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Theory and Design Tools for Studies of Reactions to Abrupt Changes in Noise Exposure

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ABBREVIATIONS AND SYMBOLS

Exact definitions of noise indices and scales for acoustical measurements can be found in general acoustical reference publications (e.g., Bennett and Pearsons, 1981). The units in which quantities are expressed are enclosed in square brackets.

A_i Annoyance with noise expressed by individual i

B_0 Constant - (Extrapolated annoyance at 0 dB noise exposure) [Annoyance scale units]

dB Decibel

B_{Dw} Level-dependent change penalty for Wave w: Annoyance associated with a 1-decibel abrupt-change in noise exposure at the time of study wave w [Annoyance scale units]

B_{D0} Level-dependent change penalty at time= 0: Extrapolated annoyance associated with a 1-decibel abrupt-change in noise exposure at time T=0 (day of the change) [Annoyance scale units]

B_L Annoyance associated with a 1-decibel difference in steady-state noise exposure (positive values indicate that annoyance increases with noise level) [Annoyance scale units]

B_{PANEL} Panel effect: Annoyance at the time of follow-up interviews that is associated with being a member of a study panel.

B_T Decay exponent: A multiplicative constant in an exponent for e that represents the reduction in annoyance associated with the time (expressed in days) that has elapsed since an abrupt change in noise exposure

B_{Ww} Noise change novelty penalty for wave w: Annoyance associated with the novelty of a change in noise exposure in study wave w

C_i — A dummy variable that is 1 for individual i after experiencing a change in noise exposure and 0 otherwise

dBEAU — Decibel Equivalent Units. This expresses annoyance effects in terms of the number of decibels that would create an equivalent effect by dividing an effect (expressed in annoyance units) by the amount of increase in annoyance (expressed in annoyance units) that is associated with a one-decibel increase in steady-state noise exposure.

DNL — Day-night Average Sound Level [dB(A)]

D_i — The abrupt change in noise exposure for individual i [dB]

e — The base for the natural logarithm (2.7183)

L_i — Noise exposure for individual i [dB]

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

L_{dn} — Day-night Average Sound Level (DNL) [dB(A)]

$PANEL_i$ — A dummy variable that is 1 for an individual who has been previously interviewed in a panel survey and 0 otherwise

PSU — Primary Sampling Unit: The sampling unit at the first stage of a multi-stage sample (usually the study area in a noise survey)

T_i — Time elapsed since the abrupt change in noise exposure for individual i [days]

U_{gpi} — Combined effect of response errors from the group, person and interview [Annoyance scale units]

U_g — Community Group effect: The effect of a community location on annoyance (normally distributed with mean of U_g=0) [Annoyance scale units]

U_p — Persistent Person effect: The effect of the person (those effects that are constant for the period of the study) on annoyance within a community (normally distributed with mean of U_p=0) [Annoyance scale units]

U_i — Specific interview effect: The effect of the conditions at the time of the interview on annoyance within a person and group (normally distributed with mean of U_i=0) [Annoyance scale units]

V_0 — Noise change novelty penalty at time=0: Extrapolated novelty effect (increment in annoyance) for an abrupt change in exposure on the day of a change (T=0) [Annoyance scale units]

W_{wi} — A dummy variable that is 1 for individual i in wave w and 0 otherwise

EXECUTIVE SUMMARY

Previous studies of airport community residents' reactions to long-term, aircraft noise environments have provided data for widely-accepted environmental noise planning tools. However, studies of residents' reactions to new, abrupt changes in aircraft noise environments have not provided a firm basis for planning. A previous NASA report found that studies of reactions to changed noise environments have been difficult to execute with sufficient precision to be useful for policy purposes. An extensive search for all previous noise-change study data sets that was conducted for this report discovered that none of the available, original data sets provide a satisfactory basis for new analyses of the effects of an abrupt change in aircraft noise exposure. This report presents a plan for a new study of reactions to changes in aircraft noise and presents a study design evaluation tool that can be used to evaluate candidate study sites.

A study of residents' reactions to abrupt changes in aircraft noise exposure is proposed that has the statistical goal of being sufficiently precise to detect any overreaction to a changed noise environment that is the equivalent of a five-decibel difference in steady-state noise exposure. The twenty-seven elements of the proposed study design include social and acoustical surveys at the same airports before and after changes in noise exposure.

New analyses of the original data from previous community reaction surveys provide the basis for the study plans. New analyses of data on seasonal effects determined that residents' reactions to noise are influenced by the season of the year and thus lead to the recommendation that the surveys before and after a change in noise exposure be conducted at the same time of year. Analyses of the original data from six previous surveys with panel designs determined that re-interviewing the same respondents at a one-year interval would increase the precision of a survey without biasing respondents' answers.

Questionnaires for a noise change study have been developed and pretested in communities that experienced or expected to experience abrupt changes in aircraft noise exposure. A program for monitoring publicity during a noise-change period was developed based on evaluations around three airports.

A model for reactions to changes in aircraft noise is proposed. The primary variables are the pre-change noise environment, the extent of change in the noise environment, and the length of time that has elapsed since the change. An analysis has been conducted of previous surveys that demonstrates a method for estimating the parameters in the model.

A study simulation computer program for evaluating alternative study plans for new abrupt change studies has been developed. This study evaluation tool predicts the precision of estimates of two parameters in a noise change model and measures the effects of errors in noise

measurements on the estimates of parameters in the noise change model. The human response parameters that are input to the evaluation tool come from an analysis of 21 previous noise surveys.

An exhaustive search was conducted to locate all satisfactory sites for a noise change study within the United States in 1998. On the basis of simple criteria all but two sites were eliminated as possible candidates. The data on the population distribution and expected noise exposures was analyzed for these two sites using the study evaluation tool. The tool determined that one site could not provide sufficiently precise estimates to meet the study design criterion. Although the precision expected from the second site was sufficient to meet the study goals, the change in operations at the airport was scheduled to occur gradually over a one-year period and thus was not suitable for a study of reactions to abrupt changes in aircraft noise.

Although no suitable site was found for a study in 1998, the study plans, questionnaire, and survey evaluation tool can be used to support a study in the future.

1.0 INTRODUCTION

Residents' reactions to the long-term noise environments near their dwellings have been widely studied. Several hundred studies have been conducted in which residents' reactions, measured in social surveys, have been related to the long-term noise environments, as measured in acoustical surveys and noise estimation programs (Fields, 1991). Estimates of noise reactions under these settled environmental conditions are now widely available for environmental noise planning purposes (Schultz, 1978; Fidell, Barber, and Schultz, 1991). However, very little satisfactory information is available about reactions to changing noise environments. As a result there is no widely-accepted basis for predicting the reactions of residents to recently changed noise environments.

Although more than 23 studies have been conducted of reactions to recently changed noise environments, a review has found that these studies have not provided solid, consistent evidence about reactions to such changing environments (Horonjeff and Robert, 1997). Many of the problems in generating strong evidence can be traced to weaknesses in the studies' designs and to the choice of fundamentally unsuitable study locations. This report presents methods for avoiding or mitigating such problems.

The purpose of the present report is to develop and demonstrate study design and site selection principles for studies that will satisfactorily estimate the impact of changes in noise exposure on residents' reactions to noise. The report seeks to achieve this goal by describing the elements of a strong noise-change study design demonstrating the use of suitable analysis techniques on existing data sets and developing and using several elements to select and evaluate study sites.

Knowledge about reactions to changed noise environments is of practical importance. Information about reactions to changed noise environments is needed for planning for changed airport operations. Many airports follow guidelines or regulations that define acceptable noise exposures on the basis of long-term noise exposure. Such guidelines or regulations either implicitly or explicitly posit a dose/response relationship between residents' reactions and their noise exposures. The primary purpose of this project is to develop studies that can determine whether that "steady/state" dose/response model also applies to the prediction of residents' reactions after an abrupt change in noise exposure or whether a different model is needed to describe reactions after an abrupt change in noise exposure. The pragmatic question that responsible authorities need answered is: "Can authorities use their current, accepted dose/response curve for planning that involves new noise exposures, or is some adjustment needed when there is a change in noise exposure?"

1.1 Definition of the noise-change issue

The purpose of the noise/change studies by this report is to estimate the incremental change in residents' annoyance to a noise source that is caused by an abrupt change in noise exposure. This is labeled an "abrupt change effect." The primary focus is on the abrupt change effect in an airport environment when the change represents an increase in noise exposure. The generality of this report's results are discussed in this section.

The proposed study designs concern abrupt changes in noise exposure in which a transition to a new noise environment is completed within a few days or weeks after which a new steady-state noise environment is established. The underlying study design principles could be modified to encompass changes that occur over a long period of perhaps a year. However, a different approach would be needed for the more general case in which there is a slow incremental increase in transportation noise over many years due to slowly increasing volumes of traffic.

The responses to noise that are studied are residents' attitudes, feelings and, to a lesser extent, behaviors as measured in social surveys. Although there are frequent references to the term "annoyance," the most widely studied reaction to noise, the study principles should also be applicable to many other types of attitudes, feelings or behaviors that are related to noise.

In this report no attempt is made to explain the highly visible, public reactions to planned changes in noise environments that occur before the environment changes. These are types of reactions that are, of course, of concern to airport planners. Such public reactions are often seen as evidence that changed noise environments will generate unusually strong annoyance reactions once a change in noise environments is introduced. The purpose of this report is to examine those post-change, private annoyance reactions to newly changed noise environments, not the visible, public reactions to plans for changes.

The abrupt change effect is a measure of a change in the dose-response relationship. A noise environment can change and individuals can recognize that change and adjust their reactions to the new environment without any abrupt change effect being present. The abrupt change effect is the change in noise annoyance that is in addition to the amount of annoyance that is predicted to a steady-state noise of the same noise level. The term "steady-state" noise refers to a noise environment in which the pattern of noise exposure has not been subject to substantial changes over a long period of several years. In most large airport environments such steady-state conditions include many sites with substantial day-to-day variations in noise exposure.

Although this report focuses on increases in noise from aircraft, the proposed plans should be equally applicable for studies of reductions in noise and, with minor modifications, for studies of noise from road traffic, railways and other noise sources. The primary differences in plans for different noise sources concern the physical noise measurement programs.

1.2 Special design problems for noise change studies

Noise change studies are subject to three major special problems in addition to the difficulties in annoyance measurement, noise measurement, and sample selection that are common to most community noise studies. These problems have received special attention in the development of the study plans in this report.

Problem #1: Identifying study sites with large changes in noise environments: Good estimates of the effects of changes in noise environments require that study airports include some environments that have experienced large changes in noise exposures. Several studies of changes in noise environments have been conducted when the planned changes in exposure were too small to have a reasonable probability of being detected (Fidell, Horonjeff, Mills, Baldwin, Teffeteller, and Pearsons, 1985; Fidell, Mills, Teffeteller, and Pearsons, 1982). At least one study was conducted when an increase of only ten percent in traffic was expected (Gjestland Liasjø, Granøien, and Fields: 1990). It is important to realize that many previous steady-state noise studies support the assumption (implicit in LAeq) that a doubling in the number of noise events will be the equivalent of only a barely noticeable, three-decibel increase in individual noise event levels. Areas with small noise changes have been used as study sites because the presence of considerable controversy during planning stages was taken as evidence that there could be substantial effects on individuals' annoyance reactions after the changes. From these past experiences, however, it appears that almost nothing can be learned about the effects of changes in airport operations unless those changes generate considerable changes in noise environments. A seeming contradictory conclusion has been reached by one road traffic study that found that a small reduction in road traffic noise generated a large reduction in annoyance (Kastka, 1980; Kastka, 1981). In this case, however, the reduction in road traffic noise was part of a highly visible set of traffic restrictions that affected other aspects of the local road traffic environment.

Problem #2: Designing study plans that can accommodate uncertain noise environment predictions: Plans for changes in airport operations provide the only available basis for predicting the aircraft noise environment that will be present at the time of a study. Reviews of previous noise-change studies and reviews of the implementation of airport operation plans have, however, revealed that these predictions are often incorrect in the following ways: 1) the timing of the operational change is revised, 2) the type of operational change is revised during one of the planning cycles before an airport opens, 3) the assumptions about types of aircraft or the amount of growth in traffic are incorrect, and 4) experience gained while implementing the operational changes leads to additional unexpected alterations. These incorrect predictions mean that aircraft noise exposures that formed the basis for the study design may not be achieved and that the aircraft operational changes that were expected to generate a single, large, abrupt change in exposure may, instead, generate a series of variably sized changes in exposures that affect different parts of the airport study environment differently.

Problem #3: Measuring and controlling for the effects of correlated variables: The most serious problem facing even the best-designed noise change study is the possibility that other variables that are spatially or temporally correlated with the noise change will distort the estimate of the effects of the change in noise environment. Both of the following two alternative strategies for studying noise change face this problem. Studies that contrast the after-change reactions at one airport with the steady state reactions at other airports can not separate the unique effects of one airport from the effects of the change in noise environments. On the other hand, studies that compare the reactions before and after a change at a single airport must consider the possibility that the comparison is affected by any of a large number of differences between the study methods or other community conditions before and after the change. This report recommends the second strategy, repeated measurements at a study airport. Attempts are made to control for the effects of correlated variables by using exactly the same study methods in the before and after study phases, by monitoring community conditions during the survey period, and by interviewing the same respondents. Nonetheless, all variables can not be controlled and correlated variables continue to pose a serious threat to a study of reactions to changes in noise environments.

2.0 CONCEPTUAL CONTEXT: THEORIES AND TESTING THEORIES IN A NOISE CHANGE STUDY

The design and analysis of a study of reactions to changes in noise levels is guided by an overall conceptual model of the factors that affect residents' reactions to environmental noise in general and to changes in noise exposure in particular. This chapter discusses possible theoretical bases for expecting an abrupt change effect, describes a model of reactions to abrupt change and lists variables that should be measured and analyzed as part of an abrupt change analysis. The primary emphasis of this chapter is on identifying the important variables. This discussion divides those variables into variables that are integral parts of an abrupt change model and those that need to be considered for their theoretical value or because they could confound the estimates of the effects of the primary model variables. Because there are not well-developed theories about the relationships between these variables, relatively little attention is directed at theories about complex forms of relationships.

2.1 Theoretical bases for expecting an abrupt change effect

Previous reports about changes in noise exposure have not offered an explicit theoretical basis for expecting that residents' reactions to recently changed, daily noise environments should be any different from those to steady-state noise environments. It is obvious that reactions will differ on the very first occasion upon which a new noise is heard. However, it is not obvious that such a reaction should persist. It would be useful to have one or more theoretical bases for expecting that residents' reactions after even a short time has elapsed (perhaps one week) should be any different from those of residents who had been exposed to the same noise in their neighborhood for all of their period of residence.

This section lists seven theories that could explain an abrupt change effect. No attempt is made to develop or evaluate these theories. This section also identifies aspects of the study design or questionnaire that are designed to provide some insight into the validity of these theories. The primary purpose of the questionnaire is not, however, to test these theories, but rather to determine whether an abrupt change effect, whatever the explanation, is present.

In considering the theories, notice is taken of the fact that a previous meta-analysis of demographic variables showed that reactions of new residents to the steady-state noise are not different from those of longer-term residents (Fields, 1993). The simple exposure to a new type of noise environment is obviously not sufficient to generate a difference in reactions.

<u>Theory #1: Analogy to short-term attention effects:</u> It is obvious that humans have their attention drawn to new, unusual aspects of their environment. It is frequently observed that visitors in a neighborhood are aware of, or even startled by, the first loud aircraft noise event they hear in a neighborhood, where as a resident may show no signs of even noticing the event. By

extrapolation, it might be expected that "newness" would persist so that people who had experienced a type of aircraft event for one week could have a different reaction than those who had experienced the same type of event for all of the time they lived in the neighborhood. It is not clear, however, that there is a strong theoretical basis for such an extrapolation. It seems possible that the initial, possibly physiologically-based, startle reactions to a new aspect of the environment may disappear after a very small number of repetitions of the event. The apparent attraction to such an extrapolation may owe more to the linguistic ambiguity of terms such as "recent" or "new" ("new" things can be one second or ten years old) than to a careful consideration of the mechanisms involved.

Theory #2: Baseline for noise evaluations: Residents who experience a change to a new noise environment may give that new environment special attention because their baseline for evaluating the noise is their previously-experienced residential noise environment. Residents without such an obvious baseline may, on the other hand, depend more on their personal, day-to-day experiences in evaluating the importance of particular noise events.

Theory #3: Lack of adaptive mechanisms: Residents with long-term exposures may have developed adaptive mechanisms to accommodate the noise exposure. They may routinely stop talking during noise events, adjust the television volume to avoid interferences from noise or have adapted the usage of their house to avoid noise exposure. Residents who are introduced to a rapid change in exposure may not have adopted such mechanisms and thus may experience more activity interference than do residents with long-term exposure. People who move into a high noise area might be more likely to more quickly adopt such mechanisms as a normal part of the process of developing new patterns of living in a new surrounding. For example, new residents might take noise level into account in determining the usage of rooms. Residents with an abrupt change, however, will have already established room-usage patterns that did not account for noise levels. These patterns may be so firmly established by the time a noise change is introduced that the patterns will not be revised to accommodate the change in noise levels. The questionnaire may provide some insight into this theory through questions about the extent to which noise interferes with activities (Q.16).

Theory #3: Realization that noise can be controlled: Beliefs about the "preventability" of noise have been found to be consistently related to noise annoyance (Fields, 1993). When the noise is changed, residents who might otherwise accept their noise exposure as inevitable may realize that noise exposure can be controlled by human actions. The questionnaire explores this theory with a question about whether noise could be reduced by pilots, airline companies, airport officials, or local governments. (Q.20)

Theory #4: Difference between accepting noise when moving to a new home and when the environment changes: People may have selected their residence on the basis of an expected noise environment. If they feel that the imposition of a new, changed noise exposure is an unfair departure from the conditions that they originally, implicitly accepted, they may be more annoyed by the new noise environment. This theory is explored with questions that ask respondents to recall their expectations, if any, about the aircraft noise at the time that they moved to their neighborhood (Q.22).

The gap between the implicitly accepted noise environment and a totally unanticipated new environment noise is a major focus for controversy about changing noise environments. It should be noted, however, that the fairness issue about values (Is it fair to change the noise?) is distinct from the scientific question (Will annoyance with the noise be any different?).

<u>Theory #5: Exposure of sensitive people to high noise:</u> If noise-sensitive people usually avoid or move out of high noise areas, then the shift in noise exposure may result in an unusual condition in which relatively sensitive people are exposed to high noise levels. This theory is partially tested with questions about residents' sensitivities to noise (Q.33, Q.34). A review of published evidence suggests that such an effect may not be present because previous studies have not found a relationship between general sensitivity to noise and environmental noise exposure (Fields, 1992).

<u>Theory #6: Heightened reactions through publicity:</u> Changes in airport noise exposure are often accompanied by heightened publicity surrounding the planning for the change and the implementation of any changes in operations. In addition, local media sources may include articles about the views of those opposing such changes and about the effects of noise. The heightened publicity about noise exposure effects might make residents more aware of the effects of noise than would be expected in a steady-state situation. Information to aid in evaluating this theory is gathered in the questionnaire with questions about exposure to the media (Q.41, Q.42, Q.43), awareness about a planned change (Q.23, Q.24), awareness of an implemented change (Q.12, Q.13, Q.14), and information gained from the media about the change (Q.13.c, Q.13.e). Plans for the proposed study also specify that information about the extent of publicity be gathered through an independent examination of publicity that appears in local media (See Chapter 4).

<u>Theory #7: Resentment concerning the decision-making process:</u> The change in exposure may have occurred after bitter disputes during the planning process for the change. Such resentment and residual bitterness might lead some residents to be more annoyed by the noise than otherwise. This knowledge might be partially disseminated through media sources. Unlike the previous theory, however, the heightened annoyance does not derive from a change in the awareness of noise itself, but rather from feelings about the process that generated that change. The questionnaire explores this issue with a question about the fairness of the decision process (Q.13.f). An independent examination of the community and the context of the change will describe the public controversy and associated issues that could be related to the noise change issues (See Chapter 4).

2.2 Variables to be measured in an abrupt change study

This section describes 17 groups of variables (lettered from "a" to" n") that are recommended for testing models and theories for abrupt change studies. The variables are loosely grouped under three headings. Some of the material in this section was discussed in the earlier NASA contractor's report on noise change studies (Horonjeff and Robert, 1997). The reader is referred to that report for a more detailed discussion of some issues, including a detailed discussion of one possible form of the relationship between annoyance and aircraft noise exposure (Horonjeff and Robert, 1997; 90).

2.2.1 Core variables and assumptions for an abrupt change model

The primary purpose of the present study is to measure and predict the relationship between a reaction to aircraft noise and two factors: 1) the noise level to which a resident is exposed and 2) the changes in noise exposure which the resident has experienced. For simply describing the magnitude of the change this report focuses on four variables. Each of these variables is briefly defined and any of their characteristics that relate to noise change studies are described. The symbol representing each variable in discussions of the abrupt change model appears in square brackets.

a. ***Response:*** A resident's reaction to noise.[A_i]
The residents' reactions to the current noise level are measured in a questionnaire (Q.8.iv, Q.11, Q.16, Q.30, Q.31, Q.38, Q39A, Q39B). A detailed discussion of the rationale for the simple annoyance response measure used in this study is given in the research plan.

b. ***Noise exposure:*** The current noise exposure at the dwelling.[L_i]
The program to estimate that exposure is described in the research plan. The primary emphasis is on the components of the Day-Night Noise Level (DNL).

c. ***Noise change:*** The change in noise exposure. [D_i]
The program for estimating the pre-change noise environment is described in the research plan. A primary, but only partially resolved, issue concerns the aspects of the noise exposure that should be measured other than the equivalent noise levels. The previous report on this project discusses the issue in some detail (Horonjeff and Robert, 1997). The primary problem for aircraft noise is that the considerable variability in flight-to-flight and day-to-day exposures in both the pre-change and post-change "steady state" environments may mean that only a more complex noise metric could measure those characteristics of an aircraft noise environment that respondents will notice.

d. ***Elapsed time:*** The time elapsed between the time of the exposure and the measure of respondents' reactions. [T_i]
Although the time between various events can be easily measured, the representation of the beginning of the period can be uncertain if the change occurred over a transition period and if that transition period included several different types of changes. An additional complication concerns the representation of elapsed time in an abrupt change model. This report accepts a decay model in which the maximum abrupt change effect has been achieved before the time of the

first observation (made at least a week after a change) and decays until it disappears at the time when the dose/response relationship is the same as that observed under the previous steady-state conditions. The report ignores the possibility that it might take a longer time for any overreaction to the change to be expressed. Even given this decay assumption, it is not clear whether the decay should be assumed to be linear, exponential, or of some other form with respect to elapsed time. These issues are left largely unexplored, partly because the presence of seasonal effects and requirement for a large number of interviews would make it difficult to estimate a decay function with any accuracy.

At least three other variables are of importance for studies of noise change generally, but are assumed to be constant for this model:

e. ***Perceived permanence:*** Whether or not the change is perceived to be permanent. This report is only concerned with changes that are expected to be permanent. Some previous studies have focused on temporary changes caused by such features as temporary runway closings due to repairs (Fidell, Horonjeff, Mills, Baldwin, Teffeteller and Pearsons, 1985) or the presence of short-term military exercises (Gjestland, Liasjø, and Granøien, 1995). Reactions to noise environments that are perceived to be transitory could be different from reactions to noises that residents assume will become a part of their neighborhood environment.

f. ***Length of transition:*** The time elapsed from the pre-change steady state to a new steady-state exposure.
This report is directed at abrupt changes in noise exposure. It is assumed that there is a transition from one persistent state to another persistent state, but that the transition period is restricted to a few days or weeks. Reactions to gradual changes over long periods of time might be quite different.

g. ***Geographical extent:*** The size of the area over which the change extends.
This report only considers changes that affect both indoor and outdoor exposure in the respondent's neighborhood. Quite different mechanisms may be involved in changes that occur only indoors (for example, from home insulation) or only in the dwelling's immediate surroundings (for example, from the construction of barriers for road traffic noise).

2.2.2 Explanatory variables with special significance for noise change model estimates

With respect to the general noise-change issue, the following variables might be expected to directly affect estimates of the noise-change effect

h. ***Acoustical characteristics of change:***
As noted above, aspects of the noise in addition to the total energy as represented in DNL could affect reactions to changes in noise and even whether the change in

noise is perceived at all. Recommendations for measuring or documenting such changes are given in the study outline when the noise-measurement program is described. The questionnaire may provide some additional insight when respondents are asked about their perceptions of changes on the noisiest days (Q.32).

i. ***Time at home:*** The amount of time the respondent has spent at home since the change.
An examination of published studies indicates that the amount of time people spend at home does not affect reactions to steady-state noise environments (Fields, 1993). However it is possible that the time at home could affect perceptions of short-term changing noise environments. People who are not at home may not have experienced the changes or not have accumulated enough experience with the new environments to judge whether there has been an overall shift in exposure. The time spent at home on weekdays is asked about in the questionnaire (Q.45).

j. ***Season of interview:*** The time of year at which the interview is conducted.
The evidence reviewed in Appendix E suggests that reactions to noise do vary with the season. A model for seasonal effects is included in that appendix. It is assumed that seasonal effects can not be adequately modeled or estimated in a noise change project and thus that the only solution is to follow procedures that control for seasonal effects through the timing of interviews.

k. ***Repeated interviews:*** The extent to which the respondent has been previously interviewed.
The evidence reviewed in Appendix D indicates that a small number of widely-spaced interviews with the same respondents do not bias the responses to noise. The available data were not sufficiently strong to determine or model any effects that might be present for closely-spaced interviews or a large number of interviews on the same subject.

2.2.3 Explanatory variables of general significance

The dependent variable in any analysis of noise change is the reaction to noise. As a result any variable that affects reactions to noise could be of importance for a noise change study. Controlling for variables that are not correlated with noise change is useful because they could, theoretically, reduce some of the unexplained variance and result in more precise estimates of the elements in a noise/change model. The identification of variables that are correlated with changes in noise exposure is of great importance since their presence could bias estimates of the abrupt change effect. The remainder of this section lists a large number of variables that deserve some attention in a noise-change study.

l. ***Noise-exposure representation:*** Although DNL and 24-hour LAeq are widely accepted as environmental noise metrics, debate continues about whether they correctly represent the various aspects of noise exposure. Estimates of noise-change effects will be biased to the extent that any incorrectly-represented factors are not related to LAeq. The effects of such variables can almost certainly not be determined in a noise-change study, but the measurement and analysis of their presence would make it possible to determine whether misspecification of the noise-exposure model could possibly account for the size of an abrupt change effect. The effort expended on measuring these variables needs to be guided by the size of any expected correlated changes and the expense of monitoring them. The most often mentioned variables include the following:

- Number of noise events
- Duration of individual noise events
- Peak levels of noise events
- Time-of-day of noise exposure
- Other temporal patterns of noise exposure and noise relief (e.g. rest periods)
- Ambient noise levels
- Noise-event onset rates

  Spectral frequency profiles

m. ***Associated aircraft impacts:*** Aircraft operations affect other aspects of the local environment. The changes in operations that generate changes in noise exposure can often have correlated effects on other aspects of the environment that may, in turn, affect reported reactions to aircraft noise. These effects tend to be highly correlated with noise level and to thus be difficult or impossible to evaluate in a single noise-change study. If the variables are almost always correlated with noise level, then understanding their role may be of little practical importance even though they are of considerable theoretical interest. These variables are listed next, along with the question number of questionnaire items that attempt to monitor respondents' perceptions of their impact:

- Odor from aircraft (Perception of "fumes or smells" in Q.17.i)
- Dirt from aircraft (Perception of "dust or dirt" in Q.17.ii)
- Lights from aircraft (Perception of "lights" in Q.17.iii)
- Noise from aircraft on the ground (Reactions to aircraft when they are "sitting on the ground running their engines or moving around the airport"in Q.17.iv)
- Fear of crashes near residences (Q.18)
- Over-head flight paths (Perception of frequency of over-head flights, Q.19)

n. ***Individual and community characteristics:*** A large number of characteristics of respondents have been considered as possible factors that impact reactions to noise. Some demographic variables are routinely controlled because their distribution is likely to be uniform over different communities (for example gender). Demographic characteristics that have been examined in the past have been found to either have no effect or to have only a small effect on annoyance (Fields 1993, Miedema and Vos, 1999) The reliance on a repeated interview design that is described below should serve to control many variables' effects. A serious threat to estimates of the abrupt change effect occurs if there are random differences in the impact of noise in different communities. If these differences affect the ways that communities react to noise, estimates of the abrupt change effect could be biased. If the community differences affect only the reaction to aircraft noise generally, the precision of study estimates could be affected. The increased variability in the study estimates must be estimated with analysis techniques that account for the lack of independence of the respondents' answers in geographically concentrated areas.

The following demographic variables are measured in the recommended questionnaire:

- Gender (Q.5)
- Household composition (Q.5)
- Length of residence (Q.21)
- Length of interview
- Age (Q.47)
- Home ownership (Q.48)
- Amount of time away from home (Q.45)
- Education level (Q.51)
- Employment associated with the airport: (Q.43)
- Relationship to military services (Q.46)

The attitudinal variables include the following:

- General noise sensitivity (Q.33, Q.34)
- Level of concern with environmental issues (Q.40)
- Fear of aircraft crashes (Q.18)
- Perception that aircraft noise can be prevented or controlled (Q.20)

Other personal variables include:

- Attenuation through double-glazed windows (Q.28)
- Plans for moving from area (Q.49)
- Discussion of questionnaire with neighbors (Q.50)

2.3 Abrupt change response model

In the preceding section, four "core" variables for an abrupt change model were identified. The basic abrupt change model used in this report therefore models the relationship between an individual's noise annoyance(A_i) and three variables, the individual's noise exposure (L_i), the amount of the abrupt change in noise exposure (D_i) and the time elapsed since that change (T_i). The discussion of these variables identified uncertainties about how these variables would be related in a response model. In this section, one model is proposed that could serve as a baseline for evaluating other models.

As a baseline model, the relationship between the four core variables is posited to be the following:

$$A_i = B_0 + B_L \bullet L_i + V_0 \bullet e^{(B_T \cdot T_i)} \bullet C_i + B_{D0} \bullet e^{(B_T \cdot T_i)} \bullet D_i + U_{gpi}$$

where:

A_i	Annoyance with noise expressed by individual i
B_0	Constant - (Extrapolated annoyance at 0 dB noise exposure)
B_{D0}	Extrapolated annoyance associated with a 1-decibel abrupt-change in noise exposure at time T=0 (day of the change)
B_L	Annoyance associated with a 1-decibel difference in steady-state noise exposure (positive values indicate that annoyance increases with noise level)
B_T	A multiplicative constant in an exponent for ***e*** that represents the reduction in annoyance associated with the time (expressed in days) that has elapsed since an abrupt change in noise exposure
C_i	A dummy variable that is 1 for individual i after experiencing a change in noise exposure and 0 otherwise
D_i	The abrupt change in noise exposure for individual i [dB]
e	The base for the natural logarithm (2.7183)
L_i	Noise exposure for individual i [dB]
T_i	Time elapsed since the abrupt change in noise exposure for individual i [days]
U_{gpi}	Combined effect of response errors from the group, person, and interview
V_0	Extrapolated novelty effect (increment in annoyance) for an abrupt change in exposure on the day of a change (T=0)

Several aspects of this model should be noted. Annoyance is assumed to be linearly related to the current noise level. Annoyance after a change is a sum of the annoyance predicted in the steady state situation and penalty increments that decay with time.

Two types of penalty increments are included in the model. The first penalty increment [$V_0 \bullet e^{(B_T \cdot T_i)}$] is labeled the novelty effect. This is an increment that is associated with the novel experience of being near an airport after the noise environment has changed. The term V_0 in the model is the extrapolated value of that increment in annoyance on the first day of a change (T=0). The value of the expression $V_0 \bullet e^{(B_T \cdot T_i)}$ is independent of the amount of change experienced but depends upon the amount of time that has elapsed since the abrupt change. This part of the abrupt change effect is the same for individuals experiencing a20-decibel increase, 1-decibel increase or a 20-decibel decrease. The second penalty increment varies with the size and direction of the change in noise exposure. Each decibel increase in noise exposure is assumed to add an additional increment to annoyance of $B_{D0} \bullet e^{(B_T \cdot T_i)}$ at time T_i.

The novelty effect can be conceptualized in several different ways that require different definitions of "C_i," the binary change indicator. For aircraft noise in the analyses in this report, pre-change respondents are assigned a value of 0 and all post change respondents are assigned a value of 1 whether or not the noise level actually changes in a respondent's location. This can be justified either on the basis that a publicity effect would generate a change in reactions or on the assumption that even though there may not have been a change in noise exposure at a location, other changes in aircraft operations might be noticed at that location. An alternative conceptualization is to only assign a value of C=1 to respondents who actually experience a change in exposure. Still another issue concerns the effects of an increase or decrease in exposure. This model assumes that the novelty effect is the same in either instance on the theory that greater awareness of noise will increase reactions. An alternative conceptualization that should be tested in analyses is that the novelty effect is different for decreases and increases in exposure.

As previously noted, this decay function predicts that the decay in response is most rapid immediately after the change and gradually reduces at an ever decreasing rate. The value of B_T is expected to always be negative. As a result the expression $[e^{(B_T \cdot T_i)}]$ is the proportion of the original response increment (from time T=0) that persists until the interview at the specified time (T_i) after the change in exposure. Figure 1 shows the values of this portion of the decay term for a two-year, post-change period (0 to 730 days) for seven values of B_T. At the extremes, a value of B_T=-1.000 implies that the effect of a change almost disappears in 60 days, while a value of B_T= -0.001 implies that the initial effect is retained at about 70 percent of its original value in 365 days and is still present after 730 days when it still retains 50 percent of its original value.

The unexplained variation in annoyance is represented by a single error term in the model above [U_{gpi}]. This single term can, however, be divided into the following three components all of which are assumed to be normally distributed with a mean of zero:

- U_g Community Group Effect: The effect of a community location on annoyance
- U_p Persistent Person Effect: The effect of the person (those effects that are constant for the period of the study) on annoyance within a community
- U_i Specific Interview Effect: The effect of the conditions at the time of the interview on annoyance within a person and group

The community group effect (U_g) represents the substantial variation between groups of respondents than can not be explained by their measured noise exposure or by random differences in individuals' responses. The analyses in Appendix G estimate that the standard deviation of this effect is the equivalent of approximately a seven-decibel difference in noise exposure. For the purposes of the analyses in this report the community group is considered to be the Primary Sampling Unit (PSU), the unit that is sampled at the first stage of a sample design. For most noise studies this is a study area that shares a single assigned noise exposure. A group effect could arise from the interaction between neighbors, publicity in local areas, unmeasured differences between noise exposures in different areas or to any other differences between areas that affect responses

The person effect (U_p) and interview effect (U_i) are evaluated separately for surveys with a panel design in which the same respondents are repeatedly interviewed. The person effect represents the consistency in each individual's response that persists between the repeated interviews. This is a measure of between-individual, but within-group, differences. Most discussions about individual differences in reactions to noise refer to such presumed enduring differences between individuals in their demographic or attitudinal characteristics.

The specific interview effect (U_i) represents the remaining unexplained variation in reactions. This could be a result of wide range of factors including effects of respondents' moods on particular days, recent experiences with noise exposure, errors in understanding questions, or interviewer effects.

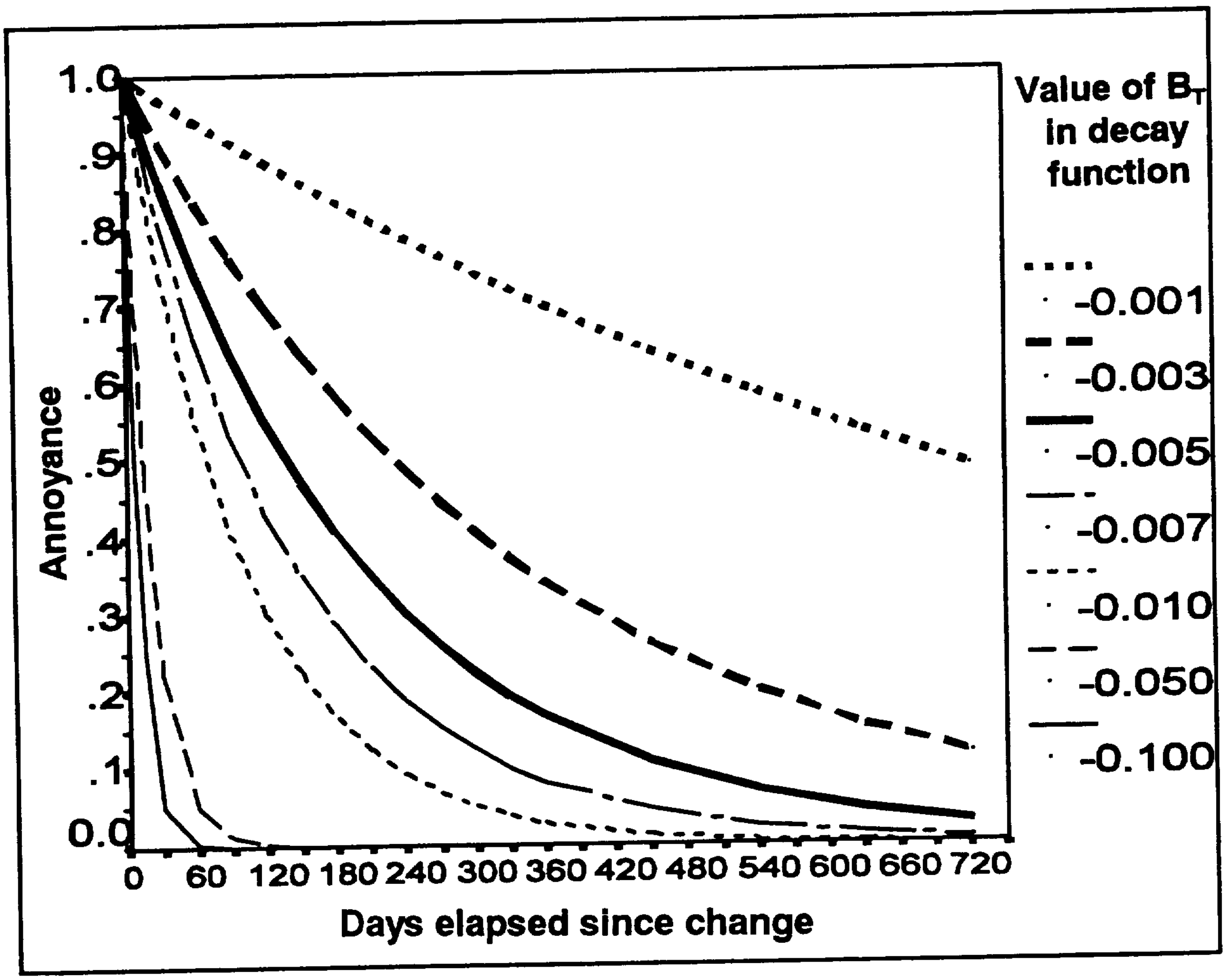

Figure 1 Slopes of the decay function over a two-year period for seven values of B_T

The model presented in this section should be only the starting point for any actual analysis of survey data. With respect to noise-change theories, one of the most important tests would be to determine whether both the novelty effect and the level-dependent change penalty are needed. The model is discussed further in Chapter 5 where an analysis of existing data is conducted.

3.0 DETAILED RESEARCH PLAN

This chapter describes the major elements of the research plan. A careful examination of the details of this plan is needed to understand the costs involved in implementing the research plan. A brief rationale is provided for each element.

3.1 Airport selection and evaluation

The first three elements describe the procedure that is followed to select one or more airports for a noise change study. As was noted earlier, this is one of the three major problems that has weakened previous noise-change studies. Although the discussion focuses on the selection of an individual airport, it should be noted that a stronger study design would include several airports. Similarly, a road traffic study would be strengthened by the inclusion of a large number of road/change situations.

