered with listening to radio or TV	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
Q14IX G	2 NO ↓ 3 NA ↓	**Q14IX H**				
x. Made the TV picture flicker	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
Q14X G	2 NO ↓ 3 NA ↓	**Q14X H**				
xi. Made the house vibrate or shake	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
Q14XI G	2 NO ↓	**Q14XI H**				
xii. Interfered with conversation	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
Q14XII G	2 NO ↓	**Q14XII H**				
xiii. Interfered with or disturbed any other activity [IF 'YES' SPECIFY ALL, ASK h OF MOST ANNOYING]	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
Q14XIIIG **Q14DESC See Other Activity Boom Disturbed List**	2 NO ↓	**Q14XIIIH**				

VERSION 3

Q14.a Can you tell me if the sonic booms during the last six months ever ...(interfere with your radio or TV)...? [IF YES, ASK b AND c IMMEDIATELY, BEFORE GOING ON TO NEXT ITEM] 9 **Missing** • **NA**		b. How often is that: very often, fairly often, or only occasionally? 9 **Missing** • **NA**				c. And how annoyed does this make you feel: very annoyed, moderately annoyed, only a little annoyed or not at all annoyed? 9 **Missing** • **NA**				
		VERY OFTEN (1)	FAIRLY OFTEN (2)	ONLY OCCASIO NALLY (3)	DK (8)	VERY (1)	MODER-ATELY (2)	ONLY A LITTLE (3)	NOT AT ALL (4)	DK (8)
i. Interfere with your radio or TV **Q14I A**	1 YES →	VERY 1	FAIRLY 2	OCCASION 3	DK 8	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 DK ↓	**Q14I B**				**Q14I C**				
ii. Startle or frighten anyone in your family **Q14II A**	1 YES →	VERY 4	FAIRLY 2	OCCASION 3	DK 8	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 DK ↓	**Q14II B**				**Q14II C**				
iii. Disturb your family's sleep **Q14III A**	1 YES →	VERY 1	FAIRLY 2	OCCASION 3	DK 8	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 DK ↓	**Q14III B**				**Q14III C**				
iv. Make your house rattle or shake **Q14IV A**	1 YES →	VERY 1	FAIRLY 2	OCCASION 3	DK 8	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 DK ↓	**Q14IV B**				**Q14IV C**				
v. Interfere with your family's rest or relaxation **Q14V A**	1 YES →	VERY 1	FAIRLY 2	OCCASION 3	DK 8	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 DK ↓	**Q14V B**				**Q14V C**				
vi. Interfere with your conversation **Q14VI A**	1 YES →	VERY 1	FAIRLY 2	OCCASION 3	DK 8	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 DK ↓	**Q14VI B**				**Q14VI C**				

For variables Q14 D:
- 9 Missing
- • NA

For variables Q14 E:
- 9 Missing
- • NA

Q14.d Can you tell me if the sonic booms during the last six months ever ...(interfere with your radio or TV)...? [IF YES, ASK e IMMEDIATELY, BEFORE GOING ON TO NEXT ITEM]		e. And how annoyed does this make you feel: very annoyed, moderately annoyed, only a little annoyed or not at all annoyed?				
		VERY (1)	MODER-ATELY (2)	ONLY A LITTLE (3)	NOT AT ALL (4)	DK (8)
i. Interfere with your radio or TV **Q14I D**	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 DK ↓	**Q14I E**				
ii. Startle or frighten anyone in your family **Q14II D**	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 DK ↓	**Q14II E**				
iii. Disturb your family's sleep **Q14III D**	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 DK ↓	**Q14III E**				
iv. Make your house rattle or shake **Q14IV D**	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 DK ↓	**Q14IV E**				
v. Interfere with your family's rest or relaxation **Q14V D**	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 DK ↓	**Q14V E**				
vi. Interfere with your conversation **Q14VI D**	1 YES →	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 DK ↓	**Q14VI E**				

Q15. I need to double check about being startled. Have you, personally, been startled or surprised by the booms at any time since you have lived in this area?

Q15

1. YES ↓ 2. NO [SKIP TO NEXT Q]
9 Missing **● NA**

Q15 A a. Have any of the sonic booms ever actually frightened and scared you <u>or</u> have they <u>only</u> startled you?

1. FRIGHTENED AND SCARED
2. ONLY STARTLED
9 Missing
● NA

Q15 B b. Has a sonic boom ever startled you so much that you flinched or jumped or made a sudden movement?

1. YES
2. NO
9 Missing
● NA

Q15 C c. Has a sonic boom ever made you drop something or fall?

1. YES
2. NO
9 Missing
● NA

Q15 D d. Compare the first times you heard the sonic booms with the way it is now-a-days. Were you more startled at first, <u>or</u> are you more startled now, <u>or</u> has it always been about the same?

1. MORE STARTLED AT FIRST
2. MORE STARTLED NOW
3. ABOUT THE SAME
9 Missing
● NA

Q15 E e. Now we will use the "How often" card again. [HAND CARD C TO RESPONDENT] During the <u>last six months</u>, about how often, if ever, have the sonic booms startled you: several times a week, several times a month, several times in the last six months, only once in the last six months, or not even once?

1. SEVERAL TIMES A WEEK
2. SEVERAL TIMES A MONTH
3. SEVERAL TIMES IN THE LAST 6 MONTHS
4. ONLY ONCE IN THE LAST 6 MONTHS
5. NEVER
9 Missing
● NA

Now for some details about vibrations and rattles from sonic booms.

Q16. At any time while you lived in this area has a sonic boom ever ...(made your windows rattle or shake)...?

	YES (1)	NO (2)	DK (8)	**Missing**	**NA**
i. made your windows rattle or shake **Q16I**	1 YES	2 NO	8 DK	**9**	●
ii. made pictures or other things on shelves or the walls rattle or move **Q16II**	1 YES	2 NO	8 DK	**9**	●
iii. made you actually <u>feel</u> the furniture or the house shake or vibrate **Q16III**	1 YES	2 NO	8 DK	**9**	●

Q17. Now consider any things that have been broken or damaged around your home here in the last few years. Have you ever thought that the sonic booms might have had anything to do with any things being broken or damaged?

