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A MODEL AND PLAN FOR A LONGITUDINAL STUDY OF COMMUNITY RESPONSE TO AIRCRAFT NOISE

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16. Abstract

This report proposes a new approach to the study of the effects of aircraft noise on people who live near large airports. The approach was an outgrowth of a planned study of the reactions of individuals exposed to changing aircraft noise conditions around the Dallas-Ft. Worth (DFW) regional airport. Although the actual research was not subsequently carried out, the planning, rationale, concepts, and proposed methods which were developed may prove to be valuable to researchers who conduct similar studies in the future. A critical review of major past studies traces the history of community response research in an effort to identify strengths and limitations of the various approaches and methodologies. A Stress-Reduction Model is presented to provide a framework for studying the dynamics of human response to a changing noise environment. The development of the survey instrument is detailed and preliminary results of pretest data are discussed.

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ABSTRACT

This report proposes a new approach to the study of the effects of aircraft noise on people who live near large airports. The approach was an outgrowth of a planned study of the reactions of individuals exposed to changing aircraft noise conditions around the Dallas-Ft. Worth (DFW) regional airport. Although the actual research was not subsequently carried out, the planning, rationale, concepts, and proposed methods which were developed may prove to be valuable to researchers who conduct similar studies in the future. A critical review of major past studies traces the history of community response research in an effort to identify strengths and limitations of the various approaches and methodologies. A Stress-Reduction Model is presented to provide a framework for studying the dynamics of human response to a changing noise environment. The development of the survey instrument is detailed and preliminary results of pretest data are discussed.

SUMMARY

This report proposes a new approach to the study of the effects of aircraft noise on people who live near airports. The approach was developed by a team of scientists from government and industry in preparing to study the reaction of individuals exposed to changing aircraft noise exposure conditions around the Dallas-Ft. Worth (DFW) regional airport and Love Field, Dallas, Texas. Although the research was not subsequently carried out, the planning, rationale, concepts, and proposed methods which were developed may prove to be valuable to researchers who conduct similar studies in the future.

A review of the major past studies reveals several factors which bear important implications for studying the effects of a changing noise environment. The conceptual framework has tended to be narrow in scope and the period of noise measurements does not necessarily coincide with the time frame of reference used by respondents in integrating their reactions to noise. The review of previous work focused on what the researchers were examining and how they went about collecting their data. In this review, no depreciation of the value of studying annoyance or complaint is intended. These responses obviously are of great importance to researchers, administrators, and policymakers and their continued study is definitely warranted. However, if progress is to be made in understanding community response to aircraft noise, the scope of the research must be broadened.

An examination of preferred methodological stances for social surveys leads to the position that studies whose purpose is to describe or assess a particular state are best served by a cross-sectional design. If the purpose is only to assess a particular condition at several points in time and there is no interest in the dynamics of change, then some type of repeated cross-sectional design should be used. However, if the purpose of the study is to examine change in some state or condition and there is interest in the dynamics of change, i.e., its causes and consequences, than a panel design is most suited. The face-to-face method of data collection, while more expensive, offers many advantages over mail or telephone surveys. Indirect, multiple item questions were found to be most suitable for obtaining unbiased and reliable data.

In the development of a methodology for the assessment of community response to aircraft noise, an important concern is the identification of specific measurable changes exhibited by the exposed community. To increase the

meaningfulness of the predicted response, typically annoyance, relationships between response categories need also be determined. The stress-reduction model is based on the premise that individuals will attempt to reduce, avoid, or eliminate stress from their lives. The model suggest that aircraft noise is perceived within two general contexts: situational conditions and human factors. That is, qualities of the individual's physical, social, and psychological environments are important in his perception of the noise. Only when the perception is "filtered" through the various meanings associated with the noise per se, is stress produced. The stress is manifested primarily in the development of negative feelings about the noise source and in health problems. However, the individual will make every effort to relieve this stress through either overt behavior or internal adjustments. Overt behavior may be of various types, including complaint, retreating indoors or out of the neighborhood, and soundproofing the home. Internal adjustments may take the form of adaptation, habituation, rationalization, and resignation to the noise. It is important to note that individuals who do not or will not take overt action or make internal adjustments will develop more stress since the development of negative feelings and health problems themselves produce stress.

A survey questionnaire, designed to obtain data related to the stress-reduction model was developed and pretested in the general area in which it was to be used.

1.0 INTRODUCTION

This report is a comprehensive statement of the rationale, concepts, and methods employed in the development of a study design for assessing the reaction of individuals exposed to changing aircraft noise exposure conditions

around the Dallas-Ft. Worth (DFW) regional airport and Love Field, Dallas, Texas. Although the research was not completed, it is important to make a complete statement of the design effort since many new problems and new ideas were encountered in the study's development.

The opening of the DFW regional airport and the consequent decrease in aircraft operations at Love Field offered a unique research opportunity. For the first time within contiguous areas it would be possible to study the effects of the onset of aircraft operations on a relatively unexposed population while, at the same time, studying the effects of a decrease of aircraft operations on a heavily exposed population. However, past research on reaction to aircraft noise did not deal with changing conditions. Instead, past work has concentrated necessarily, on static situations around preexisting airports. These conditions limited the conceptual framework for the planned research. Therefore, the scope of the present effort necessitated the development of a new and broader approach to reaction to aircraft noise. This led to the development of a new dynamic stress-reduction model of reaction which was used to guide the further development of the research design, including questionnaire construction and hypothesis formulation.

The remaining sections of this report are structured in the following manner: Section 2.0 provides a critical review of past research with the goal of showing its limited conceptual nature and the need for a broadened scope. Section 3.0 is a statement of the methodological problems inherent in surveys of reaction to aircraft noise and offers a preferred stance. Section 4.0 gives a complete explanation of the stress-reduction model and shows the derived hypotheses which can be tested with future data. Section 5.0 explains the

social survey study design of the DFW study. Section 6.0 details the noise monitoring plan. Finally, Section 7.0 details the development of the survey questionnaire and explains how it relates to the model.

2.0 CRITICAL REVIEW OF PREVIOUS STUDIES

2.1 Early United States Studies

The first studies concerned with community reaction to aircraft noise were conducted in the United States (ref. 1). During the early 1950's, a series of exploratory studies were done around numerous commercial airports. The purpose of these studies was to collect in-depth data that would enable the construction of an adequate conceptual framework which would guide future research. After these studies, additional work was performed around several United States Air Force military air bases in the late 1950's. The purpose of these further studies was to refine the research instruments and methodologie used in the previous studies, and to collect preliminary data relevant to the noise problem around the air bases.

Like many first-time efforts, these studies set several precedents for future work. Specifically, the following items were established:

1. Use of an opinion survey combined with a limited noise survey
2. Consideration of aircraft noise as the primary acoustical stimulus
3. Emphasis on annoyance as a measure of subjective behavior
4. Emphasis on complaint as a measure of objective behavior
5. Use of rudimentary measures of aircraft noise exposure
6. Use of an unspecific temporal reference for the measurement of stimulus and response
7. Disguising of the true purpose of the research

8. Concealing of the actual sponsor of the research

Each of these items require further comment.

The survey research or opinion survey format (item number 1) was chosen as the best practical means of investigating the problem. This involves selecting a random sample of households within predetermined areas and interviewing one or more of the members of each household. Sample areas are selected on the basis of initial gross estimates of aircraft noise exposure and general neighborhood characteristics. The interview is centered around a questionnaire, or interview schedule, which is especially developed to obtain answers to questions which are deemed important to the research objectives. Over a series of trials and errors, the best possible questionnaire is developed and both interviewing and sampling procedures are refined.

This methodology is common to many different research objectives. These objectives differ in the conceptual framework which guides the research and which thus determines the questions to be asked. The conceptual framework for the early study of community response to aircraft noise was an assemblage of physical, psychological, sociological, and social-psychological factors. It was quite obvious that people's reactions to aircraft noise were not simple. Some of the things which were felt to affect the relation between community response and the noise of aircraft operations are as follows (ref. 1, Appendix A):

I. The objective characteristics of neighborhood problems

II. The spatial and sociological relationships of individual residents in a single neighborhood and of adjacent neighborhoods

III. The intervening socio-psychological factors affecting individual feelings of disturbance, annoyance and complaint

IV. The range of neighborhood disturbance and annoyance

V. The readiness to complain

VI. The intervening factors affecting community action

VII. The forms of community action

Citing the need to design a practical field test, the researchers decided to limit the study to the following three sets of parameters (ref. 1 (Table 2, Appendix A)):

I. Physical characteristics of the noise

1. Peak SPL (sound pressure level)
2. Duration of peak
3. Number of exposures per time period
4. Duration of speech interference level
5. Equivalent SPL

II. Response variables

1. Number and frequency of activities disturbed
2. Degree of annoyance caused by disturbances
3. Readiness to complain

III. Intervening socio-psychological variables

1. Fear of possible crashes
2. Overall satisfaction with area
3. Feelings of importance of air base
4. Feelings of considerateness of pilots
5. Feelings of considerateness of officials
6. Feelings about potential success of complaining
7. Feelings about Air Force as an institution
8. Personal variables of age, sex, etc.

The shortened conceptual framework thus specified a small range of reactions and a number of intervening variables which were specific to the situation around a military air base.

One can see that because of the practical difficulties inherent in an opinion research format the conceptual framework was necessarily trimmed down and somewhat restricted.

The acoustical variables used in the sample design (item 2) included the numbers of jet aircraft operations, a certain percentile of the maximum flyover noise levels as measured in the 300-600 Hz octave band, the day/night time schedule of operations, and location with respect to flight path (ref. 1, part I:85). No attempt was made to sample on the basis of the level of noise from other sources such as road vehicles. In analyzing the survey results, aircraft noise exposure was characterized by measures of maximum flyover level, time duration of the flyovers, numbers of operations, and time duration of speech interference. Noise from all other sources was lumped into the general category of "background noise" and described by a single parameter, equivalent noise level, this being an energy mean level for daytime and for nighttime.

With reference to items 4 (complaint as objective behavior) and 3 (annoyance as subjective response), the Air Force studies tended to concentrate on a narrow range of human behavior and subjective feelings.

Investigation of actual complaint behavior was deferred to the study of what was called complaint potential (a general feeling of willingness to complain). This was probably due to the fact that proportionately fewer people actually complain than are willing to complain. Even so, the questions about complaint behavior were asked in a very general sense: "What do you do?" (ref. 1, 107), "have you ever...?" (ref. 1, 117), as were those about complaint potential: "Have you <u>ever</u> felt like...?" (ref. 1, 74) (emphasis in original).

Evidently, in order to obtain a better frequency distribution of responses, questions concerning behavior in the early Air Force studies were couched in a very abstract phraseology. An argument can be made that response to an abstract situation is related to response in a specific situation, but one should not assume that the two responses will be parallel. In these studies, for example, there was a difference of 6 to 28 percent in actual complaint and complaint potential (ref. 1, 74). And, although an attempt to explain this difference in terms of political efficacy and personal competentness was made, there is still a great deal of difference between an actual reported behavioral act and a feeling (attitude) about how one would (or had) reacted.

Quite obviously, the emphasis on complaint and activity interference in those early studies was a result of practical and immediate concerns with conditions around the military air bases of that time.

The use of relatively simple noise parameters (item 5) was dictated by the availability at the time of only manually-operated measuring equipment. Detailed descriptions of the acoustical sampling procedures were not included in the report and it is apparent that much of the acoustical data were obtained by extrapolations. Actual field measurements were made mostly in the 300-600 Hz octave band and other frequency-dependent parameters were inferred from this on the basis of known frequency characteristics of aircraft noise. Acoustical variables specified as stimulus parameters were (ref. 1, part II:4):

1. Average hourly operations exceeding 60 dB in the 300-600 Hz band
2. Maximum level exceeded by 10 percent of operations in (1)
3. Average duration within 5 dB of maximum flyover level for operations exceeding 80 dB in the 300-600 Hz band

4. Equivalent (energy-mean) level for aircraft only in the 300-600 Hz band
5. Duration in seconds per hour in which a speech interference level (SIL) of 60 dB is exceeded
6. Duration in which an SIL of 75 dB is exceeded

The foregoing were determined for daytime, nighttime, and different periods of the week.

For reasons which are not given in the report, the combined analysis of acoustical and response data is described for only parameters (1) plus (2), (4), and (5) above. It was concluded that (5), the duration above SIL-60, is the best measure for ranking disturbance and annoyance. (This result is at variance with all prior and subsequent studies.)

Item 6 (use of an unspecified temporal reference for the measurement of stimulus and response) refers to the fact that in the Air Force study the respondents were asked to state their feelings and opinions on an unspecified time basis. For example, in order to determine the degree of bother or annoyance to jet aircraft noise, the respondent is asked, "Does the noise of the (jet aircraft) ever bother or annoy you very much, moderately, only a little, or not at all?" This procedure is used extensively. The respondents are asked if they ever did this or if they ever did that, but never about their response to a specific stimulus. Instead, they were asked to give generalized responses to questions which had no specific time reference.

The stimulus was approached in a similar manner in the Air Force study. The engineers involved in measuring the noise for the cited study presented a series of noise exposure parameters which described in a statistical sense the volume of aircraft operations in an area, the noise levels of the most intense aircraft operations, the average length of time or duration of the

most intense operations, the combination of noise level, frequency of operations and duration, and the effect of noise on speech communication outdoors and indoors (ref. 1, 5-8). The use of these statistical descriptors of basically average sums of energy produced by the total amount of aircraft operations evidently required that the parallel human response also be measured in a general or average sense.

The problem with measuring noise exposure and human response in the manner of the Air Force study is that one has great difficulty in determining what their relation is in any definitive way. If the noise exposure were measured, say, for a 3-month prior period, and a respondent said "yes," he had been annoyed by aircraft noise, but his temporal reference was 4 months hence, then the researcher who followed the Air Force measurement methodology would likely establish a false relationship since the respondent's reference is never recorded.*

This procedure also requires the existence of a mental integrating mechanism which allows each person to report his subjective state at any point in time. Assuming this mechanism exists, the issue is further complicated by not knowing over what time period people are integrating their response. It is not known, when they answer nonspecific questions, whether people are using the past week, the past year, or even the latest noise event as the basis for their response. Given these unknowns, how is it possible to specify the stimulus and thus the response, since a day, a week, or a year makes a difference in the amount and type of stimulus received?

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*There have been considerable studies concerned with subjective evaluations of aircraft noise in both the laboratory and field settings. Most researchers agre that human subjects can estimate the acceptability of various types and levels of aircraft noise with good reliability. See Kryter (ref. 2, Chapter 9).

