#65.40 7/2/71

First Supplement to Memorandum 71-46

Subject: Study 65.40 - Inverse Condemnation (Aircraft Noise Damage)

The attached letter gives you further information on why the Commission has been requested to give further consideration to the subject of aircraft noise damage.

Rsepectfully submitted,

John H. DeMoully
Executive Secretary

1st Supp Memo 71-46

EXHIBIT I

STATE OF CALIFORNIA

BUSINESS AND TRANSPORTATION AGENCY

RONALD REAGAN
Governor

J. R. CROTTI
Director of Aeronautics
Sacramento Executive Airport
Sacramento, California 95822
916 - 445-2582

DEPARTMENT OF AERONAUTICS

JUN 30 1971

Mr. Clifton A. Moore
General Manager
L. A. Department of Airports
#1 World Way
Los Angeles, California 90045

Dear Clif:

This acknowledges our June 17 telephone conversation regarding the meeting of the California Law Revision Commission. The date, time, and place have now been firmed up. The California Law Revision Commission will meet in the State Bar Building, 601 McAllister Street, San Francisco, July 15, 1971, at 7:00 p.m.

We have asked the California Law Revision Commission to consider the problem that airports face today on inverse condemnation stemming from aircraft noise damage. Our concern is that the courts and individuals would use the California Noise Regulations, or for that matter, any numbers or contour lines used in regulations by any governmental agency as a sole or predominant basis for a claimed presumption of compensable noise damage.

This position is based upon the interpretation that the scribing of any noise contour line on a map which is based upon the operations of aircraft from an airport, and which would define acceptable and unacceptable amounts of noise, would provide an automatic tool for use in court on cases claiming damage due to noise. The precedent for this action has already been established by the award given the plaintiff AARON in the case Aaron vs. Los Angeles Department of Airports. Judge Jefferson gave this award based upon the location of the 40 NEF contour line as respecting the plaintiff's property. Although the Los Angeles Department of Airports is appealing this decision, it is their legal department's opinion that once the NEF Methodology or any other system such as the State Noise Regulations become effective, this will provide prima facie evidence of the existence of noise damage conditions which will encourage the citizens living near the airport to enter and probably win legal claims for damage.

We are greatly concerned that unless we resolve this problem, it will result in damages to our vitally important air transportation system.

Please have your attorney prepare to make a presentation to the Commission reflecting your particular problems in this area and possible solutions if you have any.

Sincerely,

ORIGINAL SIGNED BY
JOSEPH R. CROTTI

JOSEPH R. CROTTI
Director

cc Mr. Brian Van Camp, Acting Secretary
Business and Transportation Agency

Mr. Daniel Weston, Deputy Attorney General

Mr. Nicholas Yost, Deputy Attorney General

Mr. Kenneth Eldred, Wyle Laboratories

Mr. John H. DeMoully, Executive Secretary
California Law Revision Commission

NOTE: The above letter also sent to:

Mr. James Carr, General Manager
San Francisco International Airport

Mr. Christopher Knapp, Director of Aviation
Oakland Port Authority

71-46 1st Supp.

SUBCHAPTER 6. NOISE STANDARDS

Article 1. General

5000. Preamble. The following rules and regulations are promulgated in accordance with Article 3, Chapter 4, Part 1, Division 9, Public Utilities Code (Regulation of Airports) to provide noise standards governing the operation of aircraft and aircraft engines for all airports operating under a valid permit issued by the department. These standards are based upon two separate legal grounds: (1) the power of airport proprietors to impose noise ceilings and other limitations on the use of the airport, and (2) the power of the state to act to an extent not prohibited by federal law. The regulations are designed to cause the airport proprietor, aircraft operator, local governments, pilots, and the department to work cooperatively to diminish noise. The regulations accomplish these ends by controlling and reducing the noise in communities in the vicinity of airports.

NOTE: Authority cited: Section 21669, Public Utilities Code. Reference: Sections 21669–21669.4, Public Utilities Code.

History: 1. New Subchapter 6 (§§ 5000–5006, 5010–5014, 5020–5025, 5030–5032, 5035, 5040, 5045–5048, 5050, 5055, 5060–5064, 5065, 5070, 5075, 5080, 5080.1–5080.5) filed 10-25-70; designated effective 12-1-71 (Register 70, No. 48).

5001. Liberal Construction. This subchapter shall be liberally construed and appled to promote its underlying purposes which are to protect the public from noise and to resolve incompatibilities between airports and their surrounding neighbors.

5002. Constitutionality. If any provision of this subchapter or the application thereof to any person or circumstance is held to be unconstitutional, the remainder of the subchapter and the application of such provision to other persons or circumstances shall not be affected thereby.

5003. Provisions Not Exclusive. The provisions of this subchapter are not exclusive, and the remedies provided for in this subchapter shall be in addition to any other remedies provided for in any other law or available under common law. It is not the intent of these regulations to preempt the field of aircraft noise limitation in the state. The noise limits specified herein are not intended to prevent any local government to the extent not prohibited by federal law or any airport proprietor from setting more stringent standards.

5004. Applicability. These regulations establish a mandatory procedure which is applicable to and at all existing and future potential airports in California which are required to operate under a valid permit issued by the department. These regulations are applicable (to the degree not prohibited by federal law) to all operations of aircraft and aircraft engines which produce noise. Only those airports which shall have been determined to have a noise problem (in accordance with Section 5050) will be required to perform noise monitoring.

The regulations established by this subchapter are not intended to set noise levels applicable in litigation arising out of claims for damages occasioned by noise. Nothing herein contained in these regulations shall be construed to prescribe a duty of care in favor of, or to create any evidentiary presumption for use by, any person or entity other than the State of California, the counties and airport proprietors in the enforcement of these regulations.

5005. Findings. Citizens residing in the vicinity of airports are exposed to the noise of aircraft operations. There have been numerous instances wherein individual citizens or organized citizen groups have complained about airport noise to various authorities. The severity of these complaints has ranged from a few telephone calls to organized legal action. Many of these cases have been studied by acoustics research workers under sponsorship of governmental and private organizations. These studies have generally shown that the severity of the complaint is principally associated with a combination of the following factors:

(a) Magnitude and duration of the noise from aircraft operations;

(b) Number of aircraft operations; and

(c) Time of occurrence during the day (daytime, evening or night).

There are many reasons given by residents for their complaints; however, those most often cited are interference with speech communication, TV, and sleep. A number of studies have been made related to speech interference and hearing damage, and some studies have been made related to sleep disturbance and other physiological effects. These studies provide substantial evidence for the relationship between noise level and its interference with speech communication and its effect relative to hearing loss. Significantly less information is available from the results of sleep and physiological studies.

In order to provide a systematic method for evaluating and eventually reducing noise incompatibilities in the vicinity of airports, it is necessary to quantify the noise problem. For this purpose, these regulations establish a procedure for defining a noise impact area surrounding an individual airport. The criteria and noise levels utilized to define the boundaries of the noise impact area have been based on existing evidence from studies of community noise reaction, noise interference with speech and sleep, and noise induced hearing loss.

One of the fundamental philosophies underlying the procedures in these regulations is that any noise quantity specified by these regulations be measurable by relatively simple means. Therefore, these regulations utilize as their basic measure the A-weighted noise level, which is the most commonly accepted simple measure. To insure consistency between criteria and measurement, the units for the criteria are also based on the A-weighted sound level rather than one of the several more complex perceived noise levels.

These regulations provide a procedure to limit the allowable noise for an individual aircraft flyby measured at specified points in the vicinity of the airport. The noise limits are specified in terms of the class of aircraft and measurement location.

The level of noise acceptable to a reasonable person residing in the vicinity of an airport is established as a community noise equivalent level (CNEL) value of 65 dB for purposes of these regulations. This criterion level has been chosen for reasonable persons residing in urban residential areas where houses are of typical California construction and may have windows partially open. It has been selected with reference to speech, sleep and community reaction.

It is recognized that there is a considerable individual variability in the reaction to noise. Further, there are several factors which undoubtedly influence this variability and which are not thoroughly understood. Therefore, this criterion level does not have a degree of precision which is often associated with engineering criteria for a physical phenomenon (e.g., the strength of a bridge, building, et cetera). For this reason, the state will review the criterion periodically, taking into account any new information which may become available.

5006. Definitions. (a) **Sound Pressure Level (SPL):** The sound pressure level, in decibels (dB), of a sound is 20 times the logarithm to the base of 10 of the ratio of the pressure of this sound to the reference pressure. For the purpose of these regulations, the reference pressure shall be 20 micronewtons/square meter (2×10^{-4} microbar).

(b) **Noise Level (NL):** Noise level, in decibels, is an A-weighted sound pressure level as measured using the slow dynamic characteristic for sound level meters specified in ASA S1.4—1961, American Standard Specification for General Purpose Sound Level Meters, or latest revision thereof. The A-weighting characteristic modifies the frequency response of the measuring instrument to account approximately for the frequency characteristics of the human ear. The reference pressure is 20 micronewtons/square meter (2×10^{-4} microbar).

(c) **Noise Exposure Level (NEL):** The noise exposure level is the level of noise accumulated during a given event, with reference to a duration of one second. More specifically, noise exposure level, in decibels, is the level of the time-integrated A-weighted squared sound pressure for a stated time interval or event, based on the reference pressure of 20 micronewtons per square meter and reference duration of one second.

(d) **Single Event Noise Exposure Level (SENEL):** The single event noise exposure level, in decibels, is the noise exposure level of a single event, such as an aircraft flyby, measured over the time interval between the initial and final times for which the noise level of a single event exceeds the threshold noise level. For implementation in this subchapter of these regulations, the threshold noise level shall be at least 30 decibels below the numerical value of the single event noise exposure level limits specified in Section 5035.