Q17 1. YES ↓ 2. NO [SKIP TO NEXT Q]

For variables Q17* B:

8888 Don't know month and don't know year
9999 Missing
13 Spring
14 Summer
15 Fall
16 Winter
98 Don't know month or don't know year
• NA

Examples:
Summer, don't know year = 1498
Winter, 94 = 1694
I don't know = 8888
Don't know month, 93 = 9893

For variables Q17* C:

9 Missing
• NA

a. What things do you think might have been broken or damaged by the sonic booms in the last few years? (RECORD DESCRIPTION OF ITEM AND DAMAGE) (PROBE: Do you think anything else has been broken or damaged by the sonic booms?)	b. Do you happen to know about what year and month that happened or do you not know?	[STOP!!! COMPLETE a AND b FOR ALL BEFORE ASKING c] c. Please look at CARD D [HAND CARD D TO RESPONDENT] and tell me how certain you are that the sonic boom caused the damage. For the ...(DAMAGE, ITEM)... are you very certain, moderately certain, moderately uncertain or very uncertain that a sonic boom caused the damage?
COMPLETE a AND b BEFORE CONTINUING AT c.		

a. ITEM / DAMAGE	b. DATE (IF KNOWN)	CERTAIN MODERATELY (1)	CERTAIN VERY (2)	UNCERTAIN MODERATELY (3)	UNCERTAIN VERY (4)
i. **Q17I A1 See Items Damaged List** **Q17I A2 See Damage Done List**	**Q17I B** (Mo) (Yr) 8888 DK	**Q17I C** MODER 1	VERY 2	MODER 3	VERY 4
ii. **Q17II A1 See Items Damaged List** **Q17II A2 See Damage Done List**	**Q17II B** (Mo) (Yr) 8888 DK	**Q17II C** MODER 1	VERY 2	MODER 3	VERY 4
iii. **Q17IIIA1 See Items Damaged List** **Q17IIIA2 See Damage Done List**	**Q17III B** (Mo) (Yr) 8888 DK	**Q17III C** MODER 1	VERY 2	MODER 3	VERY 4

Q18. Have you kept any pets in the last few years?

1. YES ⇓ | 2. NO [SKIP TO NEXT Q]

Q18 **9 Missing** | **• NA**

a. What types of animals have they been?

Q18A 1 Response 1, See Type of Pet and Animal List
Q18A 2 Response 2
Q18A 3 Response 3

b. Has a pet been disturbed by the sonic booms, or not, or do you not know?

Q18B 1. YES ⇓ 2. NO [SKIP TO NEXT Q] 3. DO NOT KNOW [SKIP TO NEXT Q]
9 Missing • NA

c. What do you notice about the pet when it's disturbed?

Q18PET1 Response 1, See Type of Pet and Animal List
Q18C 1 (Refers to Q18PET1) See Animal Disturbances/Acts List
Q18PET2 Response 2
Q18C 2 (Refers to Q18PET2)
Q18PET3 Response 3
Q18C 3 (Refers to Q18PET3)

d. Has this ever caused a health problem for your pet?

Q18D 1. YES ⇓ 2. NO [SKIP TON NEXT Q] **9 Missing**
• NA

[PROBE IF NECESSARY: "What problem was that? What animals were those?"]

Q18D 1 See Health Problems How Lost Money List

Q19. Have you owned any livestock or other animals that you have kept for business purposes in the last few years?

Q19 1. YES ⇓ 2. NO [SKIP TO NEXT Q] **9 Missing** **● NA**

a. What types of animals have they been?
Q19A 1 Response 1, See Type of Pet and Animal List
Q19A 2 Response 2
Q19A 3 Response 3

Q19B b. Do you keep them within a mile of here or are they further away?
1. WITHIN A MILE
2. FURTHER AWAY
3. BOTH

Q19C c. Have any of those animals been disturbed by the sonic booms, or not, or do you not know?

1. YES ⇓ 2. NO [SKIP TO NEXT Q] 3. NOT KNOW [SKIP TO NEXT Q]
9 Missing **● NA**

d. What do you notice about them when they are disturbed?
Q19PET1 Response 1, See Type of Pet and Animal List
Q19D 1 (Refers to Q19PET1) See Animal Disturbances/Acts List
Q19PET2 Response 2
Q19D 2 (Refers to Q19PET2)
Q19PET3 Response 3
Q19D 3 (Refers to Q19PET3)

e. Have you ever lost any money or had to spend any money because the animals were disturbed by the sonic booms?

Q19E 1. YES ⇓ 2. NO [SKIP TO NEXT Q] **9 Missing** **● NA**

[PROBE IF NECESSARY "How did that happen? Which animals were those?"]

Q19E 1 See Health Problems How Lost Money List

Q20. In the last six months when you heard sonic booms here, did you ever feel that the boom might break or damage or hurt anything around your home?

Q20 1. YES ⇓ 2. NO [SKIP TO NEXT Q] **9 Missing** **• NA**

a. Would you say you feel this: very often, moderately often, or only occasionally?

Q20A 1. VERY OFTEN
2. MODERATELY OFTEN
3. ONLY OCCASIONALLY
9 Missing
• NA

b. What things do you feel might be broken or damaged or hurt? (PROBE IF NECESSARY: Anything else?)

[DESCRIBE VERBATIM]

Q20B 1 Response 1, See Potential Damage List
Q20B 2 Response 2
Q20B 3 Response 3

CLASSIFY OBJECTS. PROBE ONLY IF NECESSARY

c. CIRCLE ANY OF THE FOLLOWING ITEMS WHICH ARE MENTIONED (Circle all that apply.)

Q20C 1 1. WINDOWS
Q20C 2 1. CRACKS IN PLASTER OR OTHER COATINGS ON SURFACES
Q20C 3 1. OBJECTS FALLING TO THE FLOOR FROM WALLS OR SHELVES
Q20C 4 **0. NOT MENTIONED**
1. ANIMALS AND CHILDREN
2. FOUNDATION
3. WATER PIPES/PLUMBING
4. DISHES
5. DOORS
6. OTHER
9. MISSING
• NA

d. ARE THE ITEMS RELATED TO:

Q20D 1. ONLY AGRICULTURE (FARM OR RANCH)
2. ONLY RESIDENTIAL PROPERTY PREMISES
3. BOTH
9 Missing
• NA

Q21. Do you ever feel there is any danger from one of the sonic boom aircraft crashing nearby?

Q21 1. YES ⇓ 2. NO [SKIP TO NEXT Q] **9 Missing** **• NA**

a. Would you say you feel this: very often, moderately often, or only occasionally?

Q21A 1. VERY OFTEN
2. MODERATELY OFTEN
3. ONLY OCCASIONALLY
9 Missing
• NA

Q22. Do you ever hear the sonic booms when you are away from your home in this area including at work or at other places in this area?