The point of all this is to stress the implications of one's choice of measurements. Very little research has been done on the time reference people use when responding to a stimulus such as aircraft noise. It may be, for example, that there are two forms of annoyance: short term and long term. Short term annoyance could be the reaction to immediate events (e.g., 24 to 48 hours). Long term annoyance could be a reaction to the general level of noise exposure over a longer period of time (e.g., 3 months to 6 months). More research is needed to validate these concepts and to determine their interrelationships.

Items 7 (disguising the true purpose) and 8 (concealing the actual sponsor) above relate to a particular stance concerning how to elicit information from people. In the cited research it was deemed necessary to conceal the fact that the study was concerned with people's reactions to aircraft noise and that the Air Force was sponsoring the work. Thus, the research effort was represented as a study of "...how people feel about living in different places," and the sponsor was said to be N.O.R.C. Even if the respondent guessed the true purpose and sponsor from the questions being asked, the interviewer was instructed to deny everything (ref. 1, 128).

Evidently, these deceptive practices were used for two purposes: (1) to prevent the respondent's answers from becoming unduly biased, and (2) to determine the seriousness of the aircraft noise problem in the context of other neighborhood problems.

It is well known that if the respondent knows the true purpose of the research, he may slant his answers to fit what he thinks the interviewer wants. The same is true when he knows who the sponsor is. However, what happens if the respondent feels the interviewer is lying or is being deceptive is not so

well known. These are problems common to all surveys and must be handled delicately. One solution has been to put off a discussion of the purpose and sponsor until after the interview is over. The interviewer simply gives a brief statement and then says, if more information is needed, he will discuss it at the end. Usually, the brief statement will satisfy most respondents. For those whom it does not satisfy, it would be better to disclose the desired information and then record that an "open" interview was being conducted.

The problem of determining the saliency of the aircraft noise problem is a different matter. It is actually optional whether or not to determine this saliency. If the research purposes require that this be done, then the respondent must be given the opportunity to spontaneously mention aircraft noise as a problem. This can only be done by asking questions of a rather open nature early in the questionnaire and then letting the respondent take it from there. If more explicit comparisons are desired, such as aircraft noise versus traffic noise, then this would have to appear later in the questioning procedure.

2.2 British Studies

In 1961, the first of two studies around London (Heathrow) airport was performed (ref. 3). This study was well planned and executed and became a classic model which influenced the methodology of subsequent studies.

The first Heathrow survey examined the attitudes and beliefs of about 2000 residents within a 10-mile radius of the airport and analyzed these in relation to aircraft noise data supplied by the Ministry of Aviation. The main sample was drawn randomly from predetermined aircraft noise level strata; a separate sample of complainants was also studied.

In common with the earlier U. S. surveys, emphasis was placed on annoyance and complaint as response modes. The annoyance score replicated the procedures used earlier and was based on the degree of reported disturbance of everyday activities, such as rest and relaxation, sleep, watching television, and telephone conversation. Also, the true purpose of the study was initially concealed during the survey interviews. It was not until about one third of the way through the questionnaire that direct questions concerning aircraft noise were asked. (There is no indication of what the interviewers were instructed to do if the respondent was persistent and demanded to know particulars.)

The Heathrow study also continued the approach of asking questions with a nonspecific time reference. For example, questions were asked such as: "Does the noise of (aircraft) ever...?," "Do the aircraft ever...?" These latter questions were completed with such phrases as "startle you." "wake you up," and so on. Questions dealing with complaint were handled in a similar manner. That is, respondents were asked "...have you ever felt like...?," "Have you actually done any of these things?," and so on.

Several advances in methodology were incorporated in the Heathrow study. The meticulous questionnaire design permitted the construction and detailed examination of a large number of psychological variables which were found to affect the expressed degree of annoyance. The related personal factors included such items as opinions of the effects of noise on health, the total number of things disliked about the neighborhood, beliefs about the preventability of the noise, fear of aircraft crashing, susceptibility to noise in general, adaptability to aircraft noise, annoyance to jet aircraft in particular, and perception of similar viewpoints among neighbors. Another improvement was that questions were asked concerning not only aircraft noise, but also other

factors affecting satisfaction with the neighborhood, such as living quarters, smoke and dirt, convenience to work, climate, etc. This permitted putting expressed aircraft noise annoyance into a meaningful relative context by comparing it with other perceived disamenities. Finally, sophisticated statistical analyses were performed using a digital computer, permitting a much more detailed and meaningful determination of the relationships of the many variables involved than was possible in the earlier U.S. study, which employed only cross-tabulations.

The noise data were based on extensive field measurements (approximately 9000 aircraft and 85 sites). No data were taken for sound from nonaircraft sources. Variables available for analysis included the energy-mean, 50th percentile, and 90 percentile of maximum flyover levels in PNdB, the cumulative duration of levels over 85 PNdB and 95 PNdB, the numbers of flyovers, and certain distance parameters. The best correlation with annoyance was obtained by the energy-mean (simply called "average" in the report) of the flyover maxima. Noting that mean annoyance increased with both flyover level and number of aircraft, the British committee responsible for the study constructed the well-known noise and number index (NNI) containing both of these variables. In fact, the statistics of the data were such that the inclusion of the number variable had no significant value (ref. 3,4).

One deficiency of the Heathrow study was the apparent lack of coordination between the social survey and the acoustical survey during both field and analysis phases. No particular scheduled relationship seems to have occurred between interviewing and observing and/or measuring aircraft operations in various areas. This left the time frame of aircraft exposure as indefinite as that of the elicited response data. In the analysis of data, more useful

results might have been obtained had the acoustical data not been preformulated. For instance, the entire distribution of levels could have been used rather than the choice among energy-mean and two percentile values, permitting a more definitive examination of the effective components of noise exposure.

In 1967, a second survey around Heathrow airport was conducted in order to determine changes in response between 1961 and 1967, to test the validity of the 1961 findings, to further specify the effects of different aircraft operation modes on annoyance, and to obtain miscellaneous other data (MIL Research Ltd., 1971). This time, an area 20 by 30 miles around Heathrow was used for the sample region. The main sample totaled 4699 respondents, of which 3118 were located in the area of the 1961 study.

The repeat survey showed that although there had been a general worsening in satisfaction with the area and in other attitudes, the average annoyance had changed very little. The lack of validity of the noise and number index was reconfirmed, but no improved formulation was established.

Since the second Heathrow survey was supposed to be a repeat of the first, much of the same methodology was used. Many of the same questions were used, for example, even though they were often in a different order from that in the first questionnaire. In general, there were no important departures from the U.S. 1961 study in the method of conducting the social survey.

Aircraft noise data were expressed in a manner similar to that of the first Heathrow study, although the measurements were more comprehensive (28,000 aircraft flyovers) and a measure of the noise due to road traffic ("base noise level") was specified in terms of the number of minutes' walk from a respondent's dwelling to the nearest main road. Aircraft noise exposure was estimated from

level and operations data, with spot checks at some sites, for the worst day during a 3-month period and for the average day over the period. The worst mode exposure values predicted annoyance best, and the effect of increased "base noise level" was reduction of aircraft noise annoyance.

2.3 Other European Studies

The first Heathrow study served as a model for subsequent research in Germany (ref. 5), Sweden (ref. 6,7), Holland (ref. 8), France (ref. 9), and Switzerland (ref. 10). In each of these studies, the main concern was with the relationship between noise exposure and some form of annoyance, and, where there were sufficient data, with complaint.

Very similar results were obtained from these various surveys. In general, the noise exposure itself was only moderately correlated to annoyance. Several other attitudinal variables were found to be related to annoyance, viz., fear of aircraft crashes, effects on health, susceptibility to noise in general, and so on.

The emphasis of each survey was the same as that of the U.S. Air Force study via the Heathrow surveys. The primary dependent variable was feelings of annoyance or bother with the aircraft noise. The only behavioral consequence studied was complaint, although an attempt was made in the German study to determine what caused people to move from the noise exposure areas. (No selective migration bias due to noise sensitivity or attitudes was found.)

A variety of indices of noise exposure were used by the different investigators, but each index typically was very similar to the British noise and number index. Associated programs of acoustical measurement ranged from comprehensive to rather cursory.

2.4 Recent United States Studies

In 1967 a comprehensive study of community reaction to aircraft noise was initiated in the United States (ref. 11). This study was actually a series of surveys conducted around seven major airports (Boston, Chicago, Dallas, Los Angeles, Miami, and New York). About 8000 interviews were collected and over 10,000 aircraft noise signatures were recorded and analyzed.

A stratified random sample was used in each city plus special complainant and organizational samples in New York and Miami respectively. The interview questionnaires and techniques were patterned to a large extent after those of the earlier U.S. and British studies and involved initial concealment of the focus of the interview and nonspecific time references in the response-related questions. As before, the principal response modes considered were annoyance resulting from activity disturbance and complaint.

In determining noise environments, primary emphasis was on aircraft noise. Exposure to aircraft noise was reconstructed from field measurement and operations data for a period of 3 to 4 months prior to interviewing. In the first phase of the study (covering four cities), detailed frequency analyses of the aircraft noise signatures were made and comparisons performed among various parameters of level and cumulative exposure.

As in the Heathrow studies, advanced statistical analysis techniques were employed and psychological variables were explored at length. Some of the results are as follows:

1. Simple weighted sound levels (A- or N-weighting) are adequate approximations of more complex measures (such as perceived noise levels computed from band analysis data) as components of community noise exposure.

2. The noise exposure measures CNR (composite noise rating), NNI (noise and number index), and NEF (noise exposure forecast) are practically interchangeable.
3. Noise exposure alone is a rather poor predictor of annoyance.
4. Certain social-psychological variables combined with noise exposure provides good prediction of annoyance, especially with a nonlinear model.
5. The social-psychological predictors of annoyance can be ranked; the most important of these is fear of aircraft crashing.
6. There is a definite relationship between the number of highly annoyed households in a community and the number of complainants. Only a fraction of the former ever actually complain.
7. Whereas the predictors of annoyance are primarily psychological, the main predictors of complaint are sociological.
8. Complainants as a group do not show greater sensitivity to noise or neurotic tendencies than others. They do tend to have higher noise exposure and to be older, more highly educated, and more affluent.

In 1970 a second study was conducted at the airports in two smaller cities (ref. 12). The purpose of this study was to extend the results and procedures from the large-city study to smaller airports with lower volumes of air traffic. It was felt that the estimation of response might be more difficult in communities around smaller airports. There was also the question about response to infrequent but loud aircraft operations. A total of 1960 interviews were collected using a questionnaire quite similar to the one last used in the large-city study.

The following results were obtained:

1. Below 125 CNR the relationship between annoyance and noise exposure is not the same in the small cities as in the large cities. Fewer people were annoyed, at each noise exposure level, in the small cities as compared to the large cities.
2. The prediction of annoyance from relationships developed in the large-city study was not as valid for the small cities. A different predictive solution employing similar variables was derived, however, fear still was the most important predictor.
3. When large and small cities are considered, the relationship between aggregate community annoyance and complaint is well defined. The percentage of complainants is proportional to the square of the percentage of highly annoyed.
4. With a knowledge of noise exposure and population in a community, the number of complainants in the community as a whole can be estimated.

2.5 Summary

The above review of previous work focused on what the researchers were examining and how they went about collecting their data, in order to point out that a rather narrow range of subjective and objective behavior was being studied. It is clear that previous work was centered mainly on a subjective state called "annoyance" and one type of overt behavior called "complaint," and the relationship of these to indices of aircraft noise.

In this review, no deprecation of the value of studying annoyance or complaint is intended. These responses obviously are of great importance to

researchers, administrators, and policymakers and their continued study is definitely warranted. However, if progress is to be made in understanding community response to aircraft noise, the scope of research must be broadened. The human mind is so complex and behavior so varied that to limit research to only two small fragments of the total picture is unnecessarily restrictive.

In Section 4.0, dealing with a model of individual response to aircraft noise, a number of different attitudes and behaviors are offered as additional variables meriting extensive research investigation.

3.0 TOWARD THE DEVELOPMENT OF A PREFERRED METHODOLOGICAL STANCE FOR SOCIAL SURVEYS

In this section, we shall consider various methodological positions related to the study of reaction to aircraft noise. This review involves discussions and comparisons of various survey methods and is conducted in order to develop the foundation for a preferred methodological stance. That is, by reviewing the various ways of surveying and noting the associated problems we hope to discover the strengths and weaknesses of prevailing methodologies and then be able to take a position on which methods are most appropriate for studies on reaction to aircraft noise.

A review of current research methods in this field and the development of a preferred stance is important for two reasons. First, the best possible quality of data is desired, since important decisions ultimately affecting many people will be based upon the results. Second, since research is expensive, the most cost-effective methods are necessary. These two considerations are often combined and expressed as a desire for good, cost-effective data. The problem is how to obtain the best data for the least cost.*

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*Zelditch (ref. 13) puts the problem within the framework of "goodness" criteria: informational adequacy (accuracy, precision, and completeness of data) and efficiency (cost per added input of information).

It would be a mistake, for example, to use a less costly method of data collection if that method does not produce reliable or representative data. On the other hand, a method of data collection which is quite expensive is unlikely to be used no matter what the quality of the achieved data.

The area of research methods is extremely broad.** If we restrict our attention to survey research methods in the area of community reaction to aircraft noise, we find that the following areas are important: (A) study design, (B) data collection, and (C) general approach.

A. Study Design

Some of the basic study designs in survey research are cross-sectional, trend, cohort, panel, parallel, contextual, and sociometric studies (ref. 21). The cross-sectional study is basically a "one shot" survey, that is, it collects data at one point in time from a sample of respondents who are representative of a larger population. The trend, cohort, and panel studies collect data at several points in time. The trend study uses different respondents at each point in time (approximating a series of cross-sectional surveys), the cohort study focuses upon a specific subpopulation across time (e.g., a specific age group), and the panel study uses the same respondents at each point in time. The parallel survey collects standardized data from two or more subpopulations for the purpose of comparison. The contextual study collects information on both the respondent and his environment (social, physical, or other) thus providing the "context" of his answers. The sociometric study is used to establish the interrelationships among members of different groups.

**For general discussions of survey research methods see Hyman (ref. 14), Jahoda, et al. (ref. 15), Phillips (ref. 16), Forcese and Richer (ref. 17), Denzin (ref. 18), Backstrom and Hursh (ref. 19), and Babbie, (ref. 20).

