1. ask to see contract with Wyle L.

# CITY OF OXNARD

## MEMORANDUM

2. CNEL prejudges what residents, schools, etc will tolerate accept - consideration for what we want.
3. Noise patterns - let us judge what is good for us & the community.

September 25, 1970

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37

~~BRIEFING REPORT~~

**To:** City Council

**From:** Councilman Tolmach

**SUBJECT:** Citizens' Environmental Study Committee Meeting

On Friday, September 18th, a meeting was held by the Citizens' Environmental Study Committee in the Board Room of the County Court House, Ventura. As you know, this Committee was recently formed by the Ventura County Board of Supervisors to participate in a study determining what impact the development of a commercial aviation facility at the former Oxnard Air Force Base would have upon the local environment.

The first phase of this study is considering the potential noise pollution which would accompany the development of the facility into a commercial airport and has been contracted to Wyle Laboratories with Mrs. Elizabeth Cuadra, Acoustical Engineer, as project director. The purpose of the meeting on September 18th was to brief the Committee on the work accomplished by Wyle Laboratories thus far.

At this meeting, Mrs. Cuadra explained that the responsibility of Wyle Laboratories under their scope of work is to predict noise contours for the aircraft activity projected by Adrian Wilson Associates Commercial Aviation Feasibility Study for the years 1975, 1980 and 1985, and to then explain what impact these noise contours would have upon the adjacent community. In addition to these two primary tasks outlined in the scope of work, Mrs. Cuadra revealed that several additional tasks which she now feels are essential to a comprehensive noise analysis will also be undertaken by this study. These new tasks will include a survey to determine the sensitivity of Camarillo residents to noise pollution and the construction of noise contours for combinations of aircraft operations other than those predicted by Adrian Wilson Associates.

Mrs. Cuadra briefly summarized the possible effects of noise upon a community as documented by numerous short term studies in other areas, and then outlined the criteria used to determine the appropriate land use for the area adjacent to a large noise producing



Page 25 - new bldg in above 55 CNEL decrease p. 28

facility such as an airport. These subjects are discussed at length in two reports distributed to the Committee on September 18th. (copies attached)

In discussing the advantages of using the Community Noise Exposure Level (CNEL), Mrs. Cuadra explained that this composite noise rating scale is based in part upon data correlations from community-wide interview surveys of the opinions of residents living near airports. To be certain this noise rating scale applies similarly to the Camarillo community, Mrs. Cuadra has obtained the assistance of two local organizations (Aviation Economic Reserach Organization and Citizens Against a Camarillo Airport) in conducting a random survey of Camarillo residents to determine the community's sensitivity to various noise levels (copy of survey questionnaire attached). Presumably, Mrs. Cuadra will recommend more restrictive noise levels in determining adjacent land use or more limiting operational controls for the facility if this survey indicates that Camarillo residents are unusually sensitive to noise.

In discussing the noise contours which will be constructed during this study Mrs. Cuadra emphasized that each contour will be based upon very strict adherence to flight patterns and aircraft operating procedures. Therefore, it was strongly recommended that an effective noise monitoring system be installed if the airport is developed thereby assuring that operating procedures set up for the facility can be effectively enforced.

During this meeting, Committee members expressed concern over the possibility that operational limitations imposed upon the facility at the time of development to protect the adjacent community might be changed at a later date. In response to this concern, both Mrs. Cuadra and Supervisor John Conlon, Chairman of the Committee, stated that they believe methods are available which would bind future Boards to the limitations imposed at this time. Such methods currently being explored by the Board include the imposition of deed restrictions by the General Services Administration in its disposition of the facility to the county. Discussion of the matter revealed that such permanent restrictions have never been imposed on any other airport facility in this county. Country?

One of the purposes of this Committee is to provide community input into the consultants' study. During the first informal meeting with Wyle Laboratories, Mrs. Omer Raines was selected as liaison officer between the Committee and the consulting firm. After that meeting, Mrs. Raines asked each Committee member to provide a list of their concerns with respect to the noise pollution which might be generated by a new airport at the Camarillo site. These concerns have been forwarded to Mrs. Cuadra and apparently will be considered in the study. During the meeting on September 18th, Committee members offered some additional suggestions to Mrs. Cuadra. Included was a request that noise contours for single flights be constructed in addition to those for the composite CNEL rating. Such contours would help to provide a more comprehensive explanation of the potential noise effects as it would indicate to what extent residents outside the CNEL contour would be effected by certain single flights. Mrs. Cuadra agreed to provide such contours prior to the completion of the study.

The next public meeting scheduled for the Environmental Study Committee will be held Monday, September 28th. During that meeting, the second report by Wyle Laboratories will be presented and the preliminary report on the air pollution aspect of this study.

I will continue to keep you informed on the activities of the Committee.

Robert Brown

Robert Brown
Administrative Assistant I

for Councilman Tolmach

RB:JT:bb
Attachments

Preliminary Communication #1 ...

... to the citizens of Ventura County ...

... from the Acoustical Consultant.

Topic: TYPICAL CRITERIA CURRENTLY AVAILABLE FOR THE SETTING OF NOISE LIMITS

The following information is taken from a position paper on community noise by Elizabeth Cuadra, requested by the Task Force for Development of California State Plan for Health (California Department of Public Health).

# APPENDIX

## Typical Criteria Currently Available as Bases for Setting Noise Limits

Noise can have many effects on people's lives, particularly if the noise levels are high and the noise is present for a significant portion of the time. The most widespread direct effects of noise involve interference with activities, such as sleep, conversations, telephoning, listening to TV, radio or music, individual tasks requiring concentration, and the like. In addition, noise can be annoying in and of itself, particularly if it is a noise which could be reduced or eliminated. Field studies and observations are beginning to show secondary social effects (within the family and outside it) in areas heavily impacted by extreme noise of the kind generated by large airports and heavy vehicular traffic. The long-term effects of community noise on health are not yet known, but are suspected to be significant.

Noise which has semantic content (that is, which carries information) can constitute a loss of privacy. This loss of acoustical privacy is a major factor in most apartments and can be equally serious in sensitive office situations, such as those involving attorneys, doctors or psychologists. The direct effects of noise from other apartments can include sleep disturbance if the noise is severe enough, and the suspected indirect effects include sociological behavior patterns resulting from imposed inhibitions on family activities and from strained or non-existent relationships with one's neighbors. It is suspected that this widespread (and unnecessary) lack of privacy in apartment living may be a major contributing factor in the desire of most families for a single-family residence, and hence a contributor to urban sprawl and its associated compounding effects on the urban environment.

To be useful in the setting of design limits, the effects of noise on people must be quantified. There are three basic categories of quantitative information which may be utilized as input to the setting of noise limits: (1) the direct "human factors" bases, resulting from data that can be measured and hence may uncover effects of which the people themselves are unaware, (2) community-annoyance data collected from interview surveys with people living in known (measured) noise environments, and (3) complaint and community reaction data and case histories. These three bases are briefly reviewed below. The evidence for these kinds of bases for noise limitation comes from laboratory research, field studies and collected case histories, and there is a vast literature on the subject. The portion referenced here is typical of the results reported in that literature and is presented to provide the reader with an introduction to the foundation upon which noise limits can be based.

### 1. Human Factors Bases for Noise Limits

The effects which have thus far been quantified to a degree sufficient for their consideration in the process of setting noise limits are: (1) sleep disturbance effects, (2) interference with speech communication, (3) physiological (measurable) stress reactions in response to noise, and (4) permanent hearing loss due to noise exposure.

(a) Sleep Disturbance

Noise can disturb sleep even without completely awakening the sleeper. Noise which is not sufficient to arouse the subject may impair the quality of sleep by shifting him from a deeper stage of sleep to a shallower stage, or by depriving him of a sufficient amount of the portion of the sleep period which is connected with dreaming and which is thought to be most important for rest.

The effects of noise on sleep have been observed by studying the subject's brain wave patterns with an electroencephalogram (EEG). A number of laboratory experiments have been done using this technique, some using artificial and steady sounds as the disturbing noise, and others using transient sounds (such as aircraft flyby noise and truck noise) more typical of the sounds experienced in residential communities. Other laboratory experiments have been performed in which actual awakening of the subjects was the only means of observing sleep disturbance effects of the noise. Results of several of the better documented studies are described in References 1 through 4 and summarized in Reference 5. There are some inconsistencies (and a wide data scatter) among the results of the sleep experiments, and these are likely a result of differences in age of subjects, background noise level during the experiment or such other parameters as may have strong effect upon the results but were not always reported. More definitive research will be needed before these discrepancies can be resolved.

Further information on sleep disturbance by noise (particularly aircraft noise) comes from community annoyance surveys in which each person is asked to complete a detailed questionnaire (including questions on how frequently he is kept from going to sleep or is awakened by noise) and the noise characteristics of the environment are also measured. The results of the sociological survey are then analyzed against the known characteristics of the noise environment as determined from an acoustical measurement survey. A number of such survey results are available: (1) from studies around military air bases, some of which are reported in References 6 through 11 and which led to the development of annoyance prediction guides and land use planning guides in the late 1950's, References 12 and 13; (2) from studies in Europe on aircraft noise and traffic noise (e.g., References 14 through 18); and (3) from a small sample obtained in the course of a project in the soundproofing of homes around Los Angeles International Airport (Reference 19).