Q22 1. YES ↓ 2. NO [SKIP TO NEXT Q]
9 Missing **● NA**

a. Are the sonic booms more of a problem for you when you are at home, when you are away from home, or are they no different, or are they never a problem?

Q22A 1.AT HOME↓ 2.AWAY FROM HOME↓ 3.NO DIFFERENT↓ 4.NEVER PROBLEM[SKIP TO NEXT Q]
9 Missing **● NA**

b. What types of problems, if any, have they caused when you are away from home in this area?

Q22B 1. NONE
2. SOME (DESCRIBE) **Q22B 1 See Problems in Area List**
9 Missing
● NA

Q23. Have you ever felt like doing something about the sonic booms such as telephoning or writing an official or going to a meeting or doing something else to complain about the booms?

Q23 1. YES ↓ 2. NO ↓
9 Missing **● NA**

Q23A a. Did you actually do anything?

1. YES↓ 2. NO ↓
9 Missing **● NA**

Q23B b. What did you do?
See What Did You Do List

c. Do you know who to contact if you have a complaint?
Q23C
1. YES (Who is that?) 2. NO
9 Missing
● NA
Q23C 1 See Whom to Contact for Complaints List

x. Do you know who residents should contact if they have a complaint?
Q23X
1. YES? (Who is that?) 2. NO
9 Missing
● NA
Q23X 1 See Whom to Contact for Complaints List

VERSIONS 1 AND 3

Q24. Do you think people around here should complain about the sonic booms if they find them annoying?

Q24
1 YES
2 NO
3 DON'T KNOW
9 Missing
● NA

Q24.b In some places there are people who say that residents should not complain about booms if the airplanes are good for the economy and the country. Do you think residents around here should complain about the sonic booms if they find them annoying?

Q24B
- 1 YES
- 2 NO
- 3 DON'T KNOW
- **9 Missing**
- **● NA**

These next few questions are especially important because you'll be informing us about some special situations. First we will compare the sonic booms when you are outdoors and indoors. Please look at this DISTURBANCE SCALE. [HAND CARD E TO RESPONDENT] It goes from zero for "not at all disturbed" to ten for "unbearably disturbed".

Q25. How do you rate the sonic booms when you are <u>out-of-doors</u> around your house in the daytime?

Q25 [OUTSIDE]

00	01	02	03	04	05	06	07	08	09	10
NOT AT ALL DISTURBED										UNBEARABLY DISTURBED

- **99 Missing**
- **● NA**

Q26. How do you rate the sonic booms when you are <u>inside</u> your house in the daytime?

Q26 [INSIDE]

00	01	02	03	04	05	06	07	08	09	10
NOT AT ALL DISTURBED										UNBEARABLY DISTURBED

- **99 Missing**
- **● NA**

For variables Q27 1 - Q27 4:
9 Misssing
● NA

Q27 MARK CORRECT CATEGORY FROM EXAMINING Q#35., 25. AND Q#36., 26. AND PROCEED WITH CORRECT QUESTION.

1 OUTSIDE MORE ↓ 2 BOTH EQUAL [SKIP TO Q#28.] 3 INSIDE MORE ↓
9 Missing **● NA**

Q27.a So you feel the booms are worse <u>outside</u> the house. Why are they worse for you outside? [DO NOT PROMPT. CIRCLE "YES" OR "NO" FOR EACH, RECORD VERBATIM IF ANY OTHER WORDS ARE USED]			Q27..b So you feel the booms are worse <u>inside</u> the house. Why are they worse for you inside? [DO NOT PROMPT. CIRCLE "YES" OR "NO" FOR EACH, RECORD VERBATIM IF ANY OTHER WORDS ARE USED]		
	MENTION (1)	<u>NO</u> MENTION (2)		MENTION (3)	<u>NO</u> MENTION (4)
VIBRATION, RATTLE, SHAKE **Q27 1**	1 YES	2 NO	VIBRATION, RATTLE, SHAKE	3 YES	4 NO
STARTLE, SURPRISE, SCARE **Q27 2**	1 YES	2 NO	STARTLE, SURPRISE, SCARE	3 YES	4 NO
NOISIER, LOUDER (GENERALLY) **Q27 3**	1 YES	2 NO	NOISIER, LOUDER (GENERALLY)	3 YES	4 NO
OTHER ________ **Q27 4** **Q27DESC See Why Booms Worse List**	1 YES	2 NO	OTHER ________	3 YES	4 NO

Q28. During the time you've lived in this area have you ever heard sonic booms at night after you have gone to bed?

Q28 1. YES ⇩ 2. NO [SKIP TO Q29.)
9 Missing **• NA**

For variables Q28A - Q28D:
9 Missing
• NA

To rate the sonic booms at night please look at the OPINION THERMOMETER on CARD B.

Q28A a. How annoyed are you when you hear sonic booms at night after you have gone to bed?

00	01	02	03	04	05	06	07	08	09	10
NOT AT ALL ANNOYED										EXTREMELY ANNOYED

Q28B b. Now for the day. How annoyed are you by the sonic booms you hear <u>indoors</u> in the daytime?

00	01	02	03	04	05	06	07	08	09	10
NOT AT ALL ANNOYED										EXTREMELY ANNOYED

[IF "NOT AT ALL" TO BOTH, SKIP TO Q#29.]

Q28C c. Do you hear sonic booms more often during the night or during the day?
1. NIGHT
2. DAY
3. SAME
4. DON'T KNOW

Q28D d. Now consider when you hear the sonic booms most often as well as how much they bother you when you hear them. Overall, are sonic booms the most problem for you at night, or during the day, or are they never a problem?

1. NIGHT
2. DAY
3. SAME (VOLUNTEERED)
4. NEVER PROBLEM

Q29. Please look at the NOISINESS METER on CARD F. [HAND CARD F TO RESPONDENT] For this question please <u>ignore</u> any vibrating, or startling, or waking up or damage from the sonic booms; instead, <u>only</u> think about the noisiness from the <u>sounds</u> of the booms. Consider both the number and the loudness of the boom sounds. Now, using CARD F, how <u>noisy</u> are the sonic booms you hear when you are around home?

Q29

00	01	02	03	04	05	06	07	08	09	10
NOT AT ALL NOISY SOUND										EXTREMELY NOISY SOUND

99 Missing
• NA

Please look at the disturbances on CARD G. [HAND CARD G TO RESPONDENT]
Q30. Please choose the one thing, if any, that is the most disturbing about sonic booms for you. Is the most disturbing thing <u>for you</u> the rattles and vibrations, being startled or surprised, the possibility of damage, the noisiness of the sounds, something else, or nothing at all?