Which particular study design is employed depends to a great degree upon the purpose of the research. If change in any degree is to be assessed*, one of the longitudinal formats (trend, cohort, panel) must be used. A cross-sectional design can be used to establish relationships but it cannot be used to determine the amount of change. Likewise, a trend study can assess the amount of net change but it is unable to afford the explanation of how or why the change occurred.

The panel design, however, is most suited for determining change. This design is superior to repeated cross-sectional surveys in this respect because it can better record changes, can provide reasons for observed changes, provides much more data (since the same respondents are used each time), and provides information without reliance on the respondent's memory, and because changes found in panel studies are of more substantive importance than comparable changes in cross-sectional studies (ref. 22: 215-319). Of course, the panel technique is not perfect. One must be aware of two problems: panel attrition and re-interviewing bias. Panel attrition, i.e, the loss of respondents from the panel over time, can be serious if considerable numbers are lost. The re-interviewing bias results when respondents are affected by repeated questions on a particular topic. Control procedures are available to minimize this bias to some extent.

In summary, studies whose purpose is to describe or assess a particular state are best served by a cross-sectional design. If the purpose is only to assess a particular condition at several points in time and there is no interest in the dynamics of change, then some type of a repeated cross-sectional design should be used. However, if the purpose of the study is to

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*Quite often the main interest of researchers is on the effects of aircraft noise on peoples' lives. That is, in what way does exposure to aircraft noise change peoples' attitudes, beliefs, perceptions, and behavior.

examine change in some state or condition and there is interest in the dynamics of change, i.e., its causes and consequences, then a panel design is most suited.

B. Data Collection

Three issues of data collection are 1) alternative procedures for obtaining information, 2) variations in question formulation, and 3) measurement problems.

Alternative procedures - Three commonly used methods of obtaining survey data are mail, telephone, and face-to-face. The choice of the appropriate method is more complicated than it seems. On a purely cost basis, priority would go to the mail survey, followed by the telephone interview, and then the face-to-face interview. However, two other considerations enter into the calculation of costs: representativeness and quality of the data.

The mail survey* is often not representative of the target population. Two reasons for this are low response rates, i.e., few people return the questionnaire, and an incomplete sample frame, i.e., an inadequate or out-of-date list of people's addresses. Both problems produce biased answers. The former results from the fact that people who do return a mail questionnaire have certain characteristics (e.g., middle socioeconomic status) different from those who do not (e.g., minority groups, low socioeconomic status). The latter results from not being able to send the questionnaire to people not on the mailing list.

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*For an excellent summary of this technique see Erdos, (ref. 25).

The telephone survey technique is gaining in popularity among survey practitioners. In the early history of survey research the telephone technique was discredited because of the forecasting debacle during the presidential election of 1936. A poll at that time predicted the election outcome based, in part, on telephone directories and missed the actual results by some 20 percentage points (ref. 23,: 291 and ref. 24,: 327). Since that time researchers have been extremely wary of the procedure.* However, the problems with the prediction in 1936 were extensively analyzed and there is now a general feeling that with appropriate caution the telephone survey can be a useful technique. Much of the optimism is generated by the seeming ubiquitousness of telephone subscriptions and the associated reductions in field costs (from 25 to 30 percent).

In spite of this general feeling of optimism, very little research has been conducted on the relative merits of telephone interviewing, and in the research that has been conducted the results are contradictory. There are two general problems: the quality of the data and non-response bias.

The quality of the data problem concerns those conditions of interviewing in general which inhibit the collection of good data.** In the interviewing situation it is generally recognized that the respondent must be motivated, cooperative, and committed. In addition, the respondent must feel that the research is important and legitimate. In most cases the physical absence of the interviewer inhibits each of these conditions. The interviewer cannot socially motivate the respondent. She also cannot use her presence on the

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*McNemar (ref. 26;328) felt the procedure was completely unsatisfactory.

**There is some evidence (ref. 27) that responses to open-ended questions have more depth in the face-to-face situation than in the telephone interview.

doorstep to encourage cooperation. And it is difficult to establish the importance of the research and to ensure commitment to the respondent role over the telephone.

Another small but important point is that the interviewer cannot use visual aids. She will not be able to standardize items with answer cards or other instruments. The respondent will have no means of checking her credentials. The telephone procedure will also prevent the perception of subtle physical cues, e.g., facial expressions, body movements, etc., on the part of both the interviewer and respondent.

The nonresponse problem has received more attention. The problem is divided into two parts: that dealing with the bias in telephone subscription, and that dealing with the validity of responses over the telephone. The United States Census shows that telephone subscription is steadily rising. The percentage of homes in the U. S. with telephones is generally recognized to be high. However, telephone ownership varies, for example, by subpopulations, by rural-urban differences, and by population stability. Lenthold and Schee (ref. 28:254-255) showed that a telephone survey in Missouri would "...exclude one-third or more of blacks, the separated and divorced, and service workers, and one-fourth or more of the large city-dwellers." Kegeles et al (ref. 29) found much the same situation. In their study they discovered that 74 percent of their national sample had telephones. They also concluded that the following sample characteristics were underrepresented in their nationwide study: rural, south, nonwhites, unmarried females, little education, and low income (ref. 29:417).

The problem of response validity with reference to telephone surveys is not yet resolved. Larsen (ref. 32) in one of the first real tests of validity between telephone and face-to-face interviewing found that response validity was much better for face-to-face interviews and that answers given over the telephone were more distorted. He also found that face-to-face interviewing elicited more depth of knowledge about the survey subject matter than did the telephone technique. He concluded "...that great caution should be exercised in interpreting results of telephone interviews in polling problems of similar simple structure" (ref. 32:476). However, research recently conducted showed that comparable validity was obtained using a telephone interview to replicate a previous face-to-face interview (ref. 29). Nevertheless, these authors suggest that some supplementary procedure be used, e.g., a mail survey, in order to reduce bias inherent in the telephone technique (ref. 29: 419). Other research has shown that quite often in telephone surveys biased responses are obtained to questions of a sensitive nature (ref. 33, 34).

On the positive side, telephone interviewing does not seem to produce bias when it is used on selected population subgroups. For example, a survey of doctors could be effectively surveyed by telephone since essentially every doctor is capable of being reached this way. Also, if the sample frame is based on area probability sampling procedures, i.e., a specific household is designated for sampling, and the study design then calls for a determination of whether or not the household has a telephone, then refusal rates are quite similar to face-to-face interviewing (ref. 33, 35).

Bias from the interviewer may be less with telephone interviews. Phillips and Clancy (ref. 36) studied "modeling effects" of various telephone interviewers and concluded that there is a strong possibility that face-to-face

interviewing may present more opportunities for the interview's qualities to affect the respondent's answers.

Face-to-face interviewing is usually the preferred mode of data collection even though it is somewhat more expensive. It is felt that the extra expense is justified because the representativeness and the quality of the data are good - provided correct procedures of sampling, interviewer training and control, and quality control procedures have been followed.

One advantage of using the face-to-face technique is the availability of the interviewer as observer. For example, it may be necessary to obtain certain characteristics of the respondent (e.g., race, appearance, etc.) or of the dwelling place (e.g., number of fixtures or appliances, structure of the building, etc.).

In many cases it is difficult to convey the subtleties of questions. Another advantage of the face-to-face technique is that it allows the interviewer the full range of communication processes to make herself understood and to understand the respondent as completely as possible.

There is an extensive literature on interviewing, thus many of the questions concerning reliability,validity, interviewer effects, sampling, and so on will not be covered here.* Suffice it to mention that the face-to-face technique has a long history and has been studied and re-studied. It is still one of the most used and reliable techniques of data collection.

Since previous work on community reaction to aircraft noise has relied upon the face-to-face method of data collection, it would be unwise to switch to a wholesale use of another technique. There would be no way of determining whether or not a change in the type or quality of data would result unless previous methodological studies contrasting the various data

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*See, for example, Richardson et al, (ref. 37) Hyman, (ref. 38) and Cannell and Kahn, (ref. 39).

collection techniques had been conducted. Only if there were direct evidence that the face-to-face method was producing biased or inferior data would there be justification for abandoning it. The only other consideration would be one of costs, which was discussed earlier in relation to the reduced field costs of telephone interviewing. But, for the reasons stated above, one should view with caution the apparent gain in cost reduction via the telephone survey in contrast to the quality of data thereby obtained. This does not mean, however, that there is no place for telephone interviewing. Indeed, when the subject matter is not too complex, a re-interviewing procedure using the telephone merits serious consideration.

Variations in question formulation and measurement problems - Question formulation and measurement of attitudes and opinions are closely interrelated.* That is, the manner in which a question is worded (its vocabulary and syntax), its frame of reference, and the conceptualizations involved are all related to what it purports to measure. Two questions with reference to reaction to aircraft noise studies are as follows:

1. Are direct references to aircraft, aircraft noise, and the annoyance reaction more appropriate than indirect references?
2. What is the best method of measuring reaction, a single item or multiple items?

There are two issues with reference to direct or indirect questions. The first concerns the problem of leading or biasing questions. The second refers to the context in which the research occurs.

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*See Payne (ref. 40) for methods of asking questions; problems of attitude measurement are covered in Scott (ref. 41) and Upshaw (ref. 42).

All survey practitioners advise against asking leading questions (ref. 40). These are questions which are formulated in such a manner that one form of response is favored over another. The result is a distribution of answers biased in the direction of the favored response.* The bias can be the result of a number of technical operations. For example, the question may ask only about negative aspects of an item without providing balancing positive statements. Or, the question may be such that the respondent does not know what frame of reference is involved.**

A prime example of a loaded question is an interview that begins with the following: "Have you ever been annoyed by aircraft noise around here?" Taken literally, the question is very likely to be answered in the affirmative. In trying to answer this question the respondent has three difficulties. First, by using "ever" the respondent has no definite frame of reference and must therefore think back to determine if he had been annoyed by aircraft at any point in the past. Secondly, the phrase "around here" is vague. It is impossible to determine how the respondent interprets it. Third, the reference to aircraft noise is purely negative. All of these combined lead the respondent to agree with the interviewer and will produce an inflated distribution of people who report "annoyance" to aircraft noise.***

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*See Litwak (ref. 43) for a general classification of biased questions.

**Jonsson (ref. 44) demonstrated that the term used to describe the stimulus from and reaction to aircraft noise and other environmental hazards was an important determinent of the type of results obtained.

***Put in a proper context, e.g., the end question of a series of more general ones, the direct reference may not be as biasing.

In deciding what the content of the question should be and how the information is to be treated, the following advice is given (ref. 15:426):

"Each class of questionnaire content may suggest two markedly different kinds of items - those that ask explicitly for the information wanted as distinguished from those in which the desired information is inferred from responses directed to other matters. (For example, instead of asking the respondent directly about his own social adjustment, he may be asked whether more people are hard to get along with, etc.) Questions of "fact" are often asked not to obtain direct evidence on the facts (which may already be known), but as indirect measures of knowledge or interests. Opinions on an issue may be sought because of research interest in the issue ("direct" questions) or for the purpose of throwing light on the personality of the respondent ("indirect" questions)."

The second issue, the context of the research, refers to the practical restraints often encountered in research on people. In community surveys the researcher must always contend with the problems and concerns of local authorities - the police, local administration, and other organizations. Without their cooperation, research is made extremely difficult (ref. 45). The most prevalent fear of local authorities is that the research effort will create problems for them by upsetting residents or somehow implanting ideas in their heads. Of course, there are no recorded instances of surveys doing this, but this does little to lessen the apprehension of local authorities, particularly if the topic of the research is a sensitive issue.

In many places, reaction to aircraft noise is a sensitive issue and this cannot be ignored in the research design. If it is possible to assess reaction in an indirect manner and still maintain high reliability and validity, then this should be done. Every effort should be made to ensure the collection of the highest quality data by establishing conditions which will ensure cooperation from the local community.

The problem of single versus multiple items refers to the researcher's concept of measurement. The problem is whether to rely upon a single question to measure something, e.g., annoyance or fear, or to use a series of questions combined into an index or a scale. The issue cannot be resolved with certitude because the method of measurement depends to a large degree upon the researcher's judgment of the complexity of the phenomena he is trying to study. Two researchers may view the same phenomena differently. However, the history of attitude research has shown that single items often do not measure attitudes very well. Most researchers advise the use of multiple items since attitudes usually have several dimensions (ref. 41). In fact, one authority suggested the elimination of single-item questions almost 30 years ago (ref. 26:327).

One reason given for using multiple items is to reduce measurement error. In every attempt to measure a multi-dimensional phenomenon there will necessarily be some error. By using several questions to explore these dimensions, the researcher can ensure greater reliability of measurement. Other reasons for using multiple items are to improve predictive ability, to achieve greater validity, and to reduce variation of response.

C. General Approach

The general approach taken by most researchers in the field of community reaction to aircraft noise has been dictated by the type of model used to guide them in their efforts to conceptualize how aircraft noise affects people. For the most part it has been a limited stimulus-response model, with a realization that attitudes play a major intervening role. In ref. 1, for example, a comprehensive model of community response was developed, but then abandoned for a modified stimulus-response model for human subjects. However, for most cases there is no formal statement of the research model by the researcher.

The distinction between human and community response is important. The community response is not simply the sum total of each resident's response. This is necessarily true because the community has an existence separate from and independent of each individual's existence. In past research the focus has been on the response of groups of individual respondents and not communities as a whole.*

Most research has not specified the model which provided guidance. This is somewhat understandable since much of the research relied upon previous work for hints and leads. Also, in most cases past research grew of concern by public officials or other authorities with public expression of annoyance and complaint. Given this situation, it was natural for past research to be less concerned with model development than with immediate problems.

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*Just the term "community" has problems of definition. Some people would equate it with the neighborhood, others with a larger entity, such as a city. (See ref. 24, 514-536.)

However, this lack of model development has restricted the scope of the research. As noted earlier in the review of the literature, studies of response to aircraft noise were concerned with attitudes (mainly annoyance) and limited behavior (usually only complaint).

In the following section a complex model of human reaction to aircraft noise is developed. This model specifies a broad range of reaction in terms of both attitudes and behavior.

4.0 THE DEVELOPMENT OF A MODEL OF INDIVIDUAL REACTION TO AIRCRAFT NOISE

In the development of a methodology for the assessment of community response to aircraft noise, an important concern is the identification of specific measurable changes exhibited by the exposed community. Following this, the psychophysical relationship between the cause (noise) and effect (community response) needs to be determined. To increase the meaningfulness of the predicted response, relationships between response categories should also be determined. For example, if the mean annoyance of a given community is 4.8 (on a scale of 6) and this is designated as "very annoying," very little information regarding the actual state of mind of the average community resident is known. If, however, the relationship between annoyance, desire to move out of the neighborhood, health effects, sleep loss, hearing loss, activity interruption, and degradation of the perceived quality of life are predictable from knowledge of the degree of annoyance, for instance, then the information becomes considerably more meaningful to the various users, such as aircraft designers, airport operators, pilots, legislators, and public administrators.