By combining the results of all the sleep-related results from the foregoing field studies and experiments, and in spite of the scatter in the data, it becomes apparent that more noise disturbs the sleep of more people in a gradually increasing way and that a significant fraction of the population (20 percent or more) may suffer some form of sleep disturbance if the level of intruding noises in their bedroom exceeds 45 dBA.

While a direct connection between sleep disturbance and long-term health awaits scientific demonstration, it is logical to believe that repeated exposures to sleep-disturbing levels of noise may well lead to health effects and should be avoided. The sleep disturbance criterion, therefore, should play an important role in setting indoor limits for residential areas at night, as well as for hospitals and hotels.

(b) Interference with Speech Communication

Noise can interfere with speech communication by preventing one's hearing some of the words or sentences being communicated. The subject of speech communication includes direct communication between speaker and a listener (such as conversation and classroom lectures) and includes listening to television or radio and telephone communication.

The speech interference effects of noise have been thoroughly studied and well documented; and criteria for designing good speech communication environments have been a standard tool of acousticians and architects for many years in the design of offices, classrooms, auditoria, et cetera. The criteria which have been developed are expressed in terms of the "speech interference level" (SIL) of the interfering noise. The range of frequencies most important to speech communication is comprised of the three octave bands centered at 500, 1000, and 2000 Hertz; and the magnitude of a noise can be expressed in dB (SIL): the average of the octave band sound pressure levels in those three octave bands.

The ability of a speaker and listener to continue good communication in spite of an interfering noise depends not only on the magnitude and tonal characteristics of the noise but also on the voice volume the speaker is using and on the distance between the listener and speaker. Standard curves have been published, based on the accumulation of much experimental research, which show the noise limits to be set for various speaker-listener distances. The limits corresponding to the case where the speaker is using a normal voice level (as opposed to a raised voice) have been extracted from Reference 20 and shown in Table 1. The precise conversion from dB (SIL) to dBA depends on the spectrum of the sound in question, and the numbers in Table 1 are for sounds for which the sound level in dBA is about 7 dB higher than the sound level in dB (SIL), a good approximation for many aircraft and motor vehicle sounds.

From information on typical speaker-listener distances in the rooms involved (such as living rooms, family rooms or classrooms), a noise limit can be set which provides for good, uninterrupted speech communication. In general, a typical listener-speaker distance in homes and offices does not exceed 10 feet for a normal conversation, and one would therefore tend to limit the level of any frequently occurring interfering noise to 56 dBA or less in homes and offices.

For classrooms, where the distance between a teacher and a classroom of listening students will be greater but the teacher will be using a raised voice rather than a conversational tone, the standard acoustical design limit for continuous interfering noise has been 45 dB (SIL), which corresponds roughly to 52 dBA.

TABLE 1

NOISE LEVELS THAT BARELY PERMIT RELIABLE CONVERSATION AT VARIOUS DISTANCES AND A NORMAL VOICE LEVEL

| Distance Between Speaker and Listener Feet | Level of the Interfering Noise, dBA |
|---|---|
| 1 | 75 |
| 2 | 70 |
| 3 | 66 |
| 4 | 64 |
| 5 | 62 |
| 6 | 60 |
| 10 | 56 |
| 20 | 50 |

The speech interference level criterion forms a basis for the setting of limits which is extremely important in homes during the daytime, in offices and commercial buildings, and in schools, since it constitutes the most restrictive limit for daytime activities for those uses.

(c) Physiological Stress Reactions to Noise

There have been a number of experiments reported on the ability of noise to produce measurable physiological stress reactions. These stress reactions derive from a widespread activation of the autonomic nervous system, resulting in changes in salivation, gastric activity, heart rate, respiration rate, blood vessel diameter, pupil size and sweat gland activity. Experiments to establish some of the kinds of stress reactions which can be induced in animals and humans by exposure to excessive noise are typified by References 21 through 27.

Many of the experiments have used stimulus sounds at levels well above those which ordinarily occur in residential areas, offices or schools --- even those in communities adjacent to airports. However, the indications of the experiments at noise levels more ordinary to everyday experience do reinforce the (lower) levels required for a good speech communication environment. Jansen has tentatively concluded from his own experiments (Reference 2) that the threshold of stress response is at about 65 dBA and becomes pronounced at 80 to 85 dBA. The region of 80 to 85 dBA, incidentally, corresponds approximately to the threshold level at which temporary hearing loss can occur in some persons.

With regard to long-term health, it is not yet possible to be sure what effects such stress reactions may have, particularly in the context of the total stress-inducing environment present in urban living. The few scattered attempts to gain insight into this question, however, have produced results which would encourage conservatism in the setting of noise limits. For example, a Swedish study of traffic noise (Reference 17) has shown that symptoms such as headache, insomnia, and nervousness are associated with noise exposure to such an extent that the degree of subjective annoyance reported by the residents can be used as a reliable measure of the noise environment itself.

The question of psychological effects has been raised by a British study (Reference 28) which implicated noise as a possible factor in increased rates of admission to mental hospitals. In this study, such factors as age, sex, marital status, population density, and socioeconomic status were reasonably well controlled, and the study (covering two years of admissions to a psychiatric hospital) showed significantly higher rates of admission from inside an area of maximum noise near London's Heathrow Airport than outside that area.

Finally, there is reason to suspect that periods of exposure to stress (including noise as a stressor) may temporarily alter the subject's resistance to infectious disease, Reference 29.

Until such issues as these are answered definitively, conservatism is warranted in setting design noise limits for urban environments. For this reason, it is fortunate that the stress-related criteria we would expect to emerge in the future are not as restrictive as the sleep and speech communication criteria, which will therefore play an important role in the setting of design limits.

(d) Noise-Induced Hearing Loss

Exposure to high-intensity sound can cause a temporary loss of hearing, with normal hearing acuity returning gradually after the noise ceases. If the conditions leading to temporary loss are repeated frequently enough over a period of years, some degree of permanent hearing loss will result. Some permanent loss of hearing can result from a single exposure to very extreme noise, of magnitudes never experienced by most people, such as from being too near a dynamite blast or explosion.

The combination of levels of noise and repetiveness which can cause permanent hearing loss commonly occur in the work environment of noisy industries and in of exposure time and noise level which would exceed the hearing loss criterion exist in community noise situations. This is not necessarily true, however, in extreme noise situations such as in some discotheques, around some construction equipment and in some industrial situations.

It is apparent from these numbers that a discussion of hearing loss is purely academic in the context of setting limits for residential, commercial and most other urban areas, since criteria for speech communication and sleep would call for much lower noise limits.

## 2. Community Annoyance Bases for Noise Limits

It is apparent to everyone that a much more serious noise problem exists if the intruding noise occurs once every five minutes than if it only occurs, say, once every day. However, most of the foregoing direct "human factors" bases do not provide any information on the relative importance of noise level and frequency of occurrence. Evidence which brings in the effect of number of occurrences comes from (1) community annoyance surveys (in which the residents' opinions are collected by questionnaire and can be related to known properties of the noise environment they were experiencing at the time) and (2) case histories of spontaneous reactions of individuals and groups to specific (measured) community noise situations.

The first category of data source is represented by community questionnaire survey results as represented by References 14 through 18. This survey technique was tested and formalized by sociologists working with the Organization for Economic Cooperation and Development (OECD), Reference 32. When accompanied by noise measurement surveys of the same area in which the social survey is conducted, and compared against the distribution of complaints in the area, such community questionnaire surveys can be quite illuminating.

One of the most thoroughly documented surveys of this kind was the survey around Heathrow Airport (London), References 14 and 15, in which some 1730 persons were interviewed and their responses correlated against the specific aircraft noise environment where they lived. This environment was described in terms of a rating scale called Noise and Number Index (NNI), which is one of several existing types of composite scales which incorporate both the magnitude of the noise of each flyby and the number of flybys heard. The questionnaire technique involves a series of non-directive questions which will allow the respondent to initiate the subject of noise. Questions are asked about specific activities interfered with by the noise, how frequently this occurs and how annoying it is, and a number of other questions which taken as a group allow a total picture of how the person judges the noise environment. When the results are correlated against the noise environment, they show the trend of percentage of respondents affected in each way by varying amounts of noise exposure. The problem still remains, of course, that whoever is making the decisions of noise limits must make a value judgment on what percentage of the population is to be protected. This is an unavoidable result of the statistical differences in any measured characteristic of people, even such a relatively direct and nonsubjective attribute as noise-induced hearing loss.

There is an additional research program under way (under contract to NASA) in communities surrounding some airports in the United States, and it is hoped the results will provide a significant advance in our understanding of the effects of aircraft noise in people's lives, insofar as the people themselves are able to report them on a subjective basis.

3. Community Reaction Bases

Community reaction data (such as complaints and law suits) are difficult to apply to the setting of noise limits unless one accepts only those data cases about which he knows all the surrounding circumstances and can interpret the meaning of the data wisely. A number of cases about which the circumstances were well-known were summarized and utilized in Reference 5.