Q30
1. THE RATTLES AND VIBRATIONS
2. BEING STARTLED OR SURPRISED
3. THE POSSIBILITY OF DAMAGE
4. THE NOISINESS OF THE SOUNDS
5. SOMETHING ELSE (What is that?) **Q30 1 See Other Most Disturbing List**
6. NOTHING AT ALL

9 Missing
• NA

MOST RESPONDENTS SKIP THIS SHEET

☐	←"X" if Q#8.c.iv is "NOT"	IF "X" IN <u>BOTH</u> BOXES ASK THIS PAGE ALL OTHERS SKIP TO INTRODUCTION AT Q34.
☐	←"X" if Q#?, 12. is "NOT"	

Q31. Please look at CARD I to choose your next answer. [HAND CARD I TO RESPONDENT] Considering everything about the sonic booms in the last six months, would you say that you have been not at all annoyed by sonic booms, slightly annoyed by sonic booms, moderately annoyed by sonic booms, very annoyed by sonic booms or extremely annoyed by the sonic booms?

Q31
1. NOT AT ALL ANNOYED→ [SKIP TO Q#?, 37.]
2. SLIGHTLY ANNOYED
3. MODERATELY ANNOYED
4. VERY ANNOYED
5. EXTREMELY ANNOYED
6. DON'T KNOW→ [SKIP TO Q#?, 37.]

9 Missing
• NA

[TAKE BACK CARD]
Here is a practice card to get you ready for our comparison question which I'll get to in a minute [HAND CARD H TO RESPONDENT]. For this card you compare the lengths of all the other lines to the first line, the baseline, which has a score of 100. The longer the line, the higher the number you will give it. For example if a line appears to be about twice as long as the baseline, you would give it a number of 200. If it appears to be a quarter as long, you would give it a number of 25. Don't worry about being too exact. We only need your general impression. If you are ready, lets start.

Q32. Compared to the baseline with a number of 100, what number would you give to line (...A..)?

["How about line (...)?"]

> IF RESPONDENT DOES NOT GIVE NUMBERS LESS THAN 100 FOR LINE A OR GREATER THAN 100 FOR LINE B THEN GIVE SOME COACHING ON THESE LINES. IF THE RESPONDENT STILL CAN NOT CHOOSE LARGER OR SMALLER NUMBERS THAN 100 AND SEEMS TO BE UNCOMFORTABLE, THEN MARK THE 'NOT COMPLETED' BOX, THANK FOR COOPERATION AND SKIP TO Q #?, 37..
>
> POSSIBLE COACHING INSTRUCTIONS FOR LINE A:
> "Can I just check to be sure my instructions were clear? Is your line A shorter or longer than the baseline. [PAUSE FOR "shorter"]. About how much shorter would you say, maybe a half or a third or a quarter? [PAUSE FOR ANSWER] So since the baseline is 100, you will want to give a number less than 100 to line A. What number would you say is about right for line A?"

ENTER RESPONDENT'S SCORES IN PARENTHESES AT LEFT:

For variables Q32A - Q32G:
997 Unable to answer question
998 Don't know
999 Missing
• NA

	Baseline (100)	**Baseline**
Q32A	A ( )	**A**
Q32B	B ( )	**B**
Q32C	C ( )	**C**
Q32D	D ( )	**D**
Q32E	E ( )	**E**
Q32F	F ( )	**F**
Q32G	G ( )	**G**

○ CHECK HERE IF NOT COMPLETED AND THEN SKIP TO Q#?, 37..

That was very good, just what we need. Now for another kind of baseline.

Q33. For this next question, you compare things against a baseline of how you feel about sonic booms around your home. This time, your feeling that you are ...(ANSWER TO Q#?, 31.)... annoyed by sonic booms is scored one hundred. Use the sonic boom score of one hundred to measure everything else. For example, if you think you would be twice as annoyed by some other noise, give that other noise a score of two hundred. If you think you would be half as annoyed by the other noise, give that noise a score of fifty, and so on. There is no upper limit: use <u>any</u> number as long as it shows your annoyance. If <u>you</u> would not be at all annoyed by something, give it a score of zero.

So, compared to the sonic booms around here with a score of one hundred, what score would you give to ...(having a dog next door that regularly barks in the middle of the night) ...?

[SKIP TO MARK ANSWERS IN GRID FOR Q#36. ON PAGE 139 AND CONTINUE FROM THERE WITH THE ENTIRE GRID.]

ASK IF EVER ANNOYED BY SONIC BOOMS SKIP ONLY IF BOTH BOXES MARKED "X" AT Q?, 31.

Here is a practice card to get you ready for our comparison question which I'll get to in a minute [HAND CARD H TO RESPONDENT]. For this card you compare the lengths of all the other lines to the first line, the baseline, which has a score of 100. The longer the line, the higher the number you will give it. For example if a line appears to be about twice as long as the baseline, you would give it a number of 200. If it appears to be a quarter as long, you would give it a number of 25. Don't worry about being too exact. We only need your general impression. If you are ready, lets start.

Q34. Compared to the baseline with a number of 100, what number would you give to line (...A..)?

["How about line (...)?"]

IF RESPONDENT DOES NOT GIVE NUMBERS LESS THAN 100 FOR LINE A OR GREATER THAN 100 FOR LINE B THEN GIVE SOME COACHING ON THESE LINES. IF THE RESPONDENT STILL CAN NOT CHOOSE LARGER OR SMALLER NUMBERS THAN 100 AND SEEMS TO BE UNCOMFORTABLE, THEN MARK THE 'NOT COMPLETED' BOX, THANK FOR COOPERATION, ASK QUESTION #35. THEN SKIP TO Q #?, 37.. POSSIBLE COACHING INSTRUCTIONS FOR LINE A: "Can I just check to be sure my instructions were clear? Is your line A shorter or longer than the baseline. [PAUSE FOR "shorter"]. About how much shorter would you say, maybe a half or a third or a quarter? [PAUSE FOR ANSWER] So since the baseline is 100, you will want to give a number less than 100 to line A. What number would you say is about right for line A?"

ENTER RESPONDENT'S SCORES IN PARENTHESES AT LEFT:

For variables Q34A - Q34G:

997 Unable to answer question
998 Don't know
999 Missing
• NA

	Baseline (100)	——Baseline——
Q34A	A ( )	——A——
Q34B	B ( )	————B————
Q34C	C ( )	-C-
Q34D	D ( )	——————D——————
Q34E	E ( )	———E———
Q34F	F ( )	—F—
Q34G	G ( )	————G————

○ CHECK HERE IF NOT COMPLETED: ASK Q#35. AND THEN SKIP TO Q#?, 37..