Some of the specific measurable changes exhibited by airport community residents and due to aircraft noise can be determined by answers to questions in social surveys, while certain behavioral changes can be directly observed or traced through official records, such as those of the telephone company, real estate offices, and hospitals. However, a specific model of individual reaction to aircraft noise is needed in order to determine better which specific changes may be anticipated and how they can be measured.

The initial attempt at formulation of a model is shown in Figure 4-1. It was felt that response to aircraft noise was the end result of a series of passes through various "filters" or "modulator" boxes. As shown in Figure 4-1, the characteristics of the exposure conditions and the working of several modulator variables both affected response to aircraft noise. The immediate results were the interference of certain activities and psychological response. Further reaction is shown in terms of avoidance behavior, health effects, attitude change, and complaint behavior. One condition of avoidance behavior is the capability of engaging in this behavior. That is, a person can avoid the noise by moving only if he has the means to do so.

It was recognized that reaction could have an effect on certain parts of the model at future points in time. For this reason the model has a number of "feedback loops" shown as dashed lines. For example, avoidance behavior would have the effect of removing the individual from exposure to aircraft noise in the future. Health effects and attitude change were thought to affect a number of the modulator variables, many of which are attitudes. It was also believed that complaint could have a cathartic effect and allow annoyance and anxiety to subside.

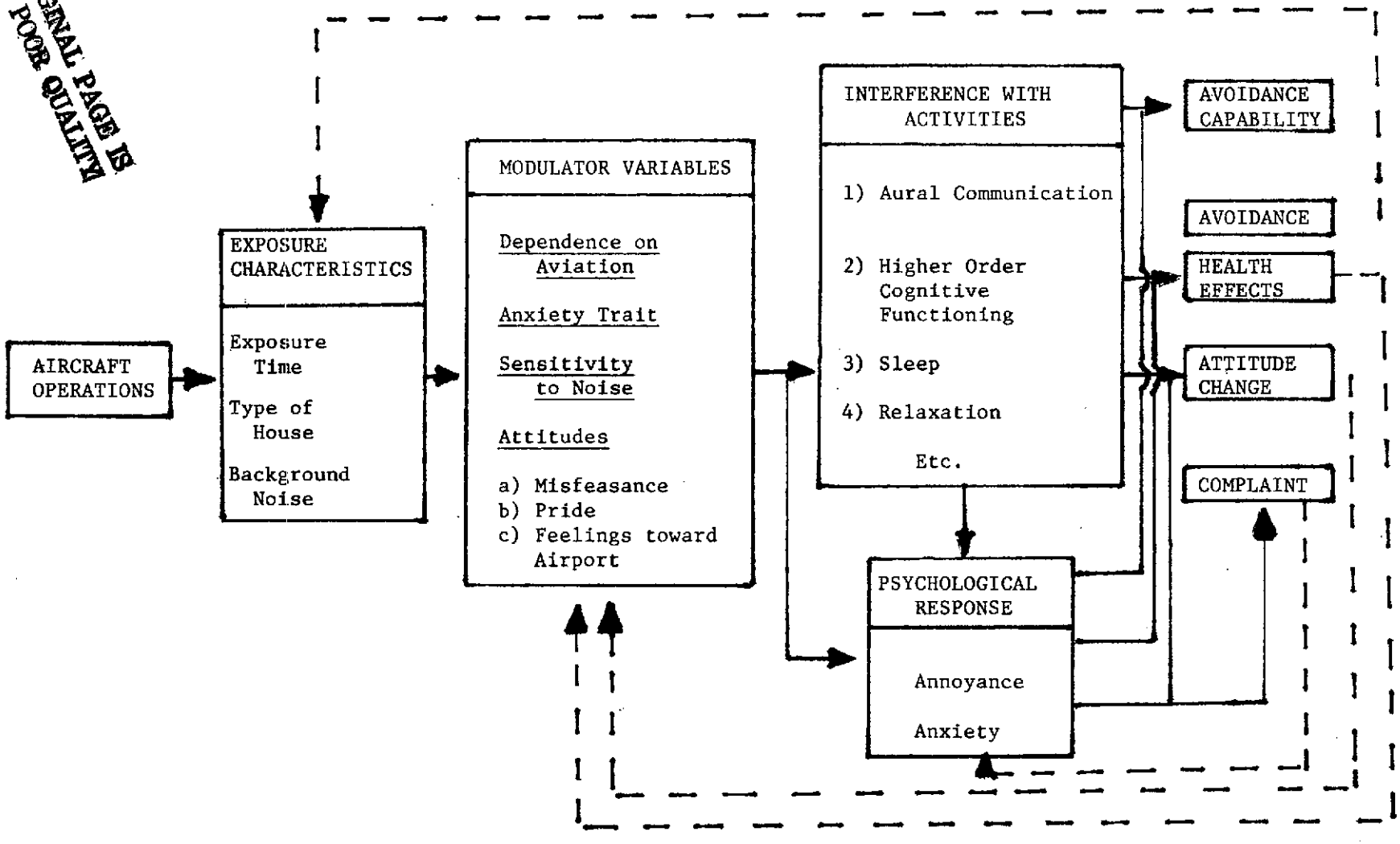

Figure 4-1. Initial Model of Individual Response to Aircraft Noise

This initial model was used to guide the researchers in the development of the questionnaire (discussed in a following section) and in the formulation of the conceptual model. It was recognized that the model needed refinement in order to be more clearly understood and to permit the development of a better research design. A major improvement was the focus on the reduction of stress in the individual. This principle was used to trim and combine elements of the initial model into a simpler, more concise model. The Stress-Reduction model of individual response to aircraft noise was the result.

This model is based upon the premise that individuals will attempt to reduce, avoid, or eliminate stress in their lives. Stress may be defined here as a general state of physical or psychological unrest. Figure 4-2 shows in schematic outline the elements of the model. The model suggests that aircraft noise is perceived within two general contexts: situational and human factors. That is, qualities of the individual's physical, social, and psychological environments are important in his perception of the noise. Only when the perception is "filtered" through the various meanings associated with the noise, through the interruption of activities and/or through evaluations of the aversive nature of the noise per se, is stress produced. The stress is manifested primarily in the development of negative feelings about the noise and in health problems. However, the individual will make every attempt to relieve this stress. Two methods are shown: overt behavior and internal adjustment. Overt behavior may be of various types, including complaint, retreating indoors or out of the neighborhood, and soundproofing the home. Internal adjustment is seen in adaptation,

habituation, rationalization, and resignation to the noise. It is important to note that individuals who do not or cannot take overt action or who do not or will not make internal adjustments will develop more stress since the development of negative feelings and health problems themselves produce stress.

A. Stimulus Factors

The stimulus factors considered important in the model are divided into two general categories: noise and vibration.

1. Noise
    1. Level
    2. Spectral characteristics
        a. General shape
        b. Discrete frequency content
    3. Temporal characteristics
        a. Time of occurrence
        b. Duration
        c. Impulsiveness
        d. Dwell (temporal concentration)
    4. Other characteristics
        a. Rate of change of above
        b. Directionality and movement
2. Vibration
    1. Level
    2. Spectral content
    3. Onset/offset characteristics
    4. Correlation with the aircraft noise
    5. Generation of secondary sounds (rattles, buzzes, etc.)

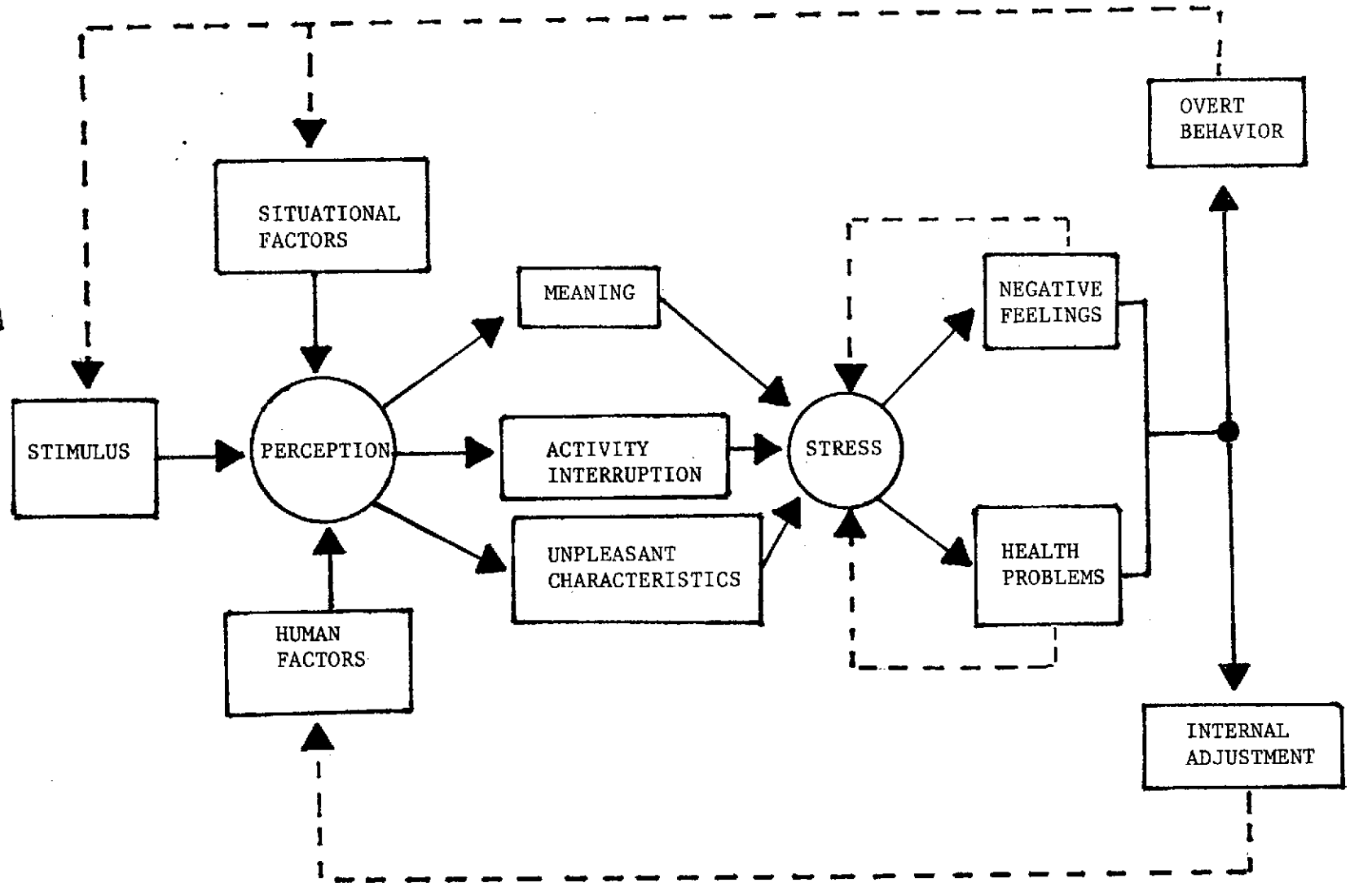

Figure 4-2. Stress-Reduction Model of Individual Reaction to Aircraft Noise

B. Situational Factors

The situational factors include the following: activity engaged in, setting, temporal factors, and other environmental conditions.

1. Activity Engaged In*

   The various activities which may be interrupted by aircraft noise are:

   1. Relaxation (reverie)
   2. Aural communications, whether active or passive, with or without visual cues
   3. Sleep
   4. Higher order cognitive functioning such as concentration, learning, problem solving, or reading
   5. Physical activities

2. Setting

   The settings at times of noise exposure which may influence individual reaction are as follows:

   1. At home or away
   2. With others or alone
   3. Indoors or out

3. Temporal Factors

   The temporal factors which must be taken into consideration are:

   1. Season
   2. Day of week
   3. Time of day

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*See Gunn, et al (ref. 46) for the effects of activity in which subjects are engaged during the noise exposure.

4. Other Environmental Conditions

Other environmental factors which might effect stimulus conditions are as follows:

1. Presence and characteristics of non-aircraft sounds
2. Climatological conditions
   a. Temperature
   b. Relative humidity
   c. Atmospheric pressure
   d. Wind
   e. Precipitation
3. Illumination
4. Esthetics of surroundings, auditory, visual, tactile, and olfactory

C. Human Factors

The human factors which may be influential in determining one's response to aircraft noise are divided into three general categories as follows: psychological factors, biological-physiological factors, and demographic factors.

1. Psychological Factors

There are at least seven psychological factors to be considered:

1. Attitudes
2. Intelligence
3. Traits
4. Needs

5. Self-concept

6. Values

7. State

2. Biological-Physiological Factors

Important biological-physiological factors are:

1. Auditory sensitivity

2. Kinesthetic sensitivity

3. Condition: rested versus fatigued

4. General health

5. State: relaxed versus tense

3. Demographic Factors

Possibly important demographic factors are:

1. Age

2. Sex

3. Occupation

4. Income

5. Education

6. Race

7. Class

8. Owner/Renter

9. Length of residence

10. Previous noise exposure

11. Dependence on aviation

D. Meaning Associated with the Noise

Kerrick et al (ref. 47) found that while noises from a variety of sources were rated equally on the basis of loudness or noisiness, they were not equally acceptable. Gunn, et al (unpublished study conducted at Wallops Station, Virginia) found that aircraft perceived as flying over an individual were rated as more annoying than aircraft perceived as flying off to the side, even at the same PNL. Connor and Patterson (ref. 12) found that "fear" of aircraft crashes was an important determinent of annoyance with aircraft noise. Wilson (ref. 48) found that aircraft noises were more acceptable and less noisy than motor vehicles at the same sound level. This suggests that the meaning associated with the source of the sound may have an important bearing on the degree of annoyance we feel about various sounds.

E. Activity Interruption

In addition to the way we may feel about exposure to unpleasant sounds or the aversive meaning we attach to them, annoyance may result if the noise interferes with an ongoing activity, such as TV viewing, radio listening sleeping, or activities requiring concentration. The extent of activity interruption could be assessed by questions on a social survey or through prediction based on controlled laboratory tests. There is good reason to think that interruption of these activities may contribute heavily to one's overall annoyance with aircraft noise.