(e) **Hourly Noise Level (HNL):** The hourly noise level, in decibels, is the average (on an energy basis) noise level during a particular hour. Hourly noise level is determined by subtracting 35.6 decibels equal to $10 \log_{10} 3600$) from the noise exposure level measured during the particular hour, integrating for those periods during which the noise level exceeds a threshold noise level.

For implementation in this subchapter of these regulations, the threshold noise level shall be a noise level which is 10 decibels below the numerical value of the appropriate criterion CNEL which is specified in Section 5012. At some microphone locations, sources of noise other than aircraft may contribute to the CNEL. Where the airport proprietor can demonstrate that the accuracy of the CNEL measurement will remain within the required tolerance in Section 5045, the department may grant a waiver to increase the threshold noise level.

(f) **Daily Community Noise Equivalent Level (CNEL):** Community noise equivalent level, in decibels, represents the average daytime noise level during a 24-hour day, adjusted to an equivalent level to account for the lower tolerance of people to noise during evening and night time periods relative to the daytime period. Community noise equivalent level is calculated from the hourly noise levels by the following:

$$\text{CNEL} = 10 \log \frac{1}{24}\left[\sum \text{antilog} \frac{\text{HNLD}}{10} + 3 \sum \text{antilog} \frac{\text{HNLE}}{10} + 10 \sum \text{antilog} \frac{\text{HNLN}}{10}\right]$$

Where

HNLD are the hourly noise levels for the period 0700–1900 hours;

HNLE are the hourly noise levels for the period 1900–2200 hours;

HNLN are the hourly noise levels for the period 2200–0700 hours; and Σ means summation.

(g) **Annual CNEL:** The annual CNEL, in decibels, is the average (on an energy basis) of the daily CNEL over a 12-month period. The annual CNEL is calculated in accordance with the following:

$$\text{Annual CNEL} = 10 \log_{10}\left[\frac{1}{365} \sum \text{antilog} \left(\frac{\text{CNEL(i)}}{10}\right)\right]$$

Where

CNEL(i) = the daily CNEL for each day in a continuous 12-month period, and Σ means summation.

When the annual CNEL is approximated by measurements on a statistical basis, as specified in Section 5022, the number 365 is replaced by the number of days for which measurements are obtained.

(h) **Noise Impact Boundary:** Noise impact boundary around an airport consists of the locus of points for which the annual CNEL is equal to the criterion value.

(i) **Noise Impact Area:** Noise impact area, in square statute miles, is the total land area within the noise impact boundary less that area deemed to have a compatible land use in accordance with Section 5014.

(j) **Airport Proprietor**: Airport proprietor means the holder of an airport permit issued by the department pursuant to Article 3, Chapter 4, Part 1, Division 9, Public Utilities Code.

(k) **Aircraft Operator**: Aircraft operator means the legal or beneficial owner of the aircraft with authority to control the aircraft utilization; except where the aircraft is leased, the lessee is the operator.

(*l*) **Air Carrier**: Air carrier is any aircraft operating pursuant to either a federal or a state certificate of public convenience and necessity, including any certificate issued pursuant to 49 U.S.C. Section 1371 and any permit issued pursuant to 49 U.S.C. Section 1372.

(m) **General Aviation**: General aviation aircraft are all aircraft other than air carrier aircraft and military aircraft.

(n) **Department**: Department means the Department of Aeronautics of the State of California.

(o) **County**: County, as used herein, shall mean the county board of supervisors or its designee authorized to exercise the powers and duties herein specified.

Article 2. Airport Noise Limits

5010. Purpose. The purpose of these regulations is to provide a positive basis to accomplish resolution of existing noise problems in communities surrounding airports and to prevent the development of new noise problems. To accomplish this purpose, these regulations establish a quantitative framework within which the various interested parties (i.e., airport proprietors, aircraft operators, local communities, counties and the state) can work together effectively to reduce and prevent airport noise problems.

5011. Methodology for Controlling and Reducing Noise Problems. The methods whereby the impact of airport noise shall be controlled and reduced include but are not limited to the following:

(a) Encouraging use of the airport by aircraft classes with lower noise level characteristics and discouraging use by higher noise level aircraft classes;

(b) Encouraging approach and departure flight paths and procedures to minimize the noise in residential areas;

(c) Planning runway utilization schedules to take into account adjacent residential areas, noise characteristics of aircraft and noise sensitive time periods;

(d) Reduction of the flight frequency, particularly in the most noise sensitive time periods and by the noisier aircraft;

(e) Employing shielding for advantage, using natural terrain, buildings, et cetera; and

(f) Development of a compatible land use within the noise impact boundary.

Preference shall be given to actions which reduce the impact of airport noise on existing communities. Land use conversion involving existing residential communities shall normally be considered the least desirable action for achieving compliance with these regulations.

5012. Airport Noise Criteria. Limitations on airport noise in residential communities are hereby established.

(a) The criterion community noise equivalent level (CNEL) is 65 dB for proposed new airports and for vacated military airports being converted to civilian use.

(b) Giving due consideration to economic and technological feasibility, the criterion community noise equivalent level (CNEL) for existing civilian airports (except as follows) is 70 dB until December 31, 1985, and 65 dB thereafter.

(c) The criterion CNEL for airports which have 4-engine turbojet or turbofan air carrier aircraft operations and at least 25,000 annual air carrier operations (takeoffs plus landings) is as follows:

Date	*CNEL in decibels*
Effective date of regulations to 12-31-75	80
1-1-76 to 12-31-80	75
1-1-81 to 12-31-85	70
1-1-86 and thereafter	65

5013. Noise Impact Boundary. The noise impact boundary at airports which have a noise problem as determined in accordance with Section 5050 shall be established and validated by measurement in accordance with the procedures given in Article 3 of this subchapter. For proposed new airports, or for anticipated changes of existing airports, the noise impact boundary shall be estimated by applicable acoustical calculation techniques.

The area of land which is within the noise impact boundary and which has incompatible land use is utilized as a measure of the magnitude of the noise problem at an airport. The concepts of noise impact boundary and noise impact area are illustrated in Figure 1.

5014. Compatible Land Uses Within the Noise Impact Boundary. The criterion for the noise impact boundary was established for residential uses including single-family and multiple-family dwellings, trailer parks, and schools of standard construction. Certain other land uses may occur within the boundary but be compatible with the community noise equivalent level and hence be excluded in the calculation of noise impact area. For this purpose, the following land uses are deemed compatible:

(a) Agricultural;
(b) Airport property;
(c) Industrial property;
(d) Commercial property;
(e) Property subject to an avigation easement for noise;
(f) Zoned open space;
(g) High-rise apartments in which adequate protection against exterior noise has been included in the design and construction, together with a central air conditioning system. Adequate protection

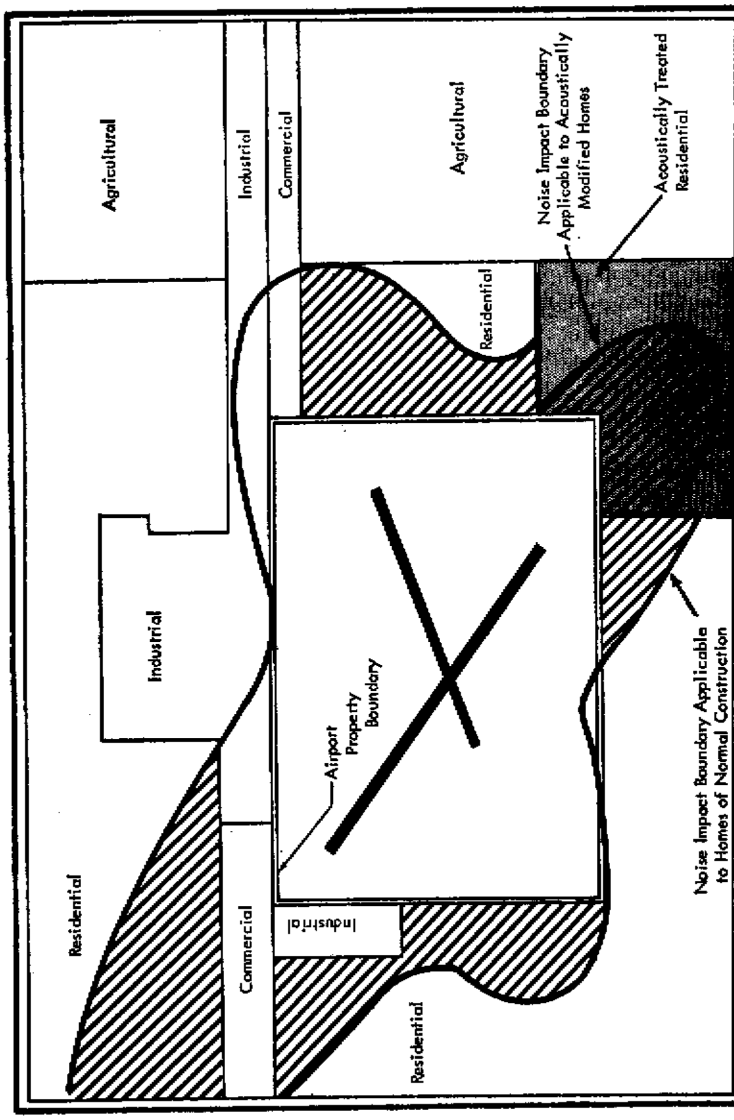


FIGURE 1. CONCEPTUAL SKETCH OF NOISE IMPACT BOUNDARY AND NOISE IMPACT AREA

The noise impact area is the sum of all the cross-hatched areas, in square statute miles.

means the noise reduction (exterior to interior) shall be sufficient to assure that interior community noise equivalent level in all habitable rooms does not exceed 45 dB during aircraft operations. Acoustical performance of the buildings shall be verified by calculation or measured by qualified officials of the building inspection agency of the city or county in which the buildings are situated;

(h) In the case of existing airports and existing homes only, residential areas in which existing homes have been acoutically treated need not be subject to exterior noise limits quite as strict as those for normal residential construction. For this purpose, the community noise equivalent level on the boundary of such a residential area may be increased by as much as 15 dB over the community noise equivalent level criterion for nonacoustically treated homes. The amount of the increase allowed on the boundary is the difference between the noise level reduction of the treated home and the value 20 decibels which is assumed to be the noise level reduction of an average normal residence. The noise level reduction of a home is defined as the average difference between aircraft noise levels in free space outside of the home and the corresponding noise levels in rooms on the exposed sides of the home.