That was very good, just what we need. Now for another kind of baseline.

Q35. Please look at CARD I to choose your next answer. [HAND CARD I TO RESPONDENT] Considering everything about the sonic booms in the last six months, would you say that you have been not at all annoyed by sonic booms, slightly annoyed by sonic booms, moderately annoyed by sonic booms, very annoyed by sonic booms or extremely annoyed by the sonic booms?

Q35 1. NOT AT ALL ANNOYED→ [SKIP TO Q#?, 37.]
2. SLIGHTLY ANNOYED
3. MODERATELY ANNOYED
4. VERY ANNOYED
5. EXTREMELY ANNOYED
6. DON'T KNOW→ [SKIP TO Q#?, 37.]
9 Missing
• NA

[TAKE BACK CARD]

SKIP <u>ONLY IF</u> BOTH BOXES MARKED "X" AT Q?, 31. OR DID NOT COMPLETE PRACTICE LINES

[SKIP INSTRUCTIONS MAKE YOU SKIP THIS QUESTION IF NEVER ANNOYED BY SONIC BOOMS OR IF DID NOT COMPLETE PRACTICE LINES]

Q36. For this next question you compare things against a baseline of how you feel about sonic booms around your home. This time your feeling that you are ...(ANSWER TO PREVIOUS QUESTION)... annoyed by sonic booms is scored one hundred. Use the sonic boom score of one hundred to measure everything else. For example if you think you would be twice as annoyed by some other noise, give that other noise a score of two hundred. If you think you would be half as annoyed by the other noise, give that noise a score of fifty and so on. There is no upper limit: use <u>any</u> number so long as it shows your annoyance. If <u>you</u> would not be at all annoyed by something give that a score of zero.

So, compared to the sonic booms around here with a score of one hundred, what score would you give to ...(having a dog next door that regularly barks in the middle of the night) ...?

For variables Q36I - Q36XVI:
99997 99997 or more
99998 Don't know
99999 Missing
• NA

	SCORE
i. having a dog next door that regularly barks in the middle of the night **Q36I**	
And compared to the sonic booms with a score of 100, what score would you give to..	
ii. having a front door that squeaks **Q36II**	

If you do not have some of these things we mention, just imagine what they might be like. Now, compared to the sonic booms with a score of 100, what score would you give to..	
iii. having unhealthy air pollution in the area **Q36III**	☐☐☐☐☐
iv. hearing big noisy trucks if you lived at a busy intersection **Q36IV**	☐☐☐☐☐
v. having cars often pull into your driveway to turn around **Q36V**	☐☐☐☐☐
And still compared to the sonic booms with a score of 100, what score would you give to..	
vi. having a junkyard business that you can see from your house **Q36VI**	☐☐☐☐☐
vii. having a smoke detector that goes off at least once a week when someone is cooking **Q36VII**	☐☐☐☐☐
viii. having a sticky window that's hard to open **Q36VIII**	☐☐☐☐☐
And still compared to the sonic booms with a score of 100, what score would you give to..	
ix. having a neighbor with power tools that sometimes make your TV picture flicker **Q36IX**	☐☐☐☐☐
x. having a pothole in the street near your house **Q36X**	☐☐☐☐☐
xi. being so near a noisy, busy highway that you must raise your voice in the yard **Q36XI**	☐☐☐☐☐
xii. having mice in your house **Q36XII**	☐☐☐☐☐
And still compared to the sonic booms with a score of 100, what score would you give to..	
xiii. a neighbor's security light that shines into your bedroom **Q36XIII**	☐☐☐☐☐
xiv. being occasionally woken up by a neighbor's car with a bad muffler **Q36XIV**	☐☐☐☐☐
xv. having a neighbor whose drink cans get onto your property **Q36XV**	☐☐☐☐☐
xvi. the telephone calls you get from salespeople at home **Q36XVI**	☐☐☐☐☐

Q37. In 1969, people in nine cities looked at this next thermometer to tell us about noise. [HAND CARD J TO RESPONDENT] Now you can use it for the sonic booms here. On this thermometer, zero means "not at all annoyed" and four means "extremely annoyed". Considering everything about the sonic booms in the last six months, what number shows how much you are bothered or annoyed by the sonic booms?

Q37

0	1	2	3	4	**9**	**●**
NOT AT ALL ANNOYED				EXTREMELY ANNOYED	**Missing**	**NA**

Q38. Do you happen to know whether most of the sonic booms around here come from military jets or from commercial airline jets?

Q38
1. MILITARY
2. COMMERCIAL
3. BOTH (VOLUNTEERED)
4. DON'T KNOW

9 Missing
● NA

Q39. What would you guess are the <u>main</u> purposes of those sonic boom jet flights; are they to train pilots, test airplanes, carry passengers, something else, or don't you know? (CIRCLE ALL THAT APPLY)

For variables Q39 1 - Q39 5:
0 Not a purpose
1 Purpose
9 Missing
● NA

Q39 1 1. TRAIN PILOTS
Q39 2 1. TEST AIRPLANES
Q39 3 1. CARRY PASSENGERS
Q39 4 1. SOMETHING ELSE (Describe) **Q39 4A See Other Purpose of Booms List**
Q39 5 1. DON'T KNOW

Q40. Do you know what airfield most of the sonic boom jets fly from? (CIRCLE ALL THAT APPLY.)

For Q40 1 - Q40 7:
0 Not circled
1 Circled
9 Missing
● NA

[DO NOT READ ANSWERS]
Q40 1 1. EDWARDS
Q40 2 1. CHINA LAKE
Q40 3 1. FORT IRWIN
Q40 4 1. MOJAVE
Q40 5 1. GEORGE AIR FORCE BASE
Q40 6 1. OTHER (Where?) **See Other Airfield List Q40 6A**

a. Do you or anyone in your household happen to work for the airfield or for a company that does business for them?

Q40A
1. FOR AIRFIELD
2. FOR COMPANY
3. NEITHER

9 Missing
● NA

Q40 7 1. DO NOT KNOW ⇓[SKIP TO NEXT Q]⇓

☐	←"X" IF Q#8.c.iv IS "NOT HEAR OR DON'T KNOW" WHETHER HEAR SONIC BOOMS	CONTINUE BUT SKIP f. AND g. BELOW

ASK ALL [EVEN IF DO NOT HEAR BOOM]

Q41. Use CARD K to tell me how much you agree or disagree with the next statements. [HAND CARD K TO RESPONDENT] The first is about defense.

a. To what extent would you agree or disagree that...(a strong, well-equipped military is important for the United States)...? Would you agree very much, agree moderately, agree a little, disagree a little, disagree moderately, disagree very much, or do you not have an opinion?