F. Unpleasant Characteristics of Aircraft Noise

The range of possible feelings about the characteristics of a sound, per se, run the gamut from very pleasant, such as enjoyable music, to very unpleasant, such as a circular saw cutting sheetmetal. Similarly,

certain aircraft sounds, at some levels, may actually be pleasant to hear, while other sounds may be perceived as neutral or unpleasant. Molino (ref. 49) developed what he calls "an equal aversiveness curve" for various bands of sound. The shape of the curve most closely resembled that of the inverse of the standard A-weighting characteristic. It is suggested that sounds above the threshold of aversiveness are "punishing" to the ear. Since the Molino data confounds aversiveness of the sound, per se, and interruption of concentration (the subjects were learning Russian during the experiment), the contour might be different under the condition of reverie. Clearly, there is a need to determine the psychophysical relationship between noise parameters and pleasantness or unpleasantness for various sounds. If a sound is perceived as being unpleasant to the ear, then continued exposure may lead to the development of stress in the unwilling listener.

G. Reported Feelings

Airport community residents are often polled in order to determine how they feel about aircraft noise, airport operations, the people who are responsible, or the aircraft industry in general. The most commonly asked questions have to do with reported annoyance with aircraft noise. Sometimes people are asked for their overall annoyance, while in other cases they are asked about the annoyance they feel about the interruption of specific activities. In the latter case, the annoyance ratings for the various activities are usually combined in some way to form a single scale of annoyance. Although such a scale is typically well correlated with the single-question self-rating of annoyance (ref. 4), it obviously represents only one particular dimension of annoyance and thus might best be termed "annoyance through disturbance of activities."

Questions are sometimes asked about feelings of "misfeasance" (feelings that those in authority are not doing all they could to alleviate problems). Feelings of "fear of aircraft crashes" are also probed. The scales used to assess the various feelings are many and varied. Validity of the scales is, for the most part, assumed.

H. Health Problems

While the evidence is scanty and sometimes in conflict, certain health-related problems resulting from aircraft noise may be:

1. Permanent hearing loss
2. Gastro-intestinal disorders
3. Increased nervousness
4. Cardio-vascular problems
5. Loss of sleep

Hospital and doctor's records might be helpful in assessing these aircraft noise related health effects.

I. Overt Behavior

Not many substantive studies have been conducted regarding the overt reaction of people to aircraft noise. Some important forms of behavior might be:

1. Moving family out of the noisy area
2. Complaints to authorities
3. Decrease in outdoor activities
4. Decrease in activities involving aural communications
5. Increased time spent out of neighborhood
6. Organizing to reduce the noise

J. Internal Adjustment

The increased stress and the development of negative feelings and health problems represent an imbalance of the individual's normal or preferred state. In an effort to return to the normal state (homeostasis), the individual either takes overt action or makes internal adjustments, both of which serve to reduce the stress.

Four types of internal adjustment are identified:

1. Adaptation
2. Habituation
3. Rationalization
4. Resignation

Thus, the individual may adapt to the noise or become habituated to it. Or, the individual may also rationalize his experience and convince himself that his situation is not so bad after all and that others are much worse off than himself.

K. Feedback Loops

Every action or nonaction of the individual has a consequence. If the individual cannot or will not take overt action to reduce the stress, or if he does not make internal adjustments, then the development of negative feelings and health problems will themselves increase the stress. These relationships are shown in Figure 4-2 by dashed lines from negative feelings and health problems back to stress. They represent positive feedback loops.

However, if the individual does take some overt action or makes an internal adjustment, then the stress will be relieved through an indirect process. Taking direct action has implications for both the stimulus and the

situational factors. For example, through lobbying efforts, the individual may persuade the noise maker to reduce the noise or to change its characteristics so as to make it more tolerable. Or, the individual may change the situation by insulating his home, by spending less time outdoors (thereby decreasing his outdoor exposure time), or by moving out of the noise-impacted area. If the individual makes an internal adjustment, this has implications for the human factors context. For example, the individual, in response to stress, may develop qualities of an "imperturbable" person. Such a person would deny that the noise ever bothered him and, in fact, might report difficulty in even perceiving the noise. These consequences of overt behavior and internal adjustment are represented by dashed lines back to the stimulus and situational factors for the former and back to human factors for the latter. Both are negative feedback loops.

L. The Nature of the "Filter" Variables

As shown in the model diagram, there are no feedback loops to the boxes representing "meaning," "activity interruption," and "unpleasant characteristics." This means only that later elements within the model are not thought to affect these elements. Certainly, events outside the model have an effect. For example, if an aircraft crashes in the near vicinity, the individual may very well associate the next flyover event to a feeling of fear of crash. In a like manner, outside events are thought to produce a certain condition within the individual which tends to "color" his perception of aircraft noise. At any one point in time these conditions work to predispose individuals to react in certain ways. Over time, however, the conditions can change

and the individual's predispositions take on a dynamic character.

M. Hypotheses

A number of specific hypotheses are suggested by the stress-reduction model. These are as follows:

1. Increased stimulus from aircraft operations will result in
   a. increased development of negative feelings about the noise and/or
   b. increased development of health problems.

These results will obtain provided the following elements are held constant:

(1) Situational factors

(2) Human factors

(3) Meaning associated with the noise

(4) Activity interruption

(5) Unpleasant characteristics of the noise, per se

2. The greater the development of negative feelings about the noise
   a. the greater the amount of overt behavior directed toward reducing or eliminating the noise, and/or
   b. the greater the internal adjustment of the individual.

The model thus suggests that once the situational and human factors are "controlled," and once the individual's perceptions are "filtered," then the following typical outcomes would be expected:

1. A reduction in outdoor activities
2. An exodus of noise sensitive individuals from the noise-impacted area (provided there is an opportunity to move)
3. An increase in overt behavior to reduce the noise exposure, e.g., soundproofing

4. An increase in health problems
5. A rise in atypical living habits, e.g., less conversation
6. An increase in positive attitudes toward the noise source for those who make an internal adjustment
7. An increase in indicators of other types of stress, e.g., family arguments

5.0 SOCIAL SURVEY DESIGN

5.1 General Approach

The main objective of the social survey was to document people's reactions to the onset of operations at DFW and the accompanying decrease at Love Field. Since people react to many things in their environment, it was important to isolate the effects of changing aircraft operations from other types of changes, e.g., economic growth, population shifts, and change in background noise. In order to do this a panel design was chosen for sampling purposes. This method, along with appropriate control groups, is the most effective means of assessing change within a specified population (ref. 50).

The general format of the study involved a multi-stage area probability sample design. Within this framework areas are first identified as impacted (present or future) by aircraft noise. Clusters of blocks are then selected on a probability-proportionate-to-size basis. Households are systematically chosen within the cluster of blocks. Finally, a random procedure is used to select one individual from a household to be the respondent.

The study would be in two stages. The first would involve interviewing before any operational changes. The second would take place approximately one year after the first stage.

5.2 Sample Design

Several types of panel designs are available. In this study a version of the Solomon four-group design was chosen in order to control for as many sources of invalidity as possible (ref. 5). Figure 5-1 shows the elements of the four-group design.

TIME A (Before)		TIME B (After)
O_1	X	O_1
O_2		O_2
	X	O_3
		O_4

FIGURE 5-1 FOUR-GROUP PANEL SAMPLE DESIGN

The first group in this design (O_1) consists of respondents who live in impacted (or potentially impacted) areas and who are interviewed both before (Time A) and after (Time B) the change in operations (X). The second group (O_2) consists of respondents who live in areas quite similar to those of group one but who are not impacted by any change in aircraft operations and who are also interviewed at Time A and Time B. Group three (O_3) is composed of impacted respondents, like group one, who are interviewed only after the change. Group four (O_4) is similar to group two.

Group O_1 is a panel of randomly chosen impacted respondents; group O_2 is a panel of randomly chosen control respondents. Group O_3 is a representative cross-sectional sample of impacted respondents; group O_4 is a representative cross-sectional sample of control respondents. The same individuals are interviewed at two points in time for each panel. The cross-sectional samples will each be different from each panel.

Utilization of this design will permit the control of the following sources of invalidity 1) history, i.e., events which may occur which could produce change in reactions; 2) maturation, i.e., learning processes, aging, etc.; 3) testing, i.e., the effect of interviewing itself; 4) instrumentation, e.g., those effects which could be produced by changes in interviewers; 5) regression, i.e., the effects produced by conscious or unconscious selection of extreme groups; 6) selection, i.e., the unintended bias in choosing groups, 7) mortality, i.e., differences produced by the differential dropout of respondents from the panel groups, and 8) various forms of interactions among these factors. For example, the difference in scores between $O_{1A} - O_{1B}$ and $O_{2A} - O_{2B}$ will determine whether or not historical events are important in producing the observed changes. If there is no difference, then history can be ruled out as a cause of any change. Another example would be $O_{1B} - O_3$, which would show the effects of differential mortality in the impact panel of respondents.

5.3 Site Selection

The sample plan takes into account three important considerations: 1) present background noise (which was not expected to change drastically), 2) present aircraft noise, and 3) future aircraft noise. Figure 5-2 shows the various combinations expected. The notation within each cell refers

to the specific combination of categories of each of the three conditions. For example, $A_1B_1C_2$ refers to an area with low background noise and present low aircraft noise but with a medium level of aircraft noise in the future. Thus, all entries above the diagonal refer to areas where the aircraft noise is expected to increase; all entries below it refer to areas expecting a decrease. The diagonals themselves refer to areas not expected to change.

The definitions of the various categories are as follows:

Aircraft Noise Levels:

Low = $< L_{dn}$ 65

Medium = $65 < L_{dn} < 70$

High = $> L_{dn}$ 70

Background Noise Levels:

Low = $< L_{dn}$ 55

Moderate and High = $> L_{dn}$ 55

A tolerance of $\pm$ 1.5 L_{dn} should be noted for each of the above levels.

One should note where the subscripts of B and C are equal, $A_1B_1C_1$ and $A_2B_1C_1$, that this refers to areas from which control samples can be drawn since the present and future aircraft noise exposure will be the same.

The selection of specific survey areas was based upon noise exposure from aircraft and non-aircraft sources, and upon population parameters. Each area was to be reasonably representative of its general area with respect to basic demographic characteristics as determined from the latest census data. Within each general area the various survey areas were to represent as many

Present Background Noise (A), Low (1)

Present Aircraft Noise (B)	Future Aircraft Noise (C) Low (1)	Medium (2)	High (3)
Low (1)	$\underline{A_1B_1C_1}$	$A_1B_1C_2$	$A_1B_1C_3$
Medium (2)	$A_1B_2C_1$	$\underline{A_1B_2C_2}$	$A_1B_2C_3$
High (3)	$A_1B_3C_1$	$A_1B_3C_2$	$\underline{A_1B_3C_3}$

Present Background Noise (A), Medium and High (2)

Present Aircraft Noise (B)	Future Aircraft Noise (C) Low (1)	Medium (2)	High (3)
Low (1)	$\underline{A_2B_1C_1}$	$A_2B_1C_2$	$A_2B_1C_3$
Medium (2)	$A_2B_2C_1$	$\underline{A_2B_2C_2}$	$A_2B_2C_3$
High (3)	$A_2B_3C_1$	$A_2B_3C_2$	$\underline{A_2B_3C_3}$

Figure 5-2.- Combinations of (A) background noise, (B) present aircraft noise, and (C) future aircraft noise.

combinations of noise exposure levels from both aircraft and road traffic as possible. Two further considerations entered into the selection process. One was that the sites around Love Field coincide with areas used in a 1967 study so that comparisons could be made. The other consideration was that no survey area contain an unexpected dominant noise source. This latter requirement was to be met by site examination.

Sampling with respect to noise exposure from aircraft and road traffic was based upon existing NEF or CNR contours for DFW, Love Field, and NAS Dallas, and proximity to major roadways. Survey areas were to be selected such that a single noise monitoring site may be used to characterize the exposure to both types of noise, within certain limits, throughout the area.

Table 5-1 shows the 18 combinations of site selection criteria and cross tabulates this by the various areas available. By examining maps of the areas overlaid with present and future noise contours, it was possible to specify certain locations within each area which matched the selection criteria. For example, areas which could be characterized by low background noise, present aircraft level low, and future aircraft level low ($A_1B_1C_1$) can be found in almost all of the areas (Dallas, Euless, Arlington, Irving, and Grapevine). However, an area characterized by low background noise, present aircraft level medium, and future aircraft level low could be located only around Love Field in Dallas. As Table 5-1 shows, a total of 44 possible survey areas were located and numbered by this procedure. For the various combinations of selection criteria the minimum number of available areas is one while the maximum is five.

The actual selection of sites depended upon the desire to insure representativeness and heterogeniety in both the acoustical and survey samples. That is, we wished to find as many combinations of background noise, present aircraft noise, and future aircraft as possible, and also to interview people from a variety of socioeconomic strata. To accomplish this it was necessary to specify various noise exposure contours in the areas around the airports and also to collect information on the following population parameters:

1. Percent structures with ten or more units
2. Owner-renter ratio
3. Percent black population
4. Housing costs
5. Percent change in total population
6. Percent change in total housing
7. Change in persons per occupied dwelling

These latter data are found in census publications. They also represent the criteria for matching the control areas with the impacted areas.

Specific sites within each of the chosen areas would be selected on the basis of the noise criteria and of how well the site represented the general area while maintaining heterogeneity.

5.4 Sample Selection

For the "before" stage the decision was made to collect no less than 65 interviews for each combination of site selection criteria. The total sample size would then be 1170 (65 x 18). The number 65 was chosen because it was the smallest number which could be used and still maintain some reliability if minimum partitioning was required. Since six of the site selection criteria

TABLE 5-1

COMBINATIONS OF SITE SELECTION CRITERIA

AND AVAILABLE AREAS

Criteria Combination	Area					
	DAL	EU	AR	GP	I	GV
A_1 B_1 C_1	1	13	19		33	39
A_1 B_2 C_1	2					
A_1 B_3 C_1	3					
A_2 B_1 C_1	4	14	20		34	40
A_2 B_2 C_1	5					
A_2 B_3 C_1	6					
A_1 B_1 C_2		15	21	23	35	41
A_1 B_2 C_2	7			24		
A_1 B_3 C_2	8					
A_2 B_1 C_2		16	22	25	36	42
A_2 B_2 C_2	9			26		
A_2 B_3 C_2	10					
A_1 B_1 C_3		17		27	37	43
A_1 B_2 C_3				28		
A_1 B_3 C_3	11			29		
A_2 B_1 C_3		18		30	38	44
A_2 B_2 C_3				31		
A_2 B_3 C_3	12			32		

DAL = Dallas
EU = Euless
AR = Arlington
GP = Grand Prairie
I = Irving
GV = Grapevine

combinations represent control group areas, the control panel would total 390 interviews. The remaining 780 would be the impact panel.