In carrying out this section, the actual use to which the land is put, not the classification for which the land is zoned, is determinative.

Article 3. Establishing and Validating Noise Impact Boundaries for Airports Required to Monitor

5020. Validation of the Noise Impact Boundary. For airports with a noise problem (in accordance with Section 5050), the noise impact boundary shall be validated by measurements made at locations specified in Section 5021 and according to frequency requirements specified in Section 5022. These measurements shall be utilized to calculate the daily community noise equivalent levels. These daily CNEL values will then be averaged (on an energy basis) to obtain the annual CNEL at each of the community measurement locations. The location of the noise impact boundary will be considered valid if the value of the annual CNEL lies within ±1.5 dB of the criterion value.

5021. Community Measurement Locations. At least twelve (12) locations, approximately equidistant, but not exceeding one and one-half (1.5) statute miles separation, shall be selected along the noise impact boundary. The locations shall be selected such that the maximum extent of the boundary be determined with reference to the airport's flight patterns.

5022. Frequency of Measurement at Community Locations. (a) For airports with 1,000 or more homes within the noise impact boundary based on a CNEL of 70 dB, continuous monitoring is required at those monitoring positions which fall within residential areas. Measurement for at least 48 weeks in a year shall be considered as continuous monitoring.

(b) For all other locations and for all locations at other airports, an intermittent monitoring schedule is allowed. The intermittent monitoring schedule shall be designed so as to obtain the resulting annual CNEL as computed from measurements at each location which will correspond to the value which would be measured by a monitor operated continuously throughout the year at that location, within an accuracy of ± 1.5 dB.

Thus, it is required that the intermittent monitoring schedule be designed so as to obtain a realistic statistical sample of the noise at each location. As a minimum, this requres that measurements be taken continuously for 24-hour periods during four 7-day samples throughout the year, chosen such that for each sample, each day of the week is represented, the four seasons of the year are represented, and the results account for the effect of annual proportion of runway utilization. At most airports, these intermittent measurements can be accomplished by a single portable monitoring instrument.

5023. Initial Establishment of the Noise Impact Boundary. The method to be used for initial establishment of the noise impact boundary of airports required to monitor will vary depending upon specific situations. The following guidelines represent one possible method:

(a) Calculate the approximate location of the noise impact boundary using applicable acoustic estimation techniques.

(b) Select convenient measurement locations on this estimated boundary according to Section 5021.

(c) Make a suitable series of CNEL trial measurements along lines perpendicular to the estimated noise impact boundary. For example, two to three measurements over a one-to-seven day period along a line perpendicular to the estimated noise impact boundary should provide sufficient data to define, within the required accuracy, the nominal position of the noise impact boundary.

Due consideration should be given to the number and time period of aircraft operations, mix of aircraft classes, average runway utilization and other measurable factors which would cause a difference between the trial measurements of CNEL and the expected annual average.

(d) Initiate validation measurements of the noise impact boundary following selection of permanent or intermittent monitoring locations to comply with the validation accuracy criterion specified in Section 5020. For permanent measurement locations at which the measured CNEL lies outside this accuracy criterion, suitable auxiliary measurements or analytical methods may be used to extrapolate the measured CNEL to determine the value on the noise impact boundary. Such extrapolation procedures are subject to approval by the department.

5024. Deviations from Specified Measurement Locations. Recognizing the unique geographic and land use features surrounding specific airports, the department will consider measurement plans tailored to fit any airport for which the specified CNEL monitoring locations are impractical. For example, monitors should not be located on bodies of water or at points where other noise sources might interfere with aircraft CNEL measurements, nor are measurements required in regions where land use will clearly remain compatible.

5025. Alternative Measurement Systems. The acquisition of measurement systems that are more extensive or scientifically more refined than those specified herein is encouraged, particularly at airports with a major noise problem, where compliance with the intent of Section 5075(a)(4) requires more comprehensive noise monitoring, particularly to monitor noise abatement procedures. Airports contemplating the acquisition of such monitoring systems may apply to the department for exemptions from specific monitoring requirements set forth in this subchapter of these regulations.

Article 4. Measurement of Single Event Noise Exposure Level

5030. Measurement Requirements. Measurements of the single event noise exposure level (SENEL) shall be made in the vicinity of airports with a noise problem as determined in accordance with Section 5050. These measurements are intended to monitor the noise of aircraft to insure compliance with the noise limits recommended by the airport proprietor and approved by the department in accordance with Article 5.

5031. Measurement Locations. Measurements shall be made on the centerline of the nominal takeoff and landing flight tracks for air carrier jet aircraft and private jet aircraft at the locations specified in Figure 2. The nominal flight track is the line projected on the ground under the nominal flight path of the aircraft. Measurements will not be required for landing or takeoff flight tracks associated with aircraft operations which do not contribute to the noise impact area of the airport.

5032. Frequency of Measurement. At each microphone location, single event noise exposure level measurements shall be made continuously for a minimum of 48 weeks per year. The remaining 4 weeks are intended to allow for intermittent periods of down-time for equipment maintenance and calibration.