The danger in indescriminate use of community reaction data lies in the fact that there are a number of factors which can affect the actual rate of complaints or law suits (for a given noise environment) which have nothing to do with the noise itself nor with the genuine welfare of the people. These include such factors as:

(a) Feelings about the effectiveness of citizen action in achieving results on any matter.

(b) Perception of the noise as being (1) avoidable or arising from a non-essential activity, or (2) unavoidable or arising from an essential activity.

(c) Status of other plans (as through new legislation or existing action programs of their governmental agencies) to diminish the noise.

(d) Ability of the community to organize and act in concert.

(e) Presence of external influences of a propagandistic nature, which may either stimulate or depress the activity level with respect to what would occur on a purely spontaneous basis.

It would be easy to cite cases exemplifying each of these factors, e.g., from past and recent experience in the Los Angeles basin, from tendencies of persons around military bases to inhibit their noise-related complaints especially in wartime, from results of the Heathrow study and from some special field experiments in Sweden.

The Heathrow study, for example, gave a picture of citizen apathy probably related to the first two foregoing factors, (a) and (b): When 1 percent of the people were registering complaints, 10 percent actually felt like doing so; and when 10 percent were complaining, 40 percent actually felt like doing so. One may easily observe factors (a) and (d) in action by comparing actions taken against aircraft noise from various socioeconomic neighborhoods in the Los Angeles basin.

The ultimate proof, however, that it is dangerous to base decisions on complaint data alone without specific knowledge of the situation and without cross-checking against all other available bases comes from a field experiment in Sweden, Reference 33. That experiment (carried out in secret and with the active cooperation of the press) was designed to test the theory that the attitudes of a population around an airport toward the noise emanating from that airport could be purposely manipulated. The degree of change was tested by comparing questionnaire survey results before and after the manipulation activity took place, and the theory was clearly verified.

With respect to the establishment of design limits for noise in urban areas, therefore, it would be far preferable to be able to base those limits on direct "human factors" kinds of information (including an improved knowledge of the long-term health implications of various noise exposures), reinforced by community annoyance survey results. In particular, the temptation to place credence in the lack of a large number of complaints in a given area at a given time as an indication that no noise problem exists should be assiduously avoided.

## 4. Critique of Existing Bases and Suggested Priority Areas for Research

The writer takes the view that present knowledge should be utilized to set noise standards without further delay, and that those standards should then be periodically reviewed in light of new knowledge. This view is apparently shared by some public health officials (e.g., References 34 and 35) and by many acousticians (Reference 36).

It is useful at this point to assess the directions such future research might take, in order to provide the kinds of answers most useful in noise-related design guidelines and standards.

To recapitulate, existing bases for setting noise limits rest upon three basic types of knowledge: (1) Human factors, such as sleep disturbance and speech interference, (2) Results of community annoyance interview surveys, and (3) complaint and community action data. People are often unaware of effects noise may be having upon them; hence, the most desirable basis for setting noise limits would be the human factors basis. Unfortunately, current human factors knowledge (1) refers only to the magnitude of noise and not to the number of events in a given time period and (2) the secondary (or health) effects which probably exist have not been directly related to the measurable human factors effects which have been the subject of laboratory experiments. In addition, there are some serious omissions in our knowledge for setting noise limits in various kinds of spaces -- outdoor recreational areas (back yards, urban parks and remote wilderness areas), for example.

First priority in such research should be directed at application to residential land uses. There are a number of questions one would wish to have answered. Taken together, the answers would define the effects (on the general well-being of the residents) of (1) lack of acoustical privacy between dwelling units, (2) noise exposure within dwelling units from exterior sources, and (3) noise exposure in the outdoor environment. Some of these questions are:

Speech interference: What are the relative roles of noise magnitude, duration and frequency of occurrence (for intermittent noise)? What portions of the 24-hour period are most sensitive to speech interference in the residential environment? What is the relative importance of speech interference as a criterion in setting noise limits for outdoor recreational environments typical of residential areas? What is the relative importance of interference with danger signals or warnings (with children playing outdoors)? What are the secondary sociological effects of frequent interference with speech communication?

Sleep disturbance: What is the relative importance of number of occurrences and magnitude per event, for intermittent sounds? What is the importance of background noise level; of age, sex and general health of the subjects; of the semantic content of the noise as related to the subjects? How are recurrent sleep disturbances correlated with health trends? What are the psychological and sociological effects of chronic low-level sleep disturbance?

Stress reactions: Under what conditions do measurable stress reactions occur in response to noise in the residential environment (both outdoors and indoors)? If levels of noise in the environment produce stress reactions, how are they correlated with (a) subjective annoyance assessment by the subjects, (b) psychological/sociological evidences of stress, and (c) physical health trends? What is the relative incidence and importance of stress reactions to noise as compared with other stresses in residential living, as a function of the noise exposure?

Relative role of residential noise exposure in context of total living pattern: For those who spend the rest of the day in much noisier or much quieter environments, what is the relative importance of the residential noise exposure?

Criteria bases for outdoor recreational areas: On what criteria should noise limits, interpretation of potential noise impact, and possible noise zoning for vehicular uses be based for various types of outdoor recreational areas ranging from urban parks to suburban campgrounds to wildlife sanctuaries and national parks? Realizing that different criteria are likely for each category, how much noise and what kinds of noises begin to defeat the purposes of such areas for restorative recreation for urban dwellers.

Of the foregoing questions, those most urgently requiring answers are the ones which deal with sleep disturbance and outdoor criteria for urban areas, as they will most likely set the noise limits for residential areas. Obtaining the answers will require extensive field investigations and epidemiological studies, probably accompanied by smaller scale, field experiments and in-depth studies of groups of families.

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Preliminary Communication #2 ...

... to the citizens of Ventura County ...

... from the Acoustical Consultant.

Topic: AIRCRAFT NOISE/LAND USE COMPATIBILITY GUIDELINES FOR NEW DEVELOPMENTS

The following information is a preliminary draft, subject to change, and is provided at this time to facilitate discussion on the question of the proposed conversion of Oxnard Air Force Base to civilian aeronautical use.

18

# AIRCRAFT NOISE/LAND USE COMPATIBILITY GUIDELINES FOR NEW DEVELOPMENTS

The purpose of the following section is to (1) provide (for information purposes) a description of the scale which is being used to describe the estimated noise environment which may be expected to result from various alternative uses of Oxnard Air Force Base as a civilian airport; and to (2) provide (for information and discussion purposes prior to finalization) some proposed airport noise/land use compatibility guidelines. These guidelines may be modified if forthcoming information on the noise sensitivity of the communities involved should clearly indicate that necessity.

## A. BASIS OF A SCALE FOR QUANTIFYING THE NOISE PATTERN OF AN AIRPORT

Community noise comes from a variety of sources, such as motor vehicles, sirens, trains, industrial plants, aircraft, and the activities of people in the neighborhood. In communities adjacent to airports, aircraft operations can be the dominant source of noise during much of the day unless suitable airport design and community design precautions are applied very early. The following briefly outlines the basic concepts necessary to the quantification of the noise pattern produced by any airport, in terms of both the physical descriptors of the noise itself and the descriptors involved in relating noise to people.

### 1. <u>Physical Concepts</u>

If we examine the sound produced by an aircraft flyby, we find that as the aircraft approaches, the sound increases in magnitude until it reaches a maximum and then generally decreases and dies away. If the sound of the flyby were recorded as a pen trace on paper, the result would be a hill-shaped curve, Figure 1. Such a trace records the time history of the noise magnitude. The maximum value reached by the sound during the flyby is called the peak or maximum level.

We also say that the sound of the aircraft flyby has a particular duration. The duration can be defined in various ways, such as the time that the sound level falls within some prescribed value (such as 10 decibels) below the peak level. As the aircraft passes by, the trace will show the sound level returning to the background or ambient noise level.

If we are standing very near the flight path, the sound magnitude from the aircraft is higher and the sound begins and ends more suddenly; that is, the duration is short. If we are standing several thousand feet away from the aircraft flight path, the sound magnitude will be less, but we will hear the sound for a longer time; that is, the duration is longer and therefore may interfere with people's activities for a longer time if the magnitude is such as to cause interference. These two situations are shown in Figures 2(a) and 2(b).

If one listens to jet aircraft operations around an airport, it is obvious that aircraft sounds have different tonal qualities, depending on the particular aircraft and what it is doing. For example, when a jet aircraft is operating at a high power setting (as for take-off and climb), the sound is a low-pitched roar, dominated by the noise of the jet exhaust. When a jet aircraft is under reduced power, on a landing approach, the sound is a high-pitched whine, dominated by the sound of the compressor and fan. Also, the tonal quality of noise produced by propeller-driven aircraft differs greatly from that of jet-powered aircraft. Let us examine the noise of an aircraft flyby at a given instant in terms of the way in which the acoustic energy is distributed across the frequency spectrum. This can be done by breaking down the signal into its frequency spectrum. Examples of spectrum shapes for take off noise and for landing noise of jet aircraft are shown in Figures 3(a) and 3(b). The pure tone spikes represent the sound of the compressor and fan.