Element #1: ***A comprehensive list of all changing airports in the United States is developed and then subjected to an initial, systematic screening process to develop a short list of candidate airports.***

Details: This element is designed to identify all possible candidate airports in the United States. Two of the essential steps for executing this element are:

1) A data base is established that includes all U.S. airports that have specified types of planned changes within a stated period. This list comes primarily from data bases and planning documents. Airports are entered into this database if any large changes are planned. Whether or not the change will be associated with a change in noise exposure is only assessed in the next screening step.
2) All airports in the data base are then screened using standardized screening criteria. The results of the screening are entered in the data base. Most of the information for this screening phase comes from personal contacts with FAA, military, and airport personnel. This initial, documented screening is based on criteria concerning:
    - a Date of change (must be within the study period)
    - b Size of the expected change in noise exposure (LAeq 24hr or DNL)
    - c Length of transition period (an abrupt change is needed)
    - d Numbers of dwellings exposed to changes in noise exposure

These steps were conducted to attempt to identify candidate airports in 1998. That search procedure is documented in Appendix A. The exact criteria that were applied in that search and the sources of data explored are also described. Almost all of the initial screening at this stage can be conducted by telephone. Extensive sets of telephone calls are needed for the most likely airports to confirm noise/change plans. Short visits of less than a day are conducted for airports where the locations of dwellings are uncertain.

Although only two screening steps are explicitly specified, it is likely that more complex, multi-phase checks will be needed on the accuracy of the information before a final decision is reached. Areas of special concern are the accuracy of the information about the pre-change noise exposure in the 14 months preceding the change, the extent to which published plans for the change are still likely to be implemented, and the distribution of dwellings within the study areas around the airport.

Rationale: This procedure is designed to identify the maximum number of airports that reach certain eligibility criteria rather than to simply identify a fixed number of "acceptable" airports for the following reasons; 1) Multiple study airports are highly desirable for the purpose of reducing the correlated variables problem; 2) An airport that appears to be acceptable in this initial screening phase has a high probability of being rejected or found to be substantially inferior to other airports as a result of the detailed screening process applied at the next stage; 3) Airport operations and study plans are sufficiently volatile that a data base is needed to be able to rapidly assess alternative sites.

Element #2: ***Selection of a study airport is based on the results from a simulation model that predicts whether the available noise environments and numbers of potential respondents are sufficient to provide an accurate estimate of the abrupt change effect.***

Details: This element has been executed for two airports. The evaluation is documented in Chapter 6. Analyses of previous social surveys were conducted to develop a computer program that predicts the accuracy of noise/change study results for alternative study designs (Chapter 6 and Appendix G). Conducting the entire evaluation required in this element is a significant project. The detailed steps are the following:

1) Predict noise levels to the nearest decibel before and after the change in exposure at all populated locations near the airport.
2) Merge a data file of census blocks containing location and population information with the before/after noise change data.
3) Create one or more sample designs that are consistent with the constraints imposed by the noise-level and population distributions in the file.
4) Predict the accuracy of the sample designs by running the study evaluation computer program that reads the data file. (The complexity of this task depends upon the number of alternative designs and noise-response options that are evaluated.)
5) Confirm the availability of the expected numbers of dwellings in the most critical noise situations through an on-site visit in which the dwellings are enumerated within each area. (The timing of this visit depends upon the relative costs of a site visit and the preceding analysis.)

An "accurate estimate" is defined in Element #9 below and further discussed in Element #23.

Rationale: The alternative of choosing the apparently "best" airport using a simpler procedure was rejected because it is judged that a simpler procedure will not give sufficient information to determine whether a study can be expected to succeed. The simulation program is described in more detail in the appendices. The program predicts the sampling errors for estimates of the abrupt/change effect parameter in a noise/change model. These standard errors are predicted in a simulation program that generates several hundred alternative social survey sample outcomes for the levels of response variance that have been identified in previous surveys. As will be noted later, the same program also shows the extent to which specific types and sizes of errors in estimating the noise exposure will bias estimates of the abrupt/change effect parameter. A simulation program is needed because it can readily evaluate the effects of complex sample and statistical error structures that could not be easily modeled with existing statistical theory. Actual population and noise/exposure data are needed from the airports to represent the complexity of the sample design.

Element #3: The cooperation of local airport and FAA officials is obtained for the study.

Details: Local airport and FAA officials will need to provide detailed data about aircraft operations, information on the timing and description of the abrupt change in exposure, and information about any changes in operation patterns during the study period.

Rationale: Examinations of other aircraft operation-change episodes have shown that plans often change and may not be publicized. The information that is needed for estimating the noise exposure during the study period is sufficiently detailed that it could not be economically obtained from any other source than the airport authorities.

3.2 Fundamental study-design elements for measuring the abrupt change effect

The next six elements describe the variables and procedures that are contained in a social survey to give an operational definition of the noise change effect. Analysis methods are not specified here but are illustrated in a later chapter.

Element #4: The definition of the abrupt change effect is the difference between the after-change annoyance at a specified noise level and the annoyance that would occur at the same noise level under steady state conditions.

Details: This difference is expressed in units of annoyance scales as well as in terms of the number of decibels that would generate an equivalent difference in annoyance responses (Decibel Equivalent Annoyance Units (dBEAU)). At least two models are tested to evaluate difference in annoyance responses at two points of time:

1) The novelty effect model assumes that the incremental increase in annoyance is the same for all changed environments
2) The level-dependent model assumes that the incremental increase in annoyance is related to the size of the change in noise level.

The estimates of either of these abrupt change effects can be derived from regression equations of annoyance (before and after a change) on the measured noise levels and the change in noise level. Alternatives to linear regression will be explored.

Rationale: The primary purpose for examining reactions under changing conditions is to determine whether the same dose/response relationship can be assumed to hold for steady-state and changing noise conditions.

Element # 5. The measures of "steady-state" annoyance and "after-change" annoyance come from responses to the existing aircraft noise at an airport approximately one month before the change and approximately one year later at 11 months after the change.

Details: Interviews in the before-change phase are spread over a four-week period (between six and two weeks before the change). Interviews after the change are spread over the next year's same four weeks, 365 days later.

Rationale: This element establishes before-change interviews at the same airport as the baseline against which the post-change reactions are measured. The overwhelming strength of this design is that it reduces the effects of a large number of variables that are correlated with the time and location of a social survey by controlling for many measured and unmeasured city, airport, neighborhood, and individual characteristics. The three following alternative baselines were considered as a basis for comparison but rejected.

Design 1: An "after-only" design that compared "changed-exposure" respondents with "no-change" respondents at the same airport was rejected on theoretical grounds because the substantial differences observed between responses in different areas at the same noise level in Appendix G and earlier analyses (Fields, 1983) would mean that the design could not determine whether the change and no-change areas had similar responses (after being adjusted for noise level) before the change.

Design 2: An "after-only" design that compares new, post-change residents with residents who were present during the change was rejected because new in-migrants might differ in other ways and because of the practical difficulties in finding enough in-migrants.

Design 3: An "after-only" design that would compare reactions at the change airport with reactions at other airports was rejected because substantial airport-specific differences in reactions would be confounded with any effects of changes in noise exposure. All major comparisons of reactions in different noise surveys have found very large differences between the dose/response relationships at different airports (Schultz, 1978: Fidell, Barber, and Schultz, 1991: Miedema and Vos, 1998). Irrespective of how stable such previous combined estimates might be, the estimate from the single or small number of noise/change airports included in the present study can not be assumed to be close to the mean of the previous estimates. Of course some of the previous observed variation between studies is probably due to differences in the study methods, years and languages of the previous studies. However, analyses of neighborhood differences (Fields, 1983) and of the differences between nine US airports within the same surveys show that there are substantial between-airport differences in reactions even after noise level and obvious differences in study methods are eliminated.

The before-change baseline at the same airport eliminates the substantial problems introduced by each of the three alternative designs. The following apparent weaknesses of the before-change baseline were considered but rejected as not being of sufficient importance to overcome the more serious, previously-enumerated weaknesses of the three alternatives. A before-change design requires that the study be designed and interviews be conducted before the change takes place. However, it is argued later that this is not a substantial additional burden if, as is argued below, the noise environment must be monitored several months before the noise change. A before-change study requires that at least some residents be directly informed of the planned change. However, this would appear to pose little risk of changing attitudes because (1) many respondents will be aware of the nature, if not the timing, of the proposed change and (2) analyses of previous surveys have indicated that noise responses are not biased when interviews are separated by several months. The before-change design is subject to a confounding of abrupt change effects with other changes that occur between the two interview phases. Attempts are made to either measure or use controls in the analysis such changes. The possibility of any such confounding changes is judged to be less than the known between-area effects that are documented in Appendix G and previous studies (Fields, 1983).

Primary reliance is placed on a 12-month spacing between waves because this spacing partially controls for seasonal differences in response and because this provides a sufficiently long period after the change to be of importance for planning purposes. The analysis in Appendix E shows that there can be substantial seasonal effects. In that appendix it is noted that the sources of seasonal effects have not been studied but could be a complex combination of factors that include weather on the day of the interview, weather during an unknown period preceding the interview over which the respondents integrate their responses, and cultural factors that determine the extent to which respondents are likely to open windows and have out-of-door activities at particular times of year. Given the unknown, but potential, complexity of the seasonal effect and the larger number of these factors that are controlled with interviews at the same time of year, it is recommended that the primary reliance be placed on interviews at 12 month intervals.

Interviews are spread over a four-week period rather than being concentrated in a shorter period to minimize the impact of any day-to-day fluctuations in noise exposure or annoyance levels such as those that were found in one survey on reactions to helicopter noise (Field and Powell, 1985: 32-33). The longer period also allows more time to increase the response rate and numbers of interviews through repeat call backs. Short interviewing periods have sometimes been recommended for noise surveys in the past due to fears about publicity attending the survey. Cases of such publicity have not been documented in the noise survey literature and are expected to pose less of a threat to the successful estimate of an abrupt change effect than would be introduced by a short interview period.

Element # 6: ***The primary interview measure of a before/after change is a measure of the difference between each respondent's before-change response and his/her own after-change response.***

Details: Although some interviews are conducted with new respondents in the after-change study waves, the primary reliance is on a longitudinal study design.
The following details are important:

1) Careful records are kept to make it possible to link individual respondent's responses across the different study waves in the analyses.
2) All respondents in the rarest noise exposure categories are in the panel design.
3) The number of new sample members for the one-year follow-up survey are restricted to the number needed to provide a satisfactory test as to the presence of a repeated-interview bias.
4) The one-month, post-change survey, if any, is not conducted with respondents who are scheduled for the one-year follow-up survey.
5) The one-month, post-change survey, if any, is approximately evenly split between previously interviewed and new sample selections.
6) The one-month, post-change survey, if any, is not conducted in critical, small population categories.

Rationale: The analyses provided in Appendix D indicate that repeated interviews may substantially increase the precision of survey results but should not result in biased estimates for a one-year follow-up survey. The one-month followup wave uses more new respondents due to concerns about possible repeated interviewing effects. The secondary importance assigned to these interviews also results in their not being conducted in noise environments with small populations.

Element #7: ***Estimating the form of a post-change, annoyance decay function is a low-priority task that would require additional interviewing phases in the weeks immediately following the change, at two years after the change, and, under favorable conditions, at some intermediate points of time.***

Details: It is expected that an abrupt change effect is largest at the time of the change and then gradually decays over time until reactions are the same as in the previous steady-state condition. Yearly follow-up interview waves beyond that scheduled for 12 months will only be conducted if a large abrupt change effect is found at the 12 month follow up. Interviews would only be conducted in the weeks after the change or in later months before the 12-month follow-up if the climatic and social conditions suggest there will be no seasonal effect and if documenting a possibly large abrupt change effect immediately after the change is important.

Rationale: Estimating the form of the relationship between the time elapsed since a change and the abrupt change effect is set as a relatively low priority task because it is likely to be expensive and the likelihood of success is uncertain. This judgment is a result of the following assumptions: 1) a substantial seasonal effect could confound any attempt to measure a decay in reactions except at the same time of year (See Appendix E.); 2) the decay of an abrupt change effect is likely to be an exponential or similar function in which the decay is rapid in the first few weeks or months; 3) the amount of the abrupt change effect after one year will be small; 4) the difference between weather conditions in the several months surrounding the change will be small; 5) there will be too few households in the most important noise-exposure categories (large noise-change groups) to provide new respondents for an additional study wave at one month after the change in noise; 6) actually specifying the shape of a decay function would require a large number of interviews at many different times; and 7) the primary goal of the study is to determine whether an abrupt change effect persists at least a year after a change in noise exposure. The recommendation for interviews immediately after the change is based on the assumption that the abrupt change effect is likely to be greatest at this time and the judgment that the credibility of a finding that there is no abrupt change effect at one year would be enhanced if the same study showed that there had been an abrupt change effect at an earlier time. If the study were conducted in an area with relatively small seasonal climatic differences then additional interviews during the first year might be considered.

Element #8: ***The social survey sample of residents is designed with the goal of maximizing the precision of the estimate of the abrupt change effect as predicted by the social survey simulation program.***

Details: The same simulation program that is used to select a study airport is used to predict the accuracy of different sizes of samples and distributions of samples between noise environments.

Rationale: The impact of the allocation of the sample design is too difficult to judge without a simulation.

Element #9: ***The statistical goal for the study design is to detect a statistically significant change in annoyance due to a change in noise exposure if the change in annoyance is the equivalent of a five-decibel difference in noise exposure under steady-state conditions.***

Details: This is the statistical goal that is used to determine whether an airport can yield sufficiently accurate estimates to be accepted as a study airport (Element #2). This minimum precision goal can be stated as follows:

> To detect a statistically significant ($p<.05$) change in reactions (beyond that predicted for steady-state conditions) due to an abrupt change in noise exposure if that change in reactions is equivalent to a five-decibel (DNL) difference in exposure to an unchanged noise environment.

The goal is stated in terms of the difference in annoyance that is predicted from data that have been collected at two times. The difference in annoyance is the difference between the annoyance score that is predicted under steady state conditions and the annoyance that is observed after the change in noise exposure. The size of the difference in annoyance that is to be detected is the difference that would be expected between two locations that differed by five decibels in their noise exposure under normal, unchanging airport noise conditions. The definition of statistical significance is set at $p<0.05$.

Rationale: A study must be able to detect a change in annoyance that is the equivalent of a five-decibel difference in steady-state reactions because many noise-regulation adjustments are made in five-decibel steps. Five decibels are taken as the minimum size on the assumption that a study that could not detect the effect of a five-decibel change in noise level would not be useful for practical applications. The goal is stated in terms of a simple linear model rather than more complex logistic or exponential models that more closely describe the relation between noise and such measures as "high" annoyance over a very broad range in noise levels. This simplification is accepted because: 1) the actual range of noise levels included in the study plans is likely to be restricted to a range over which linear models are approximately correct, especially for multi-point annoyance scales (not binary "high" annoyance scales); 2) the differences between linear and more complex models are likely to be small relative to the other inaccuracies that are present in the variance estimation process; and 3) it was felt that it was better to devote the limited model-development resources to assessing such issues as the effects of errors in noise measurements and the impact of a clustering of responses within geographical areas.

This method of explicitly stating the goal of the study is important because it provides a basis for evaluating the study designs. Depending upon the purposes of a study different, more rigorous, goals might be set.

3.3 Social survey administration procedures

The next five elements describe selected decisions about the administration of the social survey. Justifications are provided for difficult decisions about the types of data collection methods that are to be used.

Element #10: Face-to-face interviews are conducted for the primary social surveys (before and 12 month interviews) but short telephone interviews are used for any interim follow up interviews.

Details: The face-to-face interviews are conducted with a long survey form. The telephone interviews are conducted with a shorter form with questions drawn from the long form.

Rationale: The longer, face-to-face questionnaire is needed for the primary surveys because it is expected to give the highest possible response rates in areas with small numbers of dwellings, permit greater flexibility in the types of questions and visual materials that can be used, and maintain greater comparability with previous surveys. Comparability with previous surveys can be maintained through the use of show cards and sequences of questions that conceal the primary interest in changes in aircraft noise. Difficult magnitude estimation questions can be administered with visual aids. This questionnaire collects information about both long-term and short-term reactions. Face-to-face data collection methods are expected to be only slightly more expensive than other methods since all homes must be visited and all interviews will be conducted near one airport or, at most, a very small number of airports.

The shorter, telephone questionnaire is needed to obtain immediate information about reactions on specific days when respondents are telephoned in the evening. A short telephone survey allows a greater number of short interviews to be collected in short period of time than would an interviewer-administered survey.

Element #11: Interviewers are managed with procedures that enhance the quality of interviewing.

Details: The following are among the standard interviewer management procedures that are followed:

1) Interviews are conducted by professional interviewers or interviewers who have completed a multi-day course in interviewing methods.
2) A handbook that describes the questionnaire administration procedures is prepared. (Some of the contents of this handbook are given in Appendix K.)
3) A one or two-day orientation session is conducted for the survey.
4) Interviewers are not informed about the expected noise levels or measured changes in noise levels in their study areas.
5) Supervisors accompany interviews on early interviews and on occasional later interviews.
6) Telephone interviews are conducted from a central location where they can be supervised.

Rationale: Even random measurement errors can not be compensated for through increased sample sizes for the survey due to the restricted population sizes expected in the rarest noise environments. As a result care needs to be taken to control other sources of error.

Element #12: Interviewer assignments are not clustered by location.

Rationale: Interviews in each area are conducted by as many interviewers as possible to reduce the correlation between any interviewer effects and other area effects. The possibility of interviewer effects have not been explored in other surveys but are a possible explanation of the large geographical effects in noise surveys (Appendix G).

Element #13: Letters of introduction are mailed to sampled dwellings before the interviewer attempts to conduct an interview.

Details: The letter describes the survey as an environmental survey but does not refer to noise. A letter is mailed for both face-to-face and telephone interviews.

Rationale: Letters of introduction can be expected to increase response rates. Such letters also increase the perceived legitimacy of the survey. This is especially important for this survey because it should reduce respondents' security concerns about giving information about their times at home on the one-day response portion of the questionnaire that is included in both the face-to-face and telephone interviews.

Element #14: Respondents are randomly selected within households using a Kish selection-grid

Rationale: Control is needed over the selection of respondents within households to avoid biases in the estimates of abrupt change effects. This is especially important because people who are often at home and people who are not often at home may differ in their awareness of changes in exposure. The Kish selection grid uses a probability selection method for selecting respondents (Kish, 1965).

3.4 Questionnaire wording and design

The next four elements describe and justify major decisions about the construction of the questionnaire. The questionnaire is reproduced in Appendix H. The wording of each question was carefully considered by a team of researchers during the course of a series of small pretests at two noise change airports. The justifications for some of the questions are given in Appendix J.

Element #15: The primary noise/annoyance response question measures the respondent's annoyance with the aircraft noise environment that exists at the time of the interview.

Details: This question is used before respondents are aware that the survey is about changes in aircraft or about changes in noise exposure. The question is preceded by the introductory instruction "If there have been any recent changes in the noise around here, please tell me about the way it is nowadays."

Rationale: Retrospective reports about previous annoyance levels are not to be used to estimate the abrupt change effect. Several questions about reactions to the pre-change environment are included in the questionnaire but only to determine if respondents believe there has been a change in their reactions. The decisions about the wording of the questionnaire were made after carefully weighting the risks associated with the following possibilities:

1) Some respondents will not be aware of any changes in the noise environment.
2) Respondents will probably not be able to recall the noise and accompanying reactions for periods that are artificially defined in an interview.

3) Respondents may only be able to reconstruct the noise environment and their reactions on an episodic basis for the last few hours or for the day in which the interview occurs.
4) Some respondents may bias their responses if the issue of the changed noise environment is raised.
5) Other respondents may only be able to report their reactions for a period, if the period is delimited by the change in noise environment event. Their knowledge of the timing of the event may be too weak to usefully refer to a post-change period in any other way.
6) Respondents can only be expected to give their current feelings, not to accurately report previous feelings.
7) Respondents will want to report the responses that are most important for them.
8) There may be a tendency to telescope previous events into the reference period
9) Respondents can not predict their reactions in the future.

Element #16: After the initial primary annoyance questions, all respondents are informed about one aircraft noise change that has occurred in their area in the past and about one that is planned for the future.

Rationale: After a few initial questions in which the specific change in aircraft operations is not mentioned, the recent change in aircraft operations is directly described and most of the remaining questions directly ask for reactions in the period after that change. Many questions ask for reactions "after the ..(specified).. change in the last ... months." This approach was taken because it ensures that the respondent can clearly identify the period being asked about. An alternative that was rejected was to only mention a time period, for example the "last 12 months" without a mention of the noise change event. It is judged that this approach would have increased reporting errors because respondents would not be sure about the time of the change in operations and would not be certain as to whether these "unusual" changes should be considered in giving information about their noise environment.

Element #17: The same questionnaire is used for the before-change survey and the 12-month follow-up survey.

Rationale: This simplifies survey administration and ensures that responses will not be biased by the mere discussion of changes in noise environments. This also provides a baseline to measure the extent to which residents perceive change in an environment that the investigators presume has not changed. The interviews both before and after the change therefore refer both to a previous change in the past as well as a planned change in the future. Because aircraft operations are constantly changing it should be possible to identify an additional past change for the before-change interviews and an additional planned change for the after-change interviews. No problems were found during the pretests with such questions about obscure, unpublicized changes in airport operations.

Element #18: The face-to-face questionnaire contains two variations that require two slightly different forms of the questionnaire.

Details: The two different forms of the questionnaire are given to alternate households in each study location. Forms are color-coded to help ensure that the forms are correctly assigned. The few pages that differ between the two forms are provided in Appendix H.

Rationale: The questionnaire form is altered in two locations. One location, near the end of the questionnaire, alternates between two different annoyance questions. The alternative reaction questions (Q39A or Q39B) come from two of the largest scale previous studies of reactions to changes in noise environments for which the data are still available. They are included for comparisons to those previous surveys. It was felt that both could not be included in the same questionnaire without being overly repetitious or creating confusion because of the slight differences between questions. The numeric seven-point scale (Q39A) was used in the Southern England Road Opening Survey (UKD-237, UKD-297). The five-point verbal scale was used in the Burbank Aircraft Noise Change Survey (USA-203).

In the second location, a question order experiment tests for any differences between two orders for asking about pairs of noise reaction questions (Q. 16 and Q.17) the have been used in previous studies. The test is conducted because of concern that the two forms could generate different estimates of the amount of activity interference. In one form the respondent is first asked about whether each of six activity interferences occurs before being asked about annoyance reactions (Q16A). In the other form the question about annoyance immediately follows each screening question about experiencing interference before the next screening question is asked (Q16B).

3.5 Monitoring of publicity and the community context for aircraft noise controversy

The next two elements require data that are gathered outside of the questionnaire survey. These data concern local publicity and past or present events that could affect the evaluation of aircraft noise in a community. A more thorough discussion of these issues is contained in Chapter 4.

Element #19: A historical time line of official airport planning bench marks and major public events is generated that extends from the earliest discussions to the present.

Details: A record is prepared of major events from the time when the possibility of the change in the airport was first discussed. For many changes that have a long-term history of related planning exercises the time line may stretch for ten years or more. The information for the early years is only needed if it can be relatively easily obtained from official files or easily-accessible electronic data bases. The time line is much more detailed for the two or three years proceeding the planned change. The work on this time line is begun before the final airport selection decision is finalized and is brought up to the current date by the time that modifications for the before-survey are considered. The time line should include at least the following information:

1) Major airport improvement milestones such as master plan preparation, appearance in National Plan of Integrated Airport Systems (NPIAS), Airport Capital Improvement Plan, initial design plans, environmental assessment (EA), grant pre-application, environmental impact assessment, Part 150 study, final design, land acquisition, implementation of mitigation measures and construction.
2) Newspaper articles that are archived in an electronic data base.
3) Public hearings or other public events held in connection with the airport
4) The meetings and other events that airport officials can identify in which the community learned about the planned change or formed opinions about airport/community relations.

Rationale: This gives the basic, historical framework for searching for additional information about community/airport interactions. It is assumed that obtaining this information is not a major task.

Element #20: A detailed time line of public events and publicity about the change during and immediately before the study period is maintained during the entire study period.

Details: The study period is considered to start from approximately one year before the first interviews because respondents are asked for reactions during that period. The information that is available to community members during the study and the period preceding the study is gathered in the form of copies of all relevant documents and assembled in a data base with a time line on the basis of at least the following data gathering efforts:

1) Searches of electronic files, clipping files, back issues, and current issues of all city and local newspapers,
2) Reading of neighborhood association newsletters in the affected neighborhoods,
3) Monitoring of local television news programs ,
4) Any other sources of information that residents may have about the airport.

To gather current information for each source, the project subscribes to the publications and monitors local television news programs. Locating neighborhood newsletters and other local sources of information will probably require a rather intensive research effort. More information about the assembly of these data is available in Chapter 4 on monitoring local publicity. It is important that these data remain current during the study period as they could affect study plans.

Rationale: This information is needed to provide a basis for understanding the role that publicity may play in the community's reactions to the change in aircraft noise exposure. The information can be directly used to modify the study design. The timing of local events might need to be considered in scheduling interviews. Some questions in the questionnaire about local sources of information and local aircraft events are based on this information. The after-change questionnaires may also be modified, if necessary, to measure respondents' exposure to local publicity and perception of local events that might modify attitudes toward the changed aircraft noise environment. All of this information will help in gauging the place that local publicity plays in affecting attitudes towards the changed aircraft noise environment. The material that is gathered in this program would also provide the basic data for a final assessment and description of the place of publicity and community events in the study community.

Experiences with electronic data bases and national news data base services at pretest airports showed that these sources did not contain sufficient local information. The relatively labor-intensive monitoring of local news events was found to be essential.

3.6 Noise exposure measurement and documentation

Element #21: DNL is calculated for each respondent for the periods for which long-term reactions are measured in the questionnaire.

Details: DNL, Daytime LAeq and Nighttime LAeq are measured or estimated for each respondent's residence. The method for developing these methods can not be specified in general since it will depend upon the types of data that are available and can be gathered at any particular study airport. Noise exposure is described as being "estimated" for a particular dwelling for a particular period in this section because the exposure at every dwelling for the entire period referred to in the questionnaire (for example the previous year) can not be measured. The following principles are followed in developing these estimates.

1) The noise estimates for long term reactions (Q8, Q14, Q16a, Q17a, Q18-19, Q38-39) will be for the previous 12 months for the before questionnaire and for the time from the date at which the noise environment stabilized after the change until the beginning of the interview period for the 12-month follow up questionnaire.
2) If the short telephone survey is conducted in the month or two following the change in exposure, the stability of the noise environment since the change is assessed to determine when the noise estimation period should begin and whether the noise exposure needs to be adjusted for the date-of-interview. If the day-to-day noise exposure has been highly variable after the change, then it may be necessary to have estimates that are adjusted up to the day of the interview.
3) Estimates are made of the exposure that would occur at the most exposed facade of each respondent's dwelling in the absence of that facade.
4) Separate estimates are prepared for day-time and night-time LAeq as well as for DNL

Rationale: The noise measurements should match the noise environment about which respondents are asked. No adjustments are made for outdoor/indoor attenuation because outdoor exposures are used in most noise regulations and introducing outdoor/indoor transfer functions would increase the error in estimates. No adjustment is made for times when respondents are home because previous surveys have indicated that time-at-home is not related to long-term reactions (Fields, 1993).

Element #22: The noise measurement program is designed to achieve a level of accuracy that

will not substantially bias estimates of the abrupt change effect.

Details: The survey design evaluation tool described in Chapter 6 is used to set noise measurement accuracy goals. This process involves the following:

1) The social survey simulation program is executed with different assumed levels of precision and patterns of biases in the noise measurement program.
2) The extent of error that can be present without unacceptably biasing estimates of the abrupt change effect is determined from the simulations. The definition of "unacceptable" biases will need to be assessed for any particular survey.
3) A noise measurement program is designed so that it is expected to generate no biases or only small biases that are deemed to be "acceptable." A provisional goal would be to have biases of less than the equivalent of two decibels in the estimate of the abrupt change effect.

Rationale: The degree of precision that is required from the noise measurement program can not be known without examining the probable effects of these errors on survey estimates. This information may even be important in deciding whether or not to perform the study.

Element #23: The accuracy of the estimates of DNL is quantified and used to adjust estimates of the abrupt change effect.

Details: Both the bias and the sampling errors associated with the survey's estimates of DNL are estimated. In planning such a program the following factors are considered:

1) A survey statistician is likely to be needed to design an effective program for estimating the standard errors of the long-term estimates of DNL.
2) The possibility that sampling errors are substantially different at different noise levels or locations is evaluated.
3) Sources of possible bias in the estimates for different types of locations are evaluated.
4) It is expected that a significant portion of the noise estimation resources, perhaps 10 percent, is devoted to this effort.
5) Final estimates of the abrupt change effect are adjusted for estimated errors in estimating noise levels.

Rationale: Estimates of dose/response relationships can be biased by random errors in noise measurements. Systematic errors in estimating noise exposure for rare, important areas (for example areas with large changes in exposure) could distort the study estimates.

Element #24: An estimate of aircraft noise exposure is calculated for each respondent for each day during the study period.

Details: An estimate of DNL and daytime and nighttime LAeq is calculated for each respondent for each day during the study period. These estimates start from as early as 12 months before the first interview and continue until the last interview for the last study wave. Special attention is devoted to estimating the exposures during the few highest exposure periods in the evaluation period before each interview (previous 12 months for before-change, and time since change began for after-change interviews). Although information about the accuracy of these daily estimates would be useful, the daily estimates do not require the same degree of scrutiny as the long-term DNL estimates mentioned previously. It is expected that these estimates could not be formed from direct measurements but would, instead, be estimated from information about the airport operations on each day. Strategies need to be developed for estimating exposures on days when there is missing data. Estimates of the daily levels during the twelve months between the before-change interview and the last interview wave are monitored on approximately a weekly basis to determine whether the change in airport operations and noise exposure is as expected.

Rationale: The daily exposure information is needed for the following purposes:

1) A comparison of the distribution of high exposure days before and after the change will help to determine the extent to which particular respondents are exposed to clearly different types of exposure days. An absence of reactions to change may be traced to the fact that the change in exposure reflects only a change in the distribution of exposure days but no change in the highest noise exposure days. Alternatively, it might be found that the change in exposure only affected weekdays during times when most residents are absent from their homes.
2) The noise exposure on the highest noise exposure days will be used to estimate the noise exposure to match the periods referred to in Q32b and Q32d in the face-to-face, long form questionnaire and in Q5b and Q15d in the short form.
3) The information about the daily exposure patterns during the time of the change in operations will make it possible to determine when the new operation and noise-exposure pattern stabilized and thus to measure the length of exposure to new "steady-state" conditions for the after-change interviews.
4) When the information about the new exposure patterns is examined in the weeks and months after the change, decisions about the final social survey study waves can be confirmed or changed. Much smaller than expected changes might, for example, led to a significant reduction in the effort devoted to the ongoing monitoring and the final wave of interviews. Other unexpected changes in exposure might require additional study waves.

Element #25: Limited information about general changes in the within-day patterns of aircraft noise exposure is gathered.

Details: Information about changes in the patterns of daily noise exposure is gathered to the extent possible. Aspects of the daily exposure patterns to be examined include the highest peak noise levels, the hours of day when exposure is greatest, gaps between aircraft noise events, extent to which flights are directly over homes, duration of overflight noise events, and the extent to which such changes are perceptible outside of normal weekday working hours. Although it is not expected that information is available on a daily basis or for individual respondents, it is expected that it would be possible to determine whether such general patterns of changes were likely to be experienced in all areas or only a small number of areas.

Rationale: This information may help explain the extent to which people are aware of changes in noise exposure. For example, such information should help to determine whether any of the days afer the change were distinctively different from the days before the change.

Element #26: The accuracy of the estimates of the DNL for the first few after-change weeks is determined. [This is only needed if interviews are conducted in the month after the noise change.]

Details: If the short telephone survey is conducted in the few days or weeks following the change then estimates of the noise exposure are needed for these short time periods for all telephone respondents. The accuracy of these estimates is also needed. This is likely to involve a major increase in the noise exposure estimation effort because the unusual exposures on a small number of days at some sites could affect estimates. Information is needed on the accuracy of these estimates.

Rationale: The primary measure for all post-change interviews is the noise exposure during the period after the change. This period is very short for the interviews conducted in the few weeks after the change. Estimates of noise exposure for short time periods are likely be considerably less accurate than those for the longer time periods that are required for the before-change study and the 12-month follow-up wave. Comparisons between the survey results from the different waves will require that the accuracy of the noise data be assessed separately for the short periods and the long periods. If the additional step were taken of predicting the accuracy of the short-term estimates then these predictions might enter into the decision about whether or not to conduct the short-term interviews.

Element #27: An estimate of the noise exposure from 6 A.M. up to the minute of the interview is calculated for each respondent's interview date. [Low priority goal]

Details: If the reactions to daily variations in noise exposure (Q25, Q30, Q31 in the long questionnaire form and Q8, Q13 and Q14 in the short form) are to be evaluated then the noise exposure program estimates the exposure from 6:00 A.M. until the minute the interview begins for each respondent on the day of each respondent's interview at that respondent's dwelling. Data about the timing of flights at each location can also be matched with information about the times when respondents were at home during the interview day. Some information needs to be obtained about the accuracy of such estimates.

Rationale: If respondents do not overreact to changes in noise exposure or if the overall, long-term changes in exposure are small, then the ability of respondents to perceive any changes in noise exposure could become an important question. Collecting information about the exact times and approximate noise levels of flights is important because the flights that are close to the time of the interview may have a strong effect on reactions and because analyses in a previous study found that this individualization of exposure measures to account for times when respondents were not at home did increase the correlation between noise and responses to date-of-interview noise annoyance (Fields and Powell, 1985). Data are needed for all phases, not only the short-interview phase, because the objective of the analysis is to compare reactions in the different study phases.

3.7 Modifications to the questionnaire

Element #28: ***Specific, selected elements of the questionnaire are finalized during the course of the study.***

Details: The following elements in the questionnaire are finalized and pretested at the selected study airport:

1) A prior noise-change event must be inserted in the before-change questionnaire. This noise change event must have occurred at least 12 months before the time of the interview so that the previous 12 month's noise measurements can be used.
2) An anticipated future noise-change event is needed for all after-change questionnaires. This is an event that will be expected to occur several months or years after the 12-month follow-up study.
3) The introduction in the post-change questionnaires is slightly modified for people who are being re-interviewed.
4) The names of the local sources of media information need to be added to Q41, Q42 and, possibly Q13 and Q43.
5) The question about military service (Q46) can be dropped if there are no military operations at the airport.
6) If there are other major controversies about the airport or about local environmental issues, these are assessed in the questionnaire.
7) If major events occur after the noise change that could affect reactions to aircraft noise, then consideration is given to adding any questions that might help to determine whether respondents are aware of the events and whether the events may have affected the respondents' attitudes toward aircraft noise.

4.0 MONITORING AND EVALUATING PUBLICITY

Methods for gathering information about residents' reactions and measuring their noise exposure have been the subject of considerable study. Methods for gathering information about community publicity about noise problems have not been developed. This section discusses such methods. The section considers the evidence that could be evaluated to assess the relationship between publicity about aircraft noise issues and residents' reactions to that aircraft noise. The goals and strategy for a program to measure the effects of publicity are discussed. Most of the information presented in this section is based on limited attempts to obtain information about airport noise issues in three cities where changes in aircraft noise were expected or had recently occurred: the two pretest cities of Dallas and Memphis and one other city where a change is being planned, Madison, Wisconsin. A total of five newspapers and four television stations were contacted in these cities. Some information was also obtained as a result of examining the planning and approval process for airport improvements.

4.1 Introduction

Changes in aircraft noise are frequently surrounded by public controversy. The controversy is likely to involve both noise and non-noise issues. Residents' reactions to changes in aircraft noise exposure may be affected by both their personal experiences with aircraft noise exposure as well as by public controversy about the effects of that personal exposure and the predicted impact of new noise environments. To fully understand the residents' reactions, information about the impact of public events is needed.

Adequate estimates of the relative impact of public events and personal experiences require that studies be performed under different public event conditions. Any single airport, however, provides only a single history of public events. As a result studies at a small number of airports can not be expected to provide definitive information about the relationship between public events and residents' reactions. A study at a single airport or at a small number of airports could, however, be strengthened by a limited, well-documented study of local publicity that has clear goals.

4.2 Publicity goals for a limited study

Without systematic information about public events the results from any noise change study are difficult to interpret or evaluate for future use. The following goals are recommended for evaluating publicity for a standard abrupt change study:

1. To quantify the extent of the public events and publicity about airport environmental impact issues that precede and follow a change in aircraft noise.

This information would enable future users of the dose/response survey results to determine whether the publicity conditions under which the dose/response study was conducted are similar or different from those in other studies or those in communities to which the study results might be applied.

2. To determine the extent to which residents are exposed to such events and publicity.

   This information makes it possible to identify communities and residents who have such low exposure to public events that a publicity effect would not be expected.

3. To determine whether there is a relationship between noise reactions, exposure to public information and attitudes toward airport-related authorities.

   Although the presence of a relationship between reactions and publicity in questionnaire data will not prove that there is a causal connection, the strength of the relationship will give some indication of the maximum effects that could be hypothesized. The absence of any relationship would provide useful evidence that publicity effects were small.

4.3 Products from a limited publicity study

The publicity study needs to be begun before the first round of interviews so that the questionnaire can be modified. The study needs to be continued during the times between interviews so that additional modifications can be introduced to the questionnaire and so that more detailed, immediate information can be easily collected about on-going events. Finally the study needs to analyze the results. The products that could be expected from such a study are grouped under three headings.

Products at the pre-interview stage are the following:

1. A time line of all events and publicity that occurred in newspapers, neighborhood newsletters, or television broadcasts before the first round of interviews;
2. A listing of the major noise and non-noise environmental issues at the airport that have received any publicity;
3. Modifications for the before-change questionnaire
   (This would include at least an updating of the list of local media sources in Questions 41 and 42 and the identification of the pre-change issue that are the subject of questions for the before-change questionnaire. If there are additional major issues, then questions could be constructed and pretested to measure respondents' awareness and views of those issues.).

Products at the between-phase stage are the following:

4. A detailed listing of all events and publicity during and between interviewing periods,

5. An evaluation of possible modifications to after-change questionnaires,
[The after-change questionnaire would not be expected to be modified from the before-change form (except, of course, for the references to the change event) unless there had been major public events during the period since the before-change questionnaire was administered.]

Products for a final report are the following:

6. A complete time line of the events and publications before, during and after the change together with references to the complete source for each published event and a measure of the prominence of the publication.;
7. A paper or electronic copy of every printed article that appears in the above time line as well as transcripts of television segments, if available;
8. Video tapes, or references to the source of a video tape, for each televised event,
9. A discussion of the prominence of aircraft noise and other aircraft environment issues within the study area;
10. A summary of the analysis of the questionnaire items concerning the public events and the relationship between noise reactions, exposure to public information and attitudes toward airport-related authorities.

4.4 Methods for obtaining information

The process of obtaining information about publicity in Memphis, Dallas and Madison has provided the basis for the methods suggested in this section. Although useful information was gained from the experiences in these three cities, it has also been concluded that the differences between information sources of different cities and neighborhoods are so great that a publicity study will need to be individualized for each airport community.

The recommendations in the remainder of this section have been shaped by several observations during the tests in the three cities. The national electronic newspaper services do not include all local and suburban news sections. Requests for information about the contents of local media for research purposes are a routine event. Both print media and television stations have individuals who will readily provide information about their research sources and limitations. There have been major changes toward automated, electronic storage and retrieval systems for printed media sources from the late 1980's onwards. For example, newspapers originally had only "clip files" in which the actual newspaper story was cut out of the paper and filed (usually by date) in an envelope. Now newspapers have electronic files that cover some of the periods of publication. The most reliable method for obtaining stories from either newspapers or television is by knowing the date of a story. The television stations that were contacted were all uncertain about the success that could be expected from searches for key words.