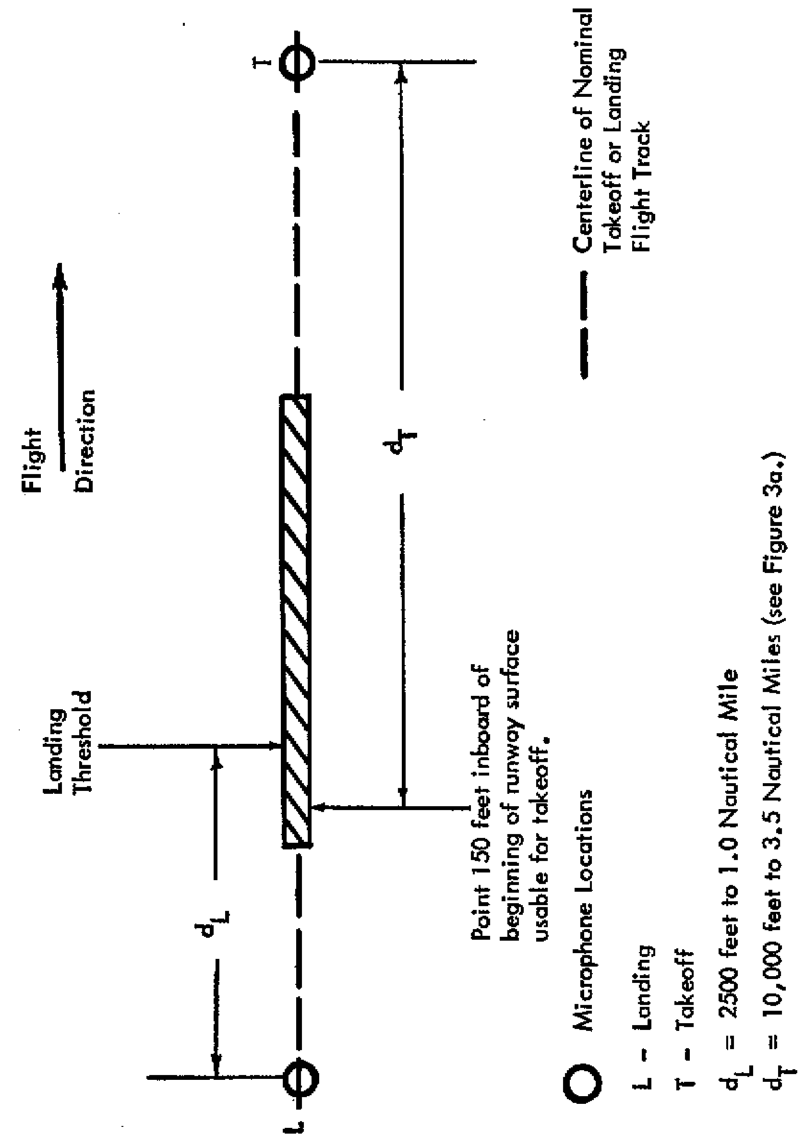


FIGURE 2. SINGLE EVENT NOISE EXPOSURE LEVEL MONITORING POSITIONS

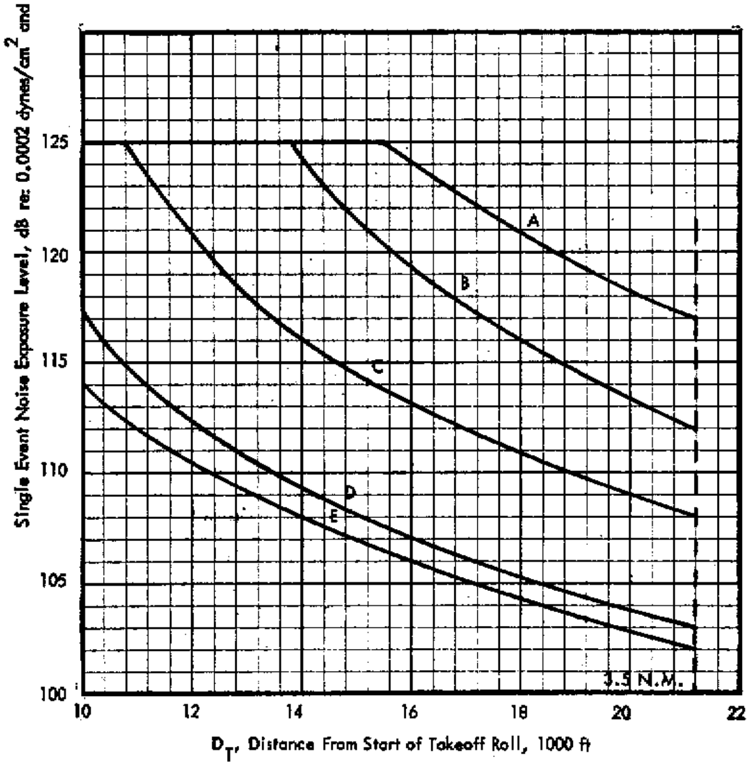
Article 5. Single Event Noise Limits

5035. Maximum Single Event Noise Exposure Levels. The proprietor of each airport which is required to perform noise monitoring shall recommend to the department the single event noise exposure level limits appropriate to his airport. In no event shall the limits recommended by the airport proprietor exceed the values in Figures 3A and 3B which correspond to the noisiest aircraft class utilizing the airport on a recurrent basis (which shall mean an average of at least two aircraft operations per day) during the six-month period prior to the determination that the airport has a noise problem (Section 5050). The values in Figures 3A and 3B are based on maximum gross weight operation without noise abatement flight procedures under standard atmospheric conditions at sea level. Airport proprietors are therefore encouraged to recommend lower limits. Upon approval of such limits at a specific airport, those limits will be enforced by the county in accordance with this entire subchapter of these regulations.

Article 6. Additional Monitoring Locations

5040. Additional Monitoring Locations. For airports which are required to monitor, additional monitoring locations may be useful in some cases. These additional locations may be utilized for measurement of either single event noise exposure levels (such as monitoring of noise abatement flight procedures) or community noise equivalent levels (such as at fixed points in high noise level residential areas). The frequency of measurement at these additional monitoring locations should be determined on the basis of each specific situation.

Curve		Aircraft Class
A	4	Engine Turbojet Turbofan (e.g., 707, 720, DC-8)
B	4	Engine "Jumbo" Turbofan* (e.g., 747)
C	3	Engine Turbofan and Airbus*(e.g.,727, DC-10, L-1011)
D	2	Engine Turbofan (e.g., DC-9, 737)
E	2	Engine Business Jet.
E + 3 dB	4	Engine Business Jet
	*	High Bypass Ratio Engine



a) Takeoff

FIGURE 3A. MAXIMUM LIMITS FOR SINGLE EVENT NOISE EXPOSURE LEVEL

Curve	Aircraft Class
Z	4 Engine Turbojet and Turbofan (e.g., 707,720,DC-8)
Y	2,3 Engine Turbofan (e.g., 727,737,DC-9)
X	4 Engine "Jumbo" Turbofan* (e.g., 747)
W	3 Engine Airbus Turbofan* (e.g., DC-10, L-1011)
V	2 Engine Business Jet
V+3 dB	4 Engine Business Jet
	* High Bypass Ratio Engine

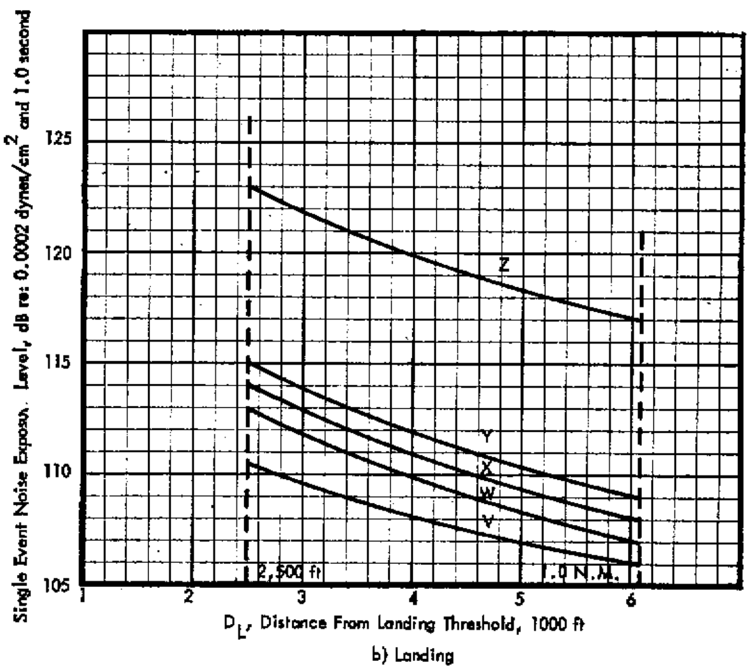


FIGURE 3B. MAXIMUM LIMITS FOR SINGLE EVENT NOISE EXPOSURE LEVEL

Article 7. Noise Monitoring System Requirements

5045. General Specifications. (a) The noise monitoring system shall provide for the following outputs:

(1) In the vicinity of airport (see Article 5). Single event noise exposure levels exceeding the maximum limits, together with their time of occurence.

(2) In community (see Section 5020). Hourly noise level for each hour of the day, together with identification of the hour.

(b) The overall accuracy of the noise measurement system shall be ± 1.5 dB, determined in accordance with the procedure of the noise measurement system specification given in Sections 5080 through 5080.5 of these regulations.

5046. Detailed Specifications. Noise monitoring systems shall be in accordance with detailed specifications given in Sections 5080 through 5080.5 of these regulations.

5047. Field Measurement Precautions. Specific locations of the monitoring system, particularly for the community measurement locations, shall be chosen, whenever possible, such that the community noise equivalent level at the location from sources other than aircraft in flight be equal to or less than 55 dB. This objective may be satisfied by selecting the location such that it is in a residential area not immediately adjacent to a noisy industry, freeway, railroad track, et cetera. The measurement microphone shall be placed 20 feet above the ground level, or at least 10 feet above neighboring roof tops, whichever is higher. To the extent practicable, the following precautions shall be followed:

(a) Each SENEL monitor location shall be in an open area surrounded by relatively flat terrain, having no excessive sound absorption characteristics such as might be caused by thick, tall grass, shrubbery, or wooded areas.

(b) No obstructions which significantly influence the sound field from the aircraft shall exist within a conical space above the measurement position, the cone being defined by an axis along a line of sight normal to the aircraft path and by a half angle of 75 degrees from this axis.

(c) When the foregoing precautions are not practicable, the microphones shall be placed at least 10 feet above neighboring buildings in a position which has a clear line-of-sight view to the path of the aircraft in flight.

5048. Number of Measurement Systems. The frequency of measurement specified in Sections 5022 and 5032 has been designed to limit the number of monitoring systems required. The minimum number of systems required per airport is:

(a) One for intermittent measurements of the noise impact boundary, plus

(b) One for continuous measurement of the single event noise exposure level for each landing or departure flight track as specified in Section 5031.

This minimum number will increase where necessary to conform to the requirement that separation distance between monitoring positions on the boundary not exceed one and one-half (1.5) statute miles or when continuous measurements are required on the measurement boundary in accordance with Section 5022.

Article 8. Implementation by Counties

5050. Counties. (a) The county wherein an airport is situated shall enforce this subchapter of these regulations.

(b) In recognition of the requirement to allow the maximum amount of local control and enforcement of this regulation, the county shall determine which of the airports within its boundaries are required to initiate aircraft noise monitoring in accordance with these regulations. The county shall require noise monitoring by the airports within its boundaries that are deemed to have a noise problem as determined by the county. For airports with joint use by both military and civilian aircraft operations, the determination of the existence of a noise problem shall be based upon the civilian operations. In making a determination that a noise problem exists around an airport, the county shall:

(1) Investigate the possible existence of a noise impact area greater than zero based on a CNEL of 70 dB, and determine whether or not people actually reside inside the noise impact boundary;

(2) Review other information that it may deem relevant, including but not limited to complaint history and legal actions brought about by aircraft noise; and

(3) Coordinate with, and give due consideration to the recommendations of, the county airport land use commission (as defined in Public Utilities Code Section 21670).

(c) Any affected or interested person or any government agency disagreeing with the county's findings regarding the existence of a noise problem at a given airport may file an appeal with the department. Upon receipt of such an appeal, the department shall make an investigation and determination as to the validity of the county's findings. The department shall serve by mail the written record of such investigation and determination to the county, the airport proprietor, and the affected or interested person or governmental agency. If the department finds that the county's determination does not correspond to the facts, the county shall adhere to the determination of the department. Whenever the department has served such record, the county, airport proprietor, affected or interested person, or government agency may in writing within 10 days demand a hearing. In such case, the department shall file a statement of issues and shall conduct proceedings in accordance with the Administrative Procedure Act (Chapter 5, Part 1, Division 3, Title 2, Government Code).

(d) For all airports required to perform noise monitoring, the counties shall validate monitoring data supplied by the airport proprietor and shall enforce these regulations in all respects.