To summarize, these basic physical concepts of magnitude, duration and spectral content must be included in any quantitative description of the properties of a sound received at a given point. However, since we are dealing with people, this is only part of the picture, and we must also identify the concepts that are important in how people perceive the noise.

2. <u>Human Factors Concepts</u>

The first thing that is important about an audible sound is its apparent magnitude. We hear sounds best at frequencies around 3000 cycles per second, and the acuity of our hearing decreases gradually at lower and higher frequencies. Thus, the way a given noise will sound to us depends on how its energy is distributed along the frequency spectrum. Measuring instruments have been devised that will approximate the frequency response of the human ear, and one of the simplest and most reliable of these is the A-weighting scale on an ordinary sound level meter. This measures both the magnitude of a sound and its frequency spectrum to indicate approximately how loud a given sound will seem to us.

In addition to the magnitude of the noise, other variables which count greatly in how much annoyance we will experience from a recurring noise are:

- The length of time the noise lasts each time we hear it (its duration),
- How often it is repeated throughout the 24-hour time period (number of occurrences), and
- Whether it occurs during the day (when most of us are awake and active), during the evening (when we are usually engaged in quiet activities and the family is generally at home together), or at night (when most people want to sleep).

There is much more of a noise problem, for example, from ten or twenty noisy flights per hour than there would be from one per hour. Also, three noisy flights between 10:00 and 11:00 p.m. would be more annoying than the same three flights between 10:00 and 11:00 a.m., since many people are engaged in quiet activities or sleeping during that part of the night. Finally, a person farther from the airport may be annoyed by a given flight, even though it produces a relatively low sound level at his house, simply because the sound has a longer duration and thus attracts his attention or interferes with his concentration for a longer time.

All of the foregoing factors have been taken into account in the noise scale which is being used in this project to describe the potential noise environment around the proposed airport in a way that is related to people. It is identical to the scale developed for application in the proposed noise standard for airports in the State of California (References 1 and 2) and only differs significantly from similar scales in other parts of the world in that it incorporates the following improvements: (a) it was designed for ease of measurement by noise monitoring systems (which we believe to be a crucial tool for controlling airport noise), (b) it provides for an evening time period (7:00 to 10:00 p.m.) when individual flights are counted more heavily than flights during the day (in addition to the usual night time period incorporated into the other composite scales), and (c) it takes account of the duration of the noise from each flyby.

The preceding factors were taken into account in developing this noise scale in the following ways:

- To quantify the combination of noise magnitude, frequency distribution of the acoustic energy and frequency response of the human ear, the A-weighted sound level is utilized. This is a quantity which is also easy to incorporate into noise monitoring systems.

- To incorporate the effects of duration and number of flights, the noise scale utilizes the time integral of the A-weighted sound level. In effect, this means we sum all the acoustic energy that the ear will perceive (for an outdoor observer). This total energy will be greater if there are more flights and generally will be dominated by the noisiest flights. The amount of emphasis to be given to the number of flights (as opposed to the noise magnitude from each flight) has been based on fairly uniform worldwide agreement among sociologists and others working in aircraft/community noise, resulting from data correlations from community-wide interview surveys of the opinions of residents around airports. The same is true for the weighting factors given to each of the three time periods, discussed next.

- To take account of the importance of when the noise occurs, weighting factors have been incorporated into the accounting procedure. A larger weighting factor is used as a multipler against flights that occur in the evening (7:00 to 10:00 p.m.) as compared to those which occur in the daytime (7:00 a.m. to 7:00 p.m.), and a still larger weighting factor is used for flight operations at night (10:00 p.m. to 7:00 a.m.). In effect, these weighting factors result in one flight at night being the equivalent of ten equally noisy flights in the daytime or three in the evening. This arises from the increased need for quiet in residential areas at night, which is due partly to the sleep-disturbing properties of noise and partly to the lower background noise in communities at night.

The combination of all these choices has resulted in a composite rating scale for describing the noise environment, which is called the Community Noise Exposure Level (CNEL) scale. It is a logarithmic scale, in decibels. That is, a ratio of two to one in acoustic energy corresponds to a decibel difference of 3, a ratio of 10 to a decibel difference of 10, and a ratio of 100 to a decibel difference of 20.

The CNEL value at a given point, say near an airport, can be considered to be a weighted average of the A-weighted noise level throughout a day. The time averaging of the noise signal is carried out on an energy basis;

hence, the result is dominated by the higher noise levels. The weighting for time periods in the 24-hour day involves increasing the average sound energy by a factor of 3 (equivalent to 5 decibels) during the evening (7:00 to 10:00 p.m.) and by a factor of 10 (equivalent to 10 decibels) during the night (10:00 p.m. to 7:00 a.m.).

## B. THE USEFULNESS OF NOISE CONTOURS IN A COMPOSITE SCALE

Using a composite noise scale (such as the CNEL scale), one can estimate the noise environment around an airport in advance, based on the type and number of aircraft which would be using the airport per day under that alternative, their approximate flight paths in connection with each runway, and the distribution of flights by the three time periods. The resulting noise environment then could be shown on a map in terms of CNEL contours (e.g., Figure 4) and the region between each pair of contours treated as a given "noise zone". for planning purposes. One can establish noise limits appropriate to various land uses and then utilize those limits (in conjunction with the noise contours) to make such decisions as:

- Appropriate site locations for new airports.
- The appropriateness of continued use of abandoned military facilities for various kinds of civilian aeronautical use.
- Necessary controls on aircraft types, operational modes and expansions of airports to prevent the incompatible spreading of their noise environments into existing communities.
- Appropriate land use controls on new development around airports, keyed to the design noise ceilings set for those airports.

For an existing airport, where the noise is available for measurement, a more accurate set of contours will be obtained by measurement over an extended time period. Measurement takes into account such variables as meteorological conditions, flight path lateral and vertical deviations, and variations in power settings which calculation techniques cannot do, since they are based on averaged data on noise and flight profiles of the aircraft types in question, on standard atmospheric conditions, and on flat terrain. It is very important to confirm the contour locations by measurement for the case of an existing airport; where there is an existing noise-impacted community involved, this point cannot be overemphasized.

## C. NOISE INSULATION AVAILABLE FROM BUILDINGS

The single-event (or human factors) bases for setting noise limits (Preliminary Communication #2) referred, of course, to the amount of noise occurring at the location of the person involved. For many land uses, the controlling factor will be the noise experienced indoors. Hence, the noise-attenuating performance of the buildings involved is a factor in the setting of limits in terms of the levels which would be measured outdoors.

Table 1 lists the typical performance of the major classes of building constructions typical of Southern California, including some with special noise insulation provisions in their design. The performance is given in terms of A-scale noise reduction (exterior to interior) as would be measured by two microphones simultaneously, one inside and the other outside the building.

Data for types 1, 2 and 3 comes from field measurements during aircraft fly-bys, taken in more than 100 rooms of 20 homes (Reference 3), supplemented by a few measurements in apartments in Inglewood. The numbers for types 4 and 5 were obtained by standard acoustical calculations using measured transmission loss properties of building components. Naturally, there will be some variation about these averages, in some cases as much as 5 dBA.

Type 1 represents the typical home without air conditioning, as well as many schools and some motels and commercial buildings. Type 2 represents the same building categories, but with the inclusion of air conditioning or a forced air system to bring in the outdoor air without cooling (with sound-attenuating ducts) to allow the option of closing windows in any season. Type 3 represents homes, schools or commercial buildings which have been either originally designed or retroactively modified to provide the equivalent of the "Stage 2 soundproofing" described in Reference 3. Type 4 is typical of most modern commercial buildings, hotels, office buildings and hospitals with air conditioning, particularly high-rise buildings. Type 5 represents the addition of double-glazed windows in the design of Type 4 especially for purposes of noise protection. Examples of this are the International Hotel and new wing of the Airport Marina Hotel near Los Angeles International Airport, the original design of the United Savings and Loan Building near Los Angeles International Airport, and the new hospital-medical complex near Torrance Municipal Airport.

## D. PROPOSED OUTDOOR NOISE LIMITS (IN THE CNEL SCALE) FOR VARIOUS LAND USES

Based on consideration of the human factors criteria and results of community annoyance surveys such as those cited in Preliminary Communication #1, plus consideration of Reference 4, the proposed exterior noise limits for various land uses involving new development are given in Figure 5. The limits are somewhat subject to judgment, and the numbers recommended here are generally lower than those in Reference 4, usually by 5 dB. They are also lower than those in the proposed state noise standard for airports (Reference 1) for the limited list of land uses referred to in that draft standard.

The bars in Figure 5 show the noise zones (in CNEL) where the given land use is expected to be compatible, on condition that the construction type descriptors associated with the letter codes inside the bars are complied with. For example, while noise of CNEL 55 or less should certainly be compatible with schools, churches and hospitals of wood frame and open-window construction, it is advisable to require inclusion of noise related design features which would give a noise reduction of 35 dBA for new buildings constructed in noise zones above CNEL 55, and noise greater than CNEL 75 is felt to be excessive for any new construction, primarily because of the outdoor noise and partly because of the difficulty of assuring low enough interior levels for these particular uses. In general, construction descriptor A corresponds to Type 1 of Table 3, B to Type 4 and C to Type 5.