For variables Q41A - Q41E: 9 **Missing** **For variables Q41F - Q41G:** 9 **Missing**; • **NA**	AGREE			DISAGREE			DON'T KNOW
	VERY MUCH (1)	MODER ATELY (2)	A LITTLE (3)	VERY MUCH (4)	MODER ATELY (5)	A LITTLE (6)	NO OPINI ON (8)
a. A strong, well-equipped military is important for the United States **Q41A**	VERY 1	MOD 2	LITTLE 3	VERY 4	MOD 5	LITTLE 6	DK 8
b. The military flights in this area are important for national defense **Q41B**	VERY 1	MOD 2	LITTLE 3	VERY 4	MOD 5	LITTLE 6	DK 8
c. It is important for the United States to have those military supersonic aircraft that make the sonic booms **Q41C**	VERY 1	MOD 2	LITTLE 3	VERY 4	MOD 5	LITTLE 6	DK 8
d. It is important for the United States to develop a commercial supersonic aircraft that could be used by the airlines **Q41D**	VERY 1	MOD 2	LITTLE 3	VERY 4	MOD 5	LITTLE 6	DK 8
e. A commercial supersonic aircraft would represent the kind of modern progress that should be strongly supported **Q41E**	VERY 1	MOD 2	LITTLE 3	VERY 4	MOD 5	LITTLE 6	DK 8
[SKIP TO Q#42. IF SONIC BOOMS MARKED "NOT HEARD" IN BOX AT TOP OF PAGE]							
f. The pilots flying the jets here could do more to reduce the sonic booms in this area **Q41F**	VERY 1	MOD 2	LITTLE 3	VERY 4	MOD 5	LITTLE 6	DK 8
g. The officials who plan the flights could do more to reduce the sonic booms in this area **Q41G**	VERY 1	MOD 2	LITTLE 3	VERY 4	MOD 5	LITTLE 6	DK 8

Q42. I am going to read you a list of potential threats to the overall quality of the environment. Please use any number from "1" to "7," where "1" means "no threat at all" and "7" means "a large threat" to tell me how much you think each problem threatens the overall quality of the environment. The more you think the problem threatens overall environmental quality, the higher the number you would give it. (PROMPT: How much does . . . (air pollution) threaten the overall quality of the environment?)

For Q42A - Q42E: 9 **Missing**	No threat at all						A large threat	(DON'T KNOW)
a. Air pollution **Q42A**	1	2	3	4	5	6	7	(8)
b. The pollution of our rivers lakes and streams **Q42B**	1	2	3	4	5	6	7	(8)
c. Acid rain **Q42C**	1	2	3	4	5	6	7	(8)
d. Global warming from the greenhouse effect **Q42D**	1	2	3	4	5	6	7	(8)
e. Using additives and pesticides in food production **Q42E**	1	2	3	4	5	6	7	(8)

Q43. Using a scale from "1" to "7" where "1" means "do not identify with at all" and "7" means "strongly identify with" please tell me how much you identify yourself with the label "environmentalist."

Q43

Do not identify with at all						Strongly identify with	(DON'T KNOW)	**Missing**
1	2	3	4	5	6	7	(8)	**9**

Now I have a few last background questions

Q44. Do you work away from home?

Q44 1. YES ⇓ 2. NO [SKIP TO NEXT QUESTION] **9 Missing**

a. (PROMPT IF NEEDED) What organization do you work for?
See Organization Respondent Works For List

Q44B b. (PROMPT IF NEEDED FOR NAME OF TOWN OR PLACE) Where is that?
See Where Work List

These next two questions are about how you spend your time on the average weekday from Monday through Friday.

Q45. This first question is about the amount of time you are more than a mile away from home. On the average Monday through Friday during the last six months, about how many hours a day were you at least one mile away from your home?

Q45 (HOURS)/DAY
98 Don't Know
99 Missing

Q46. And on the same average Monday through Friday, did you regularly spend any time out-of-doors right around your house?

Q46 1. NO
2. YES [PROBE IF NECESSARY. About how much time a day?]
9 Missing
Q46 1 :**Q46 2**/DAY
(HOURS: MINUTES)

For variable Q46 1:
99 Missing
• NA

For variable Q46 2:
1 Less than 1 minute
99 Missing
• NA

[ASK ALL]
Q47. Have you ever been in the military or worked for one of the military services?

Q47 1. YES [SKIP TO NEXT Q] 2. NO ⇓ **9 Missing**

Q47A a. Has anyone else living here ever been in the military or worked for one of the military services?

1. YES
2. NO
9 Missing
• NA

Q48. What is your date of birth? **Q48 1** (MONTH) **Q48 2** (DAY) **Q48 3** (YEAR)

For Q48 1 - Q48 3:
98 Don't know
99 Missing (refused)

Q49. Do you have any plans to move away from this house in the next 12 months?

Q49 1. YES ↓ 2. NO [SKIP TO NEXT QUESTION] **9 Missing** **• NA**

a. When do you plan to move? **Q49A 1** (MONTH) **Q49A 2** (YEAR)

For Q49A 1 - Q49A 2:
13 Spring
97 When house sells
98 Don't know
99 Missing

b. How certain are you that you will move? [PROVIDE ENOUGH DETAIL TO DETERMINE WHETHER RESPONDENT IS LIKELY TO BE AVAILABLE FOR CALL BACK INTERVIEW.]

See How Likely To Move List

Q50. Have any of your neighbors or acquaintances and you ever talked together about this study?

Q50 1. YES ↓ 2. NO [SKIP TO NEXT Q] **9 MISSING**

a. About how many times have you talked with them about the study: once or twice, 3 to 5 times, 6 to 10 times or more than ten times?

Q50 1 Form A

1. ONCE OR TWICE
2. 3 TO 5
3. 6 TO 10
4. MORE THAN 10
5. OTHER (DESCRIBE) **See Other Times Talked List**
9. **Missing**

That is the end of the interview. Your answers have been very helpful. This is just the type of information we needed.

Q51. Is there anything more you would like to tell me or are there any questions I can answer for you?