For the "after" stage the panels would be re-interviewed and the two new groups would have their first interviews. Hopefully, attrition in the panels will hold at ten percent or less and will consist essentially of random mortality. The numbers to be interviewed at both stages would be as presented in the following table.

TABLE 5-2

SIZE OF SAMPLE

TIME A (Before)			TIME B (After)	
O_1 (impacted panel)	= 780	X	O_1 (impacted panel)	= 700
O_2 (control panel)	= 390		O_2 (control panel)	= 350
		X	O_3 (impacted cross-section)	= 500
			O_4 (control cross-section)	= 250
Totals	1170			1800

Overall Total = 2970

In order to achieve a final sample of 1170 for stage one, a total of 1250 respondents will be randomly chosen. Since there is equal interest in what happens at Love Field and at DFW, the sample will be divided equally between the two areas.*

*In some areas, such as Irving, the two areas overlap somewhat.

If sample sizes are maintained at about 600 in each general area, then the standard error of the sample parameters will be between one and two percent, which would ensure high reliability in the achieved results.

The selection of respondents proceeds through the selection of clusters of blocks, of particular blocks, of a certain number of households within a block, and, finally, of a particular person within a household. A number of principles are maintained throughout the sampling process:

1. Probability proportionate to size (PPS) sampling (ref. 52:217-253) is used since we are interested in geographically distributed phenomena.
2. In order to achieve representativeness, knowledge of the exact probability of inclusion into the sample for each respondent is mandatory.

The sampling procedure has four stages. At stage one clusters of blocks are selected depending upon how well they meet the site selection criteria discussed earlier. At the second stage a stratified sample of blocks is chosen on a PPS basis. For the third stage a sample of three households from each block is selected. The fourth stage involves the selection of a specified adult from each household.

PPS sampling is used to ensure that each household, and ultimately each respondent, has an equal probability of inclusion in the sample even though blocks of different sizes are within the general site areas. This requirement can be illustrated by examining the formula for the probability of selection of a household in a PPS sample design:

$$\text{PH (Probability of selecting a household)} = \text{Number of blocks selected in the sample} \times \frac{\text{Block size}}{\text{Population size}} \times \frac{\text{Number of households per block}}{\text{Block size}}$$

In summary, the probability of selecting a household is equal to the probability of selecting the block containing the household times the probability of selecting that household within that block.

An example may clarify why each household has an equal probability of inclusion. If we assume that 200 blocks are selected for the sample, that a standard of three households per block is used, and that the total population in these 200 blocks is 60,000, then the probability for selecting a household from a block with 100 households (PH_{100}) is as follows

$$PH_{100} = 200 \times \frac{100}{60000} \times \frac{3}{100} = \frac{1}{100}$$

and the probability for selecting a household from a block with 10 households (PH_{10}) is as follows

$$PH_{10} = 200 \times \frac{10}{60000} \times \frac{3}{10} = \frac{1}{100}$$

By using the block size as a factor in selecting households it is possible to cancel out its effects on individual probabilities.

The method for selecting one adult from a household is derived from Kish (ref. 52:398-401). The basic criterion is to use the known distribution of adults within dwelling units for setting up a table which interviewers can use to select a particular respondent. The table tells the interviewer

which person to interview depending upon the number of adults in the dwelling unit.

There are actually a series of selection tables which the interviewer must use sequentially. Each table gives a slightly different priority to the total number of adults. When the tables are used in proper sequence, the resulting selection of respondents will approximate the distribution of adults in households. An example of a selection table is shown in Table 5-3.

Thus, somewhat over 16 percent of the interviews would use Selection Table 1 and slightly over 8 percent would use Selection Table 2.

In actual practice the various tables would be stamped on cover sheets which are attached to interview schedules and later removed. Figure 5-3 shows a sample cover sheet and the layout of the selection process.

5.5 Tabulation and Analysis

For the first stage "before" study, one major purpose was to characterize the subject population at that point in time in order to establish a baseline against which change could be detected. For this reason, a major part of the analytic effort in this phase was to be simply descriptive. There would be interest in differences between the impacted panel and outside (census) data which would specify the degree of representativeness achieved. There would also be interest in differences between the impacted panel and the control panel. The degree of similarity between the two panels will be evidence of successful matching between the two groups.

TABLE 5-3

EXAMPLE OF SELECTION TABLE

SELECTION TABLE 5

Number of adults in household is:	Interview the adult numbered:
1	1
2	2
3	2
4	3
5	4
6+	4

This table is one of eight tables which are used for interviewing. Table 5-4 shows these combinations and their distributions.

TABLE 5-4

TABLES FOR SELECTING AN ADULT FROM A HOUSEHOLD*

Proportion of total interviews assigned	Table number	Number of adults in household: 1	2	3	4	5	6+
		Select adult number:					
.167	1	1	1	1	1	1	1
.083	2	1	1	1	1	2	2
.083	3	1	1	1	2	2	2
.167	4	1	1	2	2	3	3
.167	5	1	2	2	3	4	4
.083	6	1	2	3	3	4	4
.083	7	1	2	3	4	5	5
.167	8	1	2	3	4	5	6

*From Kish (ref. 52:399)

The first set of tabulations will be a series of marginals consisting of frequencies and percentages for every item in each question. Succeeding tabulations will seek to establish basic characteristics of specific subgroups in the sample. Subgroups will be constructed separately be geographic location, noise exposure (both aircraft and background), ethnicity, median exposure, and other demographic characteristics. These subgroups will be tabulated against specific activities and attitudes. Such activity categories as indoor-outdoor, work-home, maintenance-leisure, escape (including recreation), and commuting will be considered important. The following attitudes are also considered relevant: generalized anxieties, job satisfaction, community satisfaction, evaluations of future change, meanings associated with the noise, and feelings of annoyance.

The primary analysis will not begin until after stage two has been completed. At this point it will be possible to compute a series of difference scores. One basic set would involve the differences between Time A and Time B for both panels. Another basic set would be between each panel and its respective control group at Time B. In this manner, the basic analysis of change would be accomplished with the proper controls.

6.0 ACOUSTICAL DATA REQUIREMENTS AND ACQUISITION PROCEDURES

The need for adequate acoustical data is implicit in any study of reaction to aircraft noise. In past research, the quality of the analysis could invariably have been improved had the noise exposure data been more comprehensive. The earlier studies suffered particularly in two areas. First, the amount of detailed acoustical information covering all sources for a long

	(Do not write in above space)

Interview No. _____

Date _____ Census Tract No. _____

Length of Interview _____ minutes Block No. _____

Dwelling Unit No. _____

R's Name _____

R's Address _____ City _____

R's Telephone No. _____

	Relation to, or connection with HEAD	Sex	Age	Adult Number	Check R	Selection Table
1	HEAD IF HOUSEHOLD					
2						
3						
4						
5						
6						

Figure 5-3.- Sample cover sheet.

period of time was limited. Second, there was a lack of integration of acoustical and sociological variables within a common conceptual framework. The Stress-Reduction model, presented in Section 4.0, provides a structural basis whereby subsequent research in this general area can overcome these deficiencies.

6.1 Primary Stimulus Data

Exposure to aircraft noise of each respondent in the survey must be determined as accurately as possible, since this is the stimulus in the model of individual reaction to aircraft noise. This requires exploration of the level-frequency-time space at length and in great detail, to the extent that, for sounds of aircraft origin, it will be possible to establish the exposure of each individual, at any reasonable point in time or over any period of time, in terms related to any mode of response or human effect. This approach is opposed to the traditional one of constructing a single generalized index (or a few preselected "independent" indices) thought to be related to response. Such a program of data acquisition obviously demands considerable resources for both obtaining and processing the data; however, great advances in the required technology have been made since the last major studies were completed.

In particular, it should be possible to assess the primary stimulus as related to each form of activity disturbance. For instance, the incidence of sleep disturbance is related only to noise parameters for the night hours (except for the small minority of night workers). As another example, the interruption of conversation or other auditory communication indoors is largely

determined by the indoor speech interference levels at the specific times of these activities or, more precisely, by the period of time during which acceptable values of SIL are exceeded. Thus the stimulus input to the stress-reduction model consists of not a single parameter but rather a set of parameters, each of which is related to the meaning, disturbance potential, or unpleasant characteristics of the aircraft sound. It is conceivable that the "effective" input can be expressed as a weighted sum or other combination of these parameters, but such a formulation is admissible only after investigations within the framework of the model have validated the procedure.

Thus the requirements for description of the primary stimulus (aircraft sounds) are extreme in terms of the amount and quality of data. The acoustical measurement resources needed for generation of adequate data are described in a later subsection.

6.2 Secondary Stimulus Data

As noted in Section 2.0, sources other than aircraft have been accorded either minor consideration or none at all in previous studies of reaction to aircraft noise. Where other sound sources have been included, they have usually been treated in an omnibus category called "background noise." In most surveys, this is more or less synonymous with "road vehicle noise," since it is ubiquitous and tends to establish the ambient levels in most populated areas. While non-aircraft noise is not included in the stimulus for the Stress-reduction model (as that model deals with response specifically to aircraft noise), more detailed consideration of secondary noise is warranted because it may provide important inputs at the "factors" stage of the model. On one hand, the extraneous or background noise is one

element among the "situational factors." This noise may mask all or part of the aircraft sounds present, thus inhibiting perception of the latter. Also, it may alter the individual's situational context through avoidance behavior which can be explained via a parallel model of similar structure.

A second path of influence of non-aircraft noise is the "human factors" component of the stress-reduction model. It is known that human reaction to noise is source-specific. For example, trucks which make as much noise as aircraft, or automobiles which make as much noise as trucks, are not tolerated. Thus, as suggested in the preceding paragraph, one could postulate different response models for various sources, operative for an individual person. Obviously, however, such models must be far from independent for an integral personality and, in fact, must be congruent at the "stress" stage. As an example of an interaction involving a secondary noise source, suppose a person works in a very noisy environment during the day (but not so noisy as to cause a temporary hearing threshold shift). If the occupational situation per se has generated a stressed condition and perhaps incipient health difficulties, then this individual may be far more aversive to any aircraft noise in his off hours at home than would be another person.

Assessment of the effects of secondary sound stimuli requires adequate definition of the acoustical characteristics of each. Outdoor noise can be evaluated as part of the aircraft noise measurement effort. Indoor sources and those not encountered when at home must be defined either by special adjunct surveys or by appropriate interview questions.

6.3 Data Requirements

As stated previously, the acoustical environment of each respondent must be determined historically in the level, frequency, and time domains. In addition, it is necessary to obtain information regarding noise sources.

Complete specification of level, whether sound pressure level or weighted sound level, may require a wide dynamic range. Ideally, this should span from the lowest steady level encountered, represented perhaps by the 90th percentile (L_{90}), to the highest peak, most likely due to an aircraft event. Typical values encountered in the field indicate that a total range of 100 dB should be sufficient, provided some consideration of ambient conditions is reflected in the absolute setting of this range. Instrumentation with only a 60 dB or 75 dB range, however, would in many cases be inadequate without overlapping of duplicate equipment, causing increased field expense as well as potential technical difficulties in the overlap region.

For accurate definition of a sound source, frequency analysis in critical bands is necessary. This requirement is usually compromised slightly in favor of third octave bands, which are standardized and readily available in instrumentation form. For specific sources of known spectral character, however, such detail is not needed in long-term monitoring. Instead, weighted levels using the standard "A" or "D" weighting characteristic can be used, as numerous studies have shown that these are well correlated with more complex level parameters computed from third octave band data, such as effective perceived noise levels (EPNL). Thus if the source and weighted level are known, other measures can be obtained by addition of a constant, within limits of accuracy comparable to those of psychophysical laboratory experiments.

The acoustical measurement resources not devoted to frequency analysis may well be dedicated to documentation of noise events in the temporal domain, as this is currently the greatest area of uncertainty in connection with response. Since it is not known whether or not human responses are connected with some integrated or cumulative measure of noise (as most earlier models imply), detailed chronological data are required. As a minimum, specification of the noise level statistics by source for the different periods of the day, day of the week, and time of year over a period of several months is needed. In addition, various cumulative measures should be computed for longer periods. In order to provide accurate data when rare events of high level are expected (as may be the case with aircraft noise) a high rate of sampling, say once per second, is required.

From the standpoint of establishing the detailed noise exposure of each respondent through the course of daily life, the only direct procedure possible would be equipping the individual with personal instrumentation running continuously for weeks or months. The logistics of such a procedure for an adequate social survey sample, even assuming that a representative sample would cooperate, are completely impractical. It is necessary to use auxiliary information along with typical noise data to reconstruct the exposure patterns. The sources of the required information are:

(1) actual measurements in the field

(2) logs of events over the time period in question (aircraft operations, road traffic counts, etc.)

(3) data from other sources regarding noise environments in various work and recreational situations and in the home

(4) questionnaire information regarding respondent living patterns as these affect exposure to various noise environments

(5) determination of house attenuation from certain observed features

With the above battery of information it would be feasible, for example, to determine a respondent's average or worst-case exposure to aircraft noise in the evenings on weekends, or even on a specific weekend, if this is a time when a certain disturbance occurs.

The indirect or reconstructive approach described above requires that available noise measurement/monitoring resources be used to explore the spatial distribution of outdoor noise in order to define the exposure of a number of respondents in close geographical proximity. The acoustical sampling plan calls for division of the sample area into zones in which the expected variation in level of the two dominant sources, aircraft and road traffic, is within 5 dB. Each such zone then receives a semipermanent monitoring station. The homogeneity of level within the zone is checked by short-term monitoring at several auxiliary points within the zone boundaries. As the acoustical and social sampling requirements are in relative opposition, it may be necessary to broaden the level variation criterion or to utilize extrapolation techniques in order to acquire an adequate survey sample in some areas.

6.4 Procedures

Acoustical data for the DFW program would be obtained via field measurements using automatic continuous portable monitor units. These instruments sample A-weighted sound level once per second and record the values on magnetic tape cassettes for later processing; they will collect over 48 hours of data without attention and have a dynamic range of 100 dB. The exact placement and deployment schedule of these monitors is dependent

upon the final sample and program schedule. Secondary instrumentation such as limited-range sound level chart recorders and hand-held sound level meters would be used for short-term monitoring and spot-checking.