## E COMPARISON OF THE RECOMMENDED LIMITS AGAINST OTHER CRITERIA

### 1. Some Comparisons Against Single-Event (Human Factors) Criteria

The principal criteria against which comparison checks may be made are those for sleep and speech communication. Homes, apartments, hotels, etc., of types requiring open windows provide 20 dBA noise reduction, and a value of 65 dBA outdoors corresponds to the desirable limit of 45 dBA indoors. Homes at a CNEL 60 boundary would experience this value, on the average, for an airport with 800 average daily departures (of noise-dominant flights) of which 70 percent are in the daytime. If there were only 100 average daily departures of noise-dominant flights, the sleep-related interior limit of 45 dBA would be exceeded by 8 dBA unless the windows were closed; and for 40 average daily departures, would be exceeded by 5 dBA even with the windows closed unless the home is of quite good construction. Figure 6 provides a rough guideline to the conversion from CNEL to peak sound level in dBA from aircraft flybys of the noise-dominant aircraft as a function of the number of operations of those aircraft affecting the ground point in question.

The foregoing example supposes the existence of night operations of noise-dominant flights. If a curfew were in effect, the relevant criterion would be speech communication, in which case interior limits of 65 dBA would be desirable to avoid any interruptions whatsoever. For homes with open windows, this criterion is met wherever there are 150 or more noise-dominant flights per day; but at 40 flights per day, would be exceeded by 5 dBA unless the windows were closed.

It is apparent that even with the relatively protective noise limits in CNEL proposed here (Figure 5), occasional exceedances of the desired single-event limits will occur if the number of noise-dominant flights per day is relatively small.

Let us now make another comparison; e.g., against some other familiar noise sources in residential and commercial areas: motor vehicles. For example, the average passenger car in California produces a sound level of 68 dBA at a distance of 50 feet (a value which is greatly exceeded by many poorly maintained cars or sports cars), and motorcylces commonly produce 80 to 90 dBA at the same distance (Reference 5). Therefore, even the sound of the average (quiet) passenger car slightly exceeds the sleep related limit for homes with open windows, and the sound of a passing motorcycle can easily exceed the sleep and the speech limits even with closed windows. It appears, then, that if we try to comply entirely with the single-event limits, we must seek both quieter motor vehicles and quieter aircraft.

## 2. Comparison Against Composite Scales in Other Countries

Based primarily on results of community questionnaire surveys with respect to aircraft noise, many countries have developed their own rating scales analogous to CNEL and have developed guidelines for land use planning such as to avoid having new airports (or expansions of existing airports) occur too close to existing residential areas or, conversely, developing land uses around airports which would be incompatible with the anticipated noise environment.

Figure 6 provides an approximate numerical comparison among several of the composite scales in use here and in other countries. The scale names and countries of origin are given on the figure. The numerical comparison is made by reading off comparative values intersected by a horizontal line through all the scales. For example, CNR 100 corresponds to CNEL 63 and so on. The relative numerical positions of some of the scales will shift slightly for large changes in number of flights or proportion by time period of the day, but too slightly to affect the present comparison.

Each of the scales is divided into several zones for land use planning guidance, and the meanings associated with each zone (in the words of the originators of the scales) are given in the table following Figure 6. In the German Q scale, for example, the recommendation for noise zone 2 (ranging from approximately 73 to 78 on the Q scale) is that any new homes constructed will require inclusion of noise control measures.

A comparison of the CNEL limits recommended herein for new development (either new airports or new land developments around existing airports) will show that

- The limit of CNEL 60 for residences of normal construction is slightly more protective than the limits recommended in all scales, except the English (where it is approximately equal to their normal criterion of NNI 38).

- The limit of CNEL 75 for multifamily residences of special construction is slightly less protective (by about 1 dB) than one (NEF) and slightly more protective than all the others.

Insofar as comparison is possible (i.e., with respect to residential use), the limits proposed here are slightly more protective of the people than those in effect elsewhere.

It must be emphasized that these proposed limits are for new development, and that slightly less protective limits might be chosen in cases where they imply severe constraints with respect to existing communities or existing airports, either of which implies large prior investments. By "new development," we mean either (a) the placement of a new airport near an existing community or (b) newly developing land uses near an existing airport. We feel that philosophically it is proper to consider the proposed Camarillo Airport as a "new airport," since no large prior investment in land or facilities has yet been made by the County, and since the decisions to be made here represent a turning point in the history of the County and the adjacent communities.

TABLE 1

NOISE REDUCTION PERFORMANCE (EXTERIOR TO INTERIOR)
OF VARIOUS BUILDING CONSTRUCTIONS

| | Construction Type | Approximate Noise Reduction dBA |
|---|---|---|
| 1. | Typical Southern California wood frame construction, some windows open | 20 |
| 2. | Typical Southern California wood frame construction, air supply (e.g., windows closed) | 28 |
| 3. | Modified wood frame construction (acoustical doors, double-glazed windows, air supply, etc.) | 35 |
| 4. | Normal concrete construction with fixed plate glass windows and air supply | 35 |
| 5. | Normal concrete construction, with air supply, and with double-glazed windows | 45 |

TABLE 1*

LAND USE CODING/CONSTRUCTION TYPE DESCRIPTORS

A. Specified land use is satisfactory, based on the assumption that any buildings involved are of normal construction, without any special noise insulation requirements.

B. New development or construction should be permitted only on condition that a detailed analysis of requirements for building noise reduction performance be made and indicated noise insulation and air supply features be included in the design and construction.

C. New development or construction should be underaken only if (1) it is directly related to airport activities or services, and (2) special noise insulation and air supply features are included in the design and construction.

D. A detailed analysis of the noise environment, considering noise from all urban and transportation sources should be made, and needed noise insulation features and/or special requirements for sound reinforcement systems should be included in the basic design.

---

* of Figure 5

TABLE 2*

LAND USE - AIRCRAFT NOISE COMPATIBILITY CLASSIFICATION

| Noise Sensitivity Code | SLUCM Code | Category |
|---|---|---|
| | 1 | RESIDENTIAL |
| 1 | 11x[3] | Single family |
| 1 | 11x | 2-4 family |
| 2 | 11 | Multi-family apartments |
| 2 | 12 | Group quarters |
| 2 | 13 | Residential hotels |
| 1 | 14 | Mobile homes |
| 3 | 15 | Transient lodging |
| 2 | 19 | Other residential, NEC[4] |
| | 2 | INDUSTRIAL/MANUFACTURING |
| 4 | 21 | Food and kindred products |
| 4 | 22 | Textile mill products |
| 4 | 23 | Apparel |
| 4 | 24 | Lumber and wood products |
| 4 | 25 | Furniture and fixtures |
| 4 | 26 | Paper and allied products |
| 4 | 27 | Printing, publishing |
| 4 | 28 | Chemicals and allied products |
| 4 | 29 | Petroleum refining and related ind. |
| | 3 | INDUSTRIAL/MANUFACTURING |
| 4 | 31 | Rubber and misc. plastic goods |
| 4 | 32 | Stone, clay and glass |
| 4 | 33 | Primary metals |
| 4 | 34 | Fabricated metals |
| 3 | 35 | Professional, scientific and controlling instruments |
| 4 | 39 | Misc. Mfg. NEC |

* of Figure 5

TABLE 2* (Cont)

| Noise Sensitivity Code | SLUCM Code | Category |
|---|---|---|
| | 4 | TRANSPORTATION, COMMUNICATIONS AND UTILITIES |
| 5 | 41 | Railroad, rapid rail transit |
| 5 | 42 | Motor vehicle transport |
| 5 | 43 | Aircraft transport |
| 5 | 44 | Marine craft transport |
| 5 | 45 | Highway and street ROW |
| 5 | 46 | Auto parking |
| 3 | 47 | Communication |
| 5 | 48 | Utilities |
| 5 | 49 | Other trans. communications and utilities NEC |
| | o5 | COMMERCIAL/RETAIL TRADE |
| 5 | 51 | Wholesale trade |
| 5 | 52 | Building materials retail |
| 3 | 53 | General merchandise retail |
| 3 | 54 | Food retail |
| 5 | 55 | Automotive retail |
| 3 | 56 | Apparel and accessories retail |
| 3 | 57 | Eating and drinking places |
| 3 | 59 | Other retail NEC |
| | o | PERSONAL AND BUSINESS SERVICES |
| 3 | 61 | Finance, insurance and real estate |
| 3 | 62 | Personal and business services |
| 5 | 63 | Contract construction services and storage |
| 5 | 64 | Auto repair services, |
| 3 | 65 | Professional services[6] |
| 3 | o | Indoor recreation services |
| 3 | 69 | Other services NEC |
| | o | PUBLIC AND QUASI-PUBLIC SERVICES |
| 1-3 | 67 | Government services |
| 1 | 68 | Education services |
| 1 | 711 | Cultural activities |
| 1 | 651 | Medical and other health services |
| 4 | 624 | Cemeteries |
| 1-3 | 69x | Nonprofit organization, incl. churches |
| 1-3 | o | Other p. and qp. services NEC |

TABLE 2* (Cont)

| Noise Sensitivity Code | SLUCM Code | |
|---|---|---|
| | o | OUTDOOR RECREATION |
| 3 | 761 | Playgrounds and neighborhood parks |
| 3 | 762 | Community and regional parks |
| 3 | 712 | Nature exhibits |
| 3 | 722 | Sports assembly |
| 4 | 741 | Golf courses, riding stables |
| 4 | 743,744 | Water based recreation areas |
| 2-3 | 75 | Resorts and group camps |
| 1-3 | 721 | Entertainment assembly |
| 1-3 | o | Other outdoor recreation NEC |
| | o | AGRICULTURE, MINING AND OPEN LAND |
| 5 | 81,NEC | Farms, except livestock |
| 4 | 815,817 | Livestock farms |
| 5 | 82 | Agriculture related activities |
| 5 | 83 | Forestry activities |
| 5 | 84 | Fishery activities |
| 5 | 85 | Mining activities |
| 5 | 91 | Undeveloped land |
| 5 | 93 | Water areas |

FOOTNOTES:

1/ Noise Code 1 contains the most noise sensitive land uses; Noise Code 5 the least sensitive.