(PARAPHRASE DISCUSSION, IF ANY, IN MARGINAL NOTES)

Q51 **See Other Comments List**

Thank you so much for your help. By answering so many questions you're making it possible to compare 19 studies in other states and countries. We do appreciate your help.

Sometimes our supervisors need to call or write to check on our work. Could you please give me some information so that my supervisor can check on me if necessary?

Q52. What is your telephone number? (_____) _____ - ______

Q53. Who should we ask for when we telephone you? (OBTAIN FIRST AND LAST NAME. CIRCLE "Mrs." or "Miss" ONLY IF VOLUNTEERED BY RESPONDENT.)

Mr.
NAME: Mrs. ____________________
Miss

Q54. (CONFIRM MAILING ADDRESS IF UNKNOWN)

Street or P.O. Box: ________________________________

____

City, State, Zip: ________________________________

In a few months we may want to check with you again to see if anything has changed around here.

Q55. Would it be all right to telephone you back for a few questions if we need to in six months?

Q55
1. YES → THANK RESPONDENT FOR COOPERATION
2. NO [IF INITIALLY SEEMS TO REFUSE BE SURE THAT RESPONDENT UNDERSTANDS THE REQUEST. GENTLY DETERMINE THE REASON FOR ANY REFUSAL.]

[THANK RESPONDENT]

TIME END

ENDHR 99 Missing

ENDMN 99 Missing

COMPLETE THE FOLLOWING ITEMS AFTER CONCLUDING THIS INTERVIEW AND BEFORE BEGINNING THE NEXT INTERVIEW

Q56

Q56. SEX OF RESPONDENT
1 MALE
2 FEMALE
9 Missing

Q57

Q57. DID THE RESPONDENT'S HEARING CAPACITY SEEM TO BE:

1. NORMAL 2. MODERATELY DIMINISHED↓ 3. SEVERELY DIMINISHED↓
9 Missing

[IF DIMINISHED] DESCRIBE EXTENT OF PROBLEM

Q57 1 See Hearing Diminished List

Q58

Q58. INTERVIEWING METHOD
1. FACE-TO-FACE
2. TELEPHONE
9 Missing

Q59

Q59. TYPE OF DWELLING
1. MOBILE HOME, TRAILER
2. SINGLE DWELLING UNIT STRUCTURE
3. MULTIPLE DWELLING UNIT STRUCTURE
4. OTHER (DESCRIBE) **See Other Dwelling List**
9 Missing

Q60. OTHER BUILDINGS ON PROPERTY (CIRCLE ALL THAT APPLY)

For Q60 1 - Q60 4:
0 Not circled
1 Circled
9 Missing

Q60 1 1. NONE
Q60 2 1. DETACHED GARAGE
Q60 3 1. BARN OR OTHER BUILDING FOR LIVESTOCK
Q60 4 1. OTHER (DESCRIBE) **See Other Buildings List** **Q60 4a**

Q61

Q61. RACE (BY OBSERVATION ONLY)
1. WHITE
2. BLACK
3. AMERICAN INDIAN
4. OTHER (DESCRIBE)
5. MEXICAN/MEXICAN-AMERICAN/HISPANIC
6. PHILIPPINO
7. ASIAN
9 Missing

Q62

Q62. HOW GOOD WAS THE RESPONDENT'S UNDERSTANDING OF THE QUESTIONS?
1. ABOUT AVERAGE OR BETTER THAN AVERAGE
2. SOMEWHAT WORSE THAN AVERAGE
3. MUCH WORSE THAN AVERAGE
9 Missing

Q63

Q63. IS THERE ANYTHING ELSE THAT SHOULD BE CONSIDERED WHEN CALLING BACK?
0 = NOTHING
1 = SOMETHING

BLDNGNUM

Number of dwelling units in building

BLDGCONS

Q64. BUILDING CONSTRUCTION
1. FRAME
2. BRICK
3. MOBILE
4. OTHER (Describe) **See Other Construction List** (Adobe, Log, etc.)
5. STUCCO

DISTANCE

Q65. DISTANCE TO NEXT INHABITED BUILDING
____________________ FEET

AG

Q66. AGRICULTURAL PROPERTY
1. NO AGRICULTURE, INCULDES HOMES WITH GARDENS
2. YES, FARM OR RANCH ON PROPERTY
3. RESIDENTIAL BUT SOME LIVESTOCK ON PROPERTY (i.e. horses, chickens, etc.)

See Anything Else to Consider List

PHRASES TO USE IF COMPLAIN ABOUT REPETITIOUS QUESTIONS:
FOR SLIGHT COMPLAINT: Even though all of our the questions are slightly different, I know a few of them can seem similar for people in special circumstances like yourself. When any seem repetitious for you, just give me a quick answer and we will move right along to other questions.
FOR MORE ELABORATE COMPLAINT: I know a few of these questions may be a bit repetitious for you. However, they were all really carefully selected and are all somewhat different. Perhaps you would like to know why we need to ask all of them. There is one main reason. To make your answers about noise really useful, we have to compare your answers to the answers that other people in others studies gave about their areas' noises. The problem is that each of these other studies used slightly different questions. Some asked about day and some about night. Some showed people lists of words and some a thermometer. We have to ask you each of those slightly different questions to be sure that your opinion will count in a comparison with each of the other studies. If any more of the questions seem repetitious to you, just give me a quick answer and I'll go right on.

OUTBLDG Other outbuildings on property
- 1 **None**
- 2 **Garage**
- 3 **Larger-barn or larger than garage**

NOISE90 Highest noise 90% of the time
- 1 **Respondent's road traffic**
- 2 **Respondent's main road traffic**
- 3 **Natural sounds**
- 4 **General**
- 5 **Other**

NOISE50 Highest noise 50% of the time
- 1 **Respondent's road traffic**
- 2 **Respondent's main road traffic**
- 3 **Natural sounds**
- 4 **General**
- 5 **Other**

NOISE10 Highest noise 10% of the time
- 1 **Respondent's road traffic**
- 2 **Respondent's main road traffic**
- 3 **Natural sounds**
- 4 **General**
- 5 **Other**