(e) The county shall submit quarterly reports to the Department of Aeronautics. Each report is due 45 days after the end of the quarter of the calendar year covered in the report. The report shall contain at least the following information on each airport within the county covered by these regulations:

(1) A map illustrating the location of the noise impact boundary, as validated by measurement, and the location of measurement points, in the four preceding quarters;

(2) The annual noise impact area as obtained from the preceding four calendar quarters, and as obtained in accordance with Article 2 of this subchapter of these regulations;

(3) The daily CNEL measurements, together with identification of the dates on which each measurement was made, number of total aircraft operations during the quarter, estimated number of operations of the highest noise level aircraft class in the quarter, and any other data which is pertinent to the activity during the quarter. In addition, the HNL data shall be retained for at least 3 years, and made available to the department upon request; and

(4) The total number of recorded violations of the single event noise exposure level limits, subtotals of such violations categorized by aircraft class, a list of the names of the aircraft operators in question, the number of violations by each, the single event noise exposure level corresponding to each violation, and the disposition made or fine collected for each violation.

(f) The counties shall establish the requirements for identification of aircraft operators whose aircraft exceed the single event noise exposure levels in Article 5 of Subchapter 6 of these regulations.

(g) The department will maintain in file, for a period of at least 3 years, all the noise data received pursuant to these regulations. These records shall be maintained in accordance with the provisions of the California Public Records Act (Chapter 3.5, Division 1, Title 1, Government Code).

Article 9. Implementation by Aircraft Operators

5055. Aircraft Operators. No operator of an aircraft shall operate any aircraft in excess of the single event noise exposure level limits adopted in accordance with Article 5 of this subchapter of these regulations. No violation exists if the operator establishes that such operation is the direct result of the pilot's exercise of his responsibility for safety of the passengers, crew, cargo and aircraft or of his emergency authority. Violation of such limits is punishable as prescribed in Public Utilities Code Section 21669.4.

Article 10. Implementation by Airport Proprietors

5060. Monitoring Requirements. (a) All airport proprietors shall cooperate with the county in the county's investigations to determine the existence of a noise problem, and shall furnish such data as the county may require.

(b) Each airport proprietor whose airport is determined to have a noise problem shall measure, establish and validate noise impact boundaries, monitor as required in Articles 3, 4 and 7 of this subchapter of these regulations, and shall furnish such data as the county may require.

5061. Single Event Noise Limit Violations. No airport proprietor shall knowingly permit any aircraft operator to exceed the single event noise exposure level limits established in accordance with Article 5 of this subchapter of these regulations.

5062. Noise Impact Area Violations. No airport proprietor shall operate his airport with a noise impact area of other than zero unless said operator has a variance as prescribed in Article 13 of this subchapter of these regulations.

5063. Submittal of Monitoring Plan. Each airport proprietor who is required to perform noise monitoring shall submit a description of his monitoring plan to the county and to the department for approval. Such descriptions shall contain at least the following information:

(a) The general monitoring system plan, including at least locations and instrumentation;

(b) Justification for any proposed deviations from the measurement system locations specified in these regulations;

(c) Statistical sampling plan proposed for intermittent monitoring at community locations;

(d) The proprietor's recommended single event noise limits for his airport; and

(e) Additional information as pertinent or as requested by the department.

5064. Grounds for Approval. Failure of the airport proprietor to comply with the provisions of Subchapter 6 of these regulations constitutes a ground for denial of approval of an airport site within the meaning of Public Utilities Code, Section 21666.

Article 11. Implementation by the Department

5065. Implementation by the Department. The department will review the data submitted quarterly by the counties for the purpose of assessing the degree of compliance with this subchapter of these regulations. The department's review will include, but not be limited to, observation of any changes in boundary monitor positions and any changes in numerical values of CNEL.

Article 12. Schedule of Implementation

5070. Schedule of Implementation. (a) For airports in existence on the effective date of this subchapter of these regulations, counties shall complete their determination of whether or not a noise problem exists within the shortest feasible time after the effective date of these regulations. In no event shall the time for completion of this determination exceed 6 months from the effective date of these regulations.

(b) Each proprietor of an airport that has a noise problem, upon receipt of notification from the county, shall initiate noise monitoring within the shortest feasible time not to exceed 6 months in accordance with this subchapter of these regulations and concurrently shall make application to the department for a temporary variance in accordance with Article 13.

Article 13. Variances

5075. Variances. (a) In granting variances, the department shall be guided by the underlying intent of these regulations as follows:

(1) That the noise impact area surrounding proposed new airports be zero;

(2) That the proprietor of each existing airport having a surrounding noise impact area of zero based on a CNEL of 70 dB take actions to prevent a noise impact area of greater than zero;

(3) That the proprietor of each existing airport having a surrounding noise impact area of greater than zero based on a CNEL of 70 dB take actions to prevent an increase of the airport's noise impact area; and

(4) That the proprietor of each existing airport having a surrounding noise impact area of greater than zero based on a CNEL of 70 dB be required to develop and implement programs to reduce the noise impact area of the airport to an acceptable degree in an orderly manner over a reasonable period of time.

(b) An airport proprietor may request variances from the requirements of any or all of these regulations, except for Sections 5012 and 5013, for periods of not exceeding one year as set forth hereinafter:

(1) The airport proprietor shall apply to the department for a variance.

(2) Such application for variance shall be made upon a form which the department shall make available.

(3) Such application shall set forth the reasons why the airport proprietor believes said variance is necessary. The application shall state the future date by which the airport proprietor expects to achieve compliance with the regulations from which a variance is sought. The application shall set forth an incremental schedule of noise impact area reductions for the intervening time.

(4) The department may grant a variance if the public interest would be satisfied by such a variance. In weighing the public interest, the department's considerations include but are not limited to the following:

(A) The economic and technological feasibility of complying with the noise standards set by these regulations;

(B) The noise impact should the variance be granted;

(C) The value to the public of the services for which the variance is sought; and

(D) Whether the airport proprietor is taking *bona fide* measures to the best of his ability to achieve the noise standards set by these regulations.

(5) The burden of proof shall be upon the applicant for a variance.

(6) On its own motion, or upon the request of an affected or interested person, the department shall hold a public hearing in connection with the approval of an application for a variance. Any interested person may obtain from the department information on pending requests for variances at any time.

(7) The department in granting a variance may impose reasonable conditions which it deems necessary to effectuate the purposes of this subchapter of these regulations.

Article 14. Specification: Noise Monitoring System

5080. Purpose and Scope. (a) **Purpose.** This specification establishes the minimum requirements for instrumentation to be utilized by agencies required to monitor aircraft noise in accordance with Articles 1 through 13 of this subchapter of these regulations.

(b) **Scope.** Two measurement systems are defined herein. One system shall be utilized to monitor the noise at specifically-designated locations adjacent to airport runways. The second system shall be utilized to monitor noise levels at specifically-designated locations in the community surrounding the airport.

(c) **Design Goals.** The design goals for the monitor system are accuracy, reliability, and ease of maintenance. The measurement techniques set forth are sufficiently uncomplicated so that current state-of-the-art instrumentation equipment may be utilized to configure the two systems. Analysis and recording techniques between community and runway monitor systems vary; however, this specification delineates a procedure whereby maximum commonality of systems elements may be achieved.

The monitor system specifications are not intended to be unduly restrictive in specifying individual system components. The specifications allow the utilization of equipment ranging from analog systems to automated computer systems. The exact configuration will depend upon the specific monitoring requirement and the nature of existing user instrumentation.

This is a total systems specification. It is the prerogative of the user to configure the system with components which will be most compatible with his existing equipment and personnel.

5080.1. Additional Definitions Applicable to Article 14. (a) **Field Instrumentation.** Refers to those elements of a noise monitoring system that are exposed to the outdoor environment in the vicinity of the measurement microphone. This equipment must function within specification during exposure to a year-around environment adjacent to any airport licensed by the state of California.

(b) **Centralized Instrumentation.** Refers to those elements of the noise monitoring system which will be contained in an environmentally-controlled room.

(c) **SENEL Monitoring System.** The SENEL monitoring system shall measure single event noise exposure levels exceeding the maximum allowable single event noise exposure level and shall log the time of occurrence of each such event. An SENEL system consists of two subsystems: a noise level subsystem and an integrator/logger subsystem.

(d) **HNL Monitoring System.** The HNL monitoring system shall measure the hourly noise level and shall provide identification of the hour. This system shall be deployed as a community monitoring system. An HNL system consists of two subsystems: a noise level subsystem and an integrator/logger subsystem.

(e) **Noise Level Subsystem.** This term defines a subsystem composed of a microphone, an A-weighted filter, a squaring circuit and a lag network. This subsystem is used to derive a signal representing the mean square, A-weighted value of acoustic pressure.

(f) **Integrator/Logger Subsystem.** This term defines a subsystem composed of a threshold comparator, an integrator, a clock, an accumulator, a logger or printer, an SENEL comparator (SENEL system only), and a logarithmic converter. This subsystem shall be used to transform the output from a noise level subsystem in excess of a pre-set threshold into SENEL or HNL.

5080.2. Examples of Possible System Configurations. (a) **Approach.** Two systems have been defined: (1) the SENEL monitoring system, and (2) the HNL monitoring system. There are many possible methods of configuring systems to produce SENEL data and HNL data. These systems may be analog systems, digital systems, or combined analog and digital systems. Figures 4 and 5 illustrate two configurations which can provide SENEL and HNL measurements. The system configurations described herein are presented for information only and not as specific design criteria.

(b) **SENEL System Configuration.** An SENEL system may be composed of the following elements:

(1) **Noise Level Subsystem.**

(A) **Microphone.** The microphone converts acoustic data to an equivalent electrical voltage.