Information can usually be more easily obtained from newspapers than from television stations. Newspapers are likely to have particular reporters assigned to the city desk who produce most stories on the airport. Television stations are not likely to assign a single reporter to the airport but are more likely to make their assignments for any particular story on the basis of who is available on a particular day. Newspapers may have a newspaper librarian. For television stations, however, the news director is only a starting point for obtaining information. Newspapers have routine archiving systems that are more or less well designed for, at least, their internal research needs. Television stations have less complete archives. In addition some stations encourage reporters to destroy notes to eliminate the possibility of their being subpoenaed for legal cases. Television stations may not retain even their video tapes for long periods. Newspapers are likely to be at least partially archived on national archiving systems such as Lexis/Nevis or Dialog. There is no similar national system for television news.

The best sources of information differed for the three cities examined in the preliminary study. Sources that were found to be useful in at least one city are listed in the remainder of this paragraph. Newspaper clip files have complete stories up to the time when many newspapers started to store papers electronically. Newspapers have different policies about assessing this information. In addition to the electronic information in Lexis/Nevis or Dialog, some newspapers provide electronic access to their own files either through a web page or some other local access point such as a public library. There may be a newspaper librarian that will be of assistance. Some public libraries and state historical societies have good sources of information on local and regional issues either in hard copy, microfilm, or electronic media. At least one television station did not provide any information through its own offices. Instead, information could be obtained through a local information service.

In addition to the information that is available locally, information may also be obtained from local airports and the FAA. Airport sources were not examined as part of this project.

Devising an economical strategy for collecting data for an airport community depends upon local conditions. In addition, it is important to keep the limited objectives of this project in mind and to limit the resources that are devoted to the study accordingly.

In general the greatest resources may be needed for locating the local sources of information that are most likely to have been read or noticed by the residents in the neighborhoods immediately surrounding the airport and for closely monitoring media during interview periods and between study phases. Local newspapers, neighborhood newsletters, airport mailings to local residents, and activities of local community organizations are all likely to be important, but potentially difficult to locate. In the early stages of the project it is expected that only minimal information could be obtained from the national, automated databases. Only a small amount of effort is devoted to searches of media long before the change. The primary focus is on more proximate events, especially any events during the course of the interviews.

Emphasis needs to be placed on developing time lines of events because this is the only reliable way of identifying newspaper, television and other publicity. Emphasis should also be placed on obtaining a copy of every printed item. Participants' memories of the contents of printed items may not be reliable. With a complete file of printed items the basic data will be readily available if a more complex problem is encountered. In addition, the printed items are needed to provide a basis for accurately worded social survey questions.

The actual assessment of each printed item can probably be quite limited for the objectives of this project. Large-scale, complex content analyses are often conducted of media. Given the availability of a single airport and the limited objectives of the project, such a content analysis will probably not be appropriate. Each printed item might be coded with information about only whether there was a mention of noise-issues or other airport environmental issues and about the amount of space devoted to noise issues. Unless publicity becomes a very major issue it should not be necessary to view television videos.

4.5 Milestones for a major airport improvement project

Airports share many common milestones that mark important stages in planning for major airport operation changes. Some of the major events are listed in the remainder of this section. The specifics could vary from airport to airport. This list is only for a major capital improvement such as the construction of a new runway. This list should however provide a general beginning point for developing the list of milestones for a specific airport. Some attempt should be made to determine whether each of the following milestones occurred and generated publicity:

1. Master Plan (up to 20 years before construction begins).

The master plan, prepared by the airport, identifies needs in the next 20 years and outlines possible solutions (projects). The plan can be updated as new needs are identified. Public meetings are often held in conjunction with master planning. The FAA finances the preparation of the plan. The final plan is a public document.

2. National Plan of Integrated Airport Systems (NPIAS) (6 to 10 years before construction begins).

The FAA Airport District Office (ADO) manager and the airport representatives meet to discuss projects the airport proposes. The FAA decides which projects would improve capacity, safety, and security of the airport system as a whole. These projects become part of the National Plan of Integrated Airport Systems (NPIAS). The NPIAS list is a public document. However, not all projects on this list are implemented.

3. Airport Capital Improvement Plan (ACIP) (5 years before construction begins).

The airport submits an Airport Capital Improvement Plan (ACIP) to the FAA. This includes items from the NPIAS list, based on the required sequence of projects at that airport. The ADO manager and the airport reach a consensus on the ACIP. This is not a public document.

3. Layout Plan (5 years before construction begins).

The airport prepares a layout plan that more precisely shows the affected airport areas. This document must be approved by the FAA.

4. Initial Design (4 to 5 years before construction begins).
The funds for design usually come from the Airport Improvement Program (AIP).

5. Environmental Assessment (EA) (3-1/2 to 4-1/2 years before construction begins).
After the initial design is completed, an Environmental Assessment (EA) must be prepared. This is the first step in the environmental assessment process. The FAA must approve the Draft EA. Public hearings and solicitations for public comments follow that approval. Advertisements must appear in a local or area-wide newspaper 30 days before a hearing. Known interested groups will be contacted directly. Certain Federal, state, and local agencies (e.g. historic preservation and endangered species groups) are consulted during the preparation of this document. The FAA reviews the Final EA, including the public comments, and either issues a Finding of No Significant Impact (FONSI) or requires that an Environmental Impact Statement (EIS) be prepared. No public notice is required about the availability of the Final EA if it is to become part of the FONSI or Draft EIS within 60 days. These documents are then announced and made available.

6. Grant Pre-application (3-1/2 years before construction begins).
After the EA is submitted the airport can submit a pre-application for Federal aid.

7. Environmental Impact Statement (EIS) (2-1/2 to 3-1/2 years before construction begins).
If there was a finding of significant impact from the EA an EIS must be prepared. The FAA publishes a notice of intent to prepare an EIS in the Federal Register. The FAA recommends that a similar notice be included in the local media. After some initial planning a Draft EIS is prepared. The public is notified about the availability of the Draft EIS. The FAA prepares the documents, typically with a contractor. Public comments are included in the Final EIS. The FAA announces the availability of the Final EIS in the local media. After a 30-day comment period a Record of Decision on the proposed action is published in the Federal Register.

8. Part 150 Study (2 to 3 years before construction begins).
An airport will usually attempt to mitigate the effects of any proposed change. AIP funds may be used to mitigate significant environmental impacts. In order to qualify for AIP noise set-aside funds for the mitigation measures a Part 150 Study must be prepared. The study can also be performed independently of a major construction project. The Part 150 study outlines the proposed upcoming projects and a Noise Compatibility Program (NCP) that will be implemented to mitigate the effects of the proposed projects. It is usually prepared either concurrently or immediately after the EIS. The Draft study is reviewed by the FAA and in a public review process a year before the Final Study is published.

9. Final Design (1-1/2 to 2 years before construction begins).
The design for the project is finalized.

10. Land Acquisition (several years before construction begins).

11. Implement Mitigating Measures (start 1 year before construction begins).

General mitigation measures outlined in the EIS such as protecting wetland areas near a new runway must be implemented before the action can occur. General AIP funds are used for this. Noise mitigation measures must also begin and continue even after the action occurs. Part 150 funds may be used for this.

12. Construction (Construction can last two or more years).

13. Completion of project and beginning of change in operations.
The actual change in operations may be marked by special public events or may occur with relatively little publicity. The change in operations may be slowly phased in over a period of time.

5.0 ESTIMATING ABRUPT CHANGE EFFECTS: DEMONSTRATION ANALYSIS

This section estimates the effect of a change in noise exposure by analyzing the data from two surveys of residents' reactions before and after a change in noise environments. A search was conducted to locate all data sets with information about changes in noise reactions. No data sets were found that provide strong information about reactions to changes in aircraft noise. The two data sets that are analyzed here, however, were constructed so that their analysis demonstrates the analysis methods that could be used for a new abrupt change study.

5.1 Identification of data sets

Appendix B describes the extensive search that was undertaken to obtain the original individual respondent data from social studies of reactions to changes in noise exposure. As a result of that search it was concluded that none of the studies for which the original survey data sets are still available provide a strong basis for estimating the parameters of an abrupt change model for aircraft noise when there has been a permanent change in noise. The absence of such information is largely explained by fact that the studies were designed for other purposes. The studies may have been quite successful in achieving their original goals even if they did not answer the questions posed in this report.

The strongest road traffic surveys have studied conditions in which the change in noise, usually a reduction, is created by a substantial reduction in the volume of road traffic on local streets (UKD-237) or by other road traffic control measures that would substantially changed the danger or inconveniences caused by road traffic(GER-246) (Kastka, 1980: Kastka, 1981). These road traffic surveys do not provide satisfactory estimates for aircraft noise changes both because noise levels were generally reduced and because the associated changes in the road traffic could easily influence respondents' judgements about the road traffic noise. The best known studies of reactions to changes in aircraft noise are studies of temporary changes in aircraft exposure due to runway repairs (USA-203) or temporary military training exercises (NOR-328). Such widely recognized temporary changes can not be assumed to generate the same types of reactions, especially long-term reactions, as would be expected from permanent changes.

Two of the temporary-change aircraft studies had a series of at least five waves of interviews that might be thought to provide a basis for at least examining decay effects. One study, however, included some study areas in which the noise exposure did not follow a simple pattern of abrupt change (USA-203). Instead there were several intermediate changes in airport operations during the study period for which the timing is not documented and the noise exposures have not been measured. The Norwegian military exercise survey studied reactions to a short, two-week military exercise and thus does not provide information about the rate of decay in reactions to a continuing change (NOR-328) or about the reactions to permanent changes.

The available studies also had a range of study design and data collection characteristics that limited their usefulness in other ways. All of the studies had small numbers of study areas. The research reported in Appendix G shows that there are large, unexplained differences between study areas. With only a small number of study areas (less than 15 in almost all studies) it is not possible to calculate sampling errors that would evaluate the precision of the survey results. Several data sets either did not repeat their interviews with the same respondents in the after-change condition or did not obtain identifiers that would have made it possible to link respondents across waves and thus obtain more precise estimates of changes in reactions. One study of changes in night-time noise environments identified only two study areas and two noise-exposure levels and thus could not be used to estimate the parameters of a model (USA-082). Other noise change studies did not use a before/after design and thus did not provide a satisfactory baseline for determining if there was a change in reactions that could be associated with a change in noise environment.

For the purposes of the demonstration analysis in this chapter two studies were chosen that had strong design features that made it possible to model changes in reactions. Both studies examined conditions in which there were large changes in exposure and both gathered identifiers that linked individuals' responses across study waves. The two studies and some of their important characteristics are as follows:

1992-93 Bodø Aircraft Military Exercise Survey (NOR-328)

This study measured residents' reactions before, during and after two intensive, short-term military exercises at the local airport(Gjestland, Liasjø, and Granøien, 1994; Gjestland, Liasjø, and Granøien, 1995). The generality of this study is especially limited by the fact that residents knew that these would be very short exercises, less than four weeks, and by the fact that such exercises were a periodic feature that occurred every few years in the community. The study included questions about several different time periods. The questions about the previous four weeks' exposure were used because the longer questions would have all been dominated by the standard, no-change noise exposure environment. Although there were six waves of interviews and respondents were asked about the previous four weeks, the possibilities of studying the dose-response relationships for four-week periods are limited. One interviewing wave was before the exercises and two were begun more than four weeks after the exercise periods and thus did not concern the change in noise. For two other "after exercise" waves the interviews were primarily, but not exclusively, more than four weeks after the exercise. For the remaining wave, the wave conducted during the exercise, more than half of the interviews were conducted within the first week of the start of the intensive exercise period. As a result the questionnaire question about the previous four-weeks concerned primarily the non-exercise period for many respondents. This question did not, therefore, match the only noise data provided in the analysis because the noise data were only for aircraft noise created during the intensive exercises. For the purposes of the present demonstration only the first wave (pre-exercise) and second wave data (during first exercise) are analyzed. Although this analysis is subject to the problem that the second wave analysis period does not match the noise levels, it is in other respects a standard before/after analysis.

1983-84 Southern England New Road Opening Survey (UKD-237 & UKD-297)
This study measured residents' reactions before and after new bypass roads were opened that left most respondents in the towns and villages with a quieter and safer traffic noise environment then they had previously experienced (Griffiths, and Raw, 1986; Griffiths, and Raw, 1989). The generality of the study is limited by the fact that noise exposures decreased at all but one site. The data analysis here is drawn from the seven of the eight study sites with 725 interviews for which both before and after-change noise data were available. In some analyses the sample size is further reduced to only those respondents who were interviewed in both of the first two study waves.

5.2 Analysis of the two data sets

For these two studies three abrupt-change reaction models were examined that are simplifications of the more general model presented at the end of Chapter 2. The results of this analysis are shown in Table 1. Each of the three lines under each of the two studies represents a different model.

Each analysis in Table 1 is a linear regression of annoyance on the current noise level. The differences between the models are in the form in which noise change is introduced. In the first row for each study only a novelty effect is considered. In the second row only the level-dependent change effect is considered. In the third row both representations of change effects are included. As these analyses are for only two study waves no attempt is made to estimate the annoyance decay term. The estimates of effects are therefore for the time of the study wave.

The analysis has been conducted with a complex, linear, mixed model analysis computer program that accounts for the clustered sample and correlated responses from the same individuals (Littell, Milliken, Stroup, and Wolfinger, 1996). In these analyses the PSU (Primary Sampling Unit) is considered to be a random effect (blocking factor) that contains individuals (also random effects) from which repeated observations are obtained. The covariance structure within subjects is assumed to be compound symmetric. The study wave and noise exposure variables are considered to be fixed effects.

The table contains estimates of sampling errors based on the clustered sample design. These are provided for purposes of illustration and discussion in this section. The actual estimates presented here are of little value because there were too few PSUs in each study to provide stable estimates (i.e. eight PSUs for UKD-237 and five PSUs for NOR-328).

The unadjusted coefficients from the regression equations can be compared within studies, but not between studies because the two studies used annoyance questions with different numbers of scale points and scored the scales differently. For the Norwegian military aircraft study (NOR-328) the regression coefficient for noise exposure (B_L) is seen to be rather stable across the three models.

For the England road traffic bypass study, on the other hand, the slope for noise level drops substantially from B_L = 2.71 to B_L= 1.57 or B_L= 1.42 when a term for the increase in noise exposure is introduced. The negative values of the study wave coefficient (B_{Ww}) indicate that the effect of the change in exposure was to reduce annoyance below that which would be expected from the steady state noise exposure. In the English study, this is consistent with the expectation that people will overreact in the direction of the change since most respondents experienced a reduction in exposure. In this study the positive values for the coefficients for the level-dependent change variable (B_{Dw})indicate that there is a very substantial over reaction to the change. In the last column of the third line, the ratio of the level-dependent change coefficient (B_{Dw}) to the steady-state noise coefficient (B_L) indicates that after estimating the response from a steady state prediction model the response needs to be incremented by the equivalent of B_{Dw}=1.32 additional decibels for every decibel of change. The equation therefore predicts that if a resident experienced a 10-decibel decrease from 65 to 55 dB (LAeq 24hr) that the new response would

Table 1: Coefficients from a regression of annoyance on abrupt change variables for two surveys

Model	Coefficients from regression analysis for:								Ratios of coefficients (dBEAU)	
	Intercept		Noise exposure		Study wave* (novelty effect)		Level-dependent effect		B_{Ww}/B_L	B_{Dw}/B_L
	B_0	σ_{B0}	B_L	σ_{BL}	B_{Ww}	σ_{BWw}	B_{Dw}	σ_{BDw}		
Study UKD-237 - Comparison of waves #1 and #2 (630 interviews)										
Novelty	-126.12	17.29	2.71	0.23	-11.54	1.77			-4.26	
Change	-48.69	21.25	1.57	0.30			2.49	0.34		1.58
Novelty & change	-34.86	20.94	1.42	0.29	-9.23	1.83	1.89	0.35	-6.48	1.32
Study NOR-328 - Comparison of waves #1 and #2 (454 interviews)										
Novelty	-48.39	12.15	1.37	0.21	-8.21	1.94			-5.98	
Change	-51.09	15.96	1.42	0.28			-1.21	0.35		-0.86
Novelty & change	-49.63	14.02	1.39	0.24	-7.24	4.03	-0.18	0.67	-5.19	-0.13

• Study wave gives the novelty effect for interviews in a particular study wave, not the estimate of the novelty effect coefficient at time=0 that is represented in the decay model in Chapter 2.

decrease beyond that expected at 55 dB (LAeq) by the equivalent of B_{W_w}= -6.48 dB (due to the novelty of the change) and the equivalent of another 13.2 dB (10 •1.32) due to the incremental decrease. Thus it is predicted that a resident experiencing a 10-decibel decrease to 55 dB (LAeq) would react in same way that residents would to steady-state noise exposures at about 35 dB (35 =55dB - 6.48dBEAU -13.2dBEAU).

The values of the coefficients in the Norwegian study, on the other hand, are counter to expectations. All of the noise change variables have negative coefficients indicating that annoyance decreased even though there was an increase in noise exposure.

Although the particular values of the standard errors are, as explained above, too unstable to be of use for these studies, an examination of their values indicates the importance of such sampling errors for the evaluation of study results. The last line for the Norwegian study, for example, shows that neither the novelty nor the level-dependent change coefficient is statistically significant ($p<0.05$). In the "Novelty" only line for the Norwegian study the 95 % confidence interval for the estimated -8.21 effect extends from approximately -4 to -12 and is thus so large as to be of limited use for policy purposes.

The actual analysis for an abrupt change study is likely to be complex and to involve professional judgment and adaptations to the data that are collected. There are likely to be additional modifications to the model as well as theory as a data set is examined.

As was previously noted the novelty term in the model presented here has been assumed to represent a negative reaction that is associated with any change in noise level. Although it has been conceived of in the context of an increase in noise exposure, it might also be conceived of as a negative reaction that would be associated with any change in exposure (increase or decrease) that is due to the fact that residents are made more aware of the presence of noise. If on the other hand it is thought of as an overreaction in the direction of the change, then separate novelty effects are estimated for increasing and decreasing noise changes.

Modeling the errors in the response process is also likely to be complex because of the presence of correlated variables. The noise exposure at the time of the followup interviews is likely to be correlated with the noise change. Of course noise levels of the PSUs differ. As a result the estimates of all parameters (not just their standard errors) were found to change when the multi-stage and repeated observation structure was recognized in the analysis. Other methods of calculating sampling errors such as pseudo-replication techniques might also be considered.

Methods of dealing with analyses of non-response also needs to be explored. The current analysis has only included individuals who responded in all study waves. An actual analysis might not discard individuals that responded in a single wave and may need to explore the structure of the data before deciding upon the best strategy.

6.0 SURVEY DESIGN EVALUATION TOOL

The purpose of an abrupt change study is to establish a basis for generalizations about future changes and not only to make statements about the particular sample of airports, neighborhoods, respondents, and interview days that are included in any specific study. Although any data set can estimate the parameters of a noise change model, these estimates must be sufficiently precise to be used in noise policy. Before conducting a survey it is therefore important to be able to predict the likelihood of obtaining sufficiently precise estimates of abrupt change effects.

This chapter describes a tool that can be used to choose candidate airports, evaluate alternative study designs, predict the likely precision of the study results and evaluate the effects of errors in determining noise exposures. These predictions are produced by a computer simulation that uses information about the specified airports' noise exposure environment, the noise response characteristics of residential populations, and alternative study designs to predict the likely accuracy of estimates of abrupt change effects.

The particular tool that is presented here has been developed to evaluate a survey with one round of interviews before the noise change and either one or two rounds of interviews after the change. The technique could be easily expanded to additional rounds of repeated interviews.

The first section of this chapter introduces the simulation method. The second section describes the inputs to the simulation. The following section presents the results from simulations for two airports. The concluding section discusses some of the limitations of this simulation model.

6.1 A simulation-based method for evaluating a survey design

Both conventional statistical tests for linear regression models and the types of simulation methods described in this chapter combine an underlying deterministic model ($A_i = B_0 + B_L \bullet L_i$) with assumptions about errors to estimate the range of outcomes that could be expected from samples of a given type (for example samples of size 1,000). Conventional textbook methods use readily available statistical theory to estimate the standard deviations of the expected samples of a given type based on a simple deterministic model and a very simple error structure that is represented by a single term (U_i) drawn from one normal distribution ($A_i = B_0 + B_L \bullet L_i + U_i$). Statistical theory has been described in a previous report that extended the estimates of standard deviations for regression coefficients for a clustered sample design (Kalton, 1983). The abrupt change model presented in this report has a more complex deterministic model and the responses are assumed to be generated by a more complex error structure. Errors may also be present in the estimates of the noise levels. These errors could affect study results and bias estimates in ways that are not modeled by the single error term.

For the more complex situation presented by a noise change model, the implications of the model and error structure have been assessed not by developing statistical theory but rather by specifying the characteristics of a model, generating a large number of samples of a specified type, and then directly observing the extent to which these samples' outcomes differ from one another and from the input model. The variations in these analyses of each sample are then characterized in the same way that the more conventional predictions are from standard statistical models in terms of the standard deviations of the parameters for samples of a specified size and design. The outcomes can also be compared to the input model to identify any biases.

The outputs from any one simulation analysis for this report are the predicted standard errors of the parameters of the noise-change model for one sample design. For example, the baseline sample design for the report has a sample of 1,000 households with a specific desired allocation between different noise environments. The design includes one pre-change and two post-change rounds of interviews at each household. To determine how precise such a sample would be, the computer simulation program generates 100 samples of that type and measures the standard deviations of the 100 estimates of each of the parameters in the noise change model. The general outline of the process for generating 100 such samples is as follows:

1) The population of all housing units and their noise exposures is created based on information about the predicted noise exposure and numbers of people in each census block.
2) The sample design is read into the program and one hundred samples of 1,000 elements each are generated following the sample design specifications.
3) The predicted annoyance response and response state (respondent or non-respondent) are assigned to each of the 1,000 dwellings in every one of the 100 samples. The annoyance response is predicted by starting with an underlying noise-change response model and then adding variability in the response that is associated with different locations, the differences between people's enduring characteristics, and the differences between each individual's responses on different interviewing occasions.
4) The resulting annoyance scores are then analyzed to provide 100 estimates of the parameters of the noise-change model. The standard deviations of those 100 estimates are calculated and are reported as the predicted standard errors of the parameters for a sample of this type.
5) To evaluate the effects of errors in noise measurements, the same 100 samples are analyzed a second time after the noise levels that were assigned to each respondent are modified by adding some random error. The analysis of the annoyance scores is again repeated and these results are compared to those from the same 100 samples that did not have noise measurement errors added.

The inputs to the program that generates the samples for the simulation are described in the next section.

6.2 Inputs to the simulation

The 27 inputs to the computer simulation are grouped into five categories in Table 2. Two of these categories represent constraints that are imposed either by the numbers of households exposed to different noise conditions (Category #1) or the variability in people's responses to noise (Category #4). Two other categories of inputs represent features of either the acoustical noise survey design (Category #2) or the social survey design (Category #3) that affect the precision of the study. The final category consists of alternative assumptions about the magnitudes and structure of the abrupt change effect that determine whether the effects can be detected. For example, even a very weak design might be able to detect a very large effect.

Table 2 gives a brief description of each variable. Symbols used in Table 2 are defined in on page 119 of this report. The last two columns in the table give the values used in the simulations that are reported in the next section of the report. The baseline simulation that appears in the first of these columns is the reference point against which different study designs and assumptions can be compared. That baseline simulation represents best estimates about the conditions that could be expected for an actual abrupt change study. The baseline represents a well-designed sample, the best estimates available for the noise environments at an airport, the values of the human response errors to which the study would be subject and an abrupt change effect that is sufficiently large that the study should be able to detect. The "Other" column contains values that are used in other simulations in this report.

The remainder of this section contains a brief discussion about each category of variables. A more detailed description of the variables, the method for implementing the concepts and the rationale for choosing the values for the simulations is given in Appendix C.

The five variables in "Category #1: Airport environment constraints" are needed to implement the severe constraints that are placed on the study design by the aircraft noise exposure environments that are available in a community and by the number of households within each environment. The data for these variables come from merging airport noise predictions with data on the distribution of the population around the airports.

The ten variables in "Category #2: Social survey design" are the study design variables that a study researcher can manipulate to increase the precision of the estimates of the abrupt change model parameters. The sample simulation program randomly selects PSUs and, ultimately individuals, based on the requirements that are specified for numbers of PSUs and sample elements in each sample strata that is defined by the before-change and after-change noise environments. The sample design specifications are set for each airport before the simulation is run. Programs have not been specially developed to suggest optimal designs.

Table 2: Inputs to the design evaluation tool for a three-phase study

ID	Name	Description	Simulation values	
			Base-line	Other
Category #1: Airport environment constraints				
1	Pre-change noise exposure	Estimate of DNL before the change in exposure	From airport input data file	Same
2	Noise exposure change	Change in DNL from before the change to after the change		Same
3	Primary Sampling Unit	Study area identifier (The records in the airport file are blocks defined for the U.S. Census)		Same
4	Block population	Number of people in census block		Same
5	Household size	Assumed number of people per household (the population is divided by this number to obtain the number of dwellings)	4	Same
Category #2: Social survey design				
6	Distribution of sample	A matrix of sample sizes (PSUs and households) for strata defined by a matrix of pre-change noise exposure by noise change noise levels	Set in sample design	Same
7	Sample strata ID	The identifiers for the sample strata. Sample strata are defined by the noise exposure matrix		Same
8	Number of study waves	Total number of times at which interviews are conducted	2	3
9	Days elapsed to Wave #2 (T_i)	Number of days from the noise change to beginning of interviewing for the second study wave (e.g. first post-change survey)	320	Same
10	Days elapsed to Wave #3 (T_i)	Number of days from noise change to beginning of interviewing for the third study wave (e.g. second post-change survey)	685	Same
11	Length of each interviewing period	Number of days from first to last interview within wave #2 and wave #3 (interviews are assumed to be evenly distributed across these days)	30	Same
12	Non-response follow-up design	The study plans that determine whether non-respondents in one wave are dropped from the issued sample in future waves	Drop-ped	Same
13	Wave #1 response rate	Proportion of sample issued for Wave #1 that responds	0.80	1.00
14	Wave #2 response rate	Proportion of sample issued for Wave #2 that responds (Assumed to be the same for newly issued households, Wave #1 respondents, and non-respondents)	0.80	1.00
15	Wave #3 response rate	Proportion of sample issued for Wave #3 that responds (See Wave #2)	0.80	1.00

ID	Name	Description	Simulation values	
			Base-line	Other
Category #3: Noise measurement/estimation errors				
16	Error in pre-change noise levels	Standard error of estimate of pre-change noise exposure, decibels	3	0-6
17	Error in noise exposure change	Standard error of estimate of change in noise exposure, decibels	2	0-6
Category #4: Human response constraints				
18	Pre-change response constant (B_0)	Pre-change intercept for a response/noise relationship, dBEAU	-32	-38
19	Pre-change response/slope (B_L)	Pre-change increase in annoyance for a 1 dB increase in noise	1	Same
20	Community group effect (σ_{Ug})	Response variation at PSU level, dBEAU	7	4
21	Persistent person effect (σ_{Up})	Stable response variation at person level, dBEAU	14	10
22	Specific interview effect, Wave 1 (σ_{Uwi})	Response variation at interview level (σ_{Uw1}) for Wave #1, dBEAU	14	10
23	Specific interview effect, Wave 2 (σ_{Uwi})	Response variation at interview level (σ_{Uw2}) for Wave #2, dBEAU	14	10
24	Specific interview effect, Wave 3 (σ_{Uwi})	Response variation at interview level (σ_{Uw3} for Wave #3, dBEAU	14	10
Category #5: Assumptions about abrupt change effects				
25	Novelty change effect (V_0)	Noise change increment (not level-dependent) at time T=0, dBEAU	13.7	5.5
26	Level-dependent change effect + pre-change response slope ($D_0 + L_1$),	Annoyance associated with increase in noise from pre-change to post-change at time T=0, dBEAU	0	6.5
27	Reaction decay exponent (D_T)	The rate at which abrupt change effects decay (D_T) expressed in ($e^{(B_T \cdot Ti)}$)	-0.003	Same

The two variables in "Category #3: Noise measurement/estimation errors" are used to introduce the effects of incorrectly specifying the values of noise environments. These represent the errors in predicting the average, long-term values of DNL for either the pre-change noise environment or the change in levels from the pre-change to post-change noise environment for the PSUs. All sample elements in a PSU are assumed to share the same noise environment.

The seven variables in "Category #4: Human response constraints" introduce the restraints on the precision of the study that are derived from a basic response model to noise that includes the random variations in groups' and individuals' responses to noise. The values of these variables for the simulation were determined through the analyses reported in Appendix G

The three variables in "Category #5: Assumptions about abrupt change effects" represent the three parameters in the abrupt change model that are input to generate the response patterns for the simulation. When the simulation is examined the input values and values from the simulation analyses are examined to determine whether there is any evidence of biases from such sources as noise measurement errors. The primary focus in the analysis, however, is on the extent to which these parameters' variables differ for different simulated samples.

6.3 Results from simulations at two airports

The study design tool has been used to evaluate study designs at the two airports, Austin-Bergstrom International Airport and MCAS Beaufort, that were identified through the analysis in Appendix A as having noise environments that would provide the strongest base for a noise-change study. The increase in noise exposure at Austin-Bergstrom in Austin Texas was expected when the airport was converted to civilian use. The increase at MCAS Beaufort in Beaufort South Carolina was expected when additional military units would be relocated there. Although neither location was expecting extremely large changes, the expected changes in noise levels and the distribution of the population suggested that Beaufort could provide a stronger study design. In both locations data on population and projected noise exposures were available. At Austin-Bergstrom the existing values of the Day-Night Average Sound Level extended to 79 dB (about 800 residents above 70 dB) but all members of the population were expected to have an increase within a narrow two-decibel range of between 3.5 to 5.5 dB. At Beaufort the existing value of DNL extended to 91dB (over 6,000 residents above 70 dB) with members of the population expected to experience from a -6 dB decrease to a +11 dB increase. Too few households were expected to have a decrease (less than 60 people) to be studied. The number of people with changes greater than 6 decibels was a little over 300. Austin-Bergstrom also had a high correlation (r=0.59, Pearson Product Moment Correlation) between the previous noise level and the expected change. At Beaufort the correlation was less than r=0.03.

All of the simulations conducted for these two sites were similar in several respects. The initial sample size was set at 1,000 individuals. It was assumed that all households had four members and that one person was selected from each household. The response rate was assumed to be 80% for both the initial and follow up waves. The sample was designed to create a wide standard deviation in both pre-change noise level and the change in noise level. Every dwelling (defined by a four-people-per-household assumption) was selected from the highest noise levels and the most extreme noise-change groups. The first wave of interviews was assumed to be conducted between 30 and 60 days before the noise change. The first wave of post-change interviews were assumed to be conducted one year later at an average of 335 days after the change (from 320 to 349 days).

A critical assumption for the samples is that the responses in each census block are independent of all other census blocks. The sample was designed with the goal of selecting only ten people from each block except in the unusual, especially important noise environments where one person from each household (every fourth person) was selected regardless of block size. The design specifications were for 93 independent blocks at Austin-Bergstrom and for 99 blocks at Beaufort. Some blocks with less than 40 residents would yield fewer than 10 selections. This design, therefore assumes that the survey's final noise measurement/estimation program could make good estimates for about 100 locations.

Although any of the inputs in the model could be varied to assess an airport, the simulations presented in Table 3 only assess variations in the following five factors: the noise-change models, noise measurement errors, sample sizes, response error assumptions, and analysis models. Four simulations have been executed for Austin-Bergstrom and eleven for Beaufort. Two underlying noise change models have been generated in the data and are shown in the three panel headings within the table. The identical first lines in the table for both Austin-Bergstrom ("Austin-Bergstrom - No level-dependent effect") and Beaufort ("Beaufort - No level-dependent effect") show that the underlying response model that generated the simulation data has an intercept of $B_0=-32$, a steady-state noise effect of $B_L=1$, a novelty effect at the average interview date for the second wave of $B_{Ww}=5$, no level-dependent change effect ($B_{Dw}= 0$) and a resulting decibel equivalent novelty effect of 5 dBEAU. Only the last line in the table was generated with the second noise change model in which there is both a novelty effect (at day 335 $B_{Ww}= 2$) and a level-dependent change effect (at day 335 $B_{Dw}= 3$).

The baseline simulation accompanied by three noise measurement error scenarios has been executed for both Austin-Bergstrom and Beaufort. The comparison of the input model values with the Austin-Bergstrom analysis #1 in Table 3 (No noise error) shows that the mean estimates from the 100 simulations match the model parameters given in the previous line and thus are approximately correct. The predicted sampling errors for these coefficients in the same line, however, show the fundamental weakness in the study possibilities at Austin-Bergstrom. The predicted standard error for the novelty effect at Austin-Bergstrom is $\sigma_{BWw} =6.60$. This large standard error yields a predicted 95 percent confidence interval for the novelty effect that extends from approximately B_{Ww} = -7 to +18 (5.52 $\pm$1.96 • 6.60). The last columns express this effect in decibel equivalent units and provide almost the same numerical estimate of the 95 percent confidence interval of about B_{Ww}/B_L = -7 to +18 (5.30 $\pm$1.96 • 6.47).

Table 3: Predicted precision of estimates of parameters of a noise change model from nine simulations at two airports

Scenario		Noise error dB	Coefficients and standard deviations (predicted standard errors)								Novelty (dBEAU)	
ID#	Description (a)		B_0	σ_{B0}	B_L	σ_{BL}	B_{Ww}	σ_{BWw}	B_{Dw}	σ_{BDw}	B_{Ww}/B_L	$\sigma_{BWw/BL}$
Austin-Bergstrom : No level-dependent effect		*0,0*	*-32*		*1*		*5*		*0*		*5*	
1	Baseline (No noise error)	0,0	-32.57	7.57	1.03*	0.12	5.52	6.60	-0.11	1.56	5.30	6.47
2	Moderate noise measurement errors	3,2	-26.71	6.42	0.91*	0.10	9.01*	1.74	-0.81*	0.38	9.96	2.13*
3	Large pre-change noise measure errors	6,0	-10.47	5.52	0.64*	0.09	4.19	6.62	0.59	1.56	6.22	10.63
4	Large noise-change measurement errors	0,6	-33.89	7.39	1.05*	0.12	9.33*	0.91	-1.02*	0.17	9.02	1.28*
Beaufort: No level-dependent effect		*0*	*-32*		*1*		*5*		*0*		*5*	
5	Novelty-only response model analysis	0,0	-34.32	3.43	1.03*	0.05	4.89*	0.82			4.75	0.83*
6	Baseline (No noise error)	0,0	-34.29	3.62	1.03*	0.05	4.61*	1.02	0.01	0.23	4.47	0.98*
7	100% response rate	0,0	-34.48	3.23	1.04*	0.05	4.84*	0.91	0.00	0.20	4.67	0.88*
8	Optimistic response assumptions (c)	0,0	-39.26	2.40	1.02*	0.04	4.91*	0.73	0.01	0.16	4.83	0.71*
9	Moderate noise measurement errors	3,2	-31.96	3.58	0.98*	0.05	5.81*	1.00	-0.21	0.22	5.92	1.04*
10	Large noise measurement errors	5,3	-28.74	3.56	0.93*	0.05	6.87*	0.95	-0.42*	0.20	7.43	1.09*
11	Large pre-change noise measure errors	6,0	-26.40	3.53	0.89*	0.05	4.99*	1.03	0.11	0.23	5.59	1.15*
12	Large noise-change measurement errors	0,6	-34.72	3.65	1.03*	0.05	7.77*	0.86	-0.86*	0.13	7.54	0.89*
13	Novelty-only with moderate error	3,2	-31.81	3.56	0.98*	0.05	8.02*	0.82			8.22	0.90*
14	3-wave panel design (d)	0,0	-34.15	3.54	1.03*	0.05	4.98*	1.14	0.01	0.27	4.84	1.07*
		(Coefficients for wave #3>>)(e)					1.75	1.30	-0.04	0.31	1.70	1.27

Scenario		Noise error dB	Coefficients and standard deviations (predicted standard errors)								Novelty (dBEAU)	
ID#	Description (a)		B_0	σ_{B0}	B_L	σ_{BL}	B_{Ww}	σ_{BWw}	B_{Dw}	σ_{BDw}	B_{Ww}/B_L	$\sigma_{BWw/BL}$
Beaufort: Level-dependent effect		*0*	*-32*		*1*		*2*		*2*		*2*	
15	Baseline with level-dependent effect	0,0	-34.30	3.61	1.03*	0.05	1.86	1.02	2.02*	0.23	1.80	0.98

* Indicates that an estimate is predicted to be significant $p<0.05$.

(a) A more complete description for each scenario is given in Table ?.

(b) The first noise measurement error is the standard deviation of the errors in the pre-change noise exposure, the second for the estimate of the change in noise.

(c) The intercept for the "Optimistic response assumptions was set at -38 in the simulation to match the values in the seven surveys from which the response assumptions were derived (See Appendix G).

(d) For the 3-wave panel design, both rows of coefficients are needed. The first row presents the same information as in other analyses in the table. The second

row contains coefficients for the third wave variables.

(e) For wave #3, the value in the model that generated the data is B_{Ww}=1.67.

The conclusion from the preceding analyses at Austin-Bergstrom is therefore that an initial sample size of 1,000 interviews with 80 percent response rates would not yield a sufficiently precise estimate of the novelty effect to meet the basic design criterion of detecting an effect that is the equivalent of a five-decibel change in steady state noise exposure (see Element #9 in Chapter 3). Given the small range in noise change conditions and the fact that all of the available population has been used from the most important noise environments it is unlikely that any sample at Austin-Bergstrom would give a sufficiently precise estimate.

The examination of the effects of noise-measurement errors in the remaining lines for Austin-Bergstrom illustrates another weakness of this site. The "moderate noise measurement errors" line introduces a random error of 3decibels (standard deviation) in the estimates of the pre-change noise environment and an additional random error of 2 decibels in the estimate of the change in the noise exposure between the two study waves. The effect of this error is to almost double the estimate of the novelty effect from the previous decibel equivalent estimate of B_{W_w}=5.30 dBEAU to B_{W_w}=9.96 dBEAU. This serious bias occurs because the analysis can no longer detect that most of the change in noise reactions between the two study waves is due to the 3.5 decibel to 5.5 decibel increase in noise exposure. As a result the change in reactions is attributed to a novelty effect. This bias is especially serious because the predicted standard errors only exacerbate the interpretation of the study results. The sampling errors for the novelty effect are reduced and thus suggest that the estimated decibel equivalent effect of 9.96 is statistically significant and even statistically significantly higher than a B_{W_w}=5 effect.

The remaining two noise-measurement error simulations for Austin-Bergstrom show that the estimate of the novelty effect is more sensitive to errors in measurements of the change in noise than to errors in measurements of the pre-change noise exposure. In line 3 of Table 3 (the "large pre-change noise measurement errors" line) with a pre-change error of 6 decibels (standard deviation) gives a moderately inflated estimate of the decibel equivalent wave effect (B_{W_w}= 6.22) with a large predicted standard error (σ_{BW_w} =10.63). However when the 6-decibel error is introduced into only the noise-change measurement in line #4, the decibel equivalent effect is again seriously overestimated (B_{W_w} =9.02) with misleading standard errors that would again indicate that this effect is statistically significantly greater than a B_{W_w} =5 effect.

The simulations in Table 3 for Beaufort show the effects of a fundamentally stronger study site. The simulation in Line #6 for Beaufort shows that the novelty effect is again estimated at about the correct value with an estimate of B_{W_w} / B_L=4.47 dBEAU. The predicted standard error of $\sigma_{BW_w/BL}$ = 0.98 (95 percent confidence interval of $\pm$ 1.9 dBEAU) now meets the design criterion of being able to detect a noise-change effect of approximately 5 dBEAU. The underestimate of the novelty effect in this line appears to be largely due to the miss-specification of the model in this analysis from including terms for both a level-dependent change effect and an novelty effect. When the analysis no longer includes a level-dependent term, the "novelty-only response model analysis" in Line #5 now provides an estimate of 4.75 dBEAU for the novelty effect.

Two of the Beaufort analyses examine the related issues of sample size and response error assumptions. Although the baseline sample design starts with 1,000 selections, the 80 percent response rate means that only 640 people with two interviews in both of the two waves provide data for all but one of the analyses in Table 3. In the single exception in Line #7 the increase in the sample size from 640 to 1000 (56% increase) reduces the predicted standard error for the novelty effect by only 11 percent (from 0.98 to 0.88 dBEAU). The optimistic response assumptions in Line #8, on the other hand, show that these smaller assumed response variances reduce the predicted standard errors by about 27 percent (from 0.98 to 0.71 dBEAU).