ID Unique identifier
HID and PID

SURVFORM (Text)	Survey Form		
		A	**Version A**
		B	**Version B—reinterview of previous respondent**
ROUND	Survey Data Collection Phase		
		1	**Nellis—Phase I—Nevada**
		2	**Nellis—Phase II—Nevada**
		3	**Edwards—Phase I—California**
STATUS2	Sampling status		
		1	**PI - Single**
		2	**PI - Multiple**
		3	**PI - Second adult**
		4	**NC - Single**
		5	**NC - Multiple**
		6	**NC - Second adult**
		7	**Vacant - Single**
		8	**Vacant - Multiple**
		9	**Vacant - Second adult**
		10	**Refusal - Single**
		11	**Refusal - Multiple**
		12	**Refusal - Second adult**
		13	**New HU - Single**
		14	**New HU - Multiple**
		15	**New HU - Second adult**
		16	**OOS - Single**
		17	**OOS - Multiple**
		18	**OOS - Second adult**
STATUS3	Sampling status--Phase 1		
		1	**Phase 1 respondent**
		2	**Second adult--Phase 1 respondent HU**
		3	**Phase 1 nonrespondent**
		4	**New HU**
S084CZ to R36P	Analysis variables, see attached		
TOWNK		**1**	**Moapa**
		2	**Caliente**
		3	**Alamo**
		4	**Hiko**
		5	**Rachel**

TOWNL

1	**Moapa West**
2	**Moapa East**
3	**Caliente**
4	**Alamo**
5	**Hiko**
6	**Rachael**
7	**Lancaster**
8	**Barstow**
9	**Rosamond**
10	**Mojave**
11	**Cal City South**
12	**Cal City North**
13	**N Edwards**
14	**Boron**
15	**Moapa Unknown**

AREA Study area
(Text)

Moapa	Rachel	Hiko	Alamo	Caliente
MK1	RE	HN	AK1	CK1
MK2		HS	AK2	CK2
MK3			AK3	CK3
			AK4	CK4
				CK5
				CK6
				CK7
				CK8
				CK9
				CK10
				CK11
				CK12

CHUNK Section within area
(Text) (see Table 4 in Survey Methodology and User's Guide to the Dataset)

KISHTABL Kish Selection Method Table Used
(Text)

M401 to M4011 Analysis Variables, see attached

CARD A: AMOUNT

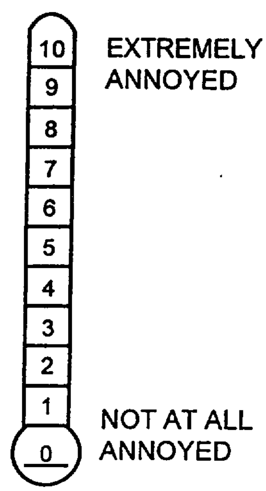
VERY MUCH

MODERATELY

A LITTLE

NOT AT ALL

CARD B: OPINION THERMOMETER



CARD C: HOW OFTEN

SEVERAL TIMES A WEEK

SEVERAL TIMES A MONTH

SEVERAL TIMES IN 6 MONTHS

ONLY ONCE IN 6 MONTHS

NEVER

CARD D

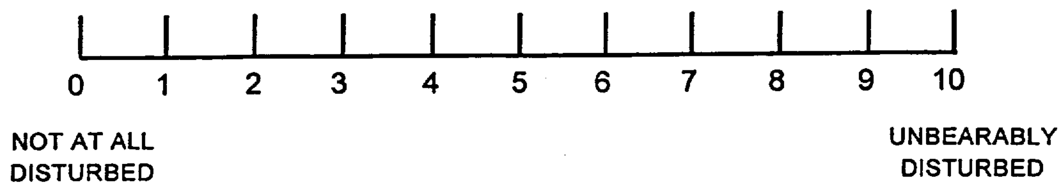
VERY CERTAIN

MODERATELY CERTAIN

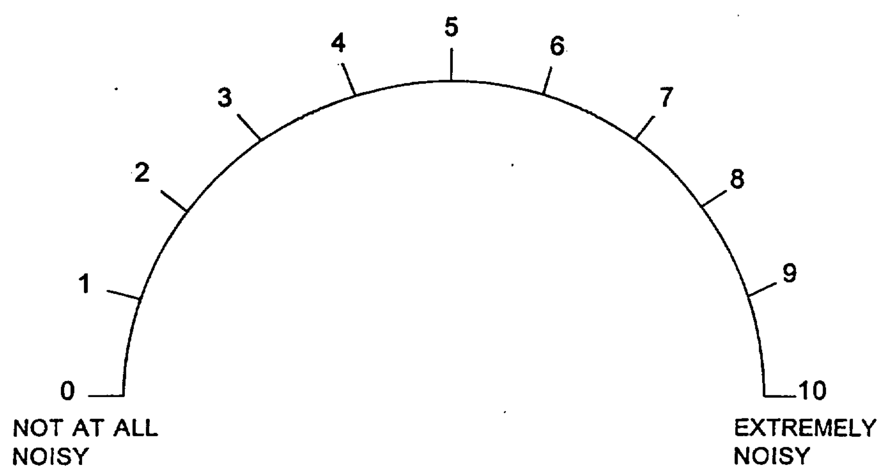
MODERATELY <u>UN</u>CERTAIN

VERY <u>UN</u>CERTAIN

CARD E: DISTURBANCE SCALE



CARD F: NOISINESS METER



CARD G: MOST DISTURBING FOR YOU

THE RATTLES AND VIBRATIONS

BEING STARTLED OR SURPRISED

THE POSSIBILITY OF DAMAGE

THE NOISINESS OF THE SOUNDS

SOMETHING ELSE

CARD H: PRACTICE CARD

Baseline (100)

A

B

C

D

E

F

G

CARD I

NOT AT ALL ANNOYED

SLIGHTLY ANNOYED

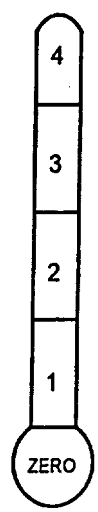
MODERATELY ANNOYED

VERY ANNOYED

EXTREMELY ANNOYED

CARD J: HOW MUCH SCALE

EXTREMELY



NOT AT ALL

CARD K: AGREE/DISAGREE

AGREE VERY MUCH

AGREE MODERATELY

AGREE A LITTLE

DISAGREE A LITTLE

DISAGREE MODERATELY

DISAGREE VERY MUCH

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13. ABSTRACT *(Maximum 200 words)*
A combined social survey and noise measurement program has been completed in 14 communities in two regions of the western United States that have been regularly exposed to sonic booms for many years. A total of 1,573 interviews were completed. Three aspects of the sonic booms are most disturbing: being startled, noticing rattles or vibrations, and being concerned about the possibility of damage from the booms. Sonic boom annoyance is greater than that in a conventional aircraft environment with the same continuous equivalent noise exposure. The reactions in the two study regions differ in severity.

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