(B) **A-Weighting Filter Network.** This filter modifies the voltage from the microphone system so that its frequency characteristics are shaped to an A-weighted, relative response in accordance with weighting curve A in ASA S1.4-1961, or latest revision thereof.

(C) **Squaring Circuit.** This circuit provides a continuous, instantaneous square of the value of the electrical signal delivered from the A-weighting network.

(D) **Lag Network.** This circuit may be a first order lag (single-pole filter) used to smooth the output of the squaring circuit for delivery to subsequent circuits. The lag network provides a slow dynamic characteristic as defined for a sound level meter in ASA S1.4-1961, or latest revision thereof.

(2) **SENEL Integrator/Logger Subsystem.**

(A) **Threshold Comparator.** This device generates an output signal during the time its input exceeds a preset threshold level.

(B) **Integrator.** This circuit provides an output signal which is the definite time-integral of the input signal. The input is a slowly-varying, smooth, unipolar signal delivered from the lag network. The integrator has three operational states: integrate or run, hold, or reset. These states would be controlled by the threshold-comparator. Initially, before the integrator input signal exceeds the threshold signal, the integrator is held in reset. When the threshold is exceeded, the integrator is set in the integrate state, causing the output to be the time-integral of the input. When the input next falls below the threshold, the integrator is set into the hold state. The output of the integrator is, at hold time, the time-integral of the input while it exceeded the measurement threshold. The same signal causing hold would be used to read the output of the integrator and the true time when the hold command occurred. Following those readings, the integrator would be returned to a reset state.

(C) **Sample and Hold (Optional).** This circuit may be used to store the value of the integral at the time of integrator hold to minimize the time required for the integrator to be maintained in hold.

(D) **Clock.** This device generates true time which may be directed to a logger upon an integrator-hold command.

(E) **Logarithmic Converter.** This element is used to convert the integrated mean square sound pressure output from the integrator (or sample and hold) into an SENEL having start time and stop time defined by the threshold circuit and a reference duration equal to one second. The reference duration may be introduced as a gain (or loss) term at the input to the log-converter or as a voltage offset at the output from the logarithmic converter.

(F) **SENEL Level Comparator.** The SENEL comparator controls the actual printing/logging operation. If the signal appearing at the output of the logarithmic converter exceeds a pre-determined value, the comparator will issue a print command. If the pre-determined value is not exceeded, the event is not recorded.

(G) **Logging Element.** This element may be a printer which can concurrently or sequentially print out values of true time and SENEL.

(c) **HNL System Configuration.** An HNL system may be composed of the following elements:

(1) **Noise Level Subsystem.** The HNL noise level subsystem is identical to the SENEL noise level subsystem.

(2) **HNL Integrator/Logger Subsystem.** The HNL integrator/logger subsystem is similar to the SENEL subsystem, as noted below.

(A) **Threshold Comparator.** Similar except that the threshold level is adjustable over a different but potentially overlapping range.

(B) **Integrator.** Similar, except that the integrator is controlled in its reset, run, and hold states so that (1) it integrates for some fixed period of time, e.g., 60 seconds, (2) it "holds" only long enough to transfer out the output value for that fixed period integration, and (3) it "resets" only long enough to return the output to zero so that another "integrate" period may be initiated.

(C) **Sample and Hold (Optional).** Similar.

(D) **Clock.** This device controls the timing of the integrator and the accumulator readout.

(E) **Logarithmic Converter (Optional).** This element is used to convert the accumulated integrated noise level to a logarithmic quantity proportional to HNL.

(F) **SENEL Level Comparator.** Not required.

(G) **Logging Element.** Similar, except substitute HNL for SENEL.

(H) **Accumulator.** This device is used to store the output of the integrator for all events exceeding the threshold level within a 3600 second period. A print command signal is also provided on the hour to the logger/printer at one hour intervals.

5080.3. Performance Specifications. (a) **Overall Accuracy.** The overall accuracy of both systems shall be ±1.5 dB when measuring noise from aircraft in flight. It is the intent of the following specifications to verify this accuracy with laboratory simulation.

(b) **Noise Level Subsystem.**

(1) **Frequency Response and Microphone Characteristics.** The frequency response, and associated tolerance of the subsystem, shall be in accordance with IEC Publication 179 entitled "Precision Sound Level Meters," paragraphs 4, 5 and 8 for the A-weighting network, to be superseded by the specifications for the Type 1 precision sound level meter in the latest revision of ASA S1.4-1961, when available.

(2) **Dynamic Range.** The system output shall be proportional to the antilog of the noise level over a noise level range of 60 dB to 120 dB.

(A) For the SENEL subsystem, this range may be covered in 30 dB or greater increments through the use of attenuators. The noise level for each attenuator range shall be at least 40 dB below full scale. Full scale range shall apply to signals with a crest factor as great as 3:1.

(B) For the HNL subsystem, the internal electrical noise shall not exceed an equivalent input noise level of 50 dB, and the full scale range of 120 dB shall apply to signals with a crest factor as great as 3:1.

(3) **Linearity.** The electrical amplitude response to sine waves in the frequency range of 22.4 Hz to 11,200 Hz shall be linear within one decibel from 30 dB below each full scale range up to 7 dB above the full scale range on any given range of the instrument.

(c) **Integrator/Logger Subsystem.**

(1) **Threshold Comparator.** For SENEL, the threshold level shall be selectable in steps of no greater than 10 dB over a noise level range of at least 60 to 90 dB. For HNL, the threshold level shall be adjustable over a noise level range of at least 55 to 70 dB. In both cases, threshold triggering shall be repeatable within ±0.5 dB.

(2) **SENEL Comparator.** The maximum allowable SENEL shall be selectable over an SENEL range of 85 to

125 dB. Comparator sensing shall be repeatable within ±0.5 dB.

(3) **Clock.** The clock shall be capable of being set to the time of day within an accuracy of 10 seconds and shall not drift more than 20 seconds in a 24-hour period. For SENEL, the clock output which identifies the start or stop time of the single event shall be readable within one second.

(4) **End-to-End Accuracy.** The end-to-end accuracy of the integrator/logger subsystem is defined in terms of a unipolar, positive-going square wave input. The logged, integrated output of the system should fall within ±1 dB of the true value predicted for the wave of a given duration at an amplitude exceeding the measurement threshold by at least 10 dB, and at all higher amplitudes within the range. The square wave shall be applied at the input to the integrator and level comparator.

(A) **SENEL Integrator/Logger Subsystem.** For square waves defined at all frequencies between 0.025 and 1.0 Hz, the subsystem shall output the SENEL exceeding the maximum allowable SENEL and its time of occurrence to demonstrate end-to-end accuracy.

(B) **HNL Integrator/Logger Subsystem.**

1. For each hour during which no noise event exceeds the HNL system noise level threshold, the subsystem shall output the time on the hour, and indicate that the antilog of the HNL for the preceding hour is zero.

2. The end-to-end accuracy shall be determined over the range of HNL from 45 dB to 95 dB for each combination of the following conditions which gives a value in this range:

a. Square waves, as defined above, shall have durations of 1, 3, 10, 30 and 100 cycles.

b. Square waves shall be at frequencies of 0.025, 0.05, 0.10 and 0.20 Hz.

c. Square waves shall have amplitudes which are equivalent to noise levels of 70, 80, 90, 100 and 110 dB.

(d) **Overall System Accuracy Demonstration.** The overall system accuracy shall be demonstrated for several conditions within each of the following ranges, utilizing a 1000 Hz sinusoidal acoustic plane wave oriented along the preferred plane wave axis of the microphone, or an equivalent signal generated in an acoustic coupler:

(1) **SENEL Monitoring System.**

(A) The SENEL comparator shall be set at several values of interest, including at least 95, 105, 115 and 125 dB.

(B) The durations of the sinusoidal acoustic signals shall include at least 5, 10, 20 and 40 seconds.

(C) The noise levels for the acoustic inputs at each of the above durations shall be set at levels calculated to produce SENEL's of −1.5, +1.5 and +10 dB relative to the SENEL comparator setting.

(2) **HNL Monitoring System.**

(A) The noise levels for the acoustic inputs shall include at least values of 70, 80, 90 and 100 dB.

(B) The durations of the sinusoidal acoustical signals shall include at least 5, 10, 20 and 40 seconds.

(C) Each of the events defined by the above combinations shall be repeated 1, 3, 10, 30 and 100 times per one hour test to obtain the HNL resulting from such repetition. The HNL accuracy for each combination is defined as the difference between the calculated and measured value for each test. Tests are not required for those combinations which produce a calculated HNL value outside the range of 45 dB to 95 dB.

5080.4. Field Calibration. The monitoring system shall include an internal electrical means to electrically check and maintain calibration without resort to additional equipment. Provision shall also be made to enable calibration with an external acoustic coupler.

5080.5. Environmental Precautions and Requirements. (a) The field instrumentation shall be provided with suitable protection such that the system performance specified will not be degraded while the system is operating within the range of weather conditions encountered at airports within the State of California.

(b) **Humidity.** The effect of changes in relative humidity on sensitivity of field instrumentation shall be less than 0.5 decibel at any frequency between 22.4 and 11,200 Hz in the range of 5 to 100 percent relative humidity.

(c) **Vibration.** The field instrumentation shall be designed and constructed so as to minimize the effects of vibration resulting from mechanical excitation. Shock mounting of the field instrumentation shall be provided as required to preclude degradation of system performance.

(d) **Acoustic Noise.** The field instrumentation shall be designed and constructed so as to minimize effects of vibration resulting from airborne noise, and shall operate in an environment of 125 dB SPL—broadband noise over a frequency range of 22.4 to 11,200 Hz—without degradation of system performance.