The primary monitoring units would operate out of doors within each sample zone, to the extent possible, for both weekdays and weekends, to sample both background (traffic) noise and aircraft noise during known operating modes of the airport. In later phases of the study, the same areas would be resampled to determine the extent of any seasonal or other changes.

Concurrent with, and for as long as possible prior to, field measurements, a detailed log would be maintained at the airport, showing type of aircraft, time and date, runway use, and flight path for each aircraft operation. This could be correlated with the field measurements in affected community areas in terms of the general "operating mode" of the airport, for reconstruction of exposure at all times during the logged period.

Discrimination between aircraft and other noise is normally afforded by examination of the level-versus-time history of the monitored data. In some cases it might be necessary to compare the operations log with the sound level history in order to confirm an identification of aircraft noise.

Finally, the interview form would contain questions for each respondent regarding his surroundings at different times, and the noise sources present or heard in each case. From this information, a description of the person's exposure to secondary-source noise could be developed.

7.0 DEVELOPMENT OF COMMUNITY LIFESTYLE QUESTIONNAIRE

7.1 Purposes of Questionnaire

The questionnaire was designed to assess changes in living habits and attitudes among residents of neighborhoods located near airports in response to changes in airports, in particular changes in aircraft operations. These changes could involve the opening of a new airport, the closing of an existing airport, or an increase or decrease in operations at an airport.

This survey instrument was developed for use in the Dallas-Ft. Worth area where a new airport is being opened and operations at Love field are being reduced. Since the questionnaire was designed around this area some changes would be required before it could be used in other cities. However, the basic approach can be applied in any area where a change in aircraft operations occurs.

The questionnaire is to be used to test a number of hypotheses formulated in the model discussed in Section 4. In order to test these hypotheses, the questionnaire must be administered several times over a period of several years to get data about changes which occur over time. Because the level of participation in outdoor activities is one behavior expected to change, the questionnaire should be administered during warm seasons when outdoor activities typically occur. In very hot climates, such as that of the Dallas-Ft. Worth area, the best times for administration are late spring or early fall when residents are less likely to be indoors in air conditioned buildings.

7.2 The Indirect Approach

This questionnaire uses an indirect approach in which the questions are designed so that it is not apparent that their purpose is to study reactions

to aircraft operations. This approach is used to avoid the bias introduced when respondents know that an airport study is being conducted and can express stronger reactions than they may actually feel in an effort to affect policy decisions about aircraft operations. This approach also allows concerns about aircraft noise and operations to be put in perspective by comparing reactions to aircraft noise with reactions to other problems and events in the respondent's life. If a person is asked directly how he feels about aircraft noise or the opening of a new airport he may state that it bothers him--yet, this problem may be minor to him in comparison with other things which concern him.

7.3 Dallas Developmental Interviews

The Questionnaire was developed during September and October, 1973. Interviews with groups of people in the Dallas-Ft. Worth area were held early in September to get information from which a questionnaire could be written. Interviews were conducted with people of different ages, economic levels and lifestyles in groups of four to eight people. Each lasted one hour to one and one half hours and was tape recorded (with the consent of the participants). Participants included:

Male and female adolescents, aged 16-18, from Irving, Texas.

Male and female middle class young adults with college education.

Female waitresses from the staff of an Irving motel.

Young to middle aged male and female residents from Fort Worth, Texas.

Housewives, active in civic affairs, from a civic organization in Irving, Texas.

A young Chicano housewife (interviewed individually).

The participants were told that the purpose of the interviews was to get information about lifestyles from which to develop a questionnaire that would study how living habits are changing in response to technology.

Interviews were generally unstructured, although the interviewer did some direct questioning to keep the discussions from straying too far from subjects of interest.

7.4 Results of Dallas Interviews

In each of the group interviews, the Dallas-Fort Worth airport was spontaneously mentioned by the participants at some point without the encouragement of the interviewer. The interviewer then asked direct questions about participants attitudes toward the airport. Since the interviewer also asked direct questions about other topics, the questions about the airport could be introduced into the conversation in a natural way.

Almost all of the participants in the groups had very positive attitudes toward the opening of the airport. Among the advantages mentioned were that the airport would increase the number of jobs, that it was causing the price of real estate in the area to increase, and that it would being in foreign visitors including the Japanese. Many participants mentioned pride in the fact that it was the biggest airport in the United States. Only one participant in one of the groups, who had previously lived in other large cities, expressed strongly negative feelings toward the airport.

Some participants did express concern that the new airport would cause traffic congestion, particularly in the area around Texas Stadium during periods when games were being held there.

A number of other topics of concern were discussed in these interviews. Some of the more frequently mentioned were the general growth and expansion in the area, changes in land use, increased traffic congestion and traffic problems, racial concerns including the movement of black families into predominantly white neighborhoods, and the need for more recreation facilities for teenagers.

In discussing living habits, participants in these interviews indicated that they spent much of their time indoors in the summers to avoid the summer heat and mosquitoes. The spring and fall months seemed to be the time of maximum participation in outdoor activities.

7.5 Preparation of the Questionnaire

The first draft of the questionnaire was written as soon as the Dallas developmental interviews were completed. In this version there were no specific questions about aircraft noise. The questionnaire included a number of questions about daily activities, many of them taken from a questionnaire used by the University of Michigan's Survey Research Center in a study of Americans' use of time. Also included were attitude questions which probed respondents' feelings about living in the area and a standardized self-administered anxiety questionnaire which assessed both state and trait anxiety (ref. 53). State anxiety is a transitory level of anxiety which may vary in intensity depending on the situation while trait anxiety refers to an individual's characteristic level of anxiety.

The first pre-test of the questionnaire was carried out in Dallas with 10 respondents at the end of September. After the results were examined, many of the questions that had been taken from the University of Michigan

questionnaire were modified to make them more specifically applicable to the purposes of the survey. The most troublesome part of the questionnaire was the "daily activities section"--a section which asked about the respondent's activities in the past 24 hours, and the amount of time spent on each activity. This section was regarded as important since it was felt that a verbatim accounting of activities would provide more accurate information about the amount of time the respondent was actually spending indoors and outdoors than would be obtained from the more general questions about activities. Because respondents in the pre-test had difficulty filling in this section, and because it took too much time, the format and instructions were simplified.

The second draft was pre-tested in Dallas in mid-October (again with 10 respondents). This pre-test showed that the length of the questionnaire would have to be reduced, still more since most of the interviews were running well over one hour. One hour was regarded as the maximum acceptable length for an interview, with 45 to 50 minutes more desirable. In addition, some respondents in the second pre-test objected to filling in the standardized anxiety scale. Therefore, the anxiety scale was dropped from the questionnaire, serving also to reduce its length. The "time wheel" or daily activities section was again modified and several questions that provided only marginal information were dropped.

Pre-tests of this version of the questionnaire (which took place in late October) showed that it could be administered in less than one hour.

After this pre-test some further changes were made in the "daily activities schedule" so that respondents were asked only about number of hours spent (a) on indoor versus outdoor activities, (b) in the neighborhood versus out of the neighborhood, and (c) on and off the job. They were asked to provide this information about a typical weekday, a typical Saturday and a typical Sunday.

Additional direct questions concerning the airport were also added. These questions were concealed by asking similar questions about three other topics which had been mentioned frequently during the Dallas developmental interviews - highway construction, new industry, and Texas Stadium.

A third pre-test was conducted at the end of October to try out these changes. This pre-test showed that the more direct questions about the airport could be asked without identifying the survey as an "airport study", so long as other topics were included as well.

Unfortunately, the interviewer had difficulty understanding the instructions about the "daily activities schedule" and did not administer it correctly. Although further work could perhaps improve this section, it is recommended that if the questionnaire is administered in its current form, that the "activities schedule" used in the second version of the questionnaire be administered. This version does have the disadvantage of not asking about typical schedules, but it would probably provide more accurate data since the respondent is asked only about activities on the previous day. He does not have to decide what a typical day is and then try to remember his activities for that day. If the latter version is administered, a question could be added to ask if the previous day was typical.

7.6 Questionnaire as it Relates to the Model

The questionnaire was designed to provide data which can be used to test hypotheses provided by the model discussed in Section 4.

This section discusses some of the variables to illustrate more specifically how data from questions will be related to hypotheses implied by the model.

Dependence on Aviation

Q. 38. Does anyone living in this household work for: railroads? automobile manufacturer, car sales, or car service? bus company? airlines or airport?

39. How about (other) relatives, do any of them work for: railroads? automobile manufacturer, car sales, or car service? bus company? airlines or airport?

40. How would you go if you had to take a trip of more than 500 miles? train, car, bus, plane

Some research has shown that a resident's feelings toward an airport in the vicinity is affected by the person's dependence on the airport with the people who perceive benefits from the airport having more positive feelings toward it, (ref. 1 and 54).

Questions 38, 39, and 40 will be used to determine dependence on the airport. In the pre-tests none of the respondents had household members working for the airlines; one respondent had a relative working for them. However, two respondents mentioned on other parts of the questionnaire that they manufactured aircraft parts or had contracts with aircraft companies. Question 38 and 39 have been revised to include a choice for "aircraft assembly or aircraft parts manufacturer".

On the 2nd and 3rd pre-tests combined, about one-fourth of the respondents stated that on a trip of 500 or more miles they would go by plane; the other three fourths would go by car.

Anxiety

Q. 18. Are there any things about living around here that sometimes make you apprehensive?

Q. 71f. How concerned or worried about health have you been in the last month?

Not concerned at all		Very concerned
0	5	10

Anxiety is postulated as both a modulator variable and a psychological response. Originally, a standardized anxiety scale was included in the questionnaire to determine both trait (characteristic) anxiety and state (in response to the situation) anxiety. This scale was dropped after some respondents in the pre-tests objected to filling it in. The above questions attempt to get some data about anxiety. Question 18 is expected to provide data about fear reactions to aircraft. Several studies (ref. 12 and 1) have postulated that "fear" is a significant component of some individuals' objection to aircraft. Since these studies used direct questionning techniques, however, it is difficult to determine how strong this fear is in comparison with other fears. Question 18 will obtain information about the percentages of respondents who fear aircraft strongly enough to mention it instead of other fears when responding to the question. In the pre-tests, two respondents have mentioned the airport as an item which makes them apprehensive. One respondent specifically mentioned a fear of planes crashing.

Sensitivity to Noise

The problem assessment technique described on page 12 will be used to determine sensitivity to noise. It is hypothesized that those individuals who rank noise items high on the scale are indicating a sensitivity to noise.

Misfeasance

Q. 20. In general, do you feel the local government is looking out for your interests?

21. What about the national government?

Misfeasance refers to the belief that responsible government officials are not doing anything about people's problems. These questions will pick up general attitudes toward the government. In the pre-tests, most respondents expressed strongly negative attitudes toward the national government and more positive attitudes toward local government.

Pride

Q. 4. People often mention to me several big public construction programs that are new in this area like the Texas Stadium, the highway construction program, the new airport and new industry.

Q. 9. What about the new airport--How is it good for the people or for the area here, do you think?

Q. 16. Which of those things do you think will be good?
16a. Why is that?

From these questions a technique such as content analysis will be used to discern feelings of pride in the airport.

Feelings Toward Airport

Q. 9. What about the new airport--How is it good for the people or for the area here, do you think? (Draft 3 of questionnaire)

Responses	Number of Times Mentioned	
More people coming in/more growth/ increases in real estate	5	
More convenient/accessible	4	
Will bring in money/more business/ lower unemployment	3	
Can handle more air traffic/has more facilities/will save travellers time	3	
I think we can do without it	1	
Total	16*	N-10

*Some respondents expressed more than one idea.

Q. 10. How is it bad?

Will bring in more traffic/congestion	5	
Will bring more people/growth is bad	2	
Nothing bad about it/exciting to have it	2	
Noise will be terrible	1	
Parking problems	1	
Not enough planning in picking site	1	
Will bring crime, prostitution, drugs	1	
I am afraid of airplanes	1	
Total	14	N-10

These questions, which appeared only in the third pre-test, were the only direct questions about the airport. Similar questions were asked about new industry, highway construction and Texas Stadium so that respondent's attention would not be focused solely on the airport. The ambivalent attitude revealed toward the growth associated with the airport (5 respondents regarded it as good and 2 respondents as bad) were reflected in other questions as well. The majority of pre-test respondents seem to view growth as a favorable event, but some questioned the value of it. These questions will be useful for assessing the changes in this attitude which occur over time.

Only one respondent mentioned the possibility of noise problems associated with the airport. Both in the developmental interviews and in other pre-tests, there was very little mention of this topic. Although information obtained in the first administration of the questionnaire cannot be regarded as "baseline" in the sense that respondents ARE already aware that the airport exists, it will provide a baseline on the level of awareness of the noise problem before the airport becomes operational which can be compared with results after the airport has been operational for a while.

Q. 3. During the time you have lived here, what do you think is the most important thing that has happened to this area?

Q. 13. In general, what kinds of things to you like most about living in this area?

Q. 14. And what kinds of things do you like least about living in this area?

Q. 15. What do you think the future will be like here? What kind of changes do you think will come?

Q. 16. Which of those things do you think will be good?
16a. Why is that?

Q. 17. Do you think any of the changes you mentioned will have any bad effects?
17a. Which? 17b. Why do you think so?

These questions allow respondents to express feelings about the airport if it is an important topic on their minds. Eleven of the thirty respondents in three pre-tests listed the new airport as the most important thing that had happened in the area since they had lived there. Five of the thirty respondents said that the airport was the thing that they liked least about the area. Three people (of the thirty) mentioned the airport as a change that will be bad while two people included it among the changes they feel it will be good.

Problem Assessment

An advantage of the indirect questioning technique is that it allows comparisons to be made between the topic under study and a variety of other problems or issues. Question 55 asks the respondent to sort a number of problems (each listed individually on a 3x5 card) into three categories -- those problems which concern him or his family a lot, those which are of some concern to him and those which are of little or no concern. He then is asked to rank the problems of most concern to him in order of importance. Three of the 24 problems presented to the respondent have to do directly with noise ("aircraft noise", "noise from cars or train near home" and "noisy neighborhood").

Q. 55. I am going to give you some cards which contain things that some people consider to be problems....Separate these cards into three piles - those problems that affect your life or your family's life very much or concern you a lot, those problems that have some effect on your life or your family's life or concern you some, and those problems that have little or no direct effect on your life and are of no concern to you. Then take the cards that have problems which affect your life very much. Look through them, and put them in order of which problems have the most effect on your life.