The effects of noise measurements errors at Beaufort are seen to be slightly less severe, but in a similar direction to those at Austin-Bergstrom. At Beaufort the two-term noise change model used in most of this table (i.e. both novelty and level-dependent effects) for the moderate noise measurement error condition in Line #9, slightly decreases the regression coefficient for noise level (from B_L=1.03 to B_L=0.98) while increasing the estimate of the novelty effect (from B_{Ww}= 4.61 to 5.81) and now giving a negative, but not statistically significant, estimate for the non-existent level dependent effect (B_{Dw}= 0.01 > B_{Dw}= -0.21). It should be noted that the increased errors in noise measurements only slightly degrade the sampling errors for the estimates. The large noise measurement errors in Line #10 (before-change error of 5 decibels and noise-change noise error of 3 decibels) continues the same trend toward higher estimates of the novelty effect, lower estimates of the level-dependent effect, and little change in the standard errors. The contrast between the large pre-change error condition in Line #11 (novelty effect of 5.59 dBEAU) and the large noise-change error condition in Line #12 (novelty effect of 7.54 dBEAU) again shows that the parameter estimates are especially sensitive to errors in measuring the change in noise level and also lead to the incorrect inference that there is a level-dependent change effect. The continued inflated value in the analysis with moderate noise error that includes only a novelty term in Line# 13 (B_{Ww} / B_L=8.22 dBEAU) shows that specifying the model correctly (e.g. only estimating a novelty effect) does not remove the bias from noise measurement errors.

As with Austin-Bergstrom, sampling errors in the Beaufort data do not guard against incorrect inferences caused by biases in the errors in noise measurements. The sampling errors in the novelty effect remain small or unaffected by the noise measurement errors and lead to the incorrect inference that the novelty effect is significantly greater that 5 dBEAU in three of the five noise measurement error conditions examined here.

Line #14 in Table 3 includes three study waves without noise measurement errors. The results for the second wave in Line #14 are, as expected, quite close to the results for the baseline simulation in Line #6. The novelty effect in the third wave of B_{Ww}=1.75 at 685 days after the change is close to the input value of B_{Ww}=1.67 that was based on the exponential decay model in which with V_0=13 and B_T=-0.003. The standard error of 1.30 that accompanies this estimate, however, is too large to detect the fact that this small change effect persists after 685 days.

The last line in Table 3 is for a simulation that includes both the novelty effect and the level-dependent change effect. The input values for the novelty effect (B_{Ww}=2) and level-dependent change effect (B_{Dw}=2) are closely matched by the values extracted from the simulation (B_{Ww}=1.86, B_{Dw}=2.02). The structure of the data is such however that the study design can detect the level-dependent change effect but not the novelty effect at the $p<0.05$ significance level.

The conclusion from the simulations in Table 3 is that Austin-Bergstrom could not provide satisfactory estimates of the parameters in an abrupt change model. The simulations suggest, however, that if the planned Beaufort changes were introduced as a single abrupt change, then a sample of 1,000 could, under average response variance conditions, provide an estimate of the novelty effect that is the equivalent of a five-decibel difference in steady-state environments. The simulations in the table indicate, however, that the accuracy of the estimates from the noise-measurement program would need to be carefully monitored to avoid biasing estimates of the parameters of the noise change model.

As was stated earlier although Austin-Bergstrom and Beaufort were the strongest candidates for noise change study sites, neither was selected. Austin-Bergstrom, as was indicated in the analysis above, did not have noise environments that would support a sufficiently precise study. Beaufort, on the other hand, was rejected because the changes analyzed here were not in fact planned for implementation in a single abrupt change. As the notes in Appendix A indicate Beaufort was not satisfactory because the noise changes were to be implemented through a series of redeployments stretching over as much as a year.

6.4 Suggestions for future use and development of the survey evaluation tool

The scenarios in Table 3 serve as examples of the types of analyses that should be executed before a sample design is finalized or a decision about the selection of an airport is finalized. Although the baselines used here are for the best, most likely outcomes from a study, a more conservative strategy would be to make predictions based on pessimistic assumptions about such features as noise-measurement errors and response characteristics. The underlying noise environments could also be treated as a variable for assessment. As indicated earlier, one of the most important problems faced by previous noise change studies is that the noise environments were not as predicted. A realistic assessment of a study site should explore the extent to which slightly different assumptions about the population's noise exposure affect the precision of the estimates. It should also be noted that the simulations in Table 3 are all for a single sample design. Other simulations could allocate the sample across noise levels differently. Of course the assumptions about noise-measurement errors should be based on an assessment of the noise-measurement program that was planned for a particular airport.

The current version of this variance estimation tool contains several assumptions that are almost certainly incorrect. It is assumed that these assumptions do not invalidate the usage of the tool and that the impact of any such unrealistic assumptions is small in comparison to the uncertainty that is due to incorrect predictions about future airport operations. The tool could be improved to more realistically model responses through the following projects:

(a) A non-linear relationship between annoyance and noise level should be modeled. The current program generates some negative annoyance scores.

(b) The amount of heteroscedasticity in the annoyance responses could be examined and modeled. In general the variance in annoyance scores can be expected to decrease with decreasing noise level.

(c) The estimates of the PSU and individual response variances might be adjusted if more detailed analyses of previous noise surveys indicated (as would be expected) that the variance is dependent upon the size and structure of the PSUs.

(d)The sizes of PSUs should be enlarged to reflect areas over which there is dependency in response. (This is almost certainly larger than the small census blocks that are used in this analysis.)

(e)The standard error for the estimate of the decay constant could be predicted if a model that included the decay term were included. (This would considerably lengthen the execution time of the simulation program.)

(f) If the noise exposures are estimated from some type of noise prediction program rather than from independent measurements at every study site, then the area over which single noise measurement errors are shared should be increased beyond the boundaries of a single PSU.

(g)In general, acousticians assessing the noise measurement difficulties at a particular airport should provide a more complex error structure for estimates of both the long-term exposure and the change in exposure. These errors might be expected to be different at different noise levels or locations relative to flight paths The error structure should then be introduced into the program.

(h)More than three survey waves of interviews could be examined. (This modification that would be essential if there were a serious attempt to estimate the form of the decay function.)

(i) A program could be developed to determine what the optimal or near-optimal sample design would be for the study airport.

7.0 CONCLUSIONS AND DISCUSSION

This report has presented a plan for designing and executing a study that can estimate the effect of an abrupt change in aircraft noise exposure on noise annoyance. The plan is partially based on new analyses that provide findings that could aid in designing most surveys of residents' reactions to noise. The first stage of the plan, searching for candidate airports, was executed but no airports were located in the United States that met all the search criteria. This lack of available airports raises questions about the probability of achieving the objectives of the noise change project and about the definition of these objectives.

7.1 Summary

A study plan has been developed to estimate the effects of an abrupt, long-term change in noise exposure at moderate or high noise levels at airports. The statistical objective is to be sufficiently precise to detect a change in reactions that is as great as that due to a five-decibel difference in steady state noise exposure.

The twenty-seven elements of the proposed study plan include social and acoustical surveys at the same airports before and after changes in noise exposure. Questionnaires for a noise change study were developed and pretested in communities that experienced or expected to experience abrupt changes in aircraft noise exposure. A program for monitoring publicity during a noise-change period was developed based on evaluations around three airports. A computer program has been developed that evaluates alternative study sites and plans for new abrupt change studies This study evaluation tool predicts the precision of estimates of two parameters in a noise change model and measures the effects of errors in noise measurements on the estimates of parameters in the noise change model.

An exhaustive search was conducted to locate all satisfactory sites for a noise change study within the United States in 1998. On the basis of simple criteria all but two sites were eliminated as possible candidates. The data on the population distribution and expected noise exposures were analyzed for these two sites using the study evaluation tool. The tool determined that one site could not provide sufficiently precise estimates to meet the study design criterion. Although the precision expected from the second site was sufficient to meet the study goals, the change in operations at the airport was scheduled to occur gradually over a one-year period and thus would not have provided evidence about reactions to an abrupt change.

Although no suitable site was found for a study in 1998, the study plans, questionnaire, and survey evaluation tool can be used to support a study in the future.

7.2 Findings from supporting analyses

The searches for useful data sets and analyses of community response surveys led to the following conclusions:

1) No social survey data sets are available that could be analyzed to provide adequate information about residents' reactions to abrupt changes in long-term noise exposure
2) The season in which a survey is conducted can affect respondents' evaluations of noise
3) After accounting for differences in noise exposure, residents at different sites respond differently. This means that accurate studies must study many sites.
4) Individual respondents are sufficiently consistent in their responses over time that substantial gains in precision for a noise change study can be obtained by reinterviewing the same respondents.
5) For widely separated interviews, the evidence suggests that previous interviews do not bias the annoyance responses of panel participants.

7.3 Reviewing study objectives

The fact that suitable candidate airports could not be identified from an exhaustive search of all US airports indicates that the type of phenomenon that was specified for study is very unusual. This in turn raises questions about the policy significance of attempting to study unusual situations.

The requirements for the study sites are that:
1. aircraft noise is present
2. a permanent change in aircraft noise exposure occurs
3. the change occurs within the study period (1998)
4. the proposed study design be sufficiently precise to detect an abrupt change effect that is the equivalent of a five-decibel difference in steady-state aircraft noise
5. exposures of at least 60 dB (DNL) be present for some respondents
6. at least a five-decibel increase in noise be predicted to occur
7. the increase must occur at one time or within less than a three-month period

The first five requirements are basic requirements that leave little room for alterations. The last two requirements, however, deserve review. These two design requirements specify a five-decibel increase and an abrupt change in exposure. The five-decibel increase was set because it was the minimum that it was suspected that residents might notice and because it was large enough to provide some protection against errors in noise measurements. The abrupt change was specified because it can be entered into a relatively simple model and because it provides a clear starting point for measuring a decay in reactions. Nonetheless, information might be gained about reactions even if these conditions were not met if the study procedures yielded sufficiently precise estimates. An alternative approach would be to evaluate study designs that would study the sizes of changes and types of changes that are most found in communities and are therefore of greatest importance for policy.

Careful consideration should be given to an alternative approach that starts, as did this project, with an identification of all proposals for aircraft operation changes that would change noise exposure. This approach would then involve a detailed analysis of each change situation in terms of such salient characteristics as size of change, length of implementation, amount of public concern and importance of change for aircraft operations. From the present review of airport change plans, it appears that such an analysis would reveal that large abrupt change situations are so rare as to not be of great policy relevance. A social survey plan would then be developed that studied the most often observed types of changes that evoke public controversy. Such a survey plan would be evaluated using the tools developed in this report to evaluate its expected precision. Although there might be little likelihood that the parameters of an abrupt change model could be estimated, such a study might be able to determine whether the small observed changes do or do not generate annoyance reactions that are the equivalent of a five-decibel steady state effect.

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APPENDIX A: IDENTIFICATION AND SCREENING OF ABRUPT CHANGE STUDY SITES

This appendix describes the initial search and evaluation of candidate airports for a noise change study. These evaluations represent the implementation of the first element of the research plan (see Section 3.1.1.1 on Airport selection and evaluation). This search was undertaken in 1997. The search located two pretest airports and two airports for detailed analyses. It was determined that no satisfactory airports were available for a noise change study at that time. As a result of this search project several sources of information for airport searches were identified, methods for evaluating airports were developed and a list of candidate airports was developed.

A.1 Introduction to procedures

As part of the process of quantifying the effect of abrupt noise level changes on annoyance it was necessary to identify airports that might experience sudden changes in noise levels in the near future. Airports were considered as candidates if there were plans for any of the following: a new or extended runway, a new or expanded terminal, a new air carrier, a reassignment of military aircraft, a sudden increase in operations, new flight procedures, conversion from military to civilian use, or a change in the engine types for aircraft. Three rounds of analyses were conducted.

In the first round of analysis a list of candidate airports was developed and information was gathered about candidate airports. A brief screening procedure determined that most of the listed airports would not be suitable candidates, primarily because the changes were expected to occur outside of the study's 1997-98 time frame.

In the second round of analysis the successfully screened airports were evaluated. Two airports were identified as satisfactory sites for pretesting study procedures and questionnaires (Memphis and Dallas/Fort Worth). Site visits were made to these airports.

The third round of analysis consisted of the combination of methods described below. Two airports were identified as the most promising study sites (Austin-Bergstrom and MCAS Beaufort). A detailed analysis was conducted of the current aircraft noise exposure and the planned, post-change exposure. These data provided one of the inputs for the evaluation tool described in Chapter 6.

Each candidate airport was analyzed based upon specific selection criteria. Brief investigation of most airports and air bases was sufficient to determine that they would not be suitable for the full study. The remaining candidate airports were evaluated further using a combination of methods described below. Two airports were identified that served as satisfactory candidates for further study. For each of these two airports a detailed analysis of noise levels before and after the anticipated abrupt change was performed.

A.2 Forming a list of candidate airports

A list of airports that received funds through the Airport Improvement Program was obtained from the FAA Headquarters. This document presented the level of funding and the proposed project for each of the years 1994, 1995, and 1996. This list was sorted by the type of work proposed. Airports which received funding for construction of new runways, new or expanded terminals, or runway extensions were considered either as pre-test candidates or as future change candidates. Since it takes several years to complete major construction projects, a list of projects funded in 1994, 1995, and 1996 would include most projects that would be completed in 1998.

A list of responses to the National Resources Defense Council's National Airport Survey conducted in the spring and summer of 1995 was obtained. This document presented expansion plans, the anticipated completion date, and the status of the Part 150 Study of many civil airports. Airports proposing to build or extend runways or build new or expanded terminals were studied further.

Over the course of this study various FAA, military, and airport personnel were contacted. Personnel in the organizations noted below were most instrumental in providing information. FAA personnel contacted were in the FAA Airports Environmental Division in Washington, D.C. as well as in the various Airport District Offices (ADO) associated with the subject airports. Military personnel contacted were usually environmental program managers in the Air Force and Navy.

Navy personnel were usually contacted regarding Naval and Marine Corps Air Stations. Regarding Air Force Bases we contacted the Air Force Center for Environmental Excellence (AFCEE), Air Force AICUZ Major Commands including the Air Mobility Command (AMC) and Air Combat Command (ACC), Headquarters Air Force (HQ USAF/ILEVP), and the NASA-Langley Research Center. Regarding Naval and Marine Corps Air Stations we contacted Naval Facilities Engineering Commands including the Southwest Division (SW DIV), the Chesapeake Division Engineering Field Activity (CHES DIV/EFA), the Atlantic Division (LANT DIV), and the Southern Division (SOUTH DIV). Through many discussions with personnel in these military organizations a fairly complete list of candidate bases was developed.

Information gathered from these sources is presented in Tables 4 and 5. All civil airports considered in the study are listed in Table 4. All military air bases and air stations considered are included in Table 5. The location of the airport, the expected change, the basis for exclusion, and the source of evidence for exclusion are presented in Tables 4 and 5. The expected changes usually included new runways and runway extensions. Other expected changes included increased operations, new air carriers, new or renovated terminals, new flight procedures, relocated aircraft, new airport, conversion to civil airport, the introduction of jet aircraft and other types of changes in aircraft.

Table 4: Civil airports evaluated

ID #	Airport and location	Expected change	Basis for exclusion	Source of evidence for exclusion
1	Albuquerque Int'l Airport, Albuquerque, NM	Runway extension	Action to occur after study period; environmental documents not yet approved	FAA personnel
2	Atlanta-Hartsfield Int'l, Atlanta, GA	New fifth runway	Action to occur after study period	Airport personnel
3	Atlantic City Int'l Airport, Atlantic City, NJ	Terminal expansion	Action occurred before study period	Airport personnel
4	Bishop Int'l Airport, Flint, MI	New terminal	Action occurred before study period	Airport personnel
5	Blue Grass Airport, Lexington, KY	New runway	Action to occur after study period; environmental documents not yet approved	FAA personnel
6	Bloomington-Normal Airport, Bloomington, IN	New runway 2-20 and introduction of jet aircraft	Action occurred before study period	Airport personnel
7	Cedar Rapids Municipal Airport, Cedar Rapids, IA	Runway extension	Action will not occur (rehabilitation not extension)	Airport personnel
8	Charlotte-Douglas Int'l Airport, Charlotte, NC	New third parallel runway	Action to occur after study period (land not purchased as of 7/97)	Airport personnel
9	Cincinnati/Northern Kentucky Int'l Airport, Covington, KY	Runway extension	Action occurred before study period	Airport personnel
10	City of Colorado Springs Municipal Airport/ Peterson Air Force Base, Colorado Springs, CO	New runway and terminal	Action occurred before study period	Air Force and city personnel
11	Cobb County Airport-McCollum Field, Marietta, GA	Increased operations	Not an abrupt change; less than 5-dB increase	Airport personnel
12	Denver Int'l Airport, Denver, CO	New airport; increased operations since opening	Action occurred before study period; steady number of operations in last year	Airport personnel
13	Detroit Metropolitan Wayne County, Detroit, MI	New parallel runway	Action to occur after study period	Airport consultants
14	Fresno Air Terminal, Fresno, CA	Terminal renovation	Less than 5-dB increase	FAA personnel

ID #	Airport and location	Expected change	Basis for exclusion	Source of evidence for exclusion
15	Fort Lauderdale-Hollywood International, Fort Lauderdale, FL	New runway	Action to occur after study period	FAA personnel
16	Ft. Smith Municipal Airport, Ft. Smith, AR	Increased operations	Action did not occur	Airport personnel
17	Gillespie Field, San Diego (El Cajon), CA	New air carrier	Less than 5-dB increase	Airport personnel
18	Grand Canyon National Park Airport, Grand Canyon, AZ	New runway	Action to occur after study period	Airport personnel
19	Greater Rockford Airport, Rockford, IL	Extension of runway 7L-25R and expansion of terminal	Insufficient number of dwellings affected	FAA and airport personnel and review of Final EA
20	Hornell Municipal Airport, Hornell, NY	New runway and introduction of jet aircraft	Action occurred before study period	Airport personnel
21	Houston Int'l Airport, Houston, TX	New runway	Action to occur after study period; Environmental documents not yet approved	FAA personnel
22	Indianapolis Int'l Airport, Indianapolis, IN	New runway	Action occurred before study period	Airport personnel and review of Part 150 Study
23	Jacksonville Int'l Airport, Jacksonville, FL	New runway and terminal expansion	Action to occur after study period	FAA personnel
24	Kent County Int'l Airport, Grand Rapids, MI	Perpendicular runway realignment from 18-36 to 17-35 for noise abatement	Insufficient number of dwellings affected	FAA and airport personnel and review of excerpts of EA and noise contour maps
25	Key West Int'l Airport, Key West, FL	Terminal renovation	Less than 5-dB increase	Airport personnel
26	Lambert-St. Louis Int'l Airport, St.-Louis, MO	New LDA flight procedures	Action not approved	Airport personnel
27	Louisville-Standiford Field, Louisville, KY	New re-oriented crosswind runway	Action occurred before study period	Airport and consultant personnel and review of EIS
28	Madison-Dane County Regional Truax Field, Madison, WI	Runway realignment from 3-21 to 4-22 for noise abatement	Insufficient number of dwellings affected	Airport personnel
29	Manassas Municipal Airport, Manassas, VA	New terminal	Less than 5-dB increase	Airport personnel

ID #	Airport and location	Expected change	Basis for exclusion	Source of evidence for exclusion
30	Manchester Airport, Manchester, NH	Increased operations; runway repair	Action did not occur; runway repair to occur after study period	Airport and study consultant
31	Manchester Int'l Airport, Manchester, England	New parallel runway	Action to occur after study period	National Physical Laboratory personnel and noise contour maps
32	McCarran Int'l Airport, Las Vegas, NV	Extension of runway 7L/25R	Insufficient number of dwellings affected; action likely to occur before study period	Review of Final Part 150 Study

Table 5: Military air bases and air stations evaluated

ID #	Airport and location	Expected change	Basis for exclusion	Source of evidence for exclusion
1	Austin-Bergstrom, Austin, TX	Civil cargo and air carrier service to begin with new terminal and new runway	Not excluded; see detailed discussion in text	FAA personnel
2	Holloman Air Force Base, Albuquerque, NM	Relocation of German Tornadoes to Holloman	Action to occur after study period	Air Force personnel
3	McDill Air Force Base, Tampa, FL	Aircraft relocated to McDill	Action occurred before study period	Air Force personnel
4	MCAS Miramar, San Diego, CA	Exchange of F/A-18's for F-14's	Action began before study period and will continue in phases	Navy personnel
5	MCAS Beaufort, Beaufort County, SC	Relocation of F/A-18's from NAS Cecil Field	Not excluded; see detailed discussion in text	Study consultant and review of preliminary environmental document
6	MCAS Cherry Point, Cherry Point, NC	Relocation of F/A-18's from NAS Cecil Field	Action unlikely to occur; action would occur in phases	Study consultant and review of preliminary environmental document
7	NAS El Centro, CA	Location of new F/A-18EF's at El Centro	Action unlikely to occur	Study consultant
8	NAWC Pt. Magu, Camarillo, CA	Location of new F/A-18EF's at Pt. Mugu and construction of new runway	Action unlikely to occur	Navy personnel and study consultant and review of draft noise contours
9	NAS Jacksonville, Jacksonville, FL	Relocation of new jet aircraft	Insufficient number of dwellings affected	Study consultant and review of EA
10	NAS LeMoore, Fresno, CA	Location of new F/A-18EF's at LeMore	Action to occur in phases; action to occur after study period	Navy personnel and study consultant

ID #	Airport and location	Expected change	Basis for exclusion	Source of evidence for exclusion
11	NAS Oceana, Virginia Beach, VA	Relocation of F/A-18's from NAS Cecil Field	Action to occur in phases; may be stopped if a lawsuit produces an injunction	Study consultant and review of preliminary environmental documents
12	Scott Air Force Base/Midamerica Airport, St. Clair County, IL	Civil air carrier service to begin with new terminal and new runway; military runway use and aircraft will change	Insufficient number of dwellings affected; action to occur in phases	Review of 1991 Final EIS and 1996 EA and contact with county, TAMS, Labatt Anderson, and Air Force personnel
13	Shaw Air Force Base, Sumter, SC	F-16 engine change	Action occurred before study period	Air Force personnel

A.3 Selection of airports for pretesting study procedures

Based on conversations with FAA personnel and a review of lists that ranked airports by total operations in 1995 and 1996 we selected candidate airports to be used as study pretest sites. After a more detailed analysis Memphis and Dallas-Fort Worth were selected. For both airports the noise contours before and after the abrupt change were reviewed and detailed street maps were obtained. A drive-by survey was conducted to determine the number of dwellings which experienced increased noise exposure. Work done at these pretest sites helped refine the evaluation criteria, interviewing procedures, and data analysis techniques which were to be used in the subsequent analysis of future changes.

A.4 Screening of candidate airports

Tables 4 and 5 list all airports considered for the abrupt change study for civil and military airports, respectively. Many of the civil airports listed in Table 4 were considered as a result of information gathered during conversations with personnel in the organizations noted above. All airports for which we learned a new runway was planned are included in Table 4. If the airport personnel had not yet applied for AIP funding we did not include the project in Table 4, since the project would not be likely to be completed within ten years. Selection criteria were not applied before listing the airports in Table 4. Most of the airports in Table 4 were quickly excluded based on information gathered during telephone calls to the airports.

Each of the airports listed in Tables 4 and 5 were evaluated using the following four selection criteria:

<u>Study Period</u> The change was expected to occur in 1998.

<u>5-dB Increase</u> At least a 5-decibel (dB) increase was predicted for some area that would be within the 60 DNL contour after the change.

<u>Single Abrupt Change</u> The change was expected to occur all at once or over no more than a three-month period.

<u>50 Dwellings</u> At least 50 dwellings were located in the 5-dB increase area.

Any new abrupt change study needed to start in 1998 and thus airports with changes before or after 1998 were eliminated. This study period requirement was responsible for eliminating the greatest number of airports. New runways are planned for many airports in the years 1999 through 2004.

The 5-decibel increase requirement was included to insure that the change would be perceptible. A change in noise level of five decibels is commonly considered to be clearly noticeable. A change that is not clearly noticeable would be of little use in an annoyance study.

The single abrupt change requirement was primarily intended to exclude airports that are only experiencing steady long-term growth. The single abrupt change requirement also usually excludes air bases and air stations that receive additional new or relocated aircraft. Newly manufactured aircraft do not involved a single abrupt change because they are usually delivered as they are manufactured at a rate of a few month. Likewise, relocated aircraft usually come in stages because several military units are usually involved and each is relocated at the time that each unit's deployment cycle is completed.

The 50 dwelling requirement was included to ensure that a sizeable group of residents would be expected to experience a moderate-sized change. The final evaluation of a site would depend upon identifying additional people who would experience a range of changes in noise exposure.

A.5 Identification of two sites for detailed analyses

Two sites were selected for detailed study: Austin-Bergstrom and Marine Corps Air Station (MCAS) Beaufort. Austin-Bergstrom is located in Austin, Texas. MCAS Beaufort is in Beaufort, South Carolina.

Bergstrom AFB was an active military base until the early 1990's when the Air Force began relocating aircraft elsewhere. Mueller airport, a busy civil airport, will close and shift all operations to a new runway and terminal at Bergstrom. The former Bergstrom AFB became Austin-Bergstrom International Airport. The new runway opened for cargo operations in 1998 and the new terminal will open in April, 1999. Although Austin-Bergstrom was subject to several weaknesses as a study site, it was one of the two best sites for further study.
Weaknesses in Austin-Bergstrom as a study site include the following:

1) The April, 1999 opening date is beyond the study period.
2) There has not been a long time period during which flight operations have remained constant.
3) Cargo operations will begin approximately one year before the anticipated date that commercial air carriers will begin service and the total number of cargo operations has increased beyond the projections.
4) The City of Austin is likely to buy all houses within the 65 DNL contour.

MCAS Beaufort is one of three sites originally proposed to receive relocated F/A-18 aircraft. The most recent plan is to locate two wings of aircraft at MCAS Beaufort and the remaining nine wings at NAS Oceana. However, the deployment schedule for the aircraft has not been determined. There may be up to a year between the time the first F/A-18 wing is deployed and the time the second wing is deployed. There will be areas impacted by a 5-decibel increase between the present and the time when both wings are deployed. However, it is unclear exactly how many dwellings will be affected.

A.6 Recommendations for future searches

The initial lists of candidate airports were developed primarily from written documents. Most basic information about possible airports to study was gathered through informal networking with FAA personnel in Washington, D.C., and Navy and Air Force personnel. Written documents did not prove to be valuable for evaluating candidate airports. In researching contender airports most information was gathered through conversations with airport personnel, conversations with FAA Airport District Office personnel, and reviews of Environmental Impact Statements, Environmental Assessments, Part 150 Studies, and AICUZ studies.

Airport personnel were able to provide an overview of the anticipated change, the timing of the change, the political climate, and the source of environmental documents. The FAA Airport District Offices sometimes provided additional information about the anticipated timing of events and a more detailed description of the anticipated change. A review of the environmental documents typically provided the most detailed information about the number of impacted dwellings and the noise level increases. In some cases it was necessary to perform site visits to determine the actual number of dwellings in a specific area.

A future abrupt change study could begin by researching the civil airports and military bases excluded in Table 4 and 5, because the action was expected to occur after the study period. Most, though probably not all, changes that civil airport will experience in 1999 and 2000 would be expected to appear in Table 4. After the year 2000 it is probable that additional airports could be identified. By the year 2000 the information in Table 5 may be largely obsolete. The sources of information listed above should, however, continue to be useful for a future abrupt change study.

APPENDIX B: SEARCH FOR SOCIAL SURVEY DATA SETS

An attempt was made to obtain all original, individual-level data sets for all surveys that could provide valuable information about three topics: reactions to changes in noise, effects of repeated interviews in panel designs, and seasonal effects on noise annoyance. Although published information was available about many data sets, this search attempted to locate the original survey data files with the combined noise and social survey data. These original data were needed to estimate the parameters of a noise change model or to estimate the response error structure that was needed for planning a new survey of reactions to noise. A large number of possible studies were identified, data sets were obtained for some of these, and, after processing the data, a total of six studies were found to have suitable data. This appendix describes the search process and results.

Much of the information in this report came from analyses of those six surveys. Of course the report is also based on other survey data. A summary of the results from publications on seasonal effects is provided in Appendix E. A description of the results from an analysis of a Dutch survey (DLO study) is described in Appendix E but the original data set was not acquired. The 19 studies that are used to estimate the response errors in Appendix G were acquired as part of a less extensive search process than the one described in this appendix.

B.1 The search process

The initial list of candidate studies consisted of the noise-change studies identified in the earlier NASA report (Horonjeff and Robert, 1997) and the seasonal-effect studies identified in a larger study of the effects of situational variables on noise annoyance (Fields, 1992). Some of these studies were based on panel designs that provide information about the effects of repeated interviews. Other studies with panel designs were identified from an examination of a noise-survey catalog (Fields, 1991). In this report the studies are frequently referred to by the six-character identifiers that come from the catalog and were used in the previous NASA report.

Attempts were made to expand this initial list by searching the Economic and Social Research Council (ESRC) data archive at the University of Essex, England for new studies, requesting any available data sets from the TNO data archive in Leiden, and sending E-mail enquiries to community noise researchers that asked about their awareness about new or other unpublished data sets. These searches located the six data sets that could be used for some aspects of the analysis for this report. Some characteristics of those studies are described in Table 8 in Appendix D.

Attempts were made to obtain studies of changes to noise that were based on before/after study designs and all other studies in which some respondents were interviewed more than once. Although a few studies were excluded from consideration because they were too small, the general approach was to acquire all possible studies and then conduct detailed screening after they were obtained. In several instances studies were acquired but it was only after extensive data analysis that it was determined that the data were not satisfactory. The most frequent problems were that the identifiers on the data sets were not adequate to link respondents across study waves, to assign noise levels to respondents or to identify the study area from which respondents came. The only general categories of change studies that were excluded from the search were studies of reactions to changes in noise due to the introduction of noise barriers or home insulation. Although a list of noise-barrier studies was compiled, no attempt was made to obtain the original data sets due to concerns, that are explained below, about their relevance for aircraft noise change. It is not certain that any large studies of noise barriers could have been obtained for analysis if they had been sought.

B.2 Results from the study search process.

The list of studies that were identified and considered for the search process are given in Table 6. Each study is identified by its catalog number, a short name, and the noise source that was studied. The primary purpose for attempting to search for the study is also given. The first six studies were used in the report for either the noise-change demonstration analysis in Chapter 5 or the panel analyses in Appendix D.

The remaining studies were not used in this report. In the "availability" column it is seen that an attempt was made to obtain most studies. No attempt was made to locate the studies that are marked as "Unknown". The few studies that are marked as "Unavailable" are ones that could not be obtained even though it is believed that the data are still available. From the information that is available, there is no indication that these studies would provide substantially better information than the available studies about reactions to abrupt changes in aircraft noise.

Table 6: List of studies considered for the study search and analysis

#	Study name	Catalog ID#	Noise source[a]	Purpose of study search[b]			Used in report?	Availability[c]	Other limitations
				Change	Panel	Season			
Studies analyzed in this report									
1)	1992-93 Bodø Aircraft Military Exercise Survey	NOR-328	Aircraft	Change	Panel		Yes	OK	Temporary military exercise
2)	1983-84 Southern England New Road Opening Survey	UKD-237 UKD-297	Road	Change	Panel		Yes	OK	Primarily reductions
3)	1993-95 Western U.S. Sonic Boom Study	USA-375	S. Boom		Panel		Yes	OK	Weak dose/response relationship
4)	1978 Canadian Four-Airport Survey	CAN-168	Ac & Road		Panel		Yes	OK	Small number of respondents
5)	1977 London Area Panel Survey	UKD-157	Road		Panel	Season	Yes	OK	Only eight study areas
6)	1973 Los Angeles Airport Night Study	USA-082	Aircraft	Change	Panel		Yes	OK	Only 2 study areas & 2 noise levels
Noise change studies - Not analyzed in this report (May or may not have panel design)									
7)	1979 Burbank Aircraft Noise Change Study	USA-203	Aircraft	Change	Panel		No	OK	Incremental, undated changes. Not able to link many individuals
8)	TRRL Multiple-Site Road Traffic Flow Change Study (Residential)	UKD-268 UKD-298	Road	Change	Panel		No	OK	No data for some rounds - Can not link some rounds to individuals
9)	1989 Oslo Airport Survey	NOR-311	Aircraft	Change			No	OK	Change is confounded with seasonal differences. No repeated interviews. Small noise changes.
10)	1990-91 Værnes Aircraft Military Exercise Survey	NOR-366	Aircraft	Change	Panel		No	OK	Temporary military exercise. High cost of adding area IDs to data set
11)	German Six-City Traffic Change Panel Study	GER-246	Road	Change	Panel		No	OK	High costs to prepare area IDs
12)	1977-78 Netherlands New Railway Line Survey	NET-195	Railway	Change	Panel		No	Lost	
13)	1974-75 Roissy Airport Before-After Opening Survey	FRA-098	Aircraft	Change	Panel		No	Unavailable	
14)	1972 Birmingham New Motorway Study	UKD-073	Road	Change	Panel		No	Lost	

#	Study name	Catalog ID#	Noise source[a]	Purpose of study search[b]			Used in report?	Availability[c]	Other limitations
				Change	Panel	Season			
15)	Controlled Exposure Helicopter Noise Study	USA-235	Aircraft.	Change	Panel		No	OK	Study of daily exposure variations
16)	1963 Welsh Village Impulse Noise (Exercise Yellow Hammer)	UKD-010	Impulse	Change	Panel		No	Lost	Daily variations in exposure to unfamiliar noises from explosions
17)	1980 Brisbane Traffic Noise Reduction Survey	AUL-264	Road	Change			No	Unknown	No "Before-change" interviews. Only 152 interviews
18)	1980 Brisbane Traffic Noise Increase Survey	AUL-265	Road	Change	Panel		No	Unknown	Only 20 interviews
19)	1977 Roissy Airport Survey	FRA-150	Aircraft	Change	Panel		No	Unknown	Studies not coordinated
20)	1972 New Tokaido & New Sanyo Shinkansen Railway	JPN-065	Railway	Change			No	Unknown	Studies not coordinated
21)	1967 Huddinge New Motorway Study	SWE-026	Road	Change			No	Unknown	No "Before-change" interviews
22)	Lake District A66 Traffic Change Study (Residential)	UKD-267	Road	Change			No	Unknown	No noise data. Not panel design
23)	1989-91 15-Site traffic change 1988 TRRL 35 Site	UKD-325 UKD-351	Road	Change			No	Lost	
24)	Porous Asphalt Road Survey (Baughn, et al, 1996)	None	Road	Change	Panel		No	Unknown	After-change data not yet available
25)	1961 St. Louis Sonic Boom Study	USA-007	S Boom	Change	Panel		No	Lost	
26)	1964 Oklahoma City Sonic Boom Study	USA-012	S Boom	Change	Panel		No	Lost	
27)	1971 J.F.K. Dynamic Preferential Runway System	USA-051	Aircraft	Change			No	Lost	
28)	1972 J.F.K. Airport Noise Survey	USA-059	Aircraft	Change			No	Lost	
29)	1977-78 F.A.A. J.F.K. Concorde Noise Study	USA-144	Aircraft	Change			No	Lost	
30)	1977 Ohio New Highway Survey	USA-156	Road	Change			No	Unknown	No "Before-change" interviews
31)	1981 John Wayne Airport Operation Change Study	USA-204	Aircraft	Change	Panel		No	Lost	
32)	1982 Westchester Airport Nighttime Noise Change	USA-301	Aircraft	Change	Panel		No	Lost	

#	Study name	Catalog ID#	Noise source[a]	Purpose of study search[b]			Used in report?	Availability[c]	Other limitations
				Change	Panel	Season			
33)	1961/67 Heathrow Aircraft Noise Surveys	UKD-008 UKD-024	Aircraft	Change			No	Lost	Gradual change. No repeated interviews. Lost UKD-008 data.
34)	1971-1972 Alton By-pass Study (Residents)	UKD-266	Road	Change	Panel		No	Lost	
Repeated interview studies without change in noise - Not analyzed in this report									
35)	1975-76 London and Liverpool Panel Survey	UKD-118	Road		Panel		No	Lost	
36)	1980-83 Noise sensitivity follow up of UKD-148	UKD-305	Aircraft		Panel		No	Lost	Only 77 repeated interviews
37)	1975-76 English Mental Health Pilot Survey	UKD-111	Aircraft		Panel		No	Unknown	Only 137 repeated interviews.
38)	1973 French Ten-City Traffic Noise Survey	FRA-092	Road		Panel		No	OK	Can not link respondents
39)	1963 Linköping Airport Noise Study	SWE-011	Aircraft		Panel		No	Unavailable	
40)	Burgsvik Sonic Boom Study	SWE-108	Sonic boom		Panel		No	Unavailable	
41)	1969 Munich Airport Noise (DFG Aircraft Noise)	GER-034	Aircraft		Panel		No	Lost	
42)	1986-87 Darmstadt Movers Survey	GER-275	Community		Panel		No	Unknown	No noise data
43)	U.S. Census Bureau Annual Housing Surveys	USA-095	Community		Panel		No	Unknown	No noise data. Information from anyone in dwelling
44)	1977-78 Three-Phase J.F.K. Concorde Noise Study	USA-143	Aircraft		Panel	Season	No	Lost	
Seasonal surveys without change in noise or repeated interviews - Not analyzed in this report									
45)	1984-85 Gandía Three-Site Traffic Noise Survey	SPA-313	Road			Season	No	Lost	Interviews not linked across waves
46)	Dutch seasonal survey	None	Many sources			Season	No	Unavailable	Data not available for release, but tables were used in analysis.
47)	German seasonal survey	None	Many sources			Season	No	Unknown	No repeated interviews. No noise data. Some variations in question wording. High cost to obtain data.
48)	1972 Calgary Noise Survey	CAN-078	Ac & Road	DK		Season	No	Lost	

#	Study name	Catalog ID#	Noise source[a]	Purpose of study search[b]			Used in report?	Availability[c]	Other limitations
				Change	Panel	Season			
49)	1972 Edmonton Community Noise Survey	CAN-077	Community	DK		Season	No	Lost	
Barriers and home insulation studies - Not requested for this study									
50)	1976 Toronto Freeway 401 Privacy Fence Survey	CAN-279	Road	Change	Panel		No	Lost	Noise barrier study
51)	1943 British Home Noise Survey	CAN-280	Road	Change	Panel		No	Unknown	Noise barrier study
52)	1991 French Before/After Noise Abatement Survey	FRA-346	Road	Change	Panel		No	Unknown	Noise barrier study
53)	1979 Wuppertal and Düsseldorf Traffic Noise Barriers	GER-282 GER-281	Road	Change	DK		No	Unknown	Noise barrier study
54)	1975 Amsterdam Home Sound Insulation Study	NET-258	Road	Change			No	Unknown	Sound insulation
55)	Kungälv Noise Barrier Study	SWE-100	Road	Change	DK		No	Unknown	Noise barrier study
56)	1970-71 Heston Noise Barrier Study	UKD-050	Road	Change	DK		No	Unknown	Noise barrier study
57)	1972 Minneapolis Freeway Noise Barrier Study	USA-069	Road	Change	Panel		No	Unknown	Noise barrier study
58)	1977 Minnesota Five-Site Freeway Noise Barrier	USA-155	Road	Change	DK		No	Unknown	Noise barrier study
59)	Atlanta Airport Acoustical Insulation Survey	USA-349	Aircraft	Change			No	Unknown	Sound insulation

a "S. Boom" refers to a study of noise from sonic booms. "Community" indicates that a specific noise source was not specified. Without examining a questionnaire it is sometimes not possible to know whether a questionnaire asked about road traffic noise or community noise generally.

b Some surveys may not have "season" marked as a basis for interest even though seasonal changes could be studied with them. DK (Don't Know) indicates that the status of the data sets was not determined for this information.

c " Lost" indicates that the data are reported to have been destroyed. "OK" indicates that the data were or could have been obtained. "Unavailable" indicates that the existing data were not available for public release. "Unknown" indicates that no attempt was made to determine their availability. " DK" indicates that attempts to communicate with a source for the data were unsuccessful.