(e) **Magnetic and Electrostatic.** The effects of magnetic and electrostatic fields shall be reduced to a minimum. The magnitude of such fields which would degrade the performance of the system in accordance with the specifications in Section 5080.3 shall be determined and stated.

(f) **Windscreen.** A windscreen suitable for use with the microphone shall be used at all times. The windscreen shall be designed so that for windspeeds of 20 miles per hour or less, the overall accuracy of the measurement system specified in Section 5080.3(a) is not compromised.

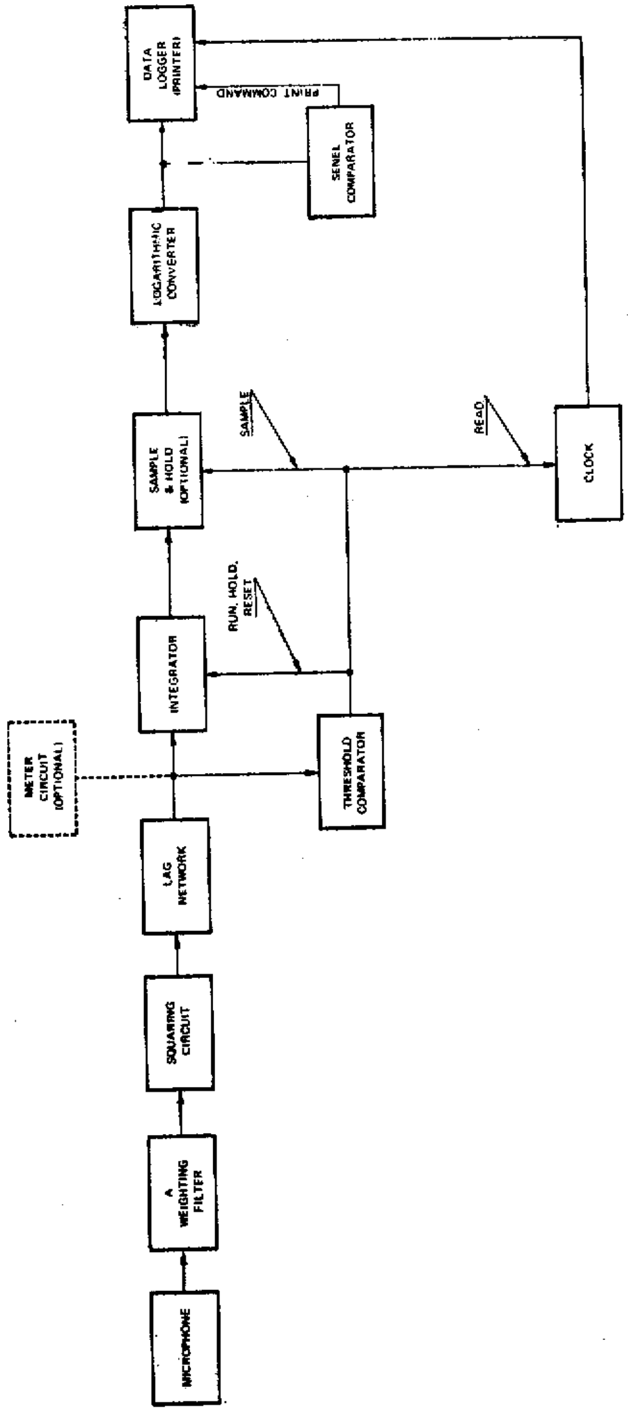


FIGURE 4. TYPICAL SINGLE EVENT NOISE EXPOSURE LEVEL (SENEL) SYSTEM

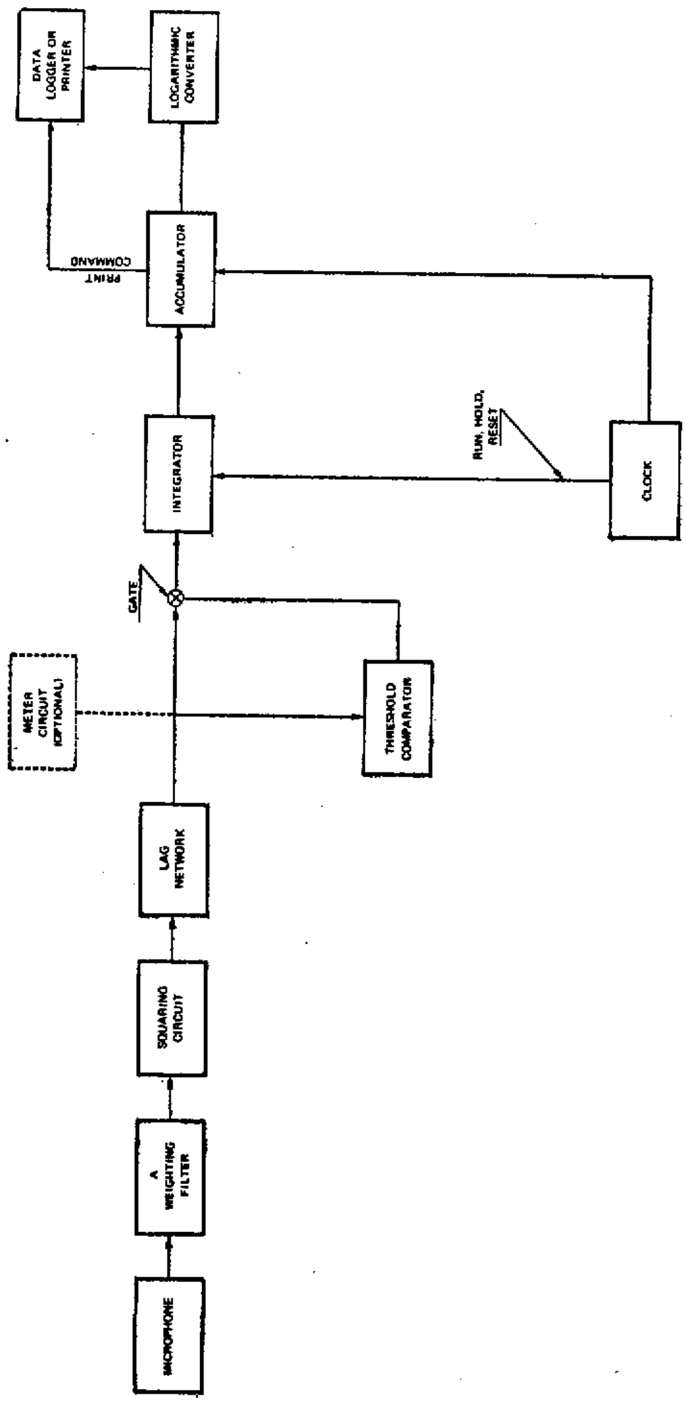


FIGURE 5. TYPICAL HOURLY NOISE LEVEL (HNL) SYSTEM

DOT TST-10-4
NASA SP-265

JOINT

DOT-NASA

CIVIL AVIATION RESEARCH AND DEVELOPMENT POLICY STUDY

REPORT

MARCH 1971
DEPARTMENT OF TRANSPORTATION
AND
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C.

Operating Problems

While the growth and success of civil aviation have produced many benefits for the Nation and have established this country's current position of world leadership, the industry is also being confronted with a number of serious problems that are rapidly growing more severe. The relative importance of these problems depends in many ways on the viewpoint of the observer. For example, the general public is becoming increasingly aware of the problems of the environment and, for this reason, the public is most concerned with aviation's major pollutant – noise. The direct user of civil aviation is interested in the service he receives and thus to him a major concern is increasing airport congestion, both in the air and on the ground. The air carriers are concerned with congestion because of its impact on operating costs. Operators are also concerned with achieving profitable short-haul operations. These three problems – noise, terminal congestion, and low-density, short-haul economics – are the major ones confronting civil aviation today and warrant further examination.

ENVIRONMENT (NOISE)

STATEMENT OF PROBLEM

The impact of civil aviation on the environment is evident in the public concern regarding noise, air pollution, water pollution, esthetics, ecological disturbances, and meteorological changes. Of these effects, noise is judged to be the most important and presently a critical constraint to the future growth of civil aviation. This constraint is already manifested in the inability to site and construct new airports in locations required to meet demand and in the reduction of existing airport capacity by noise restrictions and operational limitations. With the increasing awareness and concern of the public with the environment and with the "quality of life," increasing resistance to aircraft operations can be expected at the very time these operations should increase significantly to meet the growing travel demand.

CAUSES

The principal causes of this problem are:

- Insufficient concern and action in designing the air transportation system to meet environmental considerations. Although noise has long been recognized as a problem for aviation, trade-offs in system design in favor of noise reduction were considered low priority compared to the traditional optimization factors of speed, payload, range, and operating cost.
- The inadequacy of the technology base in providing solutions to the problems of reducing the level of the noise generated, attenuating noise transmission and minimizing its impact on the environment. Noise-related research and development for civil aviation have been conducted sporadically over the last 50 years. The introduction of jet transports provided additional emphasis on noise-reduction technology. A considerable advance has been made in reducing the noise of commercial transport turbofan engines; however, technology is not yet available to provide the magnitude of reduction desired especially when economics are considered.
- The lack of long-range planning and effective zoning of land surrounding existing and proposed airports, which has resulted in the development around major airports of areas highly sensitive to noise and the disappearance of suitable sites for future airport expansion.

MAGNITUDE OF PROBLEM

- The high-noise area around the J. F. Kennedy Airport in New York includes 35,000 dwellings, 22 public schools, and several dozen churches and clubs. This area, plus that surrounding the Los Angeles and Chicago airports, estimated at 42,000 acres, is three times greater than all the land redeveloped during the 16 years of urban renewal at a cost of $5 billion dollars.