- Water pollution
- Taxes (local, state, national)
- Busing of school children
- Air pollution
- Inflation
- Unemployment
- Lack of police protection
- Aircraft noise
- Need for better educational facilities/programs
- Government waste
- Government corruption
- Noise from cars or trains near home
- Energy Crisis (shortages of fuel, energy)
- Crime
- Neighborhood problems
- Drug use
- Cost of medical care
- Care of aged
- Noisy neighborhood
- Rundown conditions downtown
- Traffic congestion
- Police treatment of citizens
- Food prices
- Neighborhood children

Results from Second and Third Pre-Tests to Noise Items in Problem Assessment Section

	Combined Results (n=20)
Aircraft Noise	No. of Responses
Affects me a lot	5
Affects me some	8
Affects me little	7
Noise from Cars or Train Near Home	
Affects me a lot	2
Affects me some	3
Affects me little	15
Noisy Neighborhood	
Affects me a lot	1
Affects me some	3
Affects me little	16

In the pre-tests the noise items were not chosen as being of great concern by most respondents, although the item about aircraft noise was more often chosen as having at least some effect than were the items about other types of noise. This question will allow the subject of aircraft noise to be related in terms of annoyance with other types of noise and will also indicate the relative importance of aircraft noise to the respondent in comparison with many other subjects of concern. The pre-test indicates that the current list is sufficiently comprehensive. Respondents were asked if there were other items of concern not on the list. Only one additional item was mentioned.

Neighborhood satisfaction

Q. 13. In general, what kinds of things do you like most about living in this area?

Q. 14. And what kinds of things do you like least about living in this area?

Q. 17. Are there any things about living around here that sometimes make you apprehensive?

These questions in addition to allowing respondents to express feelings about the airport, will also be used to provide a measure of neighborhood satisfaction and change in neighborhood satisfaction over time.

Optimism/Pessimism

Q. 15. What do you think the future will be like here? What kind of changes do you think will come?

Q. 16. Which of those things do you think will be good?

Q. 17. Do you think any of the changes you mentioned will have any bad effects?

These questions will differentiate respondents with a positive, optimist view of the future from those with a more negative pessimist view. These data can be correlated with feelings about the airport/airport noise to determine if there is a relationship, either in basic outlook or in change over time.

Attachment to Neighborhood

Q. 1. How long have you lived in the Dallas-Ft. Worth area?

Q. 2. And how long have you lived in this house (apt.)?

Q. 19. Have you ever thought about leaving this neighborhood?
19a. If yes, why?
19b. If no, what would make you consider leaving this neighborhood?

Q. 63. Do you own your home here, rent, or what?

These questions measure the strength of a person's attachment to his neighborhood -- a factor which is expected to affect his willingness to leave the neighborhood to avoid aircraft noise.

Experience with noise

Q. 29. On a typical work day, about how many hours (or minutes) would you say you spend working with machines, tools, or other equipment (for example, typewriter, keypunch machines, jack hammer, lathe, hammer, vacuum cleaner)?

Q. 29a. What type of equipment is this usually?

These questions measure the extent to which the respondent must cope with other kinds of noise in his environment in addition to aircraft noise. In the third pre-test, the extent to which respondents were exposed to these kinds of noise ranged from 30 minutes to 9 hours per day. Types of noisy equipment to which respondents were exposed included milling machine, dental equipment, sewing machines, vacuum cleaners, typewriters, and various work-shop tools.

Scope of Reference

Scope of reference refers to the "screening" of noises and is related to noise sensitivity. It will be tested by the problem assessment technique already discussed.

EXPOSURE CHARACTERISTICS

Background Noise/Type of Dwelling

Q. 76. Type of Dwelling

One-family house, except farmhouse
Two-family house, except farmhouse

Apartment house, 10 families or less
Apartment house, 11-20 families
Apartment house, 21 families or more
Farm house
Temporary housing, trailer, etc.
Dormitory, barracks
Hotel
Other (specify)
IF APARTMENT: Which Floor?_____is that the top floor?_____

76a. Number of stories in dwelling

One story Two stories More than two stories

76b. Type of construction

Brick/stone Frame Other (specify)

These questions provide information about the type of building the respondent lives in, type of construction and the influence of noise penetration.

Exposure to Aircraft Noise

Q. 26. What hours do you usually work each day?

Q. 26a. Do you work the same hours all the time or do your working hours sometimes change (for example, do you work different shifts or have flexible hours)?

Q. 27. Thinking of all the work you do for your jobs (including work you bring home, overtime, or second jobs), how many hours did you put in during your last complete week of work?

Q. 32. We are interested in the chores that have to get done around the house like preparing meals, cleaning house, washing dishes, or washing clothes.

Q. 32a. In the last 7 days, about how many hours did you spend doing housework not including the time you spent caring for children?

Q. 32b. And, about how many hours did your spouse spend?

Q. 33. We are also interested in the chores that have to be done around your place, like mowing the lawn, caring for animals, fixing or painting buildings, washing cars, and so forth.

Q. 33a. In the last 7 days, about how many hours did you spend on outdoor chores.

Q. 33b. About how many hours did your spouse spend?

Q. 33c. About how much time do you usually have available on a typical weekend for recreation or leisure activities?

Q.34/35. Listing of a number of indoor and outdoor activities. These questions ask how many times the respondent has done each of these activities in the last week/month. (Full list presented on page 19).

Q. 44. Obtains data about amount of time respondent spends indoors and outdoors on a typical weekday, Saturday and Sunday.

Q. 65. Is this your own private yard, or do you share it with some other family?

Q. 65a. Is your yard large enough to have a get-together?

Q. 68. About how far is it from your house here to the main place where you work?

Q. 69. How long does it usually take you to get to work from here, when you don't make any special stops?

Q. 70. How do you usually get there?

A number of questions will be used to determine the extent of time to which the respondent is exposed to noise. By knowing how long a person is away at work, where he works and the amount of time he typically spends indoors versus outdoors it will be possible to estimate the amount of time the respondent is exposed to noise from the airport.

Hearing Level

Q. 71c. Do you know if you have any hearing loss?

This question was to be used to determine the relationship between hearing loss and extent of annoyance.

INTERFERENCE WITH ACTIVITIES

Aural Communications, Relaxation, Visitation, Physical Activities

Q. 34. Here is a list of activities which people sometimes do. For each of these activities I would like you to tell me: First if you ever do it and second, if so, how many times you did it in the last 7 days. Since some of these things are seasonal activities you may not have done them recently but they are on the list since this questionnaire is given at various times in the year.

ACTIVITY	DO YOU EVER DO IT?	HOW MANY TIMES IN THE LAST 7 DAYS?
•Active outdoor sports or exercises in your own yard of neighborhood		
•Playing active outdoor sports away from your neighborhood		
•Having out of town or overnight friends or relatives in to visit in home		
•Visiting with neighbors, relatives, or friends in your home or neighborhood		
•Visiting friends, relatives outside of your neighborhood.		
•Talking on the telephone at home		
•Swimming in a pool in your neighborhood or at your home		
•Swimming away from your neighborhood		
•Exercising or weight lifting in your home		
•Playing indoor games like cards, checkers, etc. in your home		
•Practicing or playing a musical instrument at home		

•Watching TV

•Reading at home

•Listening to radio at home

•Listening to stereo or tape recorder at home

•Sitting and relaxing outside or near your home

•Sitting and relaxing in your home (not counted above)

Q. 35. Now I have some more activities. I want to ask you the same kinds of questions as before, except this time, I'll ask how many times you did each of these things during the last 30 days instead of the last 7.

ACTIVITY	DO YOU EVER DO IT?	HOW MANY TIMES DID YOU DO IT IN LAST 30 DAYS
•Picnics, barbeques or parties in your neighborhood		
•Picnics away from your neighborhood		
•Pleasure drives		
•Going to watch outdoor sports		
•Going to watch indoor sports		
•Camping, hiking, fishing, hunting, boating		
•Flying small planes		
•Attending events at Texas Stadium		
•Going to drive-in movies		
•Shopping (except for groceries)		
•Movies in indoor theater		
•Club meetings, activities		

•Playing active sports indoors; basketball, bowling, ice skating

•Nightclubs, bars

•Church or church activities

•Museums, indoor exhibits, fairs and bazaars

•Outdoor concerts, fairs, garage sales, flea markets

•Weekend trips

It is hypothesized that there will be changes over time in many of the activities asked about in Question 34/35. Respondents are expected to spend less time outdoors, and less time in the community. Although these questions will not detect small changes, they are expected to reveal whether major changes in daily activities occur.

Higher-order cognitive functioning

Q. 25. Do you take any work home with you?

25a. If yes, about how many hours a week do you spend working at home?

25b. What kind of work do you bring home?

25c. Would you say the work you bring home is work that takes: a lot of concentration, some concentration, little concentration.

Q. 30. About how many hours (or minutes) do you usually spend on work which takes a lot of thinking?

30a. What kind of work is that?

Q. 60. Are you currently attending school or taking a correspondence course?

60a. About how many hours a week do you spend studying either at home or in the neighborhood?

60b. How many hours studying outside the neighborhood?

Q. 34/35 Lists of activities (full list presented on page 19).

This question will be used to test the hypothesis that the amount of time spent on activities which require higher-order cognitive functioning will lessen in areas of increased aircraft noise.

Sleep

Q. 53. Would you say that you: usually fall asleep without difficulty sometimes have trouble getting sleep, almost always have trouble getting to sleep?

53a. Do you usually sleep through the night without waking up?

53b. If no, why is that?

This question will detect whether sleep disturbances increase in areas of higher noise level.

PSYCHOLOGICAL RESPONSE

Annoyance with A/C operations

Q. 53. This question asks respondents to assess a number of problems including aircraft noise in terms of whether each problem is of much, some or little concern to the respondent or his family.

It is hypothesized that increased annoyance with aircraft noise will be expressed by attributing greater importance to aircraft noise as a problem.

Anxiety/Satisfaction with Environment/Optimism-Pessimism

The variables "anxiety", "satisfaction with the environment" and "optimism-pessimism" which have already been discussed as modulator variables

are also assumed to be forms of psychological response. The same questions will be used to test hypotheses concerning psychological responses as were discussed in the section about modulator variables.

AVOIDANCE CAPABILITY

SES-Income, Education, Occupation, Demographic

Q. 22. What is your occupation?

Q. 22a. What are the main things that you do on that job?

Q. 56. Sex

Q. 56a. Race

Q. 61. What kind of work does the head of household do? What kind of business is that?

Q. 61a. What is his date of birth?

Q. 62. Are there any other adults in this household 19 years of age or older?

Q. 62a. And their dates of birth?

Q. 62b. Are any of these people employed?

Q. 62c. How many are employed?

Q. 63. Do you own your home here, rent, or what?

Q. 63a. (IF OWN) if you were to sell your home now, about how much do you think it would sell for?

Q. 63b. (IF RENT) About how much does an apartment like this rent for?

Q. 72. How many years of school did you complete?

Q. 72a. Did you attend college?

Q. 72b. Did you receive a degree?

Q. 72c. What degrees?

Q. 73. What is your date of birth?

Q. 75. About what do you think your total income will be this year before deductions for yourself and other members of the family.

Q. 76. Type of dwelling.

The hypotheses to be tested by these questions is that ability to avoid aircraft noise (by moving or leaving the community more often) is related to socio-economic level.

Job Satisfaction

Q. 31. All things considered, how satisfied would you say you are with kind of work you do? Would you say you are completely satisfied, pretty satisfied, not very satisfied, or not at all satisfied?

Q. 31a. How about the physical surroundings where you work? Would you say you are: completely satisfied, pretty satisfied, not very satisfied, not at all satisfied?

Q. 31b. (If not satisfied) Why is that?

These questions will determine level of job satisfaction which may be inversely related to willingness to leave the area to avoid noise.

Stage of life cycle

Q. 23. Interviewer: Check one: Employed in some regular, paid job at least 10 hours per week, housewife, retired, student, disabled, other.

Q. 58. Marital status

Q. 59. Number and ages of children

Q. 63. Own home or rent?

At some stages of life people have much greater mobility than at others which will affect the degree to which they will be able to exhibit avoidance behavior. For example, a disabled person or a housewife with a number of children may not be able to leave the community as often as desired.

Personal mobility

Q. 33c. About how much time do you usually have available on a typical weekend for recreation or leisure activities?

Q. 63. Do you own your house here, rent, or what?

Q. 66. Counting everyone in this household, how many cars belong to all of you?

Q. 67. About how many miles are your cars driven each week (not including mileage of personal car when it is used for business purposes)?

These questions will provide a measure of the respondent's willingness and capabilities for leaving the community to avoid aircraft noise.

Masking Capability

Q. 41. Was the radio on at all in the last 24 hours?

Q. 42. Was the TV set on any in the last 24 hours?

Q. 43. Did you have a stereo/record player on in the last 24 hours?

Q. 64. Asks about whether R has air conditioning, television(s), radio(s), stereo, dishwasher, and other items.

These questions will discern noise sources within the household which may be masking aircraft noise.

C-2

AVOIDANCE BEHAVIOR

Movement of Activities Indoors/Movement of Activities Out of Neighborhood

Q. 34/35. List of Activities (full list presented on page 19).

Q. 32/33. Time spent on indoor and outdoor household chores (full questions presented on page 18).

These questions will test the hypotheses that movement of activities indoors and out of the neighborhood is related to changes in aircraft noise level. In neighborhoods in which aircraft noise increases, participation in indoor activities and activities outside the neighborhood is expected to increase while amount of time spent on outdoor activities is expected to decrease.

Increased Travel on Vacations

Q. 36. How many trips for fun that were more than 4 days long have you taken within the last 12 months?

Q. 36a. How many miles round-trip did you travel on each of these vacations?

At the time the model was developed, one of the hypotheses was that increased travel on vacations would occur in areas of increased aircraft noise. But the energy crisis may eliminate the possibility of travel as an avoidance behavior. Because of the energy crisis, some modifications in parts of the questionnaire such as this one may be required before it can be administered. Other avoidance behaviors hypothesized in the model are "masking of the noise with other sounds" and "avoiding communication and concentration". The questions which relate to these topics have already been discussed in the sections of the report concerning masking as an

avoidance capability and effects on communication and concentration as a form of interference with activities.

HEALTH EFFECTS

Trips to Doctor/Concern About Health

Q. 71. About how many visits did you make to the doctor in the last year?

Q. 71a. Were these visits for a temporary illness or for a long illness?

Q. 71f. How concerned or worried about health have you been in the last month?

0 1 2 3 4 5 6 7 8 10

Not concerned at all Very concerned

From the questions about health it will be determined whether increased health problems occur in areas of increased aircraft noise.

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