APPENDIX C: DESCRIPTION OF VARIABLES IN SURVEY DESIGN EVALUATION TOOL

The survey design evaluation tool was described in Chapter 6. This appendix provides a more detailed description of the variables that are input to the survey design evaluation computer program. Detailed information about each of the 27 input variables is provided in Table 7. The 27 inputs to the computer simulation are grouped into five categories. Each of these five categories of inputs is discussed in a separate section below. The discussions describe the inputs and, in some instances, explain the source of the values that were entered into the survey design evaluation simulations in Chapter 6.

C.1 The distribution of households and neighborhoods in noise environments

The study design is severely constrained by the aircraft noise exposure environments that are available in a community and by the number of households within each environment. These constraints are represented by five inputs in Table 7.

Input #1: ***Pre-change noise exposure***: The noise exposure for the time preceding the initial pre-change interview wave is estimated for each residential area.

Implementation: Noise exposure is represented by DNL in the survey design evaluation tool. The estimates of noise exposures came from noise estimation programs that use input about flight operations. For Bergstrom noise contours were obtained using the Federal Aviation Administration's Integrated Noise Model (INM) Version 5.1.b. For Beaufort noise contours were derived from the Department of Defense's NOISEMAP Version 6.5. INM was then used to extract the noise exposures for the centroids for each census block. Estimates are made to the nearest tenth if a decibel even though it is recognized they may be imprecise. Although only DNL is used in the analysis, the computer file also contains the information on the total number of operations, distance to closest aircraft operations, and number of types of operations for each residential area.

Input #2: ***Noise exposure change:*** The change in noise exposure from the pre-change exposure to the post-change exposure is estimated for each residential area.

This estimate is based on the authorities' best predictions about the future operations. This estimate is also to the nearest tenth of a decibel, thus the sum of the pre-change and change estimates provides a direct estimate of the post-change exposure, unlike the predictions that would be derived from grouped data with wide ranges in exposure.

Table 7: Definitions and locations of variables used in the design evaluation computer program

ID	Name	Description	Simulation values		Variable name*	Location*
			Base-line	Other		
Category #1: Airport environment constraints						
1	Pre-change noise exposure	Estimate of DNL before the change in exposure.	From airport input data file	Same	L	Airport file (CH106)
2	Noise exposure change	Change in DNL from before the change to after the change		Same	LD	
3	Primary Sampling Unit	Study area identifier (The records in the airport file are blocks defined for the U.S. Census)		Same	PSU	
4	Block population	Number of people in census block		Same	POP	
5	Household size	Assumed number of people per household (the population is divided by this number to obtain the number of dwellings)	4	Same	(Coded in program)	PREFRAM. SAS
Category #2: Social survey design						
6	Distribution of sample	A matrix of sample sizes (PSUs and households) for strata defined by a matrix of pre-change noise exposure by noise change noise levels	Set in sample design	Same	(Coded in program)	STRATA.MAC SAMPLE.DAT
7	Sample strata ID	The identifiers for the sample strata. Sample strata are defined by the noise exposure matrix		Same	STRATA	STRATA.MAC
8	Number of study waves	Total number of times at which interviews are conducted	2	3	(Coded)	
9	Days elapsed to Wave #2 (T_i)	Number of days from the noise change to beginning of interviewing for the second study wave (e.g. first post-change survey)	320	Same	DAYS2	ANNOY.SAS
10	Days elapsed to Wave #3 (T_i)	Number of days from noise change to beginning of interviewing for the third study wave (e.g. second post-change survey)	685	Same	DAYS3	ANNOY.SAS

ID	Name	Description	Simulation values		Variable name*	Location*
			Base-line	Other		
11	Length of each interviewing period	Number of days from first to last interview within wave #2 and wave #3 (interviews are assumed to be evenly distributed across these days)	30	Same	(Coded in program)	ANNOY.SAS
12	Non-response follow-up design	The study plans that determine whether non-respondents in one wave are dropped from the issued sample in future waves	Dropped	Same	(Coded in program)	ERROR_L.SAS MODELS.SAS
13	Wave #1 response rate	Proportion of sample issued for Wave #1 that responds	0.80	1.00	P1	ANNOY.SAS
14	Wave #2 response rate	Proportion of sample issued for Wave #2 that responds (Same for newly issued households, Wave #1 respondents, and non-respondents)	0.80	1.00	P2	ANNOY.SAS
15	Wave #3 response rate	Proportion of sample issued for Wave #3 that responds (See Wave #2)	0.80	1.00	P3	ANNOY.SAS
Category #3: Noise measurement/estimation errors						
16	Error in pre-change noise levels	Standard error of estimate of pre-change noise exposure, decibels	3	0-6	P_STD_L	PERTURB.SAS
17	Error in noise exposure change	Standard error of estimate of change in noise exposure, decibels	2	0-6	P_STUD_D	PERTURB.SAS
Category #4: Human response constraints						
18	Pre-change response constant (B_0)	Pre-change intercept for a response/noise relationship, dBEAU	-32	-38	ALPHA	ANNOY.SAS
19	Pre-change response/slope (B_L)	Pre-change increase in annoyance for a 1 dB increase in noise	1	Same	BETA	ANNOY.SAS
20	Community group effect (σ_{U_g})	Response variation at PSU level, dBEAU	7	4	RA	ANNOY.SAS
21	Persistent person effect (σ_{U_p})	Stable response variation at person level, dBEAU	14	10	RE_S	ANNOY.SAS

ID	Name	Description	Simulation values		Variable name*	Location*
			Base-line	Other		
22	Specific interview effect, Wave 1 (σ_{Uwi})	Response variation at interview level (σ_{Uw1}) for Wave #1, dBEAU	14	10	RE-S1	ANNOY.SAS
23	Specific interview effect, Wave 2 (σ_{Uwi})	Response variation at interview level (σ_{Uw2}) for Wave #1, dBEAU	14	10	RE-S2	ANNOY.SAS
24	Specific interview effect, Wave 3 (σ_{Uwi})	Response variation at interview level (σ_{Uw3}) for Wave #1, dBEAU	14	10	RE-S3	ANNOY.SAS
Category #5: Assumptions about abrupt change effects						
25	Novelty change effect (V_0)	Noise change increment (not level-dependent) at time T=0, dBEAU	13.7	5.5	ALPHA_C	ANNOY.SAS
26	Level-dependent change effect + pre-change response slope ($D_0 + L_i$),	Annoyance associated with increase in noise from pre-change to post-change at time T=0, dBEAU	0	6.5	GAMMA	ANNOY.SAS
27	Reaction decay exponent (D_T)	The rate at which abrupt change effects decay (D_T) expressed in ($e^{(B_T \cdot Ti)}$)	-0.003	Same	TAU	ANNOY.SAS

* The variable names and names of computer programs (in uppercase) aid in locating the parameters in the programs. "Coded in program" indicates that the variable is specified within the SAS program code, not as a variable in a macro).

Input #3: ***Primary sampling unit (PSU):*** The primary sampling unit (PSU) is the smallest geographical area for which data are prepared for input to the design evaluation program. Each PSU is a record in the input file that contains all of the airport-specific data. The noise measurement errors and survey response variances are assumed to be completely independent between PSUs.

The PSU is a census block. The census data comes from two data sets provided by the Department of Census. The census population counts come from the 1990 Census of Population and Housing (Summary Tape File 1A produced by the Data User Services Division, U.S. Department of Commerce). The corresponding geographic data come from the 1995 TIGER/Line file from the Geography Division of the U.S. Department of Commerce. In urban areas, a census block is often a city block. A centroid is defined for each PSU for which the noise exposures are calculated and at which the population is assumed to be concentrated. Variation, if any, in the noise exposure within each area is not evaluated and thus all elements within a PSU are assumed to have the same exposure. The use of the census block as the PSU will probably result in an overestimate of the precision of the study design because both noise measurement errors and individual response errors are likely to be correlated for larger areas.

Input #4: ***Block population:*** The block population is the number of people who reside in the PSU.

The population size was measured in the 1990 census and has, in some cases, been updated with more recent information. This can be out of date, especially around rapidly changing airports. The final evaluation of a study site should be based upon an updated, on-site survey of dwellings in at least the most critical noise exposure conditions.

Input #5: ***Household size:*** The block population is divided by an estimate of average household size to provide the estimate of the number of dwelling units upon which the remainder of the design evaluation exercise is based.

It is assumed that a single selection would be made from each household. Household size was estimated to be four for the purposes of this simulation. This probably results in undercounting the number of households. Counts of households are not available on a census block level. If it were important to obtain more interviews in rare noise environments, then additional members could be added from each household. The prediction program has not, however, been designed to account for the reduced efficiency of such a sample.

C.2 Social survey design variables

The inputs in this section are under the control of the survey designer and thus can be manipulated to increase the precision of the study

Input #6: ***Distribution of sample:*** The desired size and distribution of the sample is specified by a matrix defined by the pre-change noise levels and the size of the noise change. Both the number of households and the approximate number of PSUs are specified. The cells in the matrix are identified as sample "strata" for the purposes of sample selection. Probability selection methods are used for selecting both PSUs and households within strata.

The simulation program draws repeated samples based on one set of design specifications. The target sample size goal is always met for the total sample and the take-all-household strata. The particular sample selection algorithm used in this program sometimes allocates more or fewer selections to particular strata than are desired due to PSUs that do not have the standard number of, in most cases, 10 households. For samples at Beaufort one or more strata had as much as 70 percent more allocations or as few as 30 percent of the desired size. In one sample only 12 percent of the preferred size was allocated to one strata.

Input #7: ***Sample strata ID:*** Each of the cells in the sample-distribution matrix is identified and treated as a stratum for the purposes of sample selection.

The sample is drawn with probability selection methods. Although the analysis accounts for the clustering of responses into blocks, it weights all cases equally and the stratification is ignored in the calculation of sampling errors.

Input #8: ***Number of study waves:*** The total number of waves of interviews is specified.

Three waves of interviews are specified, one before the change and two after. Analyses of a simple, two-wave design (before/after) can be conducted with the present program. The program would need to be modified for more than three waves.

Input #9: ***Days elapsed before Wave #2 interview:*** The days from the change in noise exposure to the beginning of the interviewing period for Wave #2 (the first post-change wave) are specified.

The time from the first wave to the noise change is irrelevant since the count of elapsed days is only used for calculations of the decay in reactions from the time of the noise change.

Input #10: ***Days elapsed before Wave #3 interview:*** The days from the change in noise exposure to the beginning of the interviewing period for Wave #3 are specified.

Input #11: ***Length (days) of each interviewing wave:*** The interviews for each wave are all completed within this number of days.

The simulation distributes the interviews randomly within a 30-day period with equal probabilities for each day.

Input #12: ***Non-response follow-up design:*** The follow-up policy for non-respondents from an early wave can be varied so as to include or exclude them from the issued sample for future waves.

All sample members are assigned a latent response status for each wave. The follow-up policy's effect is introduced by excluding certain patterns of non-respondents from the analysis. The default is to issue all sample dwellings at each wave. This overestimates the numbers that could be issued in an actual survey since no attempt would probably be made to contact refusals.

Input #13: ***Wave #1 response rate:*** A response rate is set for the first (pre-change) wave. This is the percentage of the issued sampled households that yield interviews. The actual response rate is a function of both the response characteristics of the study population and the amount of resources that are devoted to response-rate enhancing field practices.

The response rate is set at 80 percent for the simulation.

Input #14: ***Wave #2 response rate:*** This is the response rate for the first post-change interview wave.

The same response rate is applied to all of the issued sample in the wave. No differentiation is made by the response status during the previous waves. In practice, response rates for previous non-respondents would be lower than the response rates for previous respondents.

Input #15: ***Wave #3 response rate:*** This is the response rate for the second, post-change wave.

The method of implementing this input is described in Input #14.

C.3 Noise measurement/estimation design variables

The precision of the noise environment estimates is a potentially important feature of the study design. The noise estimates of importance for this study are the estimates of the average, long-term noise exposure at a particular residence. It is assumed that this estimate contains some error. For a noise measurement program at selected study sites the error is most likely to arise from the requirement to use only a sample of measurements to estimate the noise environment for a much longer period of time. If the noise is predicted rather than measured then the errors may arise from random errors in the input data to the program. These errors should NOT include deviations of individual dwellings within PSUs around the mean of those dwellings' exposures.

The estimates of the precision of the noise program must be developed for any particular airport and noise measurement/estimation strategy. The purpose of including these estimates as an input to the simulation program is to determine the extent to which lack of precision in the noise measurement/prediction program will affect survey results. If these errors are large relative to the variation in noise environments found at any particular airport, the parameters of the abrupt change model could be both imprecise and biased.

Input #16: ***Errors in estimates of the pre-change exposure:*** This is the standard deviation of the estimates of the long-term noise levels around the mean noise level for all dwellings that have the same noise environment. This is not the same as the deviation of respondents' dwellings' exposure around predicted values. The critical standard deviation is the relationship between the predicted values for PSU and the true mean values for those PSUs. This is an estimate of the error in predicting the long-term, steady state noise environment at an airport.

Errors are assumed to be normally distributed and to be independent of each other for each PSU. For most actual noise-modeling programs used around airports, the errors are probably correlated over much larger geographical areas that are subject to the same errors in specifying flight operations or weather conditions. This simulation makes the assumption that these random errors are of equivalent size, when measured in decibels, at all locations around an airport.

The estimates of between-individual and PSU-related response variances from previous surveys that are introduced in Inputs #20 to #23 will have already captured some of the effects of noise measurement errors on the variances of responses. The sizes or effects of those errors can not be removed from previous surveys' estimates. The explicit introduction of noise measurement errors still helps to evaluate the effects of different levels of measurement errors on the study's estimates.

Input #17: ***Errors in estimate of noise exposure change:*** This is the standard deviation of the errors in measuring the amount of change in the noise exposure and is related to the extent to which the differences between pre-change and post-change conditions are accurately determined AFTER the study has been completed. These errors could be very small if the change was quite precisely specified (for example a doubling of aircraft under all operating conditions) even if the estimate of the pre-change, long-term noise environment were imprecise. This not a measure of the difference between the previously predicted and actual post-change noise environment.

These errors are again assumed to be normally distributed and of equivalent size (in decibels) at all types of locations around an airport.

C.4 Human response constraint variables

The precision of the survey estimates is constrained by the characteristics of residents' responses to noise and especially by the patterns of variation in their responses to similar noise environments. All of these estimates are obtained from the analysis of previous responses that is described in Appendix G. All of these estimates are expressed as a ratio of the estimated value to the regression coefficient for noise level (i.e. dBEAU units).

Input #18: ***Pre-change response constant:*** This is the intercept term for a linear regression equation that predicts annoyance from noise exposure.

The analysis in Appendix G provides a value of -32 for the baseline simulation. The value of this term does not affect any of the estimates that are utilized from the simulation.

Input #19: ***Pre-change response slope:*** This is the number of units of annoyance that is associated with each decibel increment in noise level in the steady-state pre-change condition.

This is the linear regression coefficient for predicting annoyance from noise level, B_L. The regression coefficient is measured in the annoyance units in each survey. The value is arbitrarily set to one for the simulation. All other human-response constraint inputs are expressed as multiples of this unit.

Input #20: ***Response variation (PSU level):*** The variation in residents' responses that is associated with their locations in PSUs is expressed as a standard deviation. This variation can very substantial reduce the precision of a survey's estimates, especially if the PSUs are large.

The response variance is defined as the weighted mean of the estimates of the standard deviation of the PSU effect from the previous noise surveys that are analyzed in Appendix G. As explained in the discussion of the previous input, this is expressed in regression coefficient units (dBEAU). The analysis in Appendix G provides a value of 7 for the baseline simulation. This indicates that the standard deviation of the differences between study areas (after controlling for noise level) is the equivalent of about 7 decibels.

Input #21: ***Response variation for individual (constant across waves):*** The variation associated with the characteristics of the individual that are constant over the course of the entire survey are represented by this standard deviation. This could be considered to be the consistent differences between individuals within PSUs. As with all measures of variation in the simulation, these error distributions are assumed to be normal.

Appendix G explains how the value of 14 dBEAU that is used in the baseline simulation for the survey design evaluation tool was selected.

Input #22: ***Response variance for Wave #1:*** The response variance for Wave #1 is the standard deviation of the responses in a particular wave (Wave #1) that is not associated with noise level, PSU membership, or the consistent characteristics of an individual. Random errors in measurements or random variations in day-to-day assessments of the aircraft noise would contribute to this source of variation. For the few studies that were examined there was no consistent pattern between the within individual variances for different study waves. As a result, the same value of 14 dBEAU is used for the baseline model for each study wave.

Appendix G explains how the value of 14 dBEAU that is used in the baseline simulation for the survey design evaluation tool was selected.

Input #23: ***Response variance for Wave #2:*** See Input #22. This variation could be greater than that for Wave #1 if respondents experience considerable day-to-day uncertainty in their evaluation of the new noise environment.

Appendix G explains how the value of 14 dBEAU that is used in the baseline simulation for the survey design evaluation tool was selected.

Input #24: ***Response variance for Wave #3 :*** This represents the same concept as the previous input, but is for Wave #3.

C.5 Assumptions about abrupt change effects

The size and form of the abrupt change effect partially determines whether a particular study design or analysis method can detect the effect. Three parameters are needed to specify this effect. The values have been chosen so that at the time of the first follow-up wave (Wave #2) the excess response would be the equivalent of a five-decibel increment in steady-state aircraft noise exposure. This effect was arbitrarily chosen as the smallest effect that a noise-change survey must be able to detect.

Input #25: ***Novelty abrupt change effect:*** The "novelty abrupt change effect" is the change in reactions between the pre-change and post-change waves that occurs independent of the size of the change in noise level. This is the magnitude of the effect when that effect is extrapolated to the first day of exposure to a new noise condition. As this value is decayed over-time using an exponential decay model, it is important that this value yield realistic estimates, when decayed, for times at which annoyance can be measured.

This novelty effect is assumed to affect all people in the airport community whether or not they actually experience an increase or decrease in the value of DNL. For the baseline case, there is assumed to be an abrupt change effect on the day of the change (T=0) of 13 dBEAU (the equivalent of a 13-decibel penalty). With the human response decay rate that is used, the magnitude of this abrupt change effect has declined to 5 dBEAU by the time of the first study wave at 320 days and to about 1.7 dBEAU by day 685 when the second study wave occurs.

Input #26: ***Level-dependent abrupt change effect on first day:*** The level-dependent abrupt change effect is the incremental increase in annoyance per decibel of increase in noise level that is over the increase in annoyance that would be predicted from steady-state relationships for the post-change noise level. This is again the effect that is extrapolated to occur on the first day of exposure to the changed noise exposure. This effect is decayed at the same rate as the novelty effect.

The model included in the simulation program assumes that each decibel of increased noise has the same effect. For example the increase in reactions between the experience of a one-decibel to a two-decibel increase is the same as the increase in reactions between the experience with a seven to an eight-decibel increase. No adjustments are included in either of the abrupt change effects that would model a threshold for detecting changes in noise levels. A level-dependent effect is not included in the baseline model, but is included as one of the alternative scenarios. In this scenario, the value for the level-dependent effect is set at 5.5, indicating that each one decibel increment in abrupt change exposure is subject to an additional increment in annoyance that is 5.5 times as great as that which would be expected from the one decibel increase itself. By the time of the interview at 335 days it is assumed that this value has decayed at the same rate as the novelty effect and thus is equivalent to 3 decibels. The total magnitude of the abrupt change effect at 335 days in this condition is therefore a function of both the size of the novelty effect and the size of the changes that were experienced.

Input #27: ***Reaction decay rate:*** It is assumed that the abrupt change effects will eventually disappear over time until the reaction returns to the steady state case. A decay function is included in the model. The exponent, B_T, for the base-e is introduced in the following expression in which the term "T_i" represents the days since the change in noise exposure: $e^{(B_T \cdot T_i)}$. The value of this expression is the proportional reduction in the abrupt change effect at the specified number of days after the noise change.

Both of the abrupt change effects are assumed to decay at an exponential rate. The decay in the reaction thus is most abrupt soon after the change and decreases at a slower rate with increased time. The effect of alternative values for the exponent are demonstrated in Figure 1. In the survey evaluation simulations B_T is set at -0.003. The novelty effect of 13.7 dBEAU thus decays to become 5 dBEAU at the day 335 [$5 = 13.7 \cdot e^{(-0.003 \cdot 335)}$].

APPENDIX D: EVALUATION OF BIAS AND PRECISION FOR PANEL SURVEY DESIGNS

The review of alternative baselines for noise change studies concluded that the best study design is a longitudinal design in which an interview survey that is conducted around one or more airports before a change in noise environments is followed by one or more waves of interviews that are conducted at the same airport(s) after the change in exposure. The measure of change in reactions thus comes from the comparison of responses before and after the change within the same airport areas. Given such a longitudinal design a primary design decision is whether the second wave of interviews should be part of a panel design in which the same respondents are contacted a second time or whether a new sample in the former study areas should be contacted.

D.1 Panel design issues for noise-change surveys

Panel designs have one substantial advantage for noise change surveys: they can extract more information about reactions to noise from a small number of people than can a non-panel design. As has been indicated in the text of this report, a major problem facing noise-change surveys is that there are usually fewer dwellings than are needed in some noise environments. The panel design extracts at least two interviews from each person (before and after the change) and thus doubles the number of interviews over those that could be obtained from the same population if each unit were only interviewed once. In the absence of major weaknesses in a panel design, such a design is needed for those rare populations. The primary issue for a noise-change survey is, however, the extent to which the panel design should be extended to study areas that have large enough populations to provide independent samples for the before-change and after-change study waves.

There are two potential advantages of expanding the number of respondents in the panel design. One is that panel respondents provide information about the gross patterns of changes, not only the net amount of change. It is therefore possible to determine which respondents react most strongly to changes in noise exposure. The second potential advantage is that the panel design can be expected to provide more precise estimates of the parameters of a noise change model. The within-individual comparison that is possible with a panel design makes it possible to remove many of the individual sources of variation in response and thus to gain a more precise estimate of changes in responses. The primary survey design issue is the size of this gain in precision. The analyses in this appendix address the precision issue by analyzing previous panel surveys of noise reactions.

Panel designs have two primary disadvantages that must be balanced against this expected gain in precision. One disadvantage is that panel surveys tend to be more complex and expensive to administer and analyze. Careful administrative procedures are required to ensure that the same respondents are interviewed and that their records are correctly matched. Intensive field work efforts are needed to avoid excessive loss in the panel size. Relatively complex analysis techniques must be used to account for and benefit from the correlations between individuals' responses in the data. These cost and complexity issues are present for almost all panel surveys and require careful planning.

The second potential disadvantage is the possibility of bias from gathering all after-change data from only those respondents who were previously interviewed and agreed to a second interview. The concern is data from such individuals will give biased estimates of population parameters either because the noise annoyance characteristics of people who are available and will agree to be interviewed a second time are different from the general population or because the experience of having been interviewed before the change will heighten the respondents' sensitivity to noise. Such biases could exist for some types of social survey topics but not for others. The analyses in this appendix examine the evidence from previous noise panel surveys.

D.2 Evaluation of increased precision from a panel design for noise surveys

At least 22 panel surveys of residents' reactions to environmental noise have been conducted. Surveys that have examined the consistency of residents' responses at different times have reported that these responses are consistent and have acceptably high reliability coefficients (Bullen and Hede, 1983: Griffiths, Langdon, and Swan,1980: Hall and Taylor, 1982). However, none of these publications has provided statistics to estimate the gains in precision that are associated with panel survey designs. The levels of reliability they report are a function of both the range of noise levels in the studies and the consistency of the individuals' responses.

To measure the increased precision from a panel design it has been necessary to conduct a new analysis of the data from previous noise surveys. Appendix B describes the search to identify all possible data sets. Six studies supplied the data that are used in the analyses in this section.

The increase in precision associated with repeated interviews is examined through analyses of respondents who were interviewed in both waves of a survey. In these analyses annoyance is regressed on three factors: 1) noise level; 2) the interview wave; and, when there is a change in noise level between the two waves, 3) the size of the change in noise level. The standard errors for the regression coefficients for each of these three factors are then calculated under two conditions. Under the "panel" condition, the standard errors take into account the panel sample design in which each of the respondents' answers are linked across the two waves. Under the "no linkage" condition, the standard errors ignore the linkage between respondents' responses in the two waves. The panel condition therefore assumes that there are *n* interviews with *n*/2 respondents. The no linkage condition assumes that there are *n* observations from *n* unrelated respondents.

The data from the six studies listed in Table 8 were used for the analyses. These were the only available studies in which over 100 respondents' interviews could be linked across the different waves of interviewing. Several other noise-change studies conducted interviews with the same respondents in different waves but did not maintain records to link responses from the different waves of interviews. Each of the six studies examined in this section included some respondents who were interviewed in some, but not all, waves. Those respondents were excluded from the present analyses so that the analyses would measure the maximum gain in variance reduction that could be obtained from a panel design.

The six studies listed in Table 8 provide ten related data sets for the analyses. The Canadian study

Table 8: Six studies and pairs of study waves used in the variance reduction analysis

Study ID*	Number of waves	Waves compared	Months elapsed	Noise source	Change in noise exposure	Number of interviews	Study areas (N)	Comments
UKD-237	3	1 & 2	2 to 8	Road traffic	Decrease in most areas due to road opening	2 •315=630	6	Wave #3 had less than 100 interviews
CAN-168	2	1 & 2	12	Aircraft	None	2 •184= 368	24	All respondents were asked about both noise sources
	2	1 & 2	12	Road traffic	None	2 •184= 368	24	
UKD-157	4	1 & 2	1	Road traffic	None: noise measurements differ only slightly between waves	2 •247= 494	6	No changes in noise were expected
	4	1 & 4	4	Road traffic		2 •194= 388	6	
USA-375	2	1 & 2	7	Sonic booms	Small, unplanned differences measured	2 •217= 434	6	Some households had multiple interviews. Weak noise/annoyance relationship.
NOR-328	6	1 & 2	1	Aircraft	Temporary increase from military exercise	2 •227= 454	5	The 4-week reference period in the question included some exercise noise in Wave #2
	6	1 & 6	12	Aircraft	None	2 •217= 434	5	The 4-week reference periods did not include military exercises
USA-082**	3	1 & 2	<1	Aircraft	Change in nighttime	2 •222 = 444	2	PSU-s are very large. Nighttime noise change is small. Annoyance rating period was not specified.
	3	1 & 3	1	Aircraft		2 •194 = 388	2	

* The Study ID is from the survey catalog (Fields, 1991).
** USA-082: Wave #2 was 4-17 days after the first interview. Wave #3 was 31-55 days after the first interview.

(CAN-168) provides two data sets; one based on respondents' ratings of aircraft noise and one based on those same respondents' ratings of road traffic noise. Three other surveys with more than two waves of interviews provide a total of six data sets because two pairs of waves were analyzed from each study: the first and the second wave as well as the first and last waves (UKD-157, NOR-328, USA-082). Other pairs of waves from these studies could also have been studied. The comparison of these two sets of pairs of waves, however, might be expected to provide the best evidence about whether gains in variance are related to the time elapsed between waves of interviews.

The descriptions in Table 8 indicate that the surveys are generally rather small with from 184 to 315 respondents providing twice that number of interviews. The studies are all based on clustered sample designs with from two to 24 study areas. The number of areas are so few that sampling errors that account for the clustered nature of the data can not be accurately estimated. Because of this uncertainty the increases in precision for the panel designs have been calculated both with techniques that account for the design and with techniques that ignore the clustered design.

Although these data are useful for deriving information about panel survey designs, it should be noted that they do not include studies of reactions to large, permanent changes in aircraft noise exposure. Only one study (UKD-327) includes a definite, large-scale change in exposure. This is a study of reactions to changes in road traffic noise when traffic was diverted from previously busy roads to new bypass roads around villages in England. Most of these study sites were at locations where the noise was reduced. A study around Los Angeles International Airport (USA-082) examined reactions at the time of a small change in nighttime exposure. The long-term, general annoyance question (the only type of question analyzed in this section) did not specify the time period that was to be rated. Other questions about nighttime noise in the survey that referred to shorter time periods did not show any effect of the change in noise exposure. In the Norwegian study (NOR-328) a temporary increase in noise from a military exercise started just before the second wave of interviewing. For this second wave interview the four-week period to which the annoyance question referred included both the military exercise noise and the normal noise environment before the exercise. However, for these interviews the noise data are only for the military exercise period. In the sonic boom study (USA-375) there were probably some small, real differences in exposure between the two phases due to unknown differences between the military exercise schedules in the six-month periods before each study wave.

The results from the analyses are shown in Table 9. All of the analyses regress noise annoyance on noise level and study wave (a dummy variable scored 0 or 1). Pairs of analyses are compared in which the first analysis is for the no-linkage design and the second is for the panel design. The same data are analyzed in each analysis. The only difference is that in the no linkage analysis the responses in the two waves are assumed to be independent while in the panel analysis each respondent's two responses are linked. The values in this table came from analyses in which the study area was not accounted for in estimating the sampling errors. These analyses were executed with the SAS Mixed Models programs described in Chapter 5 (Littell, Milliken, Stroup, and Wolfinger, 1996).

Both the "No linkage" and "Panel" rows in Table 9 have entries for the regression coefficients and the standard errors of those coefficients. The last column in the table gives the percentage reduction (e.g. improvement) in the standard error of the estimate of the regression coefficient for the panel design relative to the no-linkage design. The " % reduce σ"is the differences between the standard errors for the panel design in the previous column divided by the standard error for the no linkage design. Positive values in these cells indicate the panel design is more accurate.

The results are all in the same direction. In every case the panel design results in an improvement, a decrease, in the standard errors for the estimate of the differences in reactions between waves. These reductions range from 45% to 14%. There is no clear explanation for this wide range in reductions. The amount of the reduction does not appear to be attenuated over time in any of the three studies in which there was a contrast between two-week and one-month gaps between

Table 9: Changes in standard errors associated with a panel design in six studies providing 10 data sets

Study	N of interviews*	Study waves compared	Design	Results for study-wave coefficient		
				B_{Wave}	σ_{BWave}	% reduce σ
UKD-237	630	1 & 2	No linkage	-16.339	1.985	14%
			Panel	-15.310	1.709	
CAN-168	368	1 & 2 (Aircraft)	No linkage	9.931	2.904	38%
			Panel	9.931	1.811	
	346	1 & 2 (Road traffic)	No linkage	0.105	2.453	24%
			Panel	0.105	1.864	
UKD-157	494	1 & 2	No linkage	2.113	2.384	34%
			Panel	2.118	1.579	
	388	1 & 4	No linkage	-0.248	2.694	37%
			Panel	-0.262	1.696	
USA-375	434	1 & 2	No linkage	-7.353	3.167	42%
			Panel	-7.367	1.85	
NOR-328	454	1 & 4	No linkage	-8.641	2.265	22%
			Panel	-8.411	1.775	
	434	1 & 6	No linkage	-1.801	2.056	28%
			Panel	-1.801	1.478	
USA-082	444	1 & 2	No linkage	3.64	2.308	41%
			Panel	3.64	1.37	
USA-082	388	1 & 3	No linkage	3.705	2.596	45%
			Panel	3.705	1.42	

* Since each person responded twice, the number of respondents is half of the number of interviews.

interviews (USA-082), one-month and four-month gaps (UKD-157) or one-month and 12-month gaps (NOR-328). The estimated reduction is quite different for aircraft (38% improvement) and road traffic (24% improvement) for the same respondents with the same design for the Canadian survey (CAN-168). Although the aircraft surveys benefit, on the average, somewhat more from the panel design there is also considerable overlap between the aircraft and road traffic estimates. When the clustered sample design was recognized in the analysis, the estimates of the noise-level coefficients and their variances changed considerably, but the benefits from the panel design for study wave estimates remained though they were reduced, on the average, by approximately two to three percentage points.

These results clearly support the use of a panel design. It is not clear exactly how much benefit can be gained from these designs partly because of the differences between surveys and partly because of the presence of two additional sources of uncertainty.

One source of uncertainty is response rates. The estimates come from contrasting designs in which all individuals are re-interviewed or no individuals are re-interviewed. In practice, all respondents can not be reached for repeated interviews and, as a result, even a study that is committed to a panel design will have many respondents who are only interviewed once.

A second source of uncertainty concerns a statistic that has not been directly examined. To make comparisons between the results of different surveys and to provide an understandable measure for public policy the primary interest is often not only in the reaction scores (either percentage annoyed or averaged scores) but instead in the increase in reactions relative to the impact of noise level. This can be expressed as the ratio of the regression coefficient for the "study wave" variable divided by the regression coefficient for noise level. This yields the decibel Equivalent Units (dBEAU) that are discussed else where in this report. It is not clear whether the precision of this measure of study wave reactions would benefit as much from the panel design as the measures examined here have. If there are increases in the standard errors for the noise level variable these may partially cancel the reductions gained from the wave variable for estimates of this ratio.

D.3 Evaluation of bias from repeated interviews

From a brief examination of the noise literature, it appears that most previous surveys with interviews separated by at least one-month periods between surveys reported that there was no effect of repeated interviews. The interpretation of these findings is somewhat complicated by two factors: 1) the studies generally had very small control (non-panel) groups and 2) the results are not reported in detail.

One exception is a helicopter noise/response study in which residents were repeatedly interviewed (some for more than 20 times) at intervals of a few days (Fields and Powell, 1985). This study found strong evidence for day-of-interview effects and mixed evidence for a general increase in aircraft annoyance, but not road traffic annoyance, between the initial interview and later interviews after respondents had participated several times weekly for a month. This increase was approximately equivalent to a three-decibel increase in noise level (Fields and Powell, 1985: 34). Although this helicopter study did not provide conclusive evidence, the study does suggest that repeated interviewing with only a few days gap between interviews can increase reactions. This evidence is not, however, very relevant to the more typical panel design when respondents are only interviewed two or three times and those interviewing phases are widely spaced over several months or years.

This section develops better evidence about the possible bias from a panel design by conducting a new analysis of the original social survey data from three surveys. These are the three studies from Table 8 in which the second and later waves of interviews included a mixture of respondents who had been previously interviewed and those who had never been interviewed before. The extensive search reported in Appendix B discovered no other existing panel surveys on noise in which new respondents and previously-interviewed respondents could be identified. The effects of repeated interviews are examined in this section by comparing the annoyance responses of the new study participants with those of the panel participants (all having previous interviews) within each interviewing wave.

The descriptions of these data sets in Table 8 are supplemented by the information presented in the first columns of table 10. The "Months since previous interviews" column in Table 10 shows how recently the previous interviews had been conducted. The multiple entries in the column show the total time elapsed between the analyzed interview and each of the previous interviews. For example, the previously interviewed respondents in the fifth wave of study NOR-328 had been previously interviewed at two months, six months, seven months, and eight months before the Wave #5 interviews that were analyzed here. In Table 10 it is also seen that although study USA-082 has three waves of interviews, only the third wave is examined. This is because new respondents were not introduced into the design in the second wave. For NOR-328, analyses of five waves are presented (Wave #2 through #6). In all analyses, except for Wave #6 of NOR-328, the comparison is between the respondents who were interviewed for the first time in a wave and those who had been interviewed in every previous wave. For Wave #6 of this Norwegian study, 22 of the 95 previously interviewed respondents had been interviewed in four rather than all five of the previous waves.

The results from the seven analyses are presented in the remaining columns of Table 10. The effect of noise level has been controlled through linear regression analyses by entering noise level as a second independent variable in an equation that includes a 0/1 repeated interview variable. The annoyance variable is scored on a scale that extends from approximately zero to 100 using a scoring system that places annoyance scores at the midpoints of scale categories (Miedema and Vos, 1998; 3434). The coefficient for the "Panel" variable represents the effect of being repeatedly interviewed. To normalize these scores for differences in the regression coefficients from different studies, these values have been divided by the appropriate regression coefficients in the column labeled "B_{Panel}/B_L". These ratios are expressed in the decibel Equivalent Annoyance Units (dBEAU) that are used in this report.

The seven analyses in Table 10 do not provide evidence for a consistent or large bias from repeated interviewing. The negative signs for the panel effect for four of the seven analyses show that in these analyses annoyance decreases with repeated interviewing. The positive signs for the three remaining analyses indicate the opposite. The sizes of the effects are small to moderate, ranging from effects that are the equivalent of about -4.5 decibels to +2.5 decibels. The estimates of the decibel equivalent effect in the last column were within one tenth of decibel of those obtained other analyses in which the residuals from the regression of annoyance on noise level were examined. Similar estimates were obtained from analyses of residuals from logistic or quadratic regressions.

The surveys do not differ sufficiently in their quality as to suggest that any one survey's findings on the panel effect should be regarded as more accurate. The sample sizes are all relatively modest (between 95 and 430 for a single condition). None of the studies has a carefully balanced design to match the new respondents and panel respondents. All studies repeated their first-wave annoyance question in their later interviews. Although the Los Angeles survey (USA-082) used the entire (short) first-wave questionnaire in each of the subsequent waves, the other two studies used a slightly shorter questionnaire for the follow up interviews. Only one of the seven effects is estimated to be statistically significant ($p<.05$) even with the sampling errors that are based on unrealistically precise simple random sampling assumptions. This single finding that shows a reduction in annoyance for panel participants comes from the second wave of study NOR-328. However the remaining analyses for this study do not support this finding. For the four remaining

Table 10: Three studies with seven comparisons between new and previously-interviewed respondents

Study ID	Wave analyzed	Months since previous interviews	Number of interviews	Results from linear regression with two terms				B_{PANEL}/B_L (dBEAU)
				B_0	B_L	B_{PANEL}	σ B_{PANEL}	
USA-375	2	7	new=296 panel=218	18.7	0.8	1.3	3.3	1.7
USA-082	3	<1, <2	new=232 panel=154	17.4	0.6	-2.5	2.6	-4.6
NOR-328	2	1	new=430 panel=205	-50.9	1.4	-6.3	2.0	-4.6
	3	1-2	new=405 panel=164	-37.1	1.2	-0.7	1.9	-0.6
	4	4-5-6	new=253 panel=114	-42.6	1.3	0.2	2.5	0.2
	5	2-6-7-8	new=352 panel=97	-45.9	1.3	3.2	2.5	2.5
	6	4-6-10-11-12	new=388 panel =95	-54.7	1.4	-3.7	2.2	-2.6

analyses from this study, none of which is statistically significant, two show repeated interviewing increasing annoyance while two show repeated interviewing reducing annoyance.

D.4 Conclusions

The evidence reviewed in this appendix provides topic-specific information about variance reduction and bias attributable to panel designs in community noise surveys. When combined with knowledge about the general principles of panel survey design, the information provides a basis for choosing between a panel or non-panel design for community noise surveys.

The panel design increases the precision of estimates of differences between the responses at two points in time. For some surveys the increase in precision from repeated interviews was estimated to be greater than that which could otherwise be gained with more than a doubling in sample size. The magnitude of the improvement in the variance from repeated interviewing can not be confidently predicted from the data analyzed here. The estimates from different surveys and different analyses from the same surveys differ. It should also be noted that the reductions in individual variance that are expected from repeated interviews may be attenuated if the sample is clustered into relatively homogeneous areas.

The panel design does not appear to introduce bias into the survey results for the conditions reviewed here of no more than six interviews and interviews that are at least one month apart. The lack of consistency over the surveys on this finding suggests that some caution is needed. In addition, the evidence from the previously-cited helicopter survey indicates that a panel survey with many repeated interviews separated by days rather than months may create some increase in annoyance responses.

The data analyzed here indicate that a panel design would strengthen a survey of reactions to changed noise environments. Any design should, however, also include additional, non-panel, respondents in follow up waves. The use of some non-panel members is especially important if interviews are conducted at closely-spaced intervals of less than a month.