2/ "Standard Land Use Coding Manual," Urban Renewal Administration, Housing and Home Finance Agency and Bureau of Public Roads. Department of Commerce, 1st edition, January 1965.

3/ "x" after SLUCM numbers means it represents a category broader or narrower than, but generally inclusive of, the category described.

4/ NEC - Not elsewhere classified.

5/ "o" denotes no closely comparable grouping or category in SLUCM code.

6/ Ordinarily medical services would be subsumed under this heading, but noise sensitivity considerations led to a separate listing.

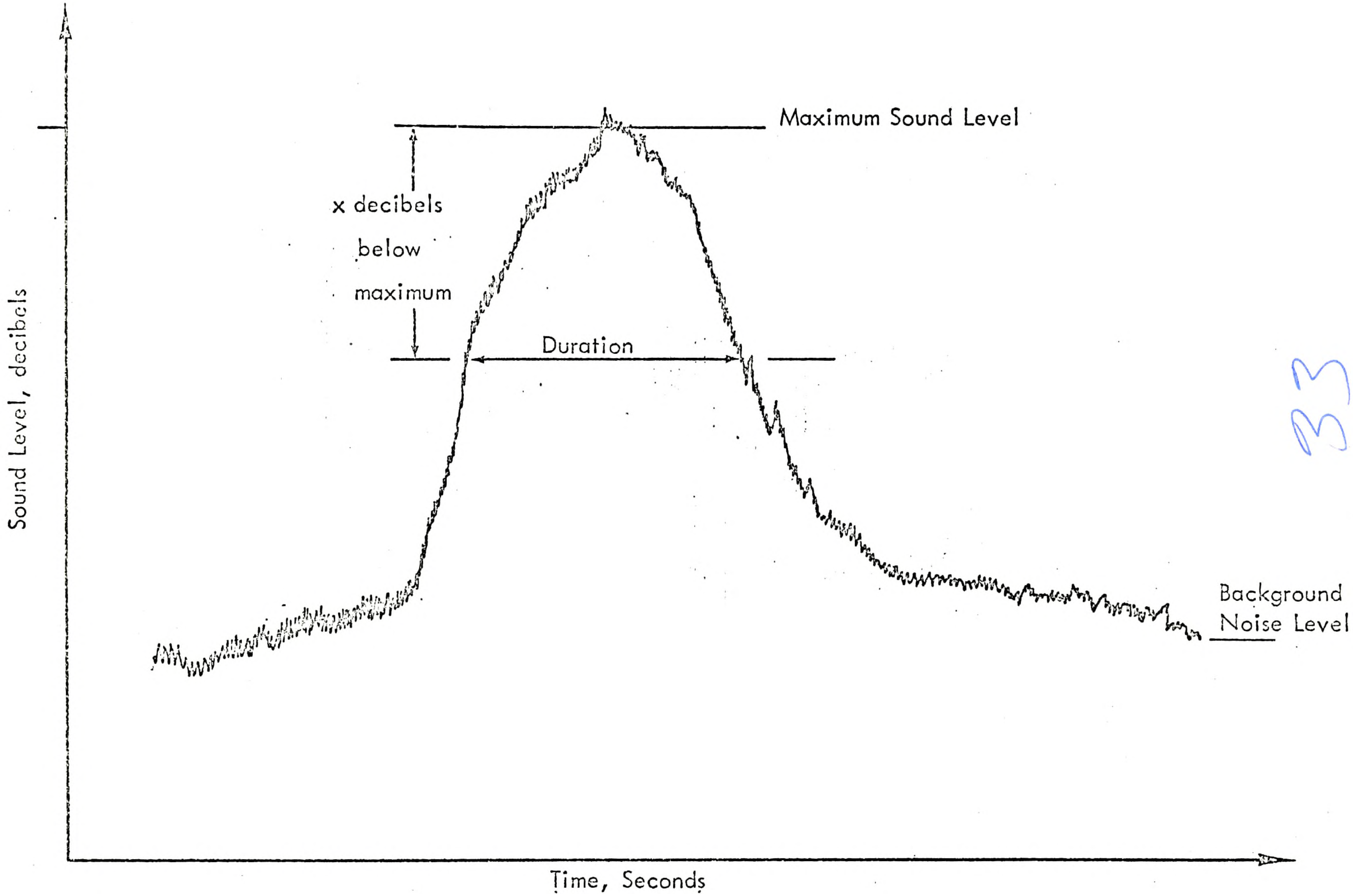
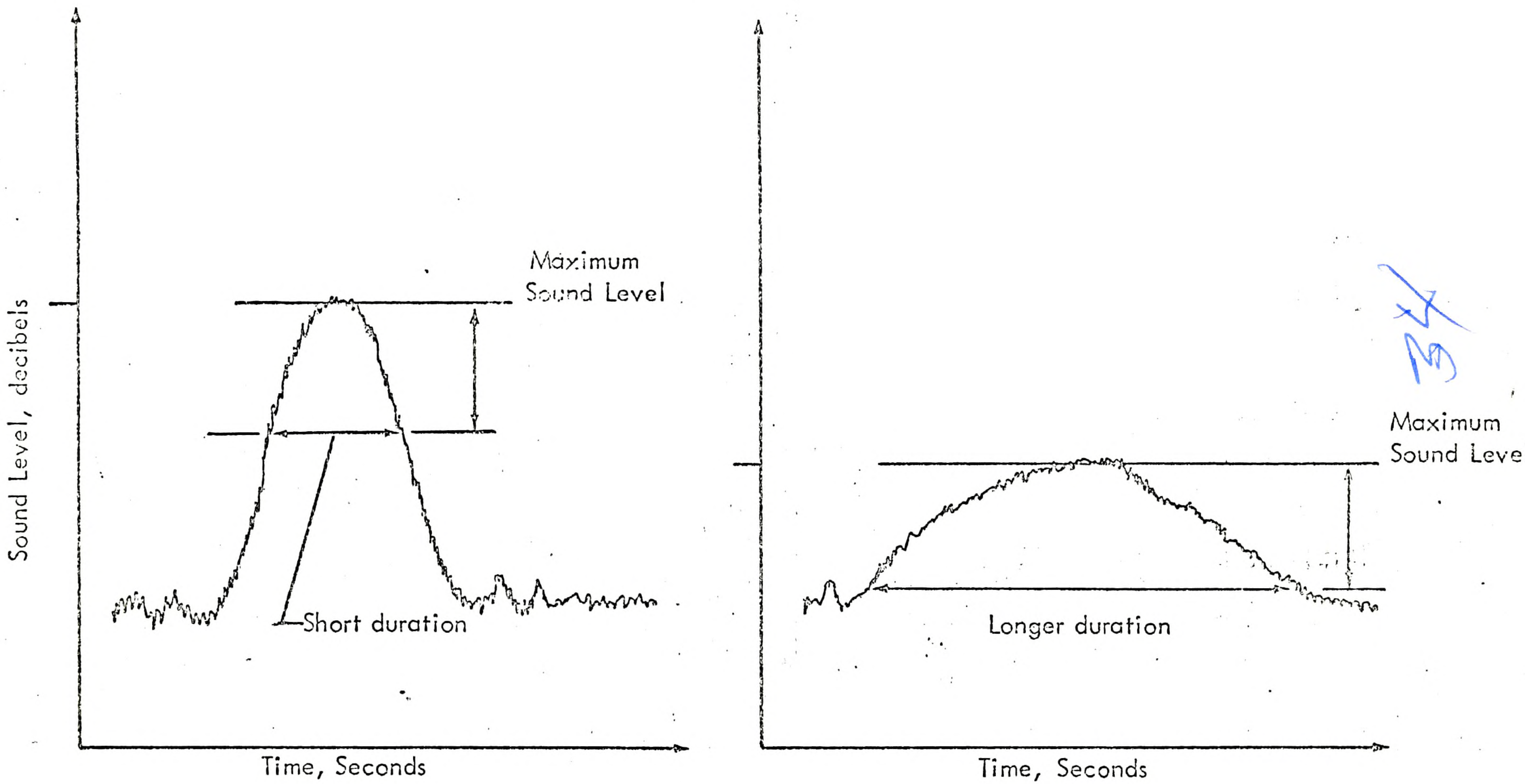