APPENDIX E: EXAMINATION OF EVIDENCE FOR SEASONAL EFFECTS ON ANNOYANCE

An abrupt change model that estimates effects for other than one-year increments must consider the possibility that seasonal effects will be confounded with abrupt change effects. In the absence of within-study controls it is necessary to either know that seasonal effects will not be important or be able to sufficiently accurately estimate seasonal effects so that these effects can be removed from an abrupt noise change study.

This appendix is divided in two four sections. First, a model is presented that suggests hypotheses that explain seasonal response differences. Next, the results are examined from a series of Dutch surveys that present the best evidence on seasonal effects. Next, the evidence from other surveys is reviewed. Finally, the results are summarized and recommendations are made for an abrupt change study design.

The primary conclusion is that the season at which an interview is conducted affects responses to noise annoyance questions. Given the present state of knowledge, an abrupt change survey will not be able to provide strong evidence about changes in noise reactions except in the same season at a year after the before-change interview or, in some conditions, in the one or two months after the change in noise exposure.

E.1 Model for seasonal response effects

This section presents a simple model in Figure 2 that links the time of year of a noise study with respondents' answers to questions about noise. Although more complex models could be developed, this model introduces some important complexities beyond the simple assumption that there is a cold season response between some dates and a warm season response the rest of the year.

The model in Figure 2 contains some important implications for the integrated annoyance response. The time of year and the climatic location are two general factors that affect climatic conditions. Four aspects of the climatic conditions (temperature, precipitation, wind velocity, and number of daylight hours) are assumed to affect two important activities, the extent to which windows are open and the extent to which residents engage in out-of-doors activities around their homes. These activities are assumed to be important because they affect residents' noise exposures. The noise exposures thus affect the annoyance experienced in any single day. The long-term, integrated annoyance response, however, depends upon the way in which these daily responses are integrated. If there is a seasonal effect then individuals perform some type of integration that lies between the extremes of giving equal weight to all exposure during the previous 12 months and ignoring all exposure except that during the interview.

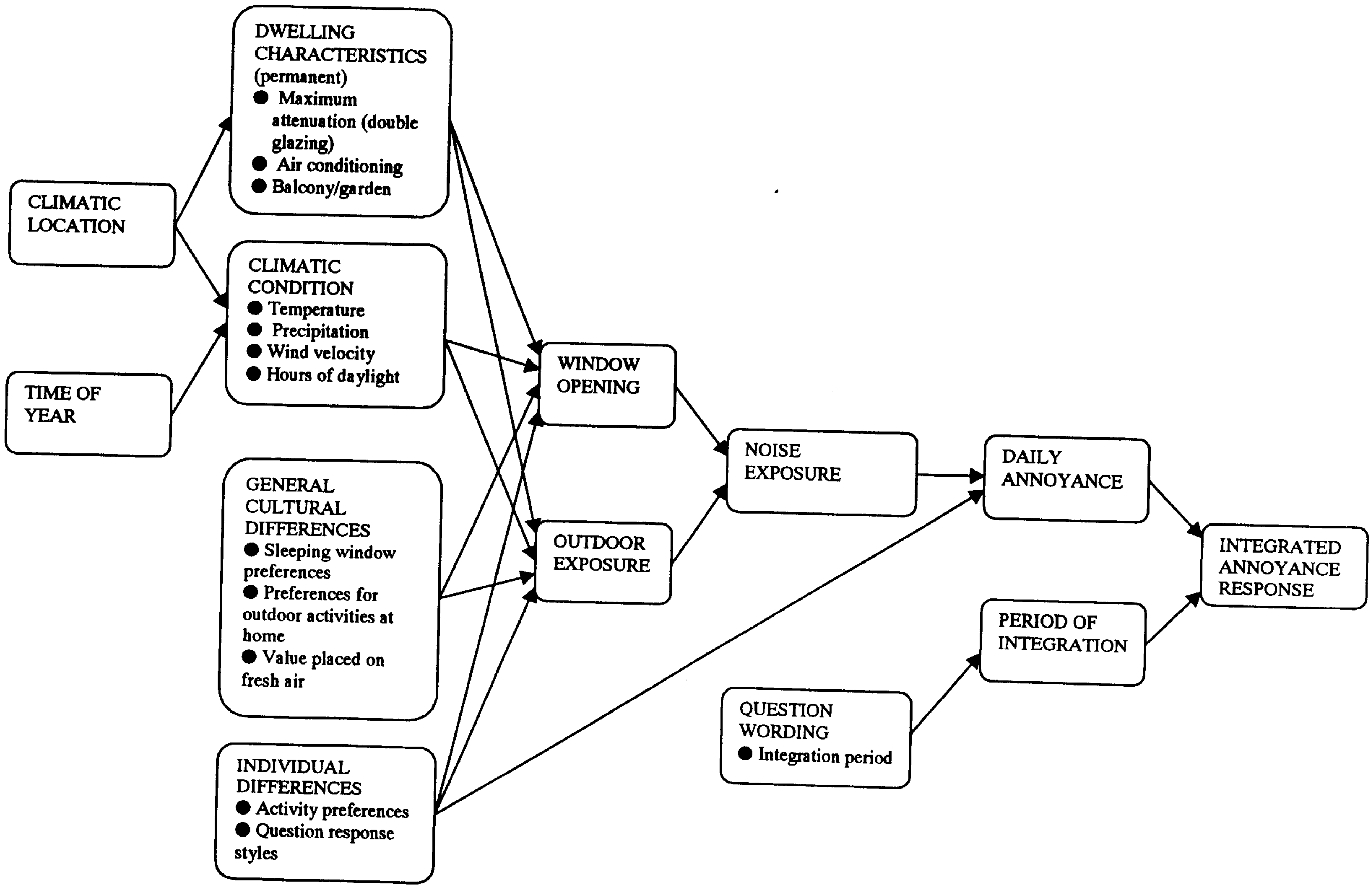

Figure 2 Model for seasonal response effects

It should be noted that the model for relating the four characteristics of seasonal weather patterns to window-opening and outdoor exposure is not obvious. It seems unlikely that there is a simple linear relationship. Below certain threshold temperatures almost all outdoor activities may cease and there may be no daytime window opening. Above certain temperatures home cooling systems may, in some countries, result in most homes' windows being closed. Complex interactions and non-linear relationships may apply to the remaining climatic factors. Precipitation may eliminate all outside activities, regardless of temperature, but, for certain dwelling designs, have little effect on window-opening patterns. Wind velocity effects, like temperature, may include threshold ranges.

The model in Figure 2 also suggests that other variables could affect the strength and timing of a seasonal effect. Various permanent characteristics of the dwelling and the surrounding area set limits on the extent to which noise exposure during the year can be varied by opening windows and by outdoor exposure. Dwelling design is relatively unimportant for the open window noise condition. However homes with relatively ineffective closed-window sound insulation will be subject to less indoors seasonal variation than homes with substantial sound insulation. The presence of an air conditioning system gives the option of cooling homes during warm times and thus of reversing the general tendency toward more open windows and less attenuation at higher temperatures. The presence of outdoor gardens or balcony areas increases the possibilities for outdoor exposure.

Cultural patterns can also be important. In some countries a value is placed on fresh air. Windows may be opened for at least a short time most mornings or windows may almost always be opened at night in sleeping rooms. Countries and regions can also differ considerably in whether activities such as eating or talking with friends occur out-of-doors in warm weather. Economic conditions may also be important. In energy-conscious locations individuals may be more likely to open windows to regulate inside temperatures. Some portion of the population may restrict window opening and outdoor activities because of either natural irritants (e.g., pollen) or poor perceived air quality.

Individual differences can, of course, affect all aspects of noise exposure and annoyance. Individual differences directly affect noise exposure through individual preferences for window opening and out-of-doors usage patterns. In addition the variations in the values placed on different types of activities could affect the importance of out-of-doors activities and the relatively importance given to noise exposure at different times of day. Of course, individual differences can also directly affect the daily annoyance.

One of the most important aspects of a seasonal effects model for a noise change study is the length of the period that affects responses. The wording of the question may have some influence by asking respondents to consider a particular period. However, it should not be assumed that respondents will simply disregard all salient experiences at other times. It is not at all clear what model should be adopted. If respondents do not give special emphasis to their most recent experiences, then there would be no seasonal effect. If respondents' answers to a question were weighted by the recency of experiences then there would probably be some type of decay effect with the most recent experiences having the greatest effect but earlier experiences also being important. Although many aspects of memory might be expected to be subject to some type of exponential decay, it is not clear that judgements of annoyance should be subject to such effects. Long-term residents have experiences over many years that have directly provided a basis during all times of year for forming a judgment. New residents might correctly judge from past experiences that the noise exposures they experience will increase if their windows are opened or they participate in outdoor activities.

The model does not explicitly address other factors and assumptions. For example, it is assumed that the noise emission patterns are relatively constant over the year. Although there are some local areas in which there are large variations in seasonal traffic, it seems unlikely that most variations will be of much importance especially if it is assumed that energy-based noise models are correct. In these models even a doubling of the numbers of events results in only a three-decibel increase in noise level.

The model also assumes that seasonal climatic conditions do not have more general response effects. Thus it is assumed that if weather affects people's moods and their outlook on life these do not in turn affect the extent to which respondents give positive or negative answers to noise annoyance. As the next section shows the Netherlands data provide some support for this assumption.

E.2 Evidence from the Continuous Life Information Survey (DLO)

The strongest evidence about seasonal effects comes from the year-round Continuous Life Information Survey (DLO) that has been conducted for more than a decade by the Central Bureau of Statistics in the Netherlands. This survey has included questions about noise annoyance since at least April 1989. The present analysis is based on seven years of data (January 1990 to December 1996). The data are especially valuable because the DLO survey is conducted on a continuous basis with a new nationally-representative sample (18 years of age and older) being studied every four weeks. Even though noise-exposure levels are not known, the fact that there is a nationally representative sample means that the same study population with only random differences in noise exposure is studied for each season. (This assumes that there are not important differences in seasonal noise emission levels.) For this seven-year period the questions remained similar with revisions being made at only one point, in January of 1994.

The basic annoyance questions are given in English in Table 11. The full wording of the questions in Dutch is given in Table 15 in Appendix F.

The percentages reporting three frequencies of being bothered by aircraft and road traffic noise are reported in Table 12 for three seasonal periods. Percentages for two other noise sources are reported in Table 16 in Appendix F. Each of the percentages in Table 12 is based on interviews conducted during four-month periods. The four-month periods are Winter (January to March and

December), Spring/Fall (April, May, October, November), and Summer (June to September). Spring and Fall were place in a single category on the basis of a brief visual inspection of the data that indicated that the responses in these periods were approximately similar. The three periods lag slightly beyond conventionally defined seasonal changes because it is assumed that, in the absence of any instructions to the contrary, respondents are likely to include experiences from a previous month in their judgments. This would be especially true of respondents who were interviewed early in a month.

Each four-month period includes between approximately 1,000 and 2,400 interviews. The percentages in Table 12 are simple averages of the monthly percentages. Statistical tests that compare groups of months are based on the number of months of observations and not on the number of interviews. Since the individual data for any one month are weighted to account for different response rates in different population categories, it is not possible to estimate the sampling errors for the individual months from the available information.

Table 11: The Netherlands DLO survey questions about noise

Part of question	Survey period*	
	April 1998 to December 1993	January 1994 to December 1996
Stem of question	Now I am going to mention a number of issues to you, which *could bother people at home.* I would like to know whether *you are bothered by them, here.* *Could you answer according to this card?* Are you here, at home, bothered by:	Now I am going to mention a number of issues to you, of which I would like to know whether *they bother you in your living environment.* Are you, in your living environment, bothered by:
Alternative answers	*[On show card:]* YES, *OFTEN* / *YES*, SOMETIMES / *SELDOM OR NEVER*	*[No show card]* YES / SOMETIMES / *NO* / REFUSES/DOESN'T KNOW
Noise sources	c) aircraft noise?	1. aircraft noise?
	d) noise from trains, trams or subways?	2. noise from trains, trams, subways?
	e) noise from cars, motorcycles or mopeds?	3. noise from cars, *lorries,* motorcycles or mopeds?
	f) street noise, from loading and unloading, or from playing children?	*4. street noise, from loading and unloading?*
		5. street noise, from playing children or young people?
	g) noise from industry or businesses?	6. noise from industry or businesses?
	h) noise from neighbors?	7. noise from neighbors?

* *Italics* indicate wording that was changed in January 1994.

The differences between the winter season responses (December to March interviews) and other seasons are also included in Table 12. For example, the last line of Table 12 shows that there was a 4.5 percentage point increase from the1990 winter months to the 1990 summer season (June to September) in the percentage who chose the responses of either "Yes/Often" or "Yes/Sometimes" (i.e. did not choose "Seldom/never" bothered). The last column in the last line of the entire table shows that the seven-year average increase in this category from winter to summer was about 2.7 percentage points. The comparable figure for aircraft noise is seen to be 3.0 percentage points. An examination of the average differences for these two noise sources and their accompanying seasonal differences shows that there is a steady increase from winter to spring/fall to summer in the percentage of residents reporting being bothered. For road traffic noise there is an increase from winter to the other seasons for 27 of the 28 comparisons that are presented in Table 12. For aircraft there is an increase for 23 of the 28 comparisons. An analysis of variance in which each of the 84 months is treated as an independent observation indicates that the differences between seasons are statistically significant at the $p<0.05$ level. This evidence clearly supports a seasonal effect.

Several other patterns emerge from an examination of the DLO survey. The seasonal percentage differences are generally larger when the base percentage annoyed is closer to 50% (for example, for road traffic or for the "sometimes" categories). This pattern adds to the concern that the size of the seasonal effect may be related to noise level. The pattern of responses within each of the two question types suggests that there is a long-term trend toward decreasing numbers of people being bothered. There is also a tendency for the question revision in 1994 to reduce the proportion choosing the middle alternative on the scale.

One other pattern is of importance. When the annoyance with a primarily indoor noise source (noise from neighbors) was examined a similar seasonal pattern was not found. This clearly contrasts with the pattern for road traffic. To compare the seasonal differences for the two types of sources the three responses to the annoyance question were first scored 1 ("Seldom/Never" or "NO"), 2 ("Yes, sometimes" or "sometimes") or 3 ("Yes, Often" or "Often"). For road traffic the average winter score was 1.43 and the average summer score was 1.47. A similar pattern was present for aircraft, railway, and industrial noise. In each case each of the four summer month scores was higher than any of the winter month scores. For neighbor noise, however, the summer score was no longer higher. The average winter score was even slightly reversed with a winter score of 1.35 and summer score of 1.34. The consistency of these results suggests that there is a statistically significant difference in the two types of questions, but this could not be directly tested because the individual-level data were not available for analysis. The lack of a seasonal response pattern for neighbor noise is important because it suggests that the seasonal response pattern to aircraft and road traffic noise is not due to an overall, undifferentiated response bias that might apply to all types of judgments during the summer or winter months.

Table 12: Responses and differences between responses in pairs of seasons for aircraft and road traffic (DLO Survey)

Season	Responses for 1990 - 1993 Question form					Responses for 1994 - 1996 Form				Average (7-years)
	response categories	1990	1991	1992	1993	responses	1994	1995	1996	
Frequency of being bothered by aircraft										
Winter* (Dec-Mar)	Seldom/never	76.7	76.2	77.3	79.7	NO	80.8	80.7	81.5	78.6
	Yes/SOMETIMES	17.1	19.4	18.7	16.1	SOMETIMES	14.6	14.4	12.5	16.6
	Yes/often	6.2	4.3	4.0	4.2	YES	4.6	4.9	5.9	4.8
Spring/Fall (Apr/May Oct/Nov)	Seldom/never	76.0	76.1	76.9	78.2	NO	84.1	79.4	83.1	78.5
	Yes/SOMETIMES	18.9	19.5	18.0	16.8	SOMETIMES	10.0	13.3	11.7	16.2
	Yes/often	5.0	4.4	5.1	5.0	YES	5.9	7.3	5.1	5.3
Summer (June-Sept)	Seldom/never	71.5	74.5	74.3	77.6	NO	75.2	76.6	80.3	75.7
	Yes/SOMETIMES	22.8	20.4	20.6	17.7	SOMETIMES	18.2	16.6	13.3	18.8
	Yes/often	5.7	5.1	5.1	4.7	YES	6.6	6.8	6.3	5.6
Number of percentage points increase in percent bothered from winter to other seasons (aircraft)										
For Spring & Fall	Yes/often	-1.2	0.1	1.1	0.8	YES	1.3	2.4	-0.8	0.5
For Summer		-0.5	0.8	1.1	0.5		2	1.9	0.4	0.8
For Spring & Fall	Yes/often & Yes/SOMETIMES	0.6	0.2	0.4	1.5	YES & SOMETIMES	-3.3	1.3	-1.6	0.1
For Summer		5.2	1.8	3	2.1		5.6	4.1	1.2	3
Frequency of being bothered by road traffic										
Winter* (Dec-Mar)	Seldom/never	67.0	67.2	68.3	69.5	NO	71.6	70.2	72.3	69.1
	Yes/SOMETIMES	22.0	22.4	21.2	21.0	SOMETIMES	14.9	15.1	15.9	19.6
	Yes/often	11.0	10.4	10.5	9.5	YES	13.5	14.8	11.9	11.3
Spring/Fall (Apr/May Oct/Nov)	Seldom/never	66.9	65.0	67.0	67.3	NO	68.1	69.7	70.2	67.5
	Yes/SOMETIMES	21.9	23.1	21.5	22.3	SOMETIMES	15.2	14.6	14.6	19.8
	Yes/often	11.2	11.8	11.5	10.5	YES	16.7	15.8	15.2	12.7
Summer (June-Sept)	Seldom/never	62.6	66.4	63.8	65.5	NO	67.7	69.2	72.7	66.4
	Yes/SOMETIMES	23.6	21.7	23.6	23.0	SOMETIMES	14.4	13.4	14.3	20.1
	Yes/often	13.9	11.9	12.5	11.5	YES	17.8	17.4	13.0	13.5
Number of percentage points increase in percent bothered from winter to other seasons (road traffic)										
For Spring & Fall	Yes/often	0.2	1.4	1	1	YES	3.2	1.0	3.3	1.4
For Summer		2.9	1.5	2	2		4.3	2.6	1.1	2.2
For Spring & Fall	Yes/often & Yes/SOMETIMES	0.1	2.1	1.3	2.3	YES & SOMETIMES	3.5	0.5	2	1.6
For Summer		4.5	0.8	4.4	4		3.8	0.9	-0.5	2.7

* A year's winter season includes January, February, and March from the beginning of the year and December from the end of the same year.

The analyses of the DLO data have been sufficient to establish the presence of a seasonal effect but not the size of that effect. Establishing the size of the effect would be difficult with the currently available data for the following reasons:

1) The DLO annoyance questions measure perceived frequency of being bothered ("often, sometimes, seldom, never") not the degree of bother or annoyance. It is not known whether the two types of questions provide equivalent estimates of seasonal effects.
2) The seasonal effects in this DLO data set are averaged over all noise levels, including areas with little or no substantial exposure. Such areas can not be separated in the analysis since noise levels were not measured. It is likely that the seasonal effects are greater for areas where the noises are clearly audible and, within those areas, in the highest noise exposure zones. It is not possible, therefore, to determine what the sizes of the seasonal effects would be in the moderate or high noise-impact areas that are important for noise regulations and noise studies.
3) The use of grouped data probably underestimates the effects of seasonal differences. The data that were available for the seasonal analyses reported here are the summary data for the entire country for each of the questions for the 84 months from 1990 through 1996. The original, individual-level data are not available to the public for analysis. The net effect has probably been to underestimate the effect of climate on noise reactions. The following limitations would all appear to attenuate estimates of the relationships between climatic conditions and noise annoyance: the weather conditions on the interview day are unknown, the monthly interview dates do not exactly match the 4-week sampling periods: the distribution of the interviews within the months are not known, sampling errors could not be calculated that would properly account for the non-response adjusted sample weights, and the absence of knowledge about the location within the Netherlands meant that adjustments could not be introduced for regional differences in weather patterns.
4) The response rates are low, less than fifty percent.

E.3 Evidence from other surveys

Tests for the presence of seasonal effects have been reported in English for at least the seven surveys that are listed in Table 13. These include all six of the published tests for seasonal effects that were found from an extensive search of pre-1988 English-language publications from 282 social surveys of noise annoyance listed in a noise survey catalog (Fields, 1991: catalog numbers 001 to 282). Other surveys have been conducted but not published in English. For example, one annual environmental survey in Germany (Umweltbundesamt, 1996) is reported to demonstrate that surveys conducted in winter months find less noise annoyance (D. Gottlob, personal communication, 1999). The methods for evaluating the findings from the six, previously-identified surveys were described in an earlier publication (Fields, 1991).

The first five of the seven studies in Table 13 report that there were greater annoyance reactions for respondents who were interviewed in warm months than for respondents who were interviewed in colder months. The remaining two studies report no difference. The results in the fourth column of Table 13 show seasonal effects for the five studies that are the equivalent of at least a five-percentage point difference in annoyance responses or a three-decibel difference in noise level. The narrative descriptions in the next-to-last column of the table document differences as large as 15 percentage points (USA-143) or the equivalent of five decibels (USA-022/USA-032/USA-044). These differences are large enough to seriously distort estimates of noise-change effects. Most of the surveys include information about dose/response relationships that could, theoretically, be used to more closely estimate the decibel equivalence of the differences in annoyance reactions in different seasons. This has not been done due to concerns about the effects of correlated variables and biases introduced by publication practices. These concerns are related to the conclusions drawn about seasonal effects, a minor goal for most surveys, and not for conclusions about the surveys' other, usually more important, goals.

Seasonal differences may be correlated with other factors in several studies. Two of the studies did not explicitly control for differences in noise exposure and did not make efforts to ensure that such differences were controlled or randomly distributed in the two seasons (UKD-008, CAN-078). For one of the remaining studies, the difference between seasons is confounded with study sites, since the two winter surveys were at different airports than the summer surveys (USA-022/USA-032/USA-044). In this particular case the two winter airports had been selected for study because they were smaller than the previously studied airports. In the analysis phase, however, it was realized that the observed response difference could not be interpreted because these two small airports were also the only ones surveyed in the winter. None of the seven studies were designed to average the seasonal effects for both seasons over several years. Five of the studies base at least one of the seasonal observations on interviews from a single month with the result that the effect of season is confounded with any other unique events at that time.

Publication practices could introduced biases if investigators reported findings when seasonal effects were found but failed to report their findings when no seasonal effects were found. Although this is a commonly recognized problem in meta-analysis (Wolf, 1986), it could be an especially serious problem for these surveys that were not designed to test for seasonal effects. The two surveys that were designed to test for seasonal effects (UKD-157, SPA-313) were the only two that did not report seasonal effects. When the list of 282 surveys that had yielded six tests of seasonal effects was reexamined, it was found that an additional 12 surveys in the list had interviews from different seasons that encompassed more than a six-month period, but that the publications had not reported any tests for seasonal effects (Fields, 1991; survey numbers: AUL-210, AUL-227, FRA-239, GER-192, GER-278, SWE-021, UKD-268, USA-059, USA-088, USA-127, USA-129, USA-156). It is not known whether these surveys examined the possibility of seasonal differences.

The seasonal findings from the 1984-85 Gandía 3-Site Traffic Noise Survey (SPA-313) have not been thoroughly described in English and thus are presented in the remainder of this section. This Spanish survey conducted interviews at many of the same houses in two different summer periods and one winter period (García and Romero-Faus, 1987).

Table 13: Findings on seasonal differences from seven studies

Study (Catalog ID)	Seasonal comparison (Sample size)	Variables controlled in analysis	Annoyance is highest in: (basis)	Narrative description of finding	References
1975 Schiphol/ Marssum and 1975 Leeuwarden NIPO [Aircraft]] (NET-115, NET-844)	September compared to November of 1975 (N=143)	Noise level, study area	Hot, dry summer (>3dB)	Annoyance is reduced by the equivalent of 3 dB(A) from September after a hot summer, until November after a wet, cool autumn.	de Jong, 1981:8, Fig. 15
USA Airport [9 Cities] (USA-022, USA-032, USA-044)	Summer of 1967 (May/ August) & 1969(July/ Nov.) compared to Oct. 1970 to Jan. 1971 (N=8500)	Noise level (different airports)	Summer (>3dB)	Mean annoyance at 7 large city airports in summers (1967-69) is the equivalent of 5 dB greater than at 2 small airports 1 to 4 years later. However annoyance in 4 of the 7 winter surveys is similar to the summer.	Connor, Patterson, 1972:31-33; Fields, 1983: 966
1961 Heathrow Aircraft (UKD-008)	September (N=1731) compared to Oct. & Nov. (N=114)of 1961	Airport (uncertain if Oct/Nov sample is of same population)	Summer (>5%) (Statistically significant, Simple random sampling assumption)	2% more "Very" and 10% more "Moderately /Very" annoyed in early Sept. than in Oct./Nov. (Barely significant, p<.05 simple random sampling assumptions)	McKennell, 1963: Appendix R
1977 3-Phase JFK Concorde (USA-143)	Summer to winter (1971) (N=5404)	Distance from airport	Summer (>5%)	At least 15% less "high" annoyance during the winter interviews.	Borsky, 1978: 20
1972 Calgary Community Noise (CAN-078)	February compared to Summer of 1972 (N=720)	None (Uncertain if same population)	Summer (>5%)	At least 10% more are annoyed in summer than in February. Self-completion questionnaires were used.	Dunn, Posey, 1974:26,27 47,48
1977 London Area Panel [ROAD TRAFFIC] (UKD-157)	Dec. 1977 to spring & Sept. 1978 (4 waves, N=888 inter-views by N=222 respondents)	Noise level, study site, respondents	No difference (p<.05)	No significant difference between noise annoyance in different seasons though reports of window opening do differ. (Panel survey with the same respondents)	Griffiths, Langdon, Swan, 1980:236
1984-85 Gandía Three-Site Traffic Noise Survey (SPA-313)	Summers of 1984 & 1985 compared to Winter 1984-85, N=543	Noise level, study site	No difference (<5%)	In addition there is more traffic in the summer and windows are open more.	García, Romero-Faus,1987, 175

The 1984-85 Gandía Three-Site Traffic Noise Survey (SPA-313) consisted of 543 interviews at three sites in Gandía, Spain. Many of the same respondents were interviewed in each of the three survey phases conducted in the Summer of 1984, Winter of 1984-85 and Summer of 1985. Noise levels were reported as being within the range of 65 to 71 dB (LAeq, 24 hr). The analysis did not link the responses of those respondents who were interviewed more than once.

The data in Table 14 do not provide consistent support for a seasonal effect. When the percentages in the three "winter" columns (Win.) are compared with the corresponding summer average-response columns (S-avg.) for their respective sites, it is seen that greater annoyance occurs in the summer at Site #1, winter at Site #2 and either the winter or the summer, depending on which categories are collapsed, at Site #3. Although these data provide stronger evidence than those of other studies in several respects, they do not provide a definitive test of a seasonal effect. The sample size of 543 is small enough so that sampling errors could be important. (The numbers of interviews for each site-by-phase column is not reported.) In addition, the annoyance question differs somewhat from standard annoyance questions in one way that may effect estimates of seasonal effects. Two of the question alternatives suggest that the question is not about the

Table 14: Annoyance during three seasons in the 1984-85 Gandía Three-Site Traffic Noise Survey (SPA-313)

Responses	Site & Season (S=summer, Win= winter of 1984-85, S - avg.=average of two summers)											
English (translation)*	Site #1: Avda. de la República Argentina				Site #2: Paseo de Germanías				Site #3: Cr. deValencia			
	S '84	S '85	S - avg.	Win	S '84	S '85	S - avg.	Win	S '84	S '85	S - avg.	Win
QUESTION: Q25 What do you think about the level of traffic noise at your home? (SHOW CARD 1) [Original in Spanish-- ¿Como considera el nivel de ruido de trafico que llega a su casa? (PRESENTAR TARJETA 1)]												
Absolutely unbearable	0.0	3.3	1.7	0.0	2.5	24.2	13.4	16.2	15.9	7.2	11.6	5.5
Very noisy	6.7	6.5	6.6	4.1	10.0	27.3	18.7	25.7	34.1	26.1	30.1	40.0
Quite noisy	23.3	20.7	22.0	21.9	40.0	22.7	31.4	28.4	29.5	44.9	37.2	32.7
Normal for a city like this	63.3	65.2	64.3	60.3	45.0	22.7	33.9	28.4	20.5	20.3	20.4	16.4
Slightly lower than normal	6.7	1.1	3.9	5.5	2.5	1.5	2.0			1.4	0.7	1.8
This is a quiet place		2.2	1.1	4.1			0.0				0.0	
This is an absolutely quiet place			0.0	1.4			0.0				0.0	
Don't know, not sure		1.1	0.6	2.7		1.5	0.8	1.4			0.0	3.6
Total (percentages)	100.0	100.1	100.1	100.0	100.0	99.9	100.0	100.1	100.0	99.9	100.0	100.0

respondents' feelings but rather about the respondents' judgements about the noise at their house relative to what is "normal for a city like this" ("Normal para una ciudad como ésta"). In as much as respondents focus on this comparison, it would be expected that the season would not affect how they rated their noise relative to other similar cities. Another question that asked about traffic noise in the city, not in the neighborhood, also failed to show a seasonal difference. Summer reactions were heightened at Sites #1 and #3 but not at Site #2 (Romero-Faus, 1987: Question 5, pp. 213, 233, 253).

E.4 Conclusions and recommendations

The Netherlands DLO survey has presented strong evidence that there are seasonal effects. However, these data are not sufficient to determine whether or not these effects would be large or only minor at the moderate or high noise levels that would be included in an abrupt change study around an airport. The remaining surveys that have been reported give mixed evidence. Although most surveys that have discussed a seasonal effect have reported finding a seasonal effect of a large size, the only two surveys that were designed to test for a seasonal effect did not find one. It is not known whether other surveys that have not reported a seasonal effect tested for its presence.

From the examination of the existing data and considerations of the model presented in Figure 2 the following conclusions are reached:

1 Season of year affects noise annoyance responses under some circumstances to an unknown degree. The evidence is consistent with effects that would be sufficiently large to distort estimates from a noise-change survey.
2 The period over which residents integrate their responses is unknown and thus methods of controlling for seasonal effects, other than the repetition of a survey at the same time of year, are uncertain.
3 Seasonal exposure differences are probably due to differences in window opening patterns or outdoor usage patterns.
4 On theoretical grounds the sizes of seasonal effects would be expected to vary greatly from survey to survey depending upon such factors as national or regional cultural differences, common dwelling characteristics and variations in seasonal climatic conditions. As a result findings about seasonal effects from one survey may not be generalizeable to other locations.
5 The timing of seasonal effects could also be expected to vary greatly from survey to survey as a function of the same factors (i.e. national or regional cultural differences, common dwelling characteristics and variations in seasonal weather patterns).
6 The best evidence on seasonal effects would come from surveys that have multiple observations on the same populations at different seasons over several years. Surveys with only one cold season and one warm season observation will confound their estimates of seasonal effects with any other time-related differences.

The possibility of strong seasonal effects leads to the following recommendations:

1 The primary measure of the size of an abrupt change effect should be derived from the comparison of reactions at the same times of year under similar weather conditions.

3 Estimates of the integration period for seasonal effects could be obtained through secondary analyses of the original, individual-level DLO data.

2 Estimates of the decay of an abrupt change effect in the one or two months after a noise change may be possible if:

   a There are no changes or only relatively small changes in the weather conditions from the beginning of the integration period before the first interviews to the completion of the final interviews.

   b The size of day-of-interview weather effects can be estimated through examinations of responses on favorable and unfavorable weather days within very short periods (i.e. adjacent study days) during the noise change study or during other studies.

4 A new noise change survey should consider the possibility of comparing spring and autumn surveys that were conducted under similar climatic conditions after the noise change.

APPENDIX F: QUESTIONS AND DETAILED TABLES FOR DLO SURVEY

This appendix contains additional information about the wording of questionnaire questions and results from the Netherlands Continuous Life Situation Survey (DLO)

F.1 Wording of the DLO Questions in Dutch

Table 15: The Netherlands DLO survey questions about noise (in Dutch)

Part of question	Wording for two survey periods			
	April 1998 to December 1993		January 1994 to December 1996	
Stem of question	1)	INT.: Card 1 Ik ga u nu een aantal zaken noemen waar mensen in huis last van kunnen hebben. Ik zou graag van u willen weten of u er hier last van heeft. Wilt u antwoorden aan de hand van de kaart. Heeft u hier in huis last van	1.	Ik ga u nu een aantal zaken noemen waarvan ik zou willen weten of u daar in uw woonomgeving last van heeft. Heeft u in uw woonomgeving last van:
Alternative answers	[card:]	JA, VAAK JA, SOMS ZELDEN OF NOOIT		JA SOMS NEE WEIGERT/WEET NIET
Noise sources	c)	lawaai van vliegtuigen	1.	lawaai van vliegtuigen/
	d)	lawaai van treinen, trams of metro's	2.	lawaai van treinen, trams of metro's/
	e)	lawaai van auto's, motoren of brommers	3.	lawaai van auto's, vrachtauto's, motoren of brommers/
	f)	straatlawaai van laden of lossen, of van spelende kinderen	4.	straatlawaai van laden of lossen?
			5.	straatlawaai van spelende kinderen of jongeren?
	g)	lawaii van industrie of bedrijven	6.	lawaii van industrie of bedrijven?
	h)	geluiden van buren	7.	geluiden van buren?

F.2 Detailed response data

This section contains the complete responses for five of the basic environmental noise questions that were included in the DLO study. The pre-1994 and post-1994 versions of the street-noise question are shown on different lines.

Table 16: Detailed results from the Netherlands DLO study

Noise source	Time of year	Answer	1989-93 Question form, Year: 1990	1991	1992	1993	1994-96 Question form, Year: 1994	1995	1996	Average
Aircraft	Winter (Jan.-March, Dec.)	Seldom/never||NO	76.7%	76.2%	77.3%	79.7%	80.8%	80.7%	81.5%	78.6%
		Yes/.||SOMETIMES	17.1%	19.4%	18.7%	16.1%	14.6%	14.4%	12.5%	16.6%
		Yes/often||YES	6.2%	4.3%	4.0%	4.2%	4.6%	4.9%	5.9%	4.8%
	Spring/Fall (Apr,May,Oct,Nov)	Seldom/never||NO	76.0%	76.1%	76.9%	78.2%	84.1%	79.4%	83.1%	78.5%
		Yes/.||SOMETIMES	18.9%	19.5%	18.0%	16.8%	10.0%	13.3%	11.7%	16.2%
		Yes/often||YES	5.0%	4.4%	5.1%	5.0%	5.9%	7.3%	5.1%	5.3%
	Summer (Jun-Sept)	Seldom/never||NO	71.5%	74.5%	74.3%	77.6%	75.2%	76.6%	80.3%	75.7%
		Yes/.||SOMETIMES	22.8%	20.4%	20.6%	17.7%	18.2%	16.6%	13.3%	18.8%
		Yes/often||YES	5.7%	5.1%	5.1%	4.7%	6.6%	6.8%	6.3%	5.6%
Road traffic	Winter (Jan.-March, Dec.)	Seldom/never||NO	67.0%	67.2%	68.3%	69.5%	71.6%	70.2%	72.3%	69.1%
		Yes/.||SOMETIMES	22.0%	22.4%	21.2%	21.0%	14.9%	15.1%	15.9%	19.6%
		Yes/often||YES	11.0%	10.4%	10.5%	9.5%	13.5%	14.8%	11.9%	11.3%
	Spring/Fall (Apr,May,Oct,Nov)	Seldom/never||NO	66.9%	65.0%	67.0%	67.3%	68.1%	69.7%	70.2%	67.5%
		Yes/.||SOMETIMES	21.9%	23.1%	21.5%	22.3%	15.2%	14.6%	14.6%	19.8%
		Yes/often||YES	11.2%	11.8%	11.5%	10.5%	16.7%	15.8%	15.2%	12.7%
	Summer (Jun-Sept)	Seldom/never||NO	62.6%	66.4%	63.8%	65.5%	67.7%	69.2%	72.7%	66.4%
		Yes/.||SOMETIMES	23.6%	21.7%	23.6%	23.0%	14.4%	13.4%	14.3%	20.1%
		Yes/often||YES	13.9%	11.9%	12.5%	11.5%	17.8%	17.4%	13.0%	13.5%
Railway	Winter (Jan.-March, Dec.)	Seldom/never||NO	94.7%	94.4%	94.3%	95.2%	95.0%	95.0%	94.9%	94.8%
		Yes/.||SOMETIMES	3.8%	4.4%	3.5%	3.3%	3.3%	2.7%	2.8%	3.5%
		Yes/often||YES	1.5%	1.2%	2.2%	1.5%	1.7%	2.3%	2.3%	1.8%
	Spring/Fall (Apr,May,Oct,Nov)	Seldom/never||NO	94.4%	93.5%	94.5%	93.4%	94.0%	96.5%	94.3%	94.3%
		Yes/.||SOMETIMES	3.7%	4.5%	3.7%	4.5%	3.4%	1.7%	3.3%	3.7%
		Yes/often||YES	1.9%	1.9%	1.8%	2.1%	2.6%	1.8%	2.5%	2.0%
	Summer (Jun-Sept)	Seldom/never||NO	94.1%	93.6%	93.6%	93.4%	93.1%	94.0%	95.3%	93.8%
		Yes/.||SOMETIMES	3.5%	4.5%	4.1%	4.8%	4.1%	3.3%	2.2%	3.9%
		Yes/often||YES	2.4%	1.8%	2.3%	1.8%	2.9%	2.6%	2.5%	2.3%

(Continued)

Noise source	Time of year	Answer	1989-93 Question form: Year 1990	1991	1992	1993	1994-96 Question form: Year 1994	1995	1996	Average
Street (Children/ Vehicle loading)	Winter (Jan.-March, Dec.)	Seldom/never||NO	86.2%	86.2%	86.4%	85.3%	.	.	.	86.0%
		Yes/.||SOMETIMES	10.1%	10.7%	10.5%	11.2%	.	.	.	10.6%
		Yes/often||YES	3.6%	3.1%	3.1%	3.6%	.	.	.	3.3%
	Spring/Fall (Apr,May,Oct,Nov)	Seldom/never||NO	85.5%	83.5%	84.0%	85.0%	.	.	.	84.4%
		Yes/.||SOMETIMES	10.6%	12.4%	12.1%	10.8%	.	.	.	11.5%
		Yes/often||YES	3.9%	4.1%	4.0%	4.2%	.	.	.	4.0%
	Summer (Jun-Sept)	Seldom/never||NO	82.4%	84.5%	84.8%	84.3%	.	.	.	84.1%
		Yes/.||SOMETIMES	12.8%	11.0%	11.1%	11.0%	.	.	.	11.4%
		Yes/often||YES	4.7%	4.4%	4.1%	4.8%	.	.	.	4.5%
Street (Vehicle loading)	Winter (Jan.-March, Dec.)	Seldom/never||NO	.	.	.	.	93.5%	93.9%	93.9%	93.8%
		Yes/.||SOMETIMES	.	.	.	.	3.7%	3.0%	3.6%	3.4%
		Yes/often||YES	.	.	.	.	2.8%	3.1%	2.5%	2.8%
	Spring/Fall (Apr,May,Oct,Nov)	Seldom/never||NO	.	.	.	.	92.9%	94.2%	94.9%	94.1%
		Yes/.||SOMETIMES	.	.	.	.	2.4%	3.2%	2.8%	2.8%
		Yes/often||YES	.	.	.	.	4.7%	2.5%	2.3%	3.1%
	Summer (Jun-Sept)	Seldom/never||NO	.	.	.	.	94.0%	93.7%	94.7%	94.1%
		Yes/.||SOMETIMES	.	.	.	.	3.2%	3.2%	2.5%	2.9%
		Yes/often||YES	.	.	.	.	2.8%	3.1%	2.9%	2.9%

APPENDIX G: ANALYSIS TO ESTIMATE ERROR VARIANCES IN THE HUMAN RESPONSE MODEL

In Chapter 6 it was seen that the predicted precision of a noise-change study is based on information and assumptions about 17 variables. One of those classes of variables is labeled "Human Response Constraints". This appendix explains how the values for that class of variables (Variables 18 to 24 in Table 2) were determined from new analyses of previous social surveys.