Figure 1. TYPICAL TIME HISTORY TRACE OF AN AIRCRAFT FLYBY




(a) Near the aircraft

(b) Farther from the aircraft

Figure 2. COMPARISON OF TIME HISTORY FOR AN OBSERVER NEAR THE AIRCRAFT AND AN OBSERVER FARTHER FROM THE AIRCRAFT

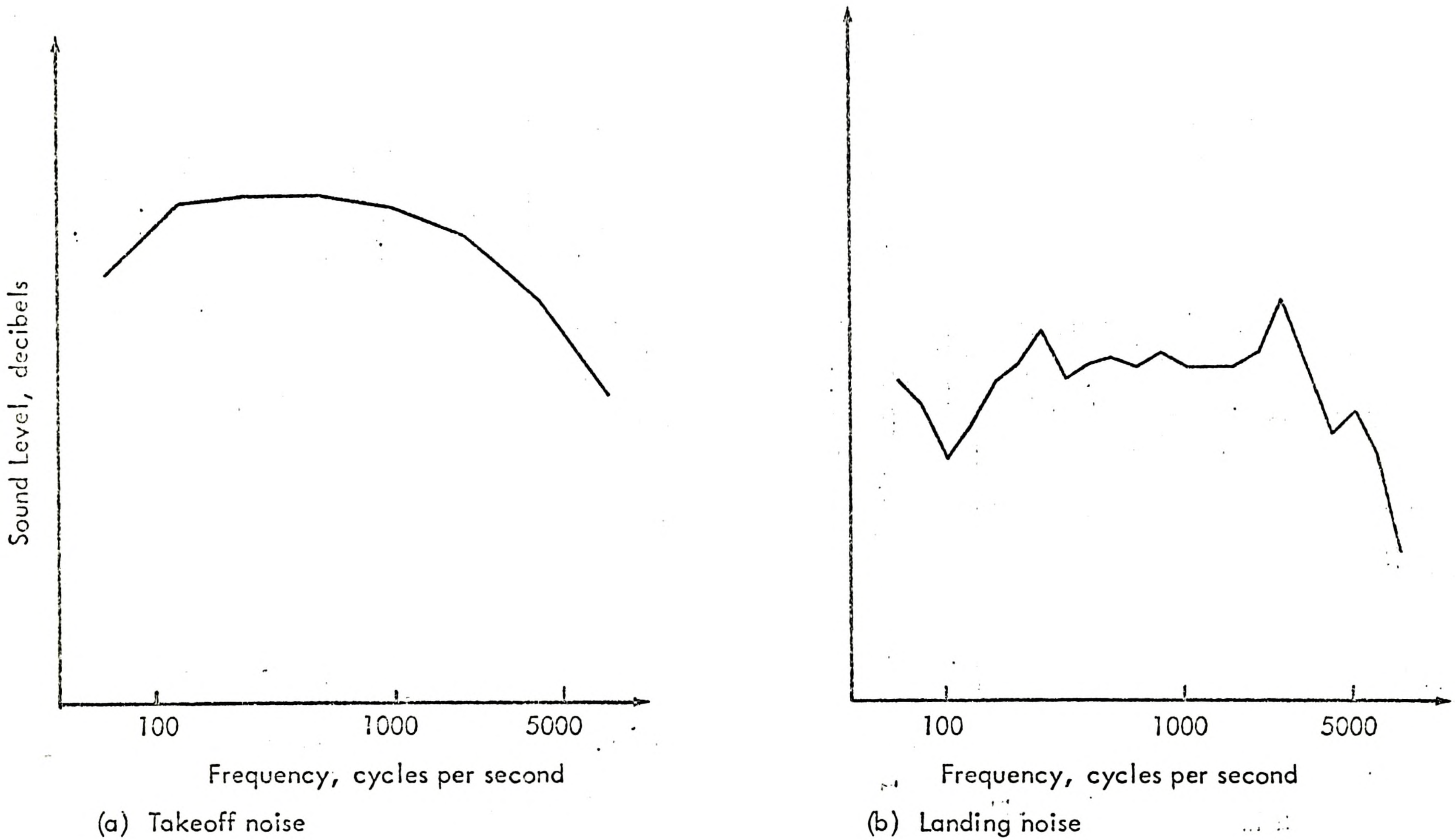



Figure 3. SPECTRUM SHAPES CHARACTERISTIC OF JET AIRCRAFT TAKEOFF AND LANDING SOUNDS

New scale

No. of aircraft

Mix of aircraft

weight factor for time of day

10 miles - 10

3

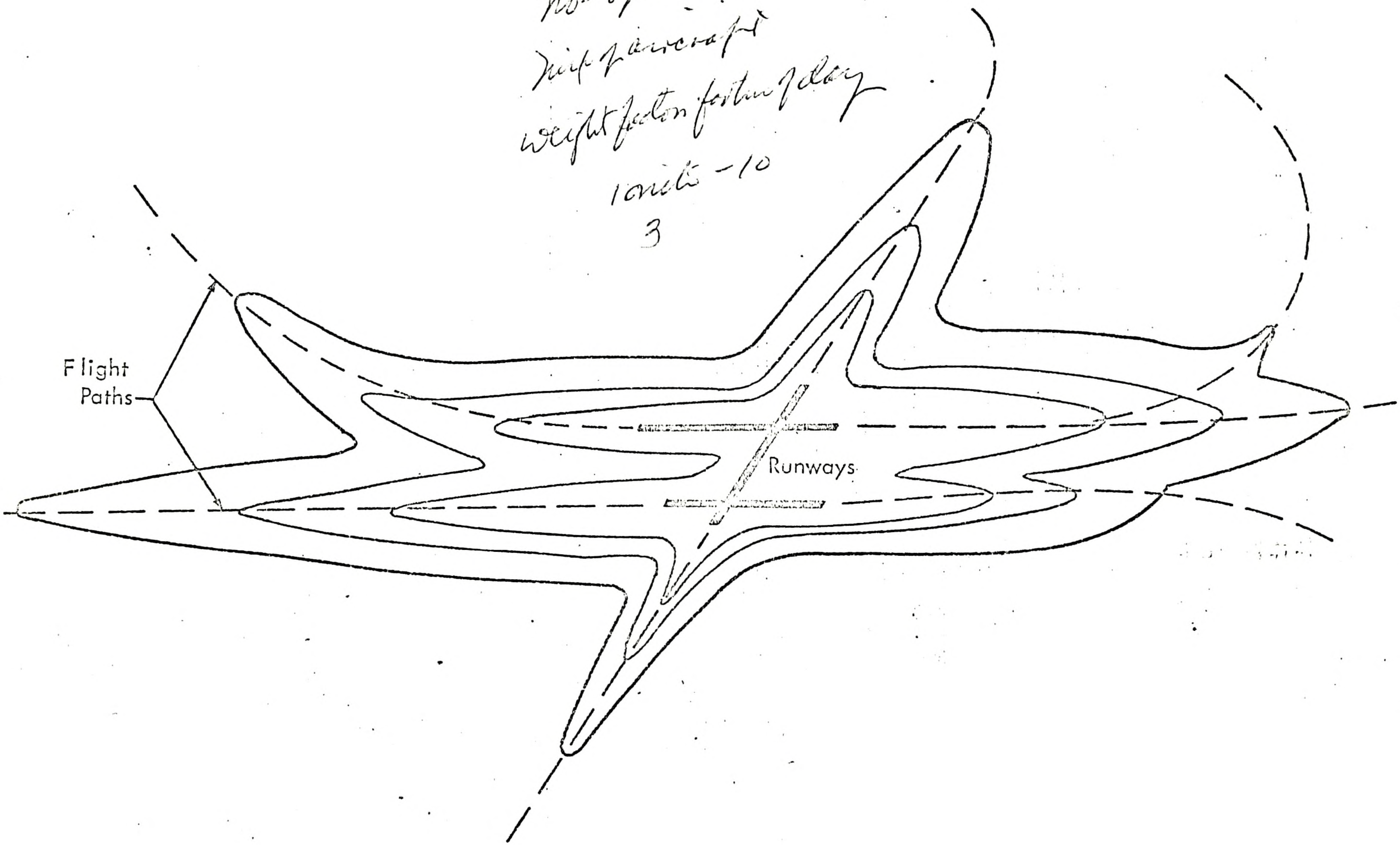
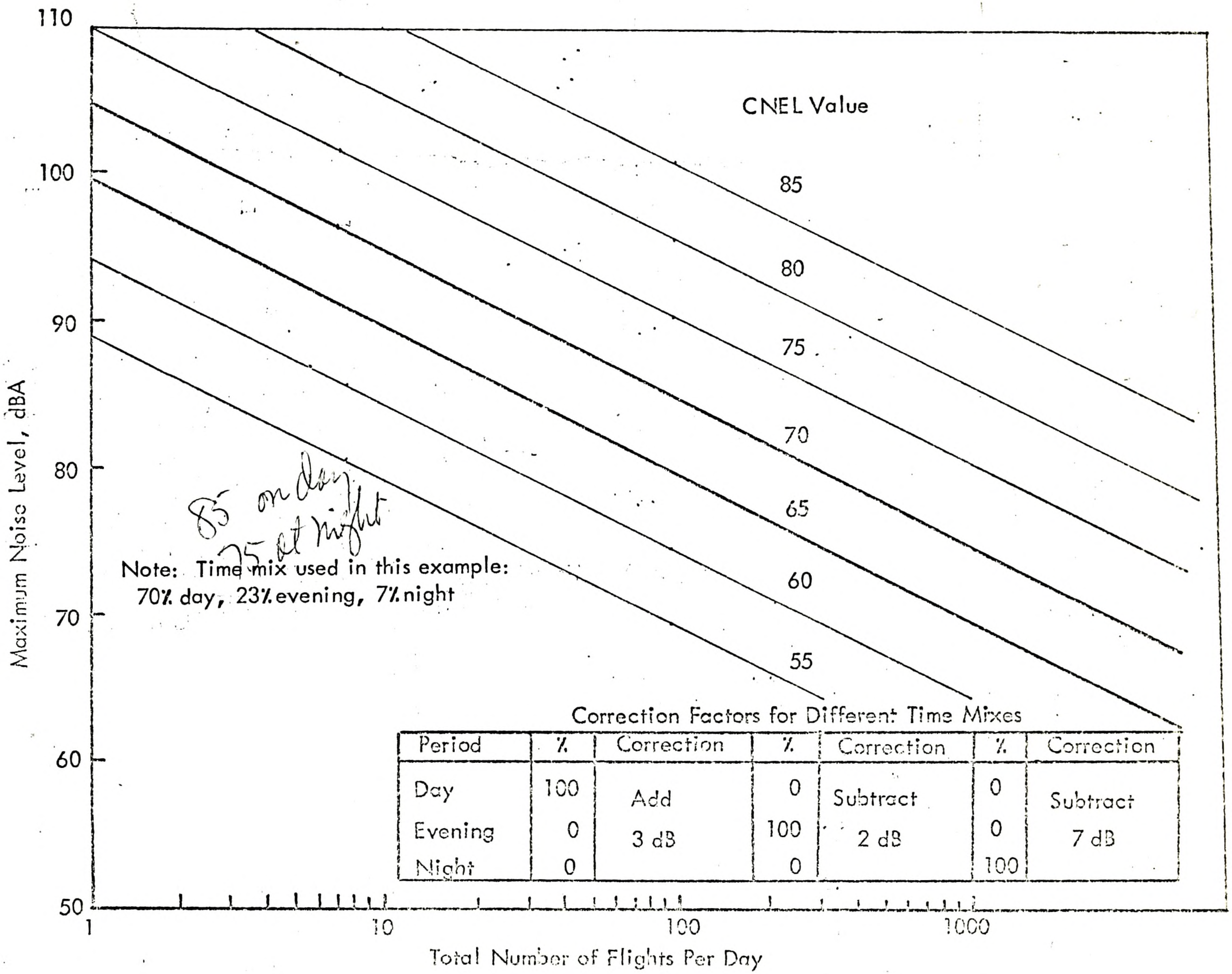



Figure 4. NOISE CONTOURS AROUND AN AIRPORT




Correction Factors for Different Time Mixes

| Period | % | Correction | % | Correction | % | Correction |
|---|---|---|---|---|---|---|
| Day | 100 | Add 3 dB | 0 | Subtract 2 dB | 0 | Subtract 7 dB |
| Evening | 0 | | 100 | | 0 | |
| Night | 0 | | 0 | | 100 | |

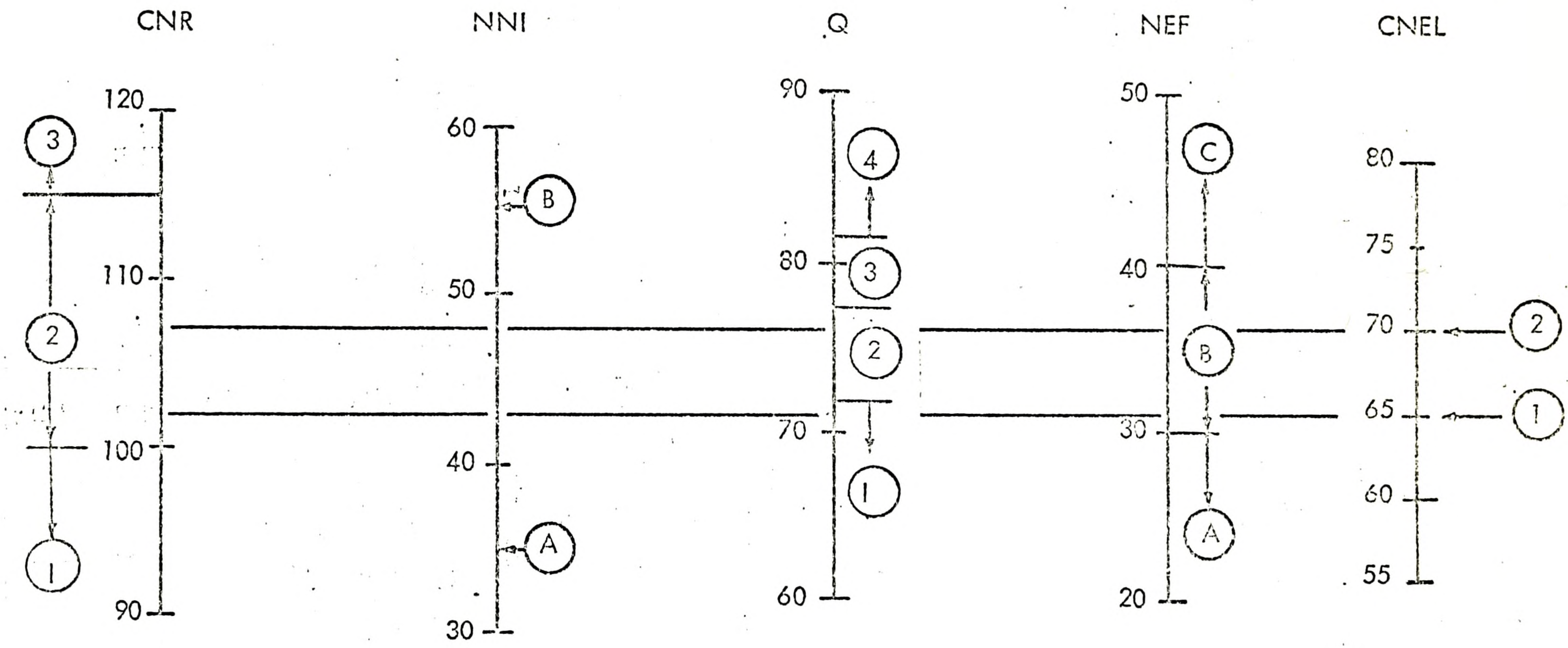
Figure 6. TYPICAL PEAK FLYBY NOISE (dBA) FOR GIVEN NUMBERS OF FLIGHTS AND CNEL VALUES.

Table I of Figure 7

MEANINGS OF THE VARIOUS ZONES IN THE MAJOR COMPOSITE RATING SCALES

| Scale | Zone or Note | Meaning as Related to Residences |
|---|---|---|
| CNEL | (1) | Recommended limit for residential use (normal construction), for new airports. |
| | (2) | Recommended limit for residential use (normal construction), for existing airports. |
| NEF | (A) | No problems with residential use. |
| | (B) | Individuals in private residences may complain, perhaps vigorously; concerted group action is possible. New single-family dwelling construction should be avoided. If apartments are constructed, noise control features should be included in their design. |
| | (C) | Residential use is incompatible. |
| Q | (1) | No restrictions, except no new hospitals should be built near boundary with zone 2. |
| | (2) | Residential construction will require some noise control measures in the design. |
| | (3) | Residential construction should be permitted only in urgent cases; and strong noise control measures are required in the design. |
| | (4) | Residential use is incompatible, regardless of building design. |
| NNI | (A) | Probable threshold for beginning of annoyance. |
| | (B) | Approximate limit beyond which the noise exposure is unacceptable (daytime). |
| CNR | (1) | Essentially no complaints expected, but the noise may occasionally interfere with certain activities of some residents. |
| | (2) | Individuals may complain, perhaps vigorously; concerted group action is possible. |
| | (3) | Individual reactions will include repeated, vigorous complaints. Concerted group action is probable. |

Figure 7. APPROXIMATE COMPARISON OF THE MAJOR COMPOSITE RATING SCALES




CNR - Composite Noise Rating (A scale used for land use planning around air bases in the U.S.)

NNI - Noise and Number Index (A scale used for airport site location and land use planning in the United Kingdom)

Q-Index - (A scale used in Germany for achieving compatability between airports and surrounding land uses)

NEF - Noise Exposure Forecast (A scale used in the U.S. for commercial airport and related land use decisions)

CNEL - Community Noise Exposure Level (A scale applicable both to noise monitoring and to airport and land use decisions under the proposed California standard for airports)

See accompanying table for land use recommendations of the user countries in the various zones.

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1. California Department of Aeronautics, "Report to the Legislature on Proposed Noise Standards for California Airports Pursuant to Public Utilities Code Section 21669," April 1, 1970 (in process of revision).

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