G.1 Overview of the requirements

The human response constraints consist of measures of the impact that the variability in residents' responses to similar noise levels have on the estimates of parameters in the abrupt change model. The abrupt change model described in Chapter 1 identified the following three sources of response variance for noise surveys:

U_g	Community Group effect: The effect of a community location on annoyance (normally distributed with mean of U_g=0)
U_p	Persistent Person effect: The effect of the person (those effects that are constant for the period of the study) on annoyance within a community (normally distributed with mean of U_p=0)
U_i	Specific interview effect: The effect of the conditions at the time of the interview on annoyance within a person and group (normally distributed with mean of U_i=0)

The relative magnitudes of these three sources of variance are estimated in this appendix. The relative magnitudes of the persistent person effect and the specific interview effect are estimated in the last part of this appendix from five noise annoyance surveys based on panel designs. These surveys did not include enough study areas, however, to provide adequate estimates of the community group effect (U_g). To estimate the size of this community effect it has been necessary to turn to 19 other surveys in which the effects of the community can be isolated but the effects of persistent personal differences and specific interview effects can not be separated.

G.2 Information from cross-sectional analyses

Nineteen studies are analyzed in this section that meet the following conditions: measured noise exposure and residents' reactions to that noise, contained at least 20 primary sampling units (PSUs) and included identifiers for those sampling units on their original survey data sets. Six of these studies included both acoustical and response data for two noise sources. As a result a total of 25 data sets representing about 55,000 evaluations of noise are analyzed in this section. The data sets, listed in Table 17, include 9 aircraft, 14 road traffic and 2 railway data sets that are drawn from seven countries. Each data set is identified by name, noise source, number of respondents, and number of PSUs. Some of the data sets were obtained from the TNO data archive in the Netherlands.

To obtain the estimates in Table 17 a multi-point measure of annoyance is scored from approximately 0 to approximately 100. This annoyance measure is then regressed on noise level, as represented by DNL, in a linear regression procedure described in Chapter 5 that estimates the random effects that can be attributed to the PSU and the individuals (Littell, Milliken, Stroup, and Wolfinger, 1996). The coefficients from this analysis presented in Table 17 are the constant term (B_0), the unadjusted regression coefficient for noise level (B_{Li}), the variance of the random effect for PSU ($\sigma_{U_g}^2$), and the variance of residual scores ($\sigma_{U_{pi}}^2$). All these coefficients vary greatly from study to study partly because the annoyance scores scales differ and the sensitivity of the scales to differences in steady-state noise levels may differ. Expressing the "PSU effect" and "Person effect" as ratios that are divided by the regression coefficient for noise level (DNL) and expressing these in decibel Equivalent Units (dBEAU) in the last columns of Table 17 partially adjust for the such differences. Expressing these effects in terms of these decibel Equivalent Units (dBEAU) is also appropriate because the final results from a noise change study will be expressed in this manner. The ratio of these two effects is shown in the last column. The last line of the table displays the average of the effects when each study's estimate is weighted by the number of responses it represents. The average estimate for the PSU effect is about 7dBEAU, for the person effect is about 20 dBEAU, and for the ratio of the two is a little over 0.3 (0.34). The next to last line in the table shows that the results that are weighted by the numbers of PSUs are similar. The analyses in Table 17 show that even though individuals vary more than primary sampling units, the PSU has a substantial effect on reactions with the standard deviation of the PSU effect being the equivalent of approximately as 7-decibel difference in steady state noise exposure.

The value for Variable 20 (Response variation PSU) in Table 2 is set at 7 dBEAU based on these analyses. The values for the "Optimistic Response Assumptions" scenario in Table 3 are also based on analyses of the data in Table 17. These values came from the weighted average of the seven studies that have response characteristics that would yield the most precise outcomes from a study. Their values in Table 17 were near or below the median for both the person effect (less than 21 dBEAU) and the ratio of the PSU to person effect (less than 0.32).

Table 17: Estimates of response variation from cross-sectional survey designs

Catalog ID	Description of study: Study name	Noise source	N of responses	N of PSUs	Estimates of effect of: Intercept B_0	Noise level B_{Li}	PSU σ_{Ug}^2	Person & interview σ_{Upi}^2	dB Equivalent for: PSU σ_{Ug}/BL_i (dBEAU)	Person σ_{Upi}/BL_i (dBEAU)	Ratio Person/PSU σ_{Ug}/σ_{Upi}
USA-022	1967 USA 4-Airport	Air	3499	61	-5.36	.16	2.23	11.16	9.26	20.73	.45
UKD-024	1967 UKD Heathrow	Air	4650	251	-3.76	.13	1.96	9.58	10.92	24.12	.45
		Road	4638	251	-3.93	.13	.86	11.26	7.31	26.52	.28
USA-032	1969 USA 3-Airport	Air	2899	187	-1.82	.13	2.18	8.83	10.98	22.11	.50
USA-044	1970 USA 2-Airport	Air	1954	24	-4.13	.13	.30	10.78	4.04	24.36	.17
UKD-071	1972 UKD London	Road	2067	37	.18	.82	93.18	761.80	11.76	33.63	.35
UKD-072	1972 UKD England	Road	904	50	-79.61	1.94	75.70	590.82	4.48	12.51	.36
FRA-092	1973 FRA 10-City	Road	879	36	-51.01	1.57	44.48	573.08	4.24	15.24	.28
UKD-116	1975 UKD Railway	Road	1453	75	-3.96	.12	.70	9.89	7.00	26.38	.27
		Rail	1453	75	-1.25	.09	.74	3.90	9.74	22.34	.44
CAN-120	1975 CAN Ontario	Road	1112	46	-69.38	1.83	64.46	749.40	4.38	14.94	.29
CAN-121	1975 CAN Ontario	Road	1147	41	-71.92	1.49	49.18	541.95	4.70	15.61	.30
UKD-130	1976 UKD Heathrow	Air	2618	44	-6.32	.16	.97	11.34	6.03	20.60	.29
		Road	2502	44	-4.96	.13	.32	10.31	4.38	24.83	.18
UKD-148	1977 UKD Heathrow	Air	5819	216	-9.33	.20	1.83	10.48	6.61	15.80	.42
		Road	5882	216	-7.63	.20	.47	6.72	3.34	12.67	.26
CAN-168	1978 CAN Toronto	Air	670	56	-9.92	.23	.93	7.40	4.28	12.05	.36
		Road	597	52	-13.29	.24	.69	3.90	3.51	8.32	.42
SWI-173	1978 SWI Zurich	Road	1219	23	-48.10	1.53	108.63	493.01	6.81	14.51	.47
GER-192	1977+ GER Rail	Road	1579	21	-46.53	1.50	38.80	394.11	4.16	13.25	.31
		Rail	1569	21	-56.21	1.48	67.09	383.89	5.53	13.24	.42
AUS-210	1980 AUS 5-Airport	Air	3212	55	-28.30	1.14	63.85	716.98	7.00	23.45	.30
UKD-242	1982 UKD 5-Airport	Air	2090	23	-11.62	.26	.78	8.83	3.45	11.62	.30
NET-276	1983 NET Tram	Road	697	30	-34.50	1.15	71.84	945.96	7.38	26.77	.28
GER-373	1987 GER Ratingen	Road	421	25	-23.53	.99	85.77	497.77	9.39	22.63	.42
Mean (Weighted by number of PSUs)					-13.85	.41	14.48	131.29	7.17	19.98	
Mean (Weighted by sample size)					-15.55	.48	19.23	170.16	6.76	19.84	.34

These estimates are presumed to be sufficient for planning purposes given the large uncertainties in other factors such as the actual noise exposure after the change in operations. The analyses that have been performed here have not fully explored the data. PSUs have been regarded as an undifferentiated type of unit even though they differ enormously from study to study. In the various Heathrow studies PSUs are local neighborhoods around a single airport. In a number of other studies, the neighborhood groups are spread between several airports and thus reflect both local neighborhood and airport differences. The possibility of non-linear relationships in the response data have not been considered in this analysis. Although PSU and number-of-respondent weights yield similar estimates, the analyses do not account for the fact that some surveys are counted twice, once for each of two noise sources.

G.3 Information from panel surveys

The person effect estimated in the previous section ($\sigma^2 = 400 = 20^2$dBEAU) includes both the variation between respondents' answers that is due to enduring differences between respondents and those additional differences associated with errors in the response process at the time of a particular interview. Repeated interviews from five studies provide a basis for dividing the response variance between these two sources.

Five repeated interview studies provide 10 data sets for the analysis summarized in Table 18. Two of the studies with only one repeated interview offer a single estimate, two with additional waves provide three estimates each, and the Norwegian study with additional waves, as well as two annoyance questions, offers four estimates. Table 18 gives the estimates of the between-person and within-person variances. These estimates come from a regression of annoyance on three terms: noise level, study wave (0/1 dummy variable), and change in noise level. The model also provided an estimate of the PSU effect (just as in Table 17) that is not included here because of the small numbers of PSUs for all but one study. The estimated effects in Table 18 thus are nested within PSU.

The last column in Table 18 shows that the ratio of the between person variation to within person variation differs between surveys from 0.37 for the first data set (UKD-237) to 2.35 for the last data set. Estimates of this ratio from simpler regression models with only noise level and study wave or only noise level and change in noise level, give estimates that were very close to these (proportional increases or decreases of no more than 10 percent in the ratio). The average of the ratios (weighted by number of interviews) shows that the two variances are estimated to be about equal (ratio of 1.08 in the last line of the table). For the baseline estimate in Table 3, the total person variance of 400 is assumed to be divided evenly between the two sources of variation with the result that the estimates of the standard deviations are 14 dBEAU (square root of 400/2).

The estimates in Table 18 do not show a consistent pattern with respect to the number of previous interviews or the length of time that has elapsed between interviews. As a result, it is assumed that the within-person standard deviation is the same for all waves (σ=14 dBEAU for the baseline case).

Table 18: Evidence on the size of the within-person variation from panel survey designs

Study ID*	Noise source	Waves compared	N of inter-views	N of study areas	Between person effect (σ^2_{Up})	Within person effect (σ^2_{Ui})	Ratio ($\sigma^2_{Up}/\sigma^2_{Ui}$)	Ratio (σ_{Up}/σ_{Ui})
UKD-237	Road traffic	1 - 2	630	6	133.15	360.14	0.37	0.61
CAN-168	Aircraft	1 - 2	368	24	386.38	301.67	1.28	1.13
	Road traffic	1 - 2	368	24	151.34	300.66	0.50	0.71
UKD-157	Road traffic	1 - 2	494	6	350.27	308.24	1.14	1.07
	Road traffic	1 - 4	388	6	343.17	275.76	1.24	1.12
USA-375	Sonic booms	1 - 2	434	6	726.34	364.48	1.99	1.41
NOR-328	Aircraft (4-week)**	1 - 2	454	5	262.15	230.06	1.14	1.07
		1 - 6	434	5	209.01	237.25	0.88	0.94
	Aircraft (indefinite period)	1-2	444	5	383.64	208.28	1.84	1.36
		1-3	388	5	459.53	195.53	2.35	1.53
Average (Weighted by number of interviews)							1.08	

* Additional information about studies is presented in Table 10.

** The first two comparisons for the Norwegian survey are for a short-term (last four weeks) annoyance question. The second is for an unspecified period that it is assumed will be interpreted as question about a general, long-term response..

*** The estimates of the variance come from an analysis that regressed annoyance on noise level and the change in noise level. The same analysis estimated the random-effect variances for PSU and, within PSU, for a person and within person for study wave. The Canadian survey (CAN-168) included only noise level and study wave in the regression model since the same noise levels were used for both study waves.

APPENDIX H: SOCIAL SURVEY QUESTIONNAIRE (LONG FORM)

This appendix contains the standard long form of the questionnaire that is designed for administration one month before a noise change and, in a followup phase, one year later. The cards to be shown to respondents follow the questionnaire. The experimental pages for the questionnaire appear at the end of the appendix.

H.1 Long interview form

The questionnaire form in this appendix must be adapted to the local airport and noise change conditions by replacing keywords that appear in braces "{}". The keywords are listed with the actual words (within quotes) that were used in the Dallas pretest.

{time-only} = time of change {e.g. ,"last fall"}
{time-only2} = months since change {e.g., "the last 9 months"}
{this-airport} = name of airport {e.g., "the Dallas/Fort Worth Airport"}
{time-change} = description of date of change and change {e.g., "last fall when the new runway opened"}
{change-only} = description of change {e.g., "open a new runway"}
{change-only2} = description of change {e.g., "the new runway opened"}
{new-change} = description of new change {e.g., "open another parallel runway"}
{new-change2} = description of new change {e.g., "opening another parallel runway"}
{new-time} = date of new change {e.g., "in about 3 years"}
{paper 1} = local newspaper #1 {e.g., "the Met"}
{paper 2} = local newspaper #2 {e.g., "the Dallas Morning News"}
{paper 3} = local newspaper #3 {e.g., "the Dallas Business Journal"}
{paper 4} = local newspaper #4

The long interview form begins on the next page.

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LONG-TERM SURVEY
VERSION 1

COMPLETE THE FOLLOWING ITEMS BEFORE BEGINNING THE INTERVIEW.

Q2. INTERVIEW ID ______ HOUSE ______ PERSON 01 ROUND

Q3. CONTACT DATE ______ MONTH ______ DAY ______ YEAR

Q4. INTERVIEWER ID ______

Q5. TYPE OF SELECTION HOUSEHOLD
1. TAKE ALL
2. RANDOM SELECTION [USE SUPPLEMENTARY SELECTION INSTRUCTIONS]
3. REPEATED INTERVIEW

Hello. I am (first & last name) from Hagler Bailly. We are conducting an opinion survey about the advantages and problems of living in different areas to help in maintaining and creating environmentally satisfactory neighborhoods. 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 (City). 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?

TIME START: ☐☐ : ☐☐ 1.__ AM 2.__ PM

Q6. ASK ONLY ONCE PER HOUSEHOLD **(RECORD ALL CONTACTS ON OTHER SIDE)**

a. First we need to know the number of adults, that is people 18 or over, who presently live in your home. Starting with males, oldest to youngest, and then females oldest to youngest. We do not need to know their names, just their relationship to you.[LIST ALL RELATIONSHIPS IN GRID]

b. RECORD SEX - OBTAIN THE STUDY R USING KISH TABLE, CIRCLE THE R BELOW, CONTINUE SURVEY WITH R

ALL PERSONS 18 OR OVER WHO SPEAK ENGLISH

Rank Order of Adults	A. Relationship (oldest male ↓ youngest female)	B. SEX (2. Male, 1. Female)
	1.	2.M 1.F
	2.	2.M 1.F
	3.	2.M 1.F
	4.	2.M 1.F
	5.	2.M 1.F
	6.	2.M 1.F
	7.	2.M 1.F

ALL PERSONS UNDER 18 OR NON-ENGLISH SPEAKING ADULTS

A. Relationship	B. SEX (2. Male, 1. Female)
1.	2.M 1.F
2.	2.M 1.F
3.	2.M 1.F
4.	2.M 1.F
5.	2.M 1.F
6.	2.M 1.F
7.	2.M 1.F

WITHIN-HOUSEHOLD SELECTION

Kish Number	**1 adult in household**	**2 adults in household**	**3 adults in household**	**4 adults in household**	**5 adults in household**	**6 + adults in household**
A	1	1	1	1	1	1

Q7. We want to learn how you feel about the neighborhood right around here, that is within about a five-minute walk of here. What are the one or two things you <u>like most</u> about living around here?

Q8. How about any things that are disadvantages. What are the one or two things that you <u>dislike</u> the most about living around here?

Q9. Next some questions about noises you might have heard when you have been at home. If there have been any recent changes in the noise around here, please tell me about the way it is nowadays.

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

b. Here is a card for rating noises here. [HAND CARD A TO RESPONDENT] If any noises have changed recently, please rate the noise the way it is now, since the change.

When you are here at home, does the noise from ...(cars or trucks or other road traffic)...bother, disturb, or annoy you extremely, very, moderately, slightly, or not at all?

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

c. [ASK FOR ALL NOISES NOT VOLUNTEERED IN a WITH "NOT AT ALL ANNOYED" IN b] Do you ever hear noise from ...(cars or trucks or other road traffic)... when you are here at home?

a b c	a. What are some of the different types of noises you hear around here at home? (PROBE ONCE: Anything else?)	b. When you are here at home, does the noise from ...(cars or trucks or other road traffic)...bother, disturb, or annoy you extremely, very, moderately, slightly, or not at all?						c. [ASK FOR ALL NOISES NOT VOLUNTEERED IN a WITH "NOT AT ALL ANNOYED" IN b] Do you ever hear noise from ... (cars or trucks or other road traffic)... when you are here at home?
		EXTREMELY (1)	VERY (2)	MODERATELY (3)	SLIGHTLY (4)	NOT AT ALL (5) (ASK c IF a=NOT VOL.)	DK (8)	
i. Cars or trucks or other road traffic	1 VOL. 2 NOT VOL.	EXT 1	VERY 2	MOD 3	SLIG 4	NOT 5	DK 8	1 YES 2 NO 8 DK
ii. Motorcycles	1 VOL. 2 NOT VOL.	EXT 1	VERY 2	MOD 3	SLIG 4	NOT 5	DK 8	1 YES 2 NO 8 DK
iii. Railway trains	1 VOL. 2 NOT VOL.	EXT 1	VERY 2	MOD 3	SLIG 4	NOT 5	DK 8	1 YES 2 NO 8 DK
iv. Aircraft	1 VOL. 2 NOT VOL.	EXT 1	VERY 2	MOD 3	SLIG 4	NOT 5 *[MARK X AT Q36]*	DK 8	1 YES 2 NO *[MARK X AT Q15]* 8 DK
v. [DESCRIBE OTHER VOLUNTEERED NOISES]. IF 'VOL', SPECIFY ALL, MARK MOST ANNOYING, ASK b OF MOST ANNOYING.]	________ ________ ________	EXT 1	VERY 2	MOD 3	SLIG 4	NOT 5	DK 8	

Q10. Here is a new scale. [HAND CARD B TO RESPONDENT] This is a zero to ten opinion scale for how much the noises we have talked about bother, disturb, or annoy you when you are here at home. If you are not at all annoyed, choose zero; if you are extremely annoyed, choose ten; if you are somewhere in between, choose a number between zero and ten. Thinking about all the noises we've talked about, what number from zero to ten best shows how much you are bothered, disturbed, or annoyed by the noise in general when you are here at home?

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

Q11. On the same "zero" to "ten" scale, what number best shows how much you are bothered, disturbed, or annoyed by noise from cars or trucks or other road traffic?

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

Q12. And when you are here at home, what number from zero to ten best shows how much you are bothered, disturbed, or annoyed by aircraft noise?

00	01	02	03	04	05	06	07	08	09	10	97
NOT AT ALL ANNOYED ↓ MARK X AT Q37										EXTREMELY ANNOYED	DO NOT HEAR (VOL.) ↓ MARK X AT Q37

TIME [ ][ ] : [ ][ ]

Q13. Do you know of any particular noises that have changed and become louder or quieter in the last few years or in the last few weeks or days?

1. YES 2. NO [SKIP TO Q13, Q13b] 8. DO NOT KNOW [SKIP TO Q13, Q13b]

↓

a. (PROMPT IF NEEDED: What noise is that?)[MARK ANSWER WITHOUT READING]

1. AIRCRAFT **[ASK Q14 and Q14a]**
2. ROAD TRAFFIC
3. OTHER [RECORD RESPONSE] ______________________

Q14. We understand there was a change at {this-airport} {time-change}.

IF MENTIONED AIRCRAFT IN Q13 ↓

DID NOT MENTION AIRCRAFT IN Q13 ↓

a. Is that what you were referring to?

1. YES ↓
2. NO →→

b. Before today, did you know about that change {time-change}, or did you not know about that change?

1. KNEW ↓
2. NOT KNOW [SKIP TO Q15]

c. Have you ever heard or learned anything about this change from...?

A newspaper article	1 YES	2 NO	8 DON'T RECALL
TV	1 YES	2 NO	8 DON'T RECALL
Radio	1 YES	2 NO	8 DON'T RECALL
Neighbor or acquaintance	1 YES	2 NO	8 DON'T RECALL
Seeing work on it	1 YES	2 NO	8 DON'T RECALL
Public meeting	1 YES	2 NO	8 DON'T RECALL
Somewhere else (Where?____ ________________)	1 YES	2 NO	8 DON'T RECALL

d. When the change occurred {time-change}, did you favor the change, oppose it, or have no opinion either way?

1. FAVOR
2. OPPOSE
3. NO OPINION
0. DID NOT KNOW ABOUT IT AT THE TIME/NEW RESIDENT (VOLUNTEERED)

e. Did you hear or read anything about how the decision was made to {change-only}?

1. YES ↓
2. NO [SKIP TO g.] ⇓

f. In your opinion, was the process that was used to decide whether to {change-only} a fair process?

1. YES
2. NO
8. DON'T KNOW/UNSURE

g. Are there any other issues or concerns that you have related to the change {time-change}?

1. YES ↓
2. NO [SKIP TO NEXT Q]

h. What types of issues or concerns?

Q15. Would you say that the aircraft noise here increased, decreased, or stayed about the same after {change-only2} {time-only}?

1. INCREASED
2. DECREASED
3. STAYED ABOUT THE SAME
8. DON'T KNOW (INCLUDING DON'T KNOW BECAUSE IS A NEW RESIDENT)

↓	←"X" if did not hear aircraft in Q9, 7.c.iv ↓↓↓ ASK Q16↓↓↓↓	SKIP TO Q17 IF BOX NOT MARKED

Q16. So nowadays after {change-only2}, how often have you heard airplanes when you are here around home: often, sometimes, only occasionally, or have you never heard an airplane?

1. OFTEN
2. SOMETIMES
3. ONLY OCCASIONALLY
4. NEVER [MARK BOX AT Q37, SKIP TO Q22]

Q17.A a. Considering {time-only2}, have the aircraft ever ...(startled you)..?

[ASK ALL ITEMS BEFORE ASKING b]

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

a. And still considering {time-only2}, have the aircraft ever ...(startled you)..?	a. OCCUR	b. When they have ..(startled you).. how annoyed does this make you feel: very much, moderately, a little, or not at all annoyed? VERY MUCH (1)	MODER-ATELY (2)	A LITTLE (3)	NOT AT ALL (4)	DK (8)
i. Startled you	1 YES ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓					
ii. Woke you up	1 YES ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓					
And still considering {time-only}, have the aircraft ever. . . (interfered with listening to radio or TV)....						
iii. Interfered with listening to radio or TV	1 YES ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 NA ↓					
iv. Made the TV picture flicker	1 YES ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓ 3 NA ↓					
v. Made the house/apartment vibrate or shake	1 YES ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓					
vi. Interfered with conversation	1 YES ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓					
vii. Interfered with or disturbed any other activity [IF 'YES' SPECIFY ALL, MARK MOST ANNOYING, AND ASK b OF MOST ANNOYING]	1 YES ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓					

Q18.A a. Here are some other ways airplanes sometimes affect areas. Still considering {time-only2}, when you are here at home nowadays do you ever notice ...(fumes or smells from aircraft)?

[ASK ALL ITEMS BEFORE ASKING b]

b. Please look at the AMOUNT CARD [HAND CARD G TO RESPONDENT]. When you notice...(READ ITEM FROM GRID).. how annoyed does this make you feel: very much, moderately, a little, or not at all annoyed?

a. Still considering {time-only2}, when you are here at home nowadays do you ever notice ...(fumes or smells from aircraft)?	a. OCCUR	b. When you notice...(READ ITEM FROM GRID).. how annoyed does this make you feel: very much, moderately, a little, or not at all annoyed?				
		VERY MUCH (1)	MODER-ATELY (2)	A LITTLE (3)	NOT AT ALL (4)	DK (8)
i. Fumes or smells from aircraft	1 YES ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓					
ii. Dust or dirt from aircraft	1 YES ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓					
iii. Lights from the aircraft at night	1 YES ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓					
iv. Any noise from the aircraft when they are sitting <u>on the ground</u> running their engines or moving around the airport	1 YES ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓					
v. Anything else from the aircraft [IF 'YES' SPECIFY ALL, MARK MOST ANNOYING, AND ASK b OF MOST ANNOYING]	1 YES ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
	2 NO ↓					

Q19. When you hear the aircraft fly overhead nowadays, do you <u>ever</u> feel there is any danger they might crash nearby?

1. YES ↓

2. NO [SKIP TO NEXT Q]

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

1. VERY OFTEN
2. MODERATELY OFTEN
3. ONLY OCCASIONALLY

Q20. How often would you say the aircraft actually fly right over your home nowadays: very often, moderately often, only occasionally, or never?

1. VERY OFTEN
2. MODERATELY OFTEN
3. ONLY OCCASIONALLY
4. NEVER

Q21. a. Do you think ...(the pilots flying the planes)... could reduce the aircraft noise around here if they wanted to?

[ASK ALL ITEMS BEFORE ASKING b]

b. Please look at this card [HAND CARD C]. How much do you think ...(the pilots flying the planes) ... could reduce the aircraft noise around here if they wanted to: very much, considerably, moderately, or a little?

a. Do you think ...(the pilots flying the planes)... could reduce the aircraft noise around here if they wanted to?	a. REDUCE	b. HOW MUCH How much do you think ..(the pilots flying the planes) ..could reduce the aircraft noise around here if they wanted to: very much, considerably, moderately, or a little? VERY MUCH	CONSIDER-ABLY	MODER-ATELY	A LITTLE	DK
i. The pilots flying the planes	1 YES ↓	1	2	3	4	8
	2 NO ↓ 8 DK ↓					
ii. The people who run the airline companies	1 YES ↓	1	2	3	4	8
	2 NO ↓ 8 DK ↓					
iii. The officials who run the airport	1 YES ↓	1	2	3	4	8
	2 NO ↓ 8 DK ↓					
iv. Local government officials	1 YES ↓	1	2	3	4	8
	2 NO ↓ 8 DK ↓					

Next we have some questions about your decision to live here.

Q22. When did you move to this house/apartment? (IF ALWAYS, CHECK BOX FOR ALWAYS)

__ __/__ __ OR ☐ LIVED HERE ALWAYS [SKIP TO Q24]
MONTH/YEAR

Q23. Back when you first decided to move here, did you expect there would be aircraft noise here?

1. YES, EXPECTED AIRCRAFT NOISE ↓
2. NO, DIDN'T EXPECT NOISE ↓
8. NOT REMEMBER [SKIP TO NEXT Q]

a. Has the aircraft noise turned out to be more, less, or about the same as what you expected?

MORE ↓	4. ABOUT THE SAME ↓	LESS ↓
b. Is it a lot more or a little more than what you expected? 1. A LOT MORE 2. A LITTLE MORE 3. DON'T KNOW	[SKIP TO NEXT Q]	c. Is it a lot less or a little less than what you expected? 5. A LOT LESS 6. A LITTLE LESS 7. DON'T KNOW

Q24. Do you know of any new changes that are planned for {this-airport} that could increase or decrease the aircraft noise here?

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

a. (PROMPT IF NEEDED: What changes are those?)

Q25. We understand that there are plans to {new-change} {new-time} at {this-airport}. Is that a change that you have heard anything about?

1. YES
2. NO [SKIP TO NEXT Q]

a. Do you favor {new-change2}, oppose it, or have no opinion either way?

1. FAVOR
2. OPPOSE
3. NO OPINION

b. After {new-change2} {new-time}, do you think the aircraft noise here at your home will increase, decrease, or stay about the same?

1. INCREASE
2. DECREASE
3. STAY ABOUT THE SAME
8. DON'T KNOW

TIME [ ][ ]:[ ][ ]

Q26. Next we need your opinion about how the aircraft noise has been around home today from six in the morning until now. First we need to find out whether you were around home today from 6:00 in the morning on.

[REPEAT A-F FOR EACH EPISODE. RECORD FIRST EPISODE UNDER EPISODE 1.
1. DO NOT RECORD EVENTS OF LESS THAN 10 MINUTES AS SEPARATE EPISODES
2. COUNT TIME SPENT AT NEARBY NEIGHBORS--WITHIN 3 HOUSES--AS TIME AROUND HOME]

a. So at ...(6:00)... were you ...?

1. AWAY FROM HOME ↓ (go to b)
A. AROUND HOME ↓ (go to c)

b. What time did you get back home? ↓
RECORD IN "TIME END" BOX, START NEW EPISODE

c. Were you indoors or outdoors at ...(6:00)...?

2. OUTDOORS ↓ (go to d)
3. INDOORS ↓ (go to e)

d. What time did you then go back indoors or leave the area? ↓
RECORD IN "TIME END" BOX, START NEW EPISODE

e. Did you go outdoors or leave home (again) later in the day?

B. YES ↓ (go to f)
C. NO ↓ RECORD CURRENT TIME IN "TIME END" BOX, SKIP TO Q27

f. What time of day was that? ↓
RECORD IN "TIME END" BOX, START NEW EPISODE

EPISODE	TIME BEGIN	AWAY FROM HOME	AROUND HOME		TIME END (Indicate AM or PM)
			OUTDOORS	INDOORS	
1	0 6:0 0 AM	1. AWAY **[DO NOT ASK Q27]**	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
2	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
3	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
4	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
5	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
6	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
7	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
8	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
9	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
10	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM

[DO NOT ASK Q27 IF AWAY FROM HOME AT 6 AM]

Q27. Were you asleep at 6:00 this morning?

1. YES ↓ 2. NO [SKIP TO NEXT QUESTION]

a. What time did you wake up?

__ __:__ __ AM/PM

Q28. Did you try to take a nap or sleep at any time here at home today?

1. YES ↓ 2. NO [SKIP TO NEXT QUESTION]

a. What time was that? (RECORD START AND END OF EACH NAP)

BEGIN: __ __:__ __ 1.AM 2.PM END: __ __:__ __ 1.AM 2.PM

BEGIN: __ __:__ __ 1.AM 2.PM END: __ __:__ __ 1.AM 2.PM

BEGIN: __ __:__ __ 1.AM 2.PM END: __ __:__ __ 1.AM 2.PM

Q29. Do you currently have double glazing, storm windows or any other special windows on your home that could help to keep some of the noise out?

1. YES
2. NO
8. DON'T KNOW

Q30. Have you left your door or any windows open in your home today?

YES, OPEN ↓ 1. NO, CLOSED [SKIP TO NEXT QUESTION]

a. In the rooms you've been in, have the doors or windows been open or closed most of the time?

2. MOSTLY OPEN
3. MOSTLY CLOSED

Q31. Next, we are going to rate the noise today. Have you heard any noise from aircraft when you were here at home today?

1. YES
2. NO [SKIP TO Q34]

a. When you were here at home today, how much did the noise from aircraft bother, disturb, or annoy you--extremely, very, moderately, slightly, or not at all?

1. EXTREMELY
2. VERY
3. MODERATELY
4. SLIGHTLY
5. NOT AT ALL

Q32. Next, I'd like you to rate today's aircraft noise on a scale from "zero" to "ten", where "zero" means the aircraft were "not at all noisy today" and "ten" means they were "extremely noisy". On this "zero" to "ten" scale, how noisy have the aircraft been here at home today?

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

Now we want to compare your rating of ___ (INSERT NUMBER FROM Q32) for today to some other days.

Q33. a. In {time-only}, has there been a day that was noisier for aircraft than today?

1. YES ↓

2. NO ↓ SKIP TO c.

(DO NOT ASK b. IF Q32=10, SKIP TO c.)

b. How would you rate that noisiest day for aircraft on a scale where "zero" is "not at all noisy" and "ten" is "extremely noisy"?

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

(DO NOT ASK c. AND d. IF VOLUNTEERED THAT THEY ARE A NEW RESIDENT SINCE THE CHANGE)

c. Before {time-change}, was there ever a day that was noisier for aircraft than today?

1. YES

2. NO ↓ [SKIP TO NEXT Q]

0. NEW RESIDENT (VOLUNTEERED) ↓ [SKIP TO NEXT Q]

d. How would you rate that day for aircraft noise from "zero" to "ten"?

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

Q34. Next we have some questions about noise generally. Please look at this card [SHOW CARD D] to tell me how annoying you find the noise from ...(a dripping faucet)...?

Do you find the noise from . . . (a dripping faucet to be extremely, very, moderately, a little, or not at all annoying)?

	Extreme-ly	Very	Moderate-ly	A little	Not at all	DON'T KNOW
a. A dripping faucet	1	2	3	4	5	8
b. A dog barking continuously	1	2	3	4	5	8
c. The sound of a knife grating on a plate	1	2	3	4	5	8
d. Someone whistling out of tune	1	2	3	4	5	8
e. Someone switching on the radio when you want to be quiet	1	2	3	4	5	8
f. A jackhammer	1	2	3	4	5	8
g. A banging door	1	2	3	4	5	8

Q35. Would you say you are more sensitive or less sensitive than other people to noise?

MORE ↓	4. ABOUT THE SAME (VOLUNTEERED) ↓	LESS ↓
a. Would you say you are a lot more or a little more sensitive? 1. A LOT MORE 2. A LITTLE MORE 3. DON'T KNOW	[SKIP TO NEXT Q]	b. Would you say you are a lot less or a little less sensitive? 5. A LOT LESS 6. A LITTLE LESS 7. DON'T KNOW

Q36. Have you done something about the aircraft noise, such as telephoning the airport, writing an official, signing a petition, going to a meeting, or done something else to complain about the aircraft noise?

1. YES ↓

2. NO ↓

a. What have you done? (DO NOT READ; CIRCLE ALL THAT APPLY)

1. PHONED THE AIRPORT
2. WROTE A LETTER
3. SIGNED A PETITION
4. WENT TO A MEETING (SPECIFY TYPE OF MEETING):

5. OTHER (SPECIFY):

b. Have you ever felt like doing something?

1. YES
2. NO

c. Do you know who residents should contact if they have a complaint?

1. YES ↓

2. NO [SKIP TO NEXT Q]

d. Who is that?

TIME [ ][ ] : [ ][ ]

☐	←"X" IF NEVER HEAR AIRCRAFT IN Q16, SKIP TO Q41

☐	←"X" if "not at all annoyed" in Q9, 7.b.iv	SKIP TO NEXT QUESTION IF EITHER BOX IS BLANK
☐	←"X" if "not at all annoyed" or volunteered "DO NOT HEAR" in Q12	
IF X X ↓↓	IF <u>BOTH</u> BOXES ARE "X" ↓↓↓ ASK Q37 ↓↓↓↓	

Q37. You said earlier that the aircraft noise does not actually annoy you personally, but we did not ask you if you thought it was a good or a bad feature of the area. Considering the strong and weak points of living here, would you say that hearing aircraft is a disadvantage of living here, or an advantage of living here?

1. DISADVANTAGE
2. ADVANTAGE [SKIP TO Q41]
3. NEITHER (VOLUNTEERED) [SKIP TO Q41]

Here is a practice card for a comparison question [HAND CARD E TO RESPONDENT]. The first line is the baseline, which has a score of 100. Use this first line to rate the length of the other lines. The longer another line is, the higher the score you give it. For example, if a line is about twice as long as the baseline, you would score it 200. If it is a quarter as long, you would score it 25. Don't worry about being too exact. We only need your general impression.

Q38. Compared to the baseline with a score of 100, what score 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 CANNOT CHOOSE LARGER OR SMALLER NUMBERS THAN 100 AND SEEMS TO BE UNCOMFORTABLE, THEN MARK THE 'NOT COMPLETED' BOX, THANK FOR COOPERATION AND MOVE TO NEXT QUESTION.
>
> 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:

Baseline (100)

A (___ ___ ___)

B (___ ___ ___)

C (___ ___ ___)

D (___ ___ ___)

E (___ ___ ___)

F (___ ___ ___)

G (___ ___ ___)

◯ CHECK HERE IF NOT COMPLETED AND THEN CONTINUE WITH NEXT QUESTION

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

Q39. Now you compare things against a baseline of how you feel about aircraft noise nowadays around your home.

This time your feeling about aircraft noise is scored "one hundred." Use the aircraft noise score of "one hundred" to measure everything else. For example, if you are twice as annoyed by some other noise, give that other noise a score of "two hundred." If you are nine times as annoyed by another noise, give it a score of "nine hundred." If you are half as annoyed by some other noise, give that other noise a score of "fifty," and so on. There is no upper limit: use <u>any</u> number that shows how much you are annoyed.

First, consider having a dog next door that regularly barks in the middle of the night. Would that be more annoying or less annoying than aircraft noise?

1. MORE ANNOYING THAN AIRCRAFT
2. LESS ANNOYING THAN AIRCRAFT

So, compared to a score of "one hundred" for aircraft noise around here nowadays, what score would you give to ...(having a dog next door that regularly barks in the middle of the night) ...?

	SCORE
i. having a dog next door that regularly barks in the middle of the night	☐☐☐☐☐
Now consider having a front door that squeaks. Would that be more annoying or less annoying than aircraft noise? 1. MORE ANNOYING THAN AIRCRAFT 2. LESS ANNOYING THAN AIRCRAFT So, compared to a score of 100 for the aircraft noise nowadays, what score would you give to..	
ii. having a front door that squeaks	☐☐☐☐☐
If you do not have some of these things we mention, just imagine what they might be like. Next, compared to a score of 100 for the aircraft noise nowadays, what score would you give to..	
iii. having unhealthy air pollution in the area (IF LESS THAN 100, CHECK HERE ☐ AND PROBE IF MORE ANNOYING OR LESS ANNOYING THAN AIRCRAFT)	☐☐☐☐☐
iv. hearing big noisy trucks if you lived at a busy intersection	☐☐☐☐☐

And still compared to a score of 100 for the aircraft noise nowadays, what score would you give to..	SCORE
v. having a junkyard business that you could see from your home	☐☐☐☐☐
vi. having a smoke detector that gives a false alarm about once a <u>month</u> when someone is cooking	☐☐☐☐☐
vii. what if it went off twice a month?	☐☐☐☐☐
viii. having a sticky window that's hard to open	☐☐☐☐☐
And still compared to a score of 100 for the aircraft noise nowadays, what score would you give to..	
ix. having a neighbor with appliances or power tools that sometimes make your TV picture flicker	☐☐☐☐☐
x. having a pothole in the street near your home	☐☐☐☐☐
xi. being so near a noisy, busy highway that you must raise your voice when you are outside	☐☐☐☐☐
xii. having mice in your home	☐☐☐☐☐
And still compared to a score of 100 for the aircraft noise nowadays, what score would you give to..	
xiii. a neighbor's outside light that shines into your bedroom at night	☐☐☐☐☐
xiv. getting telephone calls at home from salespeople about <u>once a day</u> (IF LESS THAN 100, CHECK HERE ☐ AND PROBE IF MORE ANNOYING OR LESS ANNOYING THAN AIRCRAFT)	☐☐☐☐☐
Last, let's compare the aircraft noise nowadays with what might happen in the future. Compared to a score of 100 for the aircraft noise nowadays, what score would you give to..	
xv. the aircraft noise that you might expect to hear {new-time} after {new-change2}	☐☐☐☐☐

○ CHECK HERE IF NOT COMPLETED AND THEN CONTINUE WITH NEXT QUESTION

TIME ☐☐ : ☐☐

Q40.A Over 13,000 people in 80 cities have looked at this scale to tell us about the noise they can hear when they are inside their house. [HAND CARD F TO RESPONDENT] The scale goes from "one" if you feel the aircraft noise is definitely satisfactory, to "seven" if it is definitely unsatisfactory. Which position on the card shows how you feel about the level of aircraft noise when you are in your home nowadays?

DEFINITELY SATISFACTORY	1	2	3	4	5	6	7	DEFINITELY UNSATISFACTORY

ASK ALL [EVEN IF DO NOT HEAR AIRCRAFT NOISE]

Q41. Now I am going to read you a list of potential threats to the overall quality of the environment. Please use any number from "one" to "seven," where "one" means "no threat at all" and "seven" 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: So, on a scale from "one" to "seven", how much does . . . (air pollution)...threaten the overall quality of the environment?)

	No threat at all						A large threat	DON'T KNOW
a. Air pollution	1	2	3	4	5	6	7	8
b. The pollution of our rivers, lakes, and streams	1	2	3	4	5	6	7	8
c. Acid rain	1	2	3	4	5	6	7	8
d. Global warming from the greenhouse effect	1	2	3	4	5	6	7	8
e. Using additives and pesticides in food production	1	2	3	4	5	6	7	8

Now I have a few last background questions [ASK ALL]

Q42. Do you regularly read . . . . .? [READ LIST]

a. {Paper 1}	1 YES	2 NO
b. {Paper 2}	1 YES	2 NO
c. {Paper 3}	1 YES	2 NO
d. {Paper 4}	1 YES	2 NO
e. Another local newspaper	1 YES	2 NO

(SPECIFY:______________________________)

Q43. Do you regularly read . . . .? [READ LIST]

a. Any newsletter from {this-airport}	1 YES	2 NO
b. Any newsletter for your local neighborhood	1 YES	2 NO

Q44. Do you regularly watch local TV news programming?

1. YES
2. NO

Q45. Do you or anyone else in your household work at an airport or for a company that does business there?

1. YES
2. NO

Q46. This next question is about the amount of time you spend away from home during the week. On the average Monday through Friday, about how many hours a week are you away from your home?

____ ____ ____ HOURS/WEEK

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

1. YES [SKIP TO NEXT QUESTION]
2. NO
   - a. Has anyone else living here ever been in the military or worked for one of the military services?
     1. YES
     2. NO

Q48. What is your date of birth? ____ ____ MONTH ____ ____ DAY ____ ____ YEAR

Q49. Do you own your home or are you renting?

1. OWN (Include owing a mortgage)
2. RENTING

Q50. Do you have any plans to move away from this house/apartment in the next 12 months?

1. YES
2. NO [SKIP TO NEXT Q]

a. When do you plan to move?

____ ____ (MONTH) ____ ____ (YEAR)

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

Q51. Have any of your neighbors or acquaintances and you ever talked together about this questionnaire?

1. YES
2. NO

Q52. What is the highest education level you have completed?

1. EIGHTH GRADE OR LESS
2. 9TH TO 11TH GRADE
3. 12TH GRADE (HIGH SCHOOL GRADUATE)
4. 13 TO 15 YEARS (SOME COLLEGE, BUSINESS, TRADE SCHOOL)
5. 16 YEARS (COLLEGE-UNIVERSITY GRADUATE)
6. 17 YEARS+ (SOME GRADUATE WORK)
7. MASTERS, DOCTORAL, OR PROFESSIONAL DEGREE
9. REFUSED

That is the end of the interview. Your answers have been very helpful.

Q53. 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)

Q54. My supervisors verify some of my interviews. Would you mind giving me your telephone number so they can do that?

1. YES (TELEPHONE NUMBER: (_ _ _)_ _ _ - _ _ _ _
2. NO [SKIP TO Q57]

Q55. Who should they ask for when they telephone? (OBTAIN FIRST AND LAST NAME. CIRCLE "Mrs." or "Miss" ONLY IF VOLUNTEERED BY RESPONDENT.)

NAME: Mr.
Mrs. ______________________
Miss

Q56. (CONFIRM MAILING ADDRESS IF UNKNOWN)

Street or P.O. Box: ______________________

____

City, State, Zip: ______________________

Q57. Would it be all right to telephone you back for a few questions if we need to?

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 [|]:[|]

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

Q58. SEX OF RESPONDENT

1. MALE
2. FEMALE

Q59. DID THE RESPONDENT'S HEARING CAPACITY SEEM TO BE:

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

[IF DIMINISHED] DESCRIBE EXTENT OF PROBLEM

Q60. INTERVIEWING METHOD

1. FACE-TO-FACE
2. TELEPHONE

Q61. TYPE OF DWELLING

1. MOBILE HOME, TRAILER
2. SINGLE DWELLING UNIT STRUCTURE
3. MULTIPLE DWELLING UNIT STRUCTURE
4. OTHER (DESCRIBE) ______________________

Q62. RACE (BY OBSERVATION ONLY)

1. WHITE
2. BLACK
3. AMERICAN INDIAN
4. OTHER (DESCRIBE) ______________________

Q63. 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

Q64. IS THERE ANYTHING ELSE THAT SHOULD BE CONSIDERED WHEN CALLING BACK?

1. YES (DESCRIBE) ______________________
2. NO

PHRASES TO USE IF COMPLAIN ABOUT REPETITIOUS QUESTIONS:

FOR SLIGHT COMPLAINT:
Even though all of 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 scale of numbers.

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.

H.2 Show cards

The cards on the following pages are shown to respondents at the places where their use is prompted in the text of the questionnaire.

CARD A

EXTREMELY

VERY

MODERATELY

SLIGHTLY

NOT AT ALL

CARD B

-- 10 EXTREMELY
-- 9
-- 8
-- 7
-- 6
-- 5
-- 4
-- 3
-- 2
-- 1
-- 0 NOT AT ALL

CARD C: HOW MUCH COULD THEY REDUCE NOISE

VERY MUCH

CONSIDERABLY

MODERATELY

A LITTLE

CARD D: HOW ANNOYING

EXTREMELY

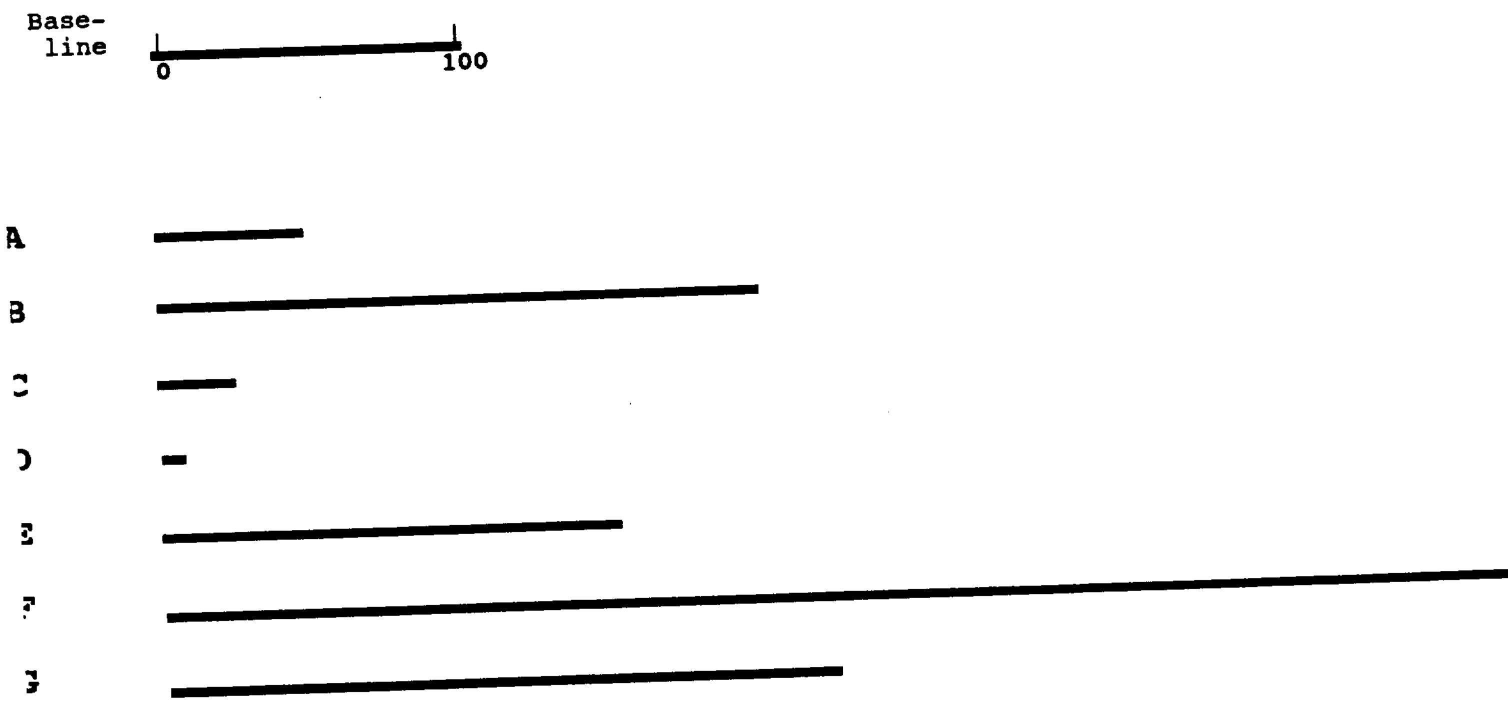
VERY

MODERATELY

A LITTLE

NOT AT ALL

CARD E: LINE LENGTHS



CARD G: AMOUNT

VERY MUCH

MODERATELY

A LITTLE

NOT AT ALL

CARD F: SATISFACTION SCALE

DEFINITELY SATISFACTORY	1	2	3	4	5	6	7	DEFINITELY UNSATISFACTORY

H.3 Experimental questionnaire pages

The next two pages are the alternative version of two pages that are to be used in half of the long form surveys to test two question forms.

ALTERNATIVE QUESTION FORMAT (Q39B)

Q39B Over 6,000 people in the United States have answered this next question to tell us about the aircraft noise at their homes <u>in the past week</u>. While you've been at home over the past week, just since last (...DAY), 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?

1. NOT AT ALL ANNOYED
2. SLIGHTLY ANNOYED
3. MODERATELY ANNOYED
4. VERY ANNOYED
5. EXTREMELY ANNOYED
8. DON'T KNOW

ALTERNATIVE QUESTION FORMAT (Q16B)

Q16B a. Considering {time-only2}, have the aircraft ever ...(startled you)..?

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

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

a,b a. And still considering {time-only2}, have the aircraft ever ...(startled you)..?	a.OCCUR	b. When they have ..(startled you).. how annoyed does this make you feel: very much, moderately, a little, or not at all annoyed? VERY MUCH (1)	MODER-ATELY (2)	A LITTLE (3)	NOT AT ALL (4)	DK (8)
i. Startled you	1 YES ⊃ 2 NO ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
ii. Woke you up	1 YES ⊃ 2 NO ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
And still considering {time-only}, have the aircraft ever. . . (interfered with listening to radio or TV)....						
iii. Interfered with listening to radio or TV	1 YES ⊃ 2 NO ↓ 3 NA ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
iv. Made the TV picture flicker	1 YES ⊃ 2 NO ↓ 3 NA ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
v. Made the house/apartment vibrate or shake	1 YES ⊃ 2 NO ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
vi. Interfered with conversation	1 YES ⊃ 2 NO ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8
vii. Interfered with or disturbed any other activity [IF 'YES' SPECIFY ALL, MARK MOST ANNOYING, AND ASK b OF MOST ANNOYING] ______	1 YES ⊃ 2 NO ↓	VERY 1	MODER 2	LITTLE 3	NOT 4	DK 8

APPENDIX I: SOCIAL SURVEY QUESTIONNAIRE (SHORT FORM)

This appendix contains the short form of the questionnaire that is designed for administration via telephone. This questionnaire is for use only after the noise change. It provides data at additional points in time to supplement the long-form questionnaire that is administered at about 11 months after the noise change. Almost all of these questions are also included in the long form of the questionnaire either in the primary response measurement section (Long Form Q.6 to Q.8) or in the one-day evaluation section (Long Form Q.25 to Q.32).

The questionnaire form in this appendix must be adapted to the local airport and noise change conditions by replacing keywords that appear in braces "{}". The keywords are listed with the actual words (within quotes) that were used in the Dallas pretest.

{recent-change} = description of recent change {e.g., "opening a new parallel runway"}
{recent-change2} = description of recent change {e.g., "the new runway opened}
{short time-only} = date of recent change {e.g., "Monday, June 30"}

The short interview form begins on the next page.

OMB APPROVAL

NO.: 2120-0621
Expires: 10/31/2000

SHORT FORM -- TELEPHONE INTERVIEW
VERSION 1

COMPLETE THE FOLLOWING ITEMS BEFORE BEGINNING THE INTERVIEW.

Q1. INTERVIEW ID ______ HOUSE ______ PERSON __01__ ROUND

Q2. CONTACT DATE ______ MONTH ______ DAY ______ YEAR

Q3. INTERVIEWER ID ______

Hello. I am (first & last name) from Hagler Bailly. We are conducting an opinion survey about the advantages and problems of living in different areas to help in maintaining and creating environmentally satisfactory neighborhoods. We would like to get your views. The survey is sponsored by the National Aeronautics and Space Administration. For this study, I need to speak to the adult, 18 years of age or more, in your household who had the most recent birthday. Would that be you?

1. YES [CONTINUE]
2. NO [GET NAME OF ELIGIBLE ADULT; ASK TO SPEAK WITH HIM/HER OR SCHEDULE CALLBACK; REPEAT INTRODUCTION]

(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 (City). 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 15 minutes or less?)

TIME START: ☐☐ : ☐☐ 1.__ AM 2.__ PM

Q4. When did you move to this house/apartment? (IF ALWAYS, CHECK BOX FOR ALWAYS)

__ __/__ __ MONTH/YEAR OR ☐ LIVED HERE ALWAYS

Q5. We want to learn how you feel about the neighborhood right around your home, that is within about a five-minute walk of your home. What are the one or two things you like most about living around here?

Q6. How about any things that are disadvantages. What are the one or two things that you dislike the most about living around here?

Q7. Next some questions about noises you might have heard when you have been at home. If there have been any recent changes in the noise around here, please tell me about the way it is nowadays.

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

b. Next I'd like to ask you to rate the noises around here. If any noises have changed recently, please rate the noise the way it is now, since the change.

When you are here at home, does the noise from ...(cars or trucks or other road traffic)...bother, disturb, or annoy you extremely, very, moderately, slightly, or not at all?

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

c. [ASK FOR ALL NOISES NOT VOLUNTEERED IN a WITH "NOT AT ALL ANNOYED" IN b] Do you ever hear noise from ...(cars or trucks or other road traffic)... when you are here at home?

a → b → c	a. What are some of the different types of noises you hear around here at home? (PROBE ONCE: Anything else?)	b. When you are here at home, does the noise from ...(cars or trucks or other road traffic)...bother, disturb, or annoy you extremely, very, moderately, slightly, or not at all?						c. [ASK FOR ALL NOISES NOT VOLUNTEERED IN a WITH "NOT AT ALL ANNOYED" IN b] Do you ever hear noise from ... (cars or trucks or other road traffic)... when you are here at home?
		EXTREMELY (1)	VERY (2)	MODERATELY (3)	SLIGHTLY (4)	NOT AT ALL (5) (ASK c if a=NOT VOL.)	DK (8)	
i. Cars or trucks or other road traffic	1 VOL. 2 NOT VOL.	EXT 1	VERY 2	MOD 3	SLIG 4	NOT 5	DK 8	1 YES 2 NO 8 DK
ii. Motorcycles	1 VOL. 2 NOT VOL.	EXT 1	VERY 2	MOD 3	SLIG 4	NOT 5	DK 8	1 YES 2 NO 8 DK
iii. Railway trains	1 VOL. 2 NOT VOL.	EXT 1	VERY 2	MOD 3	SLIG 4	NOT 5	DK 8	1 YES 2 NO 8 DK
iv. Aircraft	1 VOL. 2 NOT VOL.	EXT 1	VERY 2	MOD 3	SLIG 4	NOT 5	DK 8	1 YES 2 NO 8 DK
v. [DESCRIBE OTHER VOLUNTEERED NOISES]. IF 'VOL', SPECIFY ALL, MARK MOST ANNOYING, ASK b OF MOST ANNOYING.]	______ ______ ______	EXT 1	VERY 2	MOD 3	SLIG 4	NOT 5	DK 8	

Q8. Next we need your opinion about how any noises have been around home today from six in the morning until now. But, before we ask about the noises, we need to know when you might have been around to hear the noises.

[REPEAT A-F FOR EACH EPISODE. RECORD FIRST EPISODE UNDER EPISODE 1.
1. **DO NOT RECORD EVENTS OF LESS THAN 10 MINUTES AS SEPARATE EPISODES**
2. **COUNT TIME SPENT AT NEARBY NEIGHBORS--WITHIN 3 HOUSES--AS TIME AROUND HOME]**

a. So at ...(6:00)... were you ...?

1. AWAY FROM HOME ↓ — A. AROUND HOME ⇓

b. What time did you get back home? ↓
RECORD IN "TIME END" BOX, START NEW EPISODE

c. Were you indoors or outdoors at ...(6:00)...?
2. OUTDOORS ↓ — 3. INDOORS ↓

d. What time did you then go back indoors or leave the area? ↓
RECORD IN "TIME END" BOX, START NEW EPISODE

e. Did you go outdoors or leave home (again) later in the day?
B. YES ↓ — C. NO ↓

f. What time of day was that? ↓
RECORD IN "TIME END" BOX, START NEW EPISODE

RECORD CURRENT TIME IN "TIME END" BOX, SKIP TO Q9

EPISODE	TIME BEGIN	AWAY FROM HOME	AROUND HOME		TIME END (Indicate AM or PM)
			OUTDOORS	INDOORS	
1	0 6:0 0 AM	1. AWAY **[DO NOT ASK Q9]**	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
2	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
3	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
4	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
5	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
6	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
7	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
8	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
9	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM
10	__ __:__ __	1. AWAY	2.OUTDOORS	3.INDOORS	__ __:__ __AM/PM

(DO NOT ASK Q9 IF AWAY FROM HOME AT 6 AM)

Q9. Were you asleep at 6:00 this morning?

1. YES
2. NO [SKIP TO NEXT QUESTION]

a. What time did you wake up?

__ __:__ __ AM/PM

Q10. Did you try to take a nap or sleep at any time here at home today?

1. YES
2. NO [SKIP TO NEXT QUESTION]

a. What time was that? (RECORD START AND END OF EACH NAP)

BEGIN: __ __:__ __	1.AM 2.PM	END: __ __:__ __	1.AM 2.PM
BEGIN: __ __:__ __	1.AM 2.PM	END: __ __:__ __	1.AM 2.PM
BEGIN: __ __:__ __	1.AM 2.PM	END: __ __:__ __	1.AM 2.PM

Q11. Do you currently have double glazing, storm windows or any other special windows on your home that could help to keep some of the noise out?

1. YES
2. NO
8. DON'T KNOW

Q12. Have you left your door or any windows open in your home today?

YES, OPEN ↓ 1. NO, CLOSED [SKIP TO NEXT QUESTION]

a. In the rooms you've been in, have the doors or windows been open or closed most of the time?

2. MOSTLY OPEN
3. MOSTLY CLOSED

Q13. Next, we are going to rate the noise today. Have you heard any noise from aircraft when you were here at home today?

1. YES ↓ 2. NO [SKIP TO Q16]

a. When you were here at home today, how much did the noise from aircraft bother, disturb, or annoy you--extremely, very, moderately, slightly, or not at all?

1. EXTREMELY
2. VERY
3. MODERATELY
4. SLIGHTLY
5. NOT AT ALL

Q14. Next we have a "zero" to "ten" opinion scale for rating the aircraft noise here at home today. If the aircraft were "not at all noisy today", choose "zero". If the aircraft were "extremely noisy", choose "ten", and if they were somewhere in between, choose a number between "zero" and "ten". On this "zero" to "ten" scale, how noisy have the aircraft been here at home today?

00 01 02 03 04 05 06 07 08 09 10

00 = NOT AT ALL NOISY; 10 = EXTREMELY NOISY

Now we want to compare your rating of ___ (INSERT NUMBER FROM Q14) for today to some other days.

Q15. a. Since {recent-change} {short time-only}, has there been a day that was noisier for aircraft than today?

1. YES

2. NO → SKIP TO c.

(DO NOT ASK b. IF Q14=10, skip to c.)

b. How would you rate that noisiest day for aircraft on a scale where "zero" is "not at all noisy" and "ten" is "extremely noisy"?

00 01 02 03 04 05 06 07 08 09 10

00 = NOT AT ALL NOISY; 10 = EXTREMELY NOISY

(DO NOT ASK c. or d. IF VOLUNTEERED THAT THEY ARE A NEW RESIDENT SINCE THE CHANGE)

c. Before {recent-change} {short time-only}, was there ever a day that was noisier for aircraft than today?

1. YES

2. NO → [SKIP TO NEXT Q]

0. NEW RESIDENT (VOLUNTEERED) → [SKIP TO NEXT Q]

(DO NOT ASK d. IF b.=10)

d. How would you rate that day for aircraft noise from "zero" to "ten"?

00 01 02 03 04 05 06 07 08 09 10

00 = NOT AT ALL NOISY; 10 = EXTREMELY NOISY

Q16. We understand {recent-change2} on {short time-only}. Before we talked, did you know about this change?

1. YES
2. NO

Q17. What changes in the aircraft noise, if any, have you noticed since {recent-change2} on {short time-only}? (PROBE TO GET SPECIFIC CHANGE)

Now I have one background question.

Q18. In what year were you born?

19__ __

One last thing I need to verify is the name of your street so we can tell how far you live from the airport.

Q19. Do you live on (STREET NAME)? (CHECK THAT THIS AGREES WITH RECORDS AND OBTAIN EXPLANATION IF DOES NOT AGREE)

1. YES
2. NO → (CORRECT STREET NAME ______________________________)

Q20. I just want to check: is ______________________________ the closest street next to you?

1. YES
2. NO → (CORRECT CLOSEST STREET ______________________________)

That's all the questions that I have. I'd like to thank you for your time!

TIME END [|] : [|]

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

Q21. SEX OF RESPONDENT

1. MALE
2. FEMALE

Q22. DID THE RESPONDENT'S HEARING CAPACITY SEEM TO BE:

1. NORMAL 2. MODERATELY DIMINISHED 3. SEVERELY DIMINISHED

[IF DIMINISHED] DESCRIBE EXTENT OF PROBLEM

Q23. INTERVIEWING METHOD

1. FACE-TO-FACE
2. TELEPHONE

Q24. 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

APPENDIX J: QUESTIONNAIRE NOTES

The purposes for including each of the questions has been explained in the text of this report where the questions were identified by their question numbers. This section contains some additional information about some questions where the choice of the wording was guided by specific considerations beyond the obvious ones of meeting study objectives, being clear to respondents, and reducing the possibilities of non-sampling error. These specific considerations usually relate to the decision to repeat a question from a previous questionnaire for the purpose of strengthening comparisons with the previous study's results. In other cases a previous study's question was used only because it had been found to be satisfactory in that study. In either case, a review of the previous study's results may aid in interpreting and planning the analysis for a noise change survey.

Q. 8 & Q.11 These are the two primary aircraft noise response questions. The questions are worded to conform with the recommendations of the Community Response Team (Team 6) of the International Commission on the Biological Effects of Noise). The justification for the wording of the questions has been reported in considerable detail (Fields, 1996b; Fields, et al., 1998).

The term "cars, trucks or other road traffic" has been used in the sonic boom study (USA-375) and in several British road traffic surveys (UKD-)

Q.9 This 11-point question about general noise sources s primarily a training question before the more important road traffic and aircraft questions.

Q.16A This set of activity disturbance items has been used in many aircraft surveys in Britain including the first Heathrow surveys in the 1960's.

Q,18 This question on fear from aircraft was first used in the 1967 Heathrow survey.

Q.22 A somewhat similar question about moving expectations was asked in an Australian aircraft survey (AUL-210).

Q.25 - Q.30 and all of short, telephone questionnaire about the day-of-interview reactions
The form of all of these questions and the exact wording of many of the questions was used in a repeated-interview study of helicopter noise (Fields and Powell, 1985: Fields and Powell, 1987)

Q33. These noise-sensitivity items have been used in several surveys (UKD-008, UKD-024). This version has five points rather than the two (yes/no) points that were used in previous surveys.

Q.34 This overall noise-sensitivity judgment question has been used in several surveys (UKD-072, UKD-148). For the noise change questionnaire the follow-up questions "a" and "b" were used to expand the number of points on the scale.

Q.36 This question and some of the previous questions that are filters for it are included to support the magnitude estimation questions that appear later. The question is needed to determine if the respondent has any negative reactions because the magnitude estimation question can only be used if there are negative reactions to aircraft noise.

Q.37 and Q38 These are somewhat modified, improved versions of magnitude estimation questions that were used in a previous sonic boom survey (USA-375) as reported by Fields (1996a).

Q/39A The seven point satisfaction scale is the question that was used in a English study of reactions to changes in road traffic noise (UKD-237) and that is analyzed in this report.

Q.39B This five point scale is the same as was used in a study of reactions to temporary changes in aircraft noise exposure in Burbank California (USA-203). The one-week time period matches the question that was used in that survey.

Q.40 This question about environmental issues comes from a Sept 4-17, 1990 survey administered by Cambridge Report/Research International, 955 Mass. Ave. Cambridge, MA 02139. The question was used in several different years, as late as 1991 and (in a possibly different context) 1992.

APPENDIX K: INTERVIEWER INSTRUCTIONS

The interviewer instructions for both the long form and short form of the questionnaires are presented in this appendix. These instructions provide a basis for some of the study-specific training that interviewers receive for the study. The instructions provide important insight into how difficulties in understanding the questionnaire will be addressed in the data collection process.

INTERVIEWER INSTRUCTIONS -- LONG FORM

Contact Sheet, Household Information (Q1-4), and the Introduction

You will be provided with a cover sheet that contains the household ID number and complete address. On this contact sheet, you will record the date, time, and outcome of every contact with the household.

Fill in Questions 1-4 according to the information on the contact sheet. The household ID number is critical and should be completed immediately. The remainder of this box can be completed later.

Introduction: Interviewers can exercise discretion in the order in which they present the information in the introduction. However, do NOT mention noise or airports in the introduction. The phrases you should emphasize are:

- 'National Aeronautics and Space Administration'
- 'Your name and address will be held in confidence'

Refusals: If the respondent attempts to refuse:

- Don't be apologetic or feel like you are intruding. This is a very important study.
- Try to engage the respondent in conversation
- Hand the respondent the letter from NASA and say "today obviously is not a good day. I'll come back later after you have had a chance to read this letter"

If the respondent absolutely refuses after you had made the above attempts:

- Record the exact reason(s) for the refusal. We will be trying to convert the refusals and need as much information as possible.

Time: Right justify the time; do NOT use military time, check AM or PM. There are several other places throughout the interview where you will also record the time.

Q5–Sampling an Eligible Adult

To be eligible for the study, a respondent must be 18 years old or more and must speak English. The sampled adult must be selected using the respondent selection scheme in Question 5. This sampling scheme will enable you to select an adult from the household in a random manner.

- After the introduction, the interviewer begins by determining all respondents who meet the sample criteria (in this case 18 years old or more and English speaking) who live in the household.

- Starting with the oldest male, record all males 18 years old or more.

- Repeat the process above for all females in the household, starting with the oldest female in the household. Again, the criteria is 18 years old or more and English speaking.

- If there is a reason to be uncertain, ask if everyone speaks English.

- Assign a number to all the eligible adults as follows: the oldest male is assigned 1, next oldest male (if there is one) numbered 2, and so forth through <u>all</u> males listed. Continue numbering with the oldest female, next oldest female, and so on.

  For example, consider a household with a husband, wife, an adult son, an adult daughter, and the wife's father. Here, the assigned numbers would be: 1) the wife's father, 2) the husband, 3) the adult son, 4) the wife, and 5) the adult daughter.

- After you have listed and numbered all the adults from oldest male to youngest female, sum the number of eligible adults. Use the table on the contact sheet to select the appropriate respondent. Table 1 below shows the <u>full</u> selection table-- only the row matching the Kish number for that household will appear on your contact sheet.

  Using the same example noted above (5 adults), let's say the within household selection Kish number E1 appears on the contact sheet for that household. In this case, you would ask to speak with adult number 3 (the adult son). Circle number 3 to indicate this is the person you interviewed.

Table 1: WITHIN-HOUSEHOLD SELECTION

Kish Number	1 adult in household	2 adults in household	3 adults in household	4 adults in household	5 adults in household	6 + adults in household
A	1	1	1	1	1	1
B1	1	1	1	1	2	2
B2	1	1	1	2	2	2
C	1	1	2	2	3	3
D	1	2	2	3	4	4
E1	1	2	3	3	3	5
E2	1	2	3	4	5	5
F	1	2	3	4	5	6

Q6 In this question, as well as all others, always stress underlined words.

The word neighborhood should be used for all locations.

If respondent does not volunteer at least two items liked, use the single simple probe ("What else?"). Only probe once.

Q7 If respondent does not volunteer at least two items disliked, use the single simple probe ("What else?"). Only probe once.

Although an attempt should always be made to record responses verbatim, it is <u>especially important that the phrases which are used to describe environmental nuisances are recorded verbatim for this question</u>. (If the respondent is speaking too fast, then mention that you have to write it all down and don't want to miss anything they said.) This question is useful for determining whether aircraft noise change is a highly salient, current, and important issue for the respondent at the present moment. The question also allows respondents to feel that their strongest feelings have been recorded. Respondents should not, however, be encouraged to provide details that will be asked about again later. If they start to do so, tell them you'll ask more about that later.

CARDS Question 8b is the first time the response cards are to be used. NOTE: It is very important that interviewers keep all cards at their side except when a card is being used.

Special instructions for any time when the respondent is not able to see the card: Read all the alternative answers for at least the first three checklist items. If there is a digression or any discussion between items on the checklist, be sure to read all alternatives again. If the respondent hesitates, reread the alternatives.

Q8 This is the first grid where careful attention must be directed at the order of asking the items in the questions. Ask Q8a first. Probe for a second response. These responses should be marked as "VOL." in the HEAR column. If several "other" noises are mentioned in Q8a, write down all the noises. Then ask Q8b about the single most annoying "other" noise, and circle that most annoying noise.

After asking Q8a, as indicated by the arrow, read the entire list in Q8b prior to asking Q8c.

Repeat Q8b in full when you get to part iv "aircraft". This is one of the most important questions in the survey. If the respondent answers "not at all" to "aircraft", mark an "X" just before Q36. It is critical that you mark these boxes when instructed to do so, as they will help you later in the survey to possibly skip questions. Take back the card immediately after it is used in Q8b and keep it until needed again.

If the respondent says "no" to "aircraft" in Q8c, mark an "X" at Q15. It is critical that you mark these boxes when instructed to do so, as they will help you later in the survey to possibly skip questions.

Q9-10 Hand Card B to the respondent. Please note that these are critical questions.

Q11 Continue to use Card B. Note that if the respondent is not at all annoyed by the noise from aircraft when they are here around home or they volunteer that they do not hear aircraft, you should mark an "X" at Q36.

Q12 Record verbatim all noises that have changed in Q12a. Probe to be sure what noise source is being mentioned. Do not, however, probe for so many details that the next question is awkward. The next question (Question 13 and Question 13a) needs to be asked of everyone to be sure that they are referring to the same noise source.

Q13a, Q13b If "aircraft" was mentioned in Q12 and you have probed to ensure that the change is what we expect given the sampled airport, ask Q13a. If aircraft was not mentioned in Q12 or they don't know if any noises have changed, ask Q13b.

Q13d This question should be asked of all respondents, regardless of how long they have lived there since new residents could have known about the change even when living at another location.

Q13h Record issues/concerns verbatim. Probe for clarification if needed.

Q14 If a respondent doesn't know the answer because they are a new resident, check don't know.

Q15 If the box is checked indicating that they did not hear aircraft in Q8c.iv, ask Q15. Otherwise, proceed to Q16.

Q16 There are two versions of Q16 (Q16A and Q16B). Please note the different pattern for asking parts "a." and "b." for Q16A and Q16B (the pattern varies depending upon the version of the survey you have.)

For Q16A, ask about all the items in "a" before asking part "b" of the question. For Q16B, ask parts "a" and "b" for each item, prior to moving on to the next item.

If respondent is a new resident, the time frame should be "since you moved here".

Q17 There are two versions of Q17 (Q17A and Q17B). Please note the different pattern for asking parts "a." and "b." for Q17A and Q17B (the pattern varies depending upon the version of the survey you have.)

For Q17A, ask about all the items in "a" before asking part "b" of the question. For Q17B, ask parts "a" and "b" for each item, prior to moving on to the next item.

Q20 Ask Q20a for all items prior to asking Q20b.

Q21 If they don't recall the month, probe with "what time of year was that" to try to help them remember. A time of year is better than nothing at all.

Q23 Record in detail the new changes they have heard about.

Q24 This is one of several places in the interview where an interviewer may want to use the preemptive warning that they may be asking a question that the respondent has already answered, but that they must ask everyone at this point. When answering the question, it is very important that respondents focus on the planned change that we are informing them about in this question (rather than responding to their volunteered change mentioned in Q23).

Q25 If there are more than 10 episodes, carefully record all extra episodes on a separate sheet. The skip patterns in this question can be difficult if you are not familiar with all possible combinations of skips. However, this question has been successfully used in other studies. Thus, it is important that you practice the skip patterns with all possible sequences of answers until it becomes natural. Respondents will not have any trouble answering the question if you are clear with your skips.

Q26 Do not ask Q26 if they were away from their home at 6 AM.

Q27 If the respondent has tried to take a nap or sleep more than 3 times that day, record the beginning and ending time of the additional times below the grid.

Q28 The windows did not have to be installed solely to keep the noise out. We just want to know if they have these types of windows.

Q31 Emphasize that we are talking about today's aircraft noise when they have been at home. Circle their rating, and record it in the blank below question 31.

Q32 Note that you do not ask parts "c" and "d" if they have earlier volunteered that they are a new resident since the change.

Q33 If the respondent does not know what the word "grating" is, you can say "grinding".

Q35 We do not want detailed information about past complaint actions and do not want to imply that we would take any action with respect to their complaints or that NASA is an appropriate place to make complaints. If the respondent wants to know what they should do, say "I really don't know".

If the respondent says they went to a meeting, probe for type of meeting.

Q36 CAUTION: Note differences in SKIP instructions.

- ☐ If there is an X in the first box, skip to Q40
- ☐ If there is an X in the second <u>and</u> third box, ask Q36. By checking the

two boxes we know that there were two instances where the respondent said they were not bothered or annoyed or did not hear aircraft noise. We want to confirm this with one final annoyance question (Q36), before deciding whether to skip the whole section, or to continue on with the line exercise.

- ☐ If there is only one X in the second or third box, skip to Q37

Q37 Right justify the answers. If the respondent cannot complete Q37, check the circle at the bottom of Q37 and skip to Q38.

Q38 Everyone is asked the magnitude estimation questions even if they could not perform the line-length exercise in Q37.

Right justify the answers. Read the probes in the grids as written. For numbers larger than the spaces provided, record the answer in the margin.

Prompt respondents to reconsider their answers if the answers to "i", "ii", and "iii" are not consistent. Probe to see if more or less annoying than aircraft.

If the respondent cannot answer this question, place a check mark at the end of the question and continue with the next question.

Q39 Note there are two versions of this question, each with a different type of scale. Q39A uses a 7 point scale of definitely satisfactory to definitely unsatisfactory, while Q39B uses a 5 point scale of not at all annoyed to extremely annoyed.

Q40 If the respondent asks "Do you mean nationally or locally", say "It's what it means to you".

Q41, Q42 If the respondent says they only occasionally or sometimes read the newspaper or the newsletter, record their answer as "no".

Q45 Note that this is asking for the total amount of time away from home on Monday through Friday.

Q49 This question specifically asks about plans to move. Thus, if they are only considering moving or have given it only casual thought, they should answer "no".

Q53 It is all right if the respondent gives a work number. Simply note that it is a work number.

Thank you Interviewers may paraphrase the proceeding thank you and explanation if they want to.

Last page Complete the last page about the respondent and residence characteristics immediately after the interview. Describe in detail any unusual circumstances occurring during the interview, or any cautions we should use in a follow-up interview.

Complaints Become very familiar with these responses to complaints of the survey being too repetitious. These responses are found at the end of the survey. They are classified by degree of objection to the survey.

INTERVIEWER INSTRUCTIONS -- SHORT FORM

Household Information (Q1-3), and the Introduction

Introduction: Interviewers can exercise discretion in the order in which they present the information in the introduction. However, do NOT mention noise or airports in the introduction. The phrases you should emphasize are:

- 'National Aeronautics and Space Administration'
- 'Your name and address will be held in confidence'

Refusals: If the respondent attempts to refuse:

- Don't be apologetic or feel like you are intruding. This is a very important study.
- Try to engage the respondent in conversation
- Say "today obviously is not a good day. I'll call you back at a more convenient time"

If the respondent absolutely refuses after you had made the above attempts:

- Record the exact reason(s) for the refusal. We will be trying to convert the refusals and need as much information as possible.

Time: Right justify the time; do NOT use military time, check AM or PM. There are several other places throughout the interview where you will also record the time.

Sampling an Eligible Adult

To be eligible for the study, a respondent must be 18 years old or more and must speak English. We want to speak with an English speaking adult, 18 years old or more, who had the most recent birthday. This sampling scheme will enable you to select an adult from the household in a random manner.

Q4 If they don't recall the month, probe with "what time of year was that" to try to help them remember. A time of year is better than nothing at all.

Q5 In this question, as well as all others, always stress underlined words.

The word neighborhood should be used for all locations.

If respondent does not volunteer at least two items liked, use the single simple probe ("What else?"). Only probe once.

Q6 If respondent does not volunteer at least two items disliked, use the single simple probe ("What else?"). Only probe once.

Although an attempt should always be made to record responses verbatim, it is <u>especially important that the phrases which are used to describe environmental nuisances are recorded verbatim for this question</u>. (If the respondent is speaking too fast, then mention that you have to write it all down and don't want to miss anything they said.) This question is useful for determining whether aircraft noise change is a highly salient, current, and important issue for the respondent at the present moment. The question also allows respondents to feel that their strongest feelings have been recorded. Respondents should not, however, be encouraged to provide details that will be asked about again later. If they start to do so, tell them you'll ask more about that later.

Q7 Ask Q7a first. Probe for a second response. These responses should be marked as "VOL." in the HEAR column. If several "other" noises are mentioned in Q7a, write down all the noises. Then ask Q7b about the single most annoying "other" noise, and circle that most annoying noise.

After asking Q7a, as indicated by the arrow, read the entire list in Q7b <u>prior</u> to asking Q7c. Repeat Q7b in full for the first four items (through "aircraft").

Q8 If there are more than 10 episodes, carefully record all extra episodes on a separate sheet. The skip patterns in this question can be difficult if you are not familiar with all possible combinations of skips. However, this question has been successfully used in other studies. Thus, it is important that you practice the skip patterns with all possible sequences of answers until it becomes natural. Respondents will not have any trouble answering the question if you are clear with your skips.

Q9 Do not ask Q9 if they were away from their home at 6 AM.

Q10 If the respondent has tried to take a nap or sleep more than 3 times that day, record the beginning and ending time of the additional times below the grid.

Q11 The windows did not have to be installed solely to keep the noise out. We just want to know if they have these types of windows.

Q14 Emphasize that we are talking about today's aircraft noise when they have been at home. Circle their rating, and record it in the blank below question 14.

Q15 Note that you do not ask parts "c" and "d" if they have earlier volunteered that they are a new resident since the change.

Q20 The objective of this question and question 19 is to pinpoint the exact location of their home. In Q20, respondents may want to give you the name of a major road that is the crossroad. We do NOT want the major road, unless it is really the closest crossroad to them.

Thank you Interviewers may paraphrase the proceeding thank you and explanation if they want to.

Last page Complete the last page about the respondent immediately after the interview. Describe in detail any unusual circumstances occurring during the interview, or any cautions we should use in a follow-up interview.

Complaints Become very familiar with these responses to complaints of the survey being too repetitious. These responses are found at the end of the survey. They are classified by degree of objection to the survey.

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13. ABSTRACT (Maximum 200 words)
Study plans, a pretested questionnaire, a sample design evaluation tool, a community publicity monitoring plan, and a theoretical framework have been developed to support combined social/acoustical surveys of residents' reactions to an abrupt change in environmental noise. Secondary analyses of more than 20 previous surveys provide estimates of three parameters of a study simulation model; within individual variability, between study wave variability, and between neighborhood variability in response to community noise. The simulation model predicts the precision of the results from social surveys of reactions to noise, including changes in noise. When the study simulation model analyzed the population distribution, noise exposure environments and feasible noise measurement program at aproposed noise change survey site, it was concluded that the site could not yield sufficient precise estimates of human reaction model to justify conducting a survey. Additional secondary analyses determined that noise reactions are affected by the season of the social survey.

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