- The potential cost of damages from law suits with respect to the control of aircraft noise cannot be evaluated at this time with any confidence. However, in Los Angeles there are 34 law suits against the airport, and the Los Angeles Unified School District alone is seeking $95 million in damages.
- The reaction to noise has brought about a limitation on night operations at some airports, 11:00 p.m. to 7:00 a.m. at Washington National Airport, for example. This results in a 20% loss of capacity for these airports and is particularly important to the profitability of all-cargo planes where night operations are a distinct advantage.
- Several alternatives have been proposed for reducing the impact of aircraft noise on the community:
  - Retrofit of the current jet fleet by engine nacelle modification and acoustic lining to achieve a reduction of about 10 dB in approach noise. The cost may range from $0.5 billion to $1.2 billion depending on the extent of the retrofit and the classes of aircraft modified.
  - Establish buffer zones around existing large airports. The cost of acquiring noise easements from residents in high noise areas has been estimated at $9.4 billion.
- If the effect of noise caused an airport to be located 10 miles farther from the population area it served, the additional cost to travelers and employees could exceed $30 million annually for each major airport.
- Restrictions will limit supersonic flight over land areas because of the sonic boom. Overland operation requires a technological breakthrough to effectively eliminate the sonic boom.

CURRENT PROGRAMS

The current aircraft noise abatement program resulted largely from the efforts of the Jet Aircraft Noise Panel, an ad hoc group formed by the Office of Science and Technology in 1965. The recommendations of this panel[1] led to the introduction of legislation to provide specific FAA authority to regulate in the area of aircraft noise, and to the establishment of the Interagency Aircraft Noise Abatement Program under the leadership of DOT, and provided the stimulus for initiation of a number of key studies and R&D activities. These programs, federally sponsored with industry participation, cover all areas of noise research and promise important advances in further reducing noise levels. The programs often are small but productive (e.g., laboratory research to develop acoustical lining techniques for attenuating noise generated by engine turbomachinery). Some laboratory efforts have grown into flight demonstration programs such as the NASA acoustic nacelle project involving a 707 and a DC-8 flight demonstration of acoustic treatment technology. Other programs, for example, the NASA Quiet Engine and FAA's fan and compressor noise studies, will provide benefits in the development of specific design technology that will find applications in future engine component designs. To further assist in basic noise research, an acoustic test laboratory is being designed and built at the NASA Langley Research Center.

The support for these activities has been provided from funds of NASA, DOT, DOD, HUD, and HEW, supplemented by industry. Figure 5.1 shows the funding for FY 1969 through 1971 and the proposed budget for FY 1972. The NASA program on nacelle acoustic treatment with DC-8 and 707 aircraft accounted for the major part of the NASA expenditures in FY 1969, and was

[1] Alleviation of Jet Aircraft Noise Near Airports, March 1966, Office of Science and Technology.

completed in that time period. The FY 1970 program includes funding for the NASA Langley Acoustic Test Laboratory and the start of the NASA Quiet Engine Program. FY 1971 shows an increased expenditure in a number of areas.

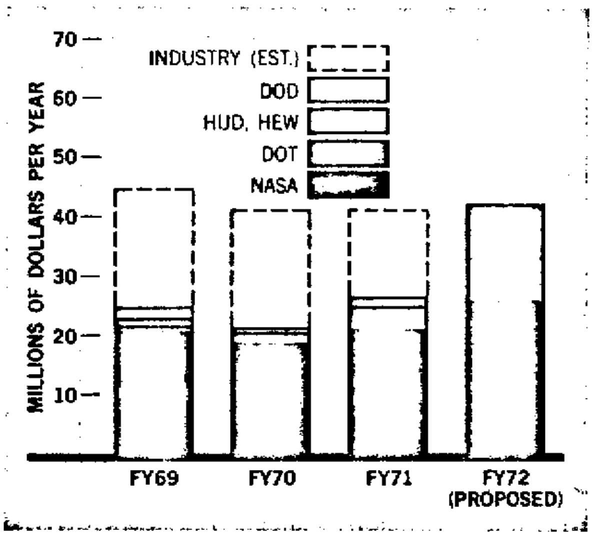


Figure 5.1. Funding for aircraft noise abatement.

The proposed FY 1972 program includes work directed toward reducing noise generation at the "source" (aircraft and engine design), optimizing procedures that can be used in controlling the aircraft "path" through steep descent and curved approaches, and work to minimize the impact on the "receiver," such as land-use planning and control. The programs of DOT and NASA proposed in FY 1972 include R&D on STOL technology, microwave instrument landing systems, and subsonic and supersonic transports. The translation of the proposed budget into appropriations at the levels submitted is considered vital to continued progress in this area.

Regulatory Actions

In 1968, the FAA received Congressional authority under Public Law 90-411 to establish standards for relief from present and future aircraft noise. In November 1969, the FAA issued the Part 36 noise rule, which was responsive to the Public Law in that it ensured in new-generation aircraft the maximum noise reduction that technology would permit within reasonable economic constraints. This rule has been adopted in concept as the basis for the International Civil Aviation Organization (ICAO) proposed noise rule.

New transport aircraft and all new subsonic turbojet aircraft must be certificated for noise as specified by Federal Air Regulation, Part 36, and shown in Figure 5.2. Also shown are the noise levels for representative aircraft of the current jet fleet. As can be seen, the noise of these aircraft is as much as 15 EPNdB higher than the levels now

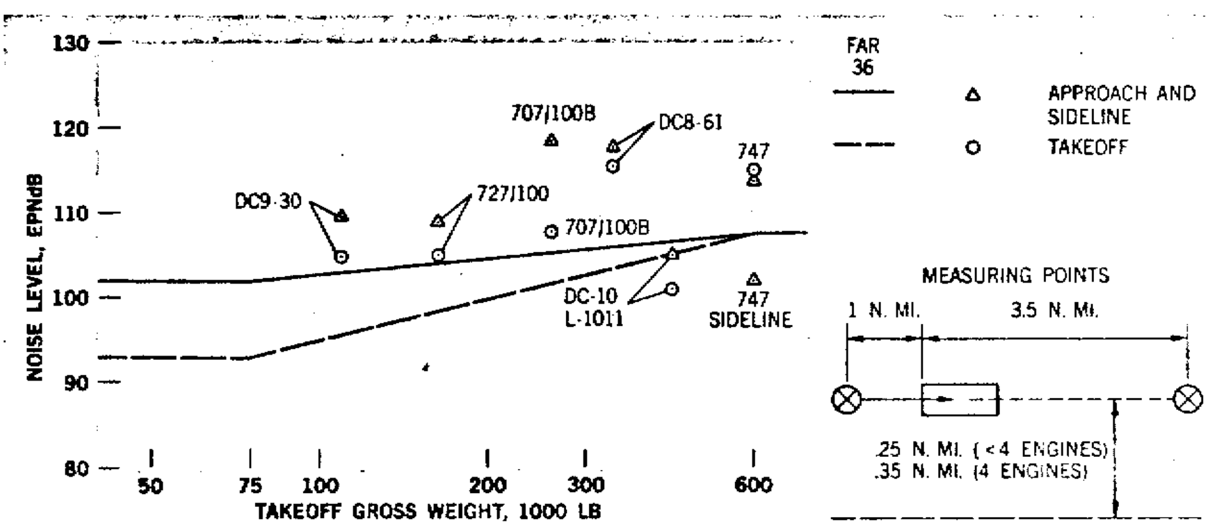


Figure 5.2. Noise levels of current aircraft.

set for approach and sideline noise, and as much as 10 EPNdB higher than the levels for takeoff. A retrofit engine nacelle modification has been tested that would significantly reduce the noise level of the 707 and DC-8 (JT3D engine), but would meet FAR 36 on approach only. The effectiveness of retrofit for other aircraft (727, 737, DC-9 using the JT8D engine) has not been tested. It is apparent, however, that a comparison of the costs and effectiveness of other approaches to noise reduction, such as steep decent and possible land acquisition, is necessary. Such a trade-off is shown in Figure 5.3. If engine noise is not reduced, it would cost roughly $17 billion to purchase the approximately 1300 square miles affected by noise levels of 30 Noise Exposure Factor (NEF) or greater. On the other hand, if engine noise could be reduced by 10 dB, the land exposed to 30 NEF or greater would cost an estimated $1.6 billion.

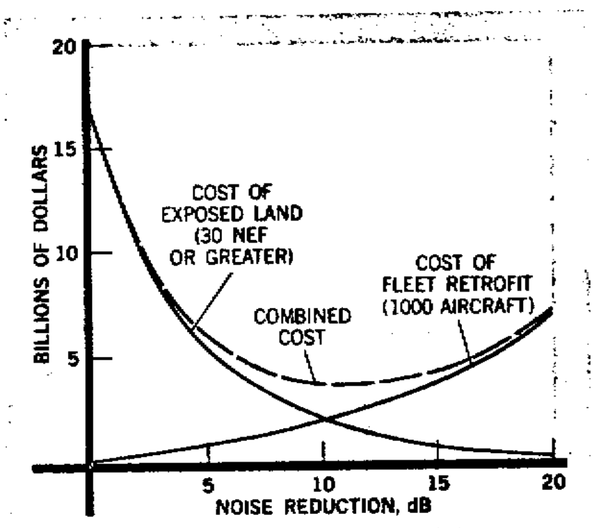


Figure 5.3. Cost of acquiring exposed land vs. retrofitting fleet (United States).

The evaluation must also include the performance and operating cost penalties of the retrofit aircraft, the expected life of the current fleet, the improvements to be gained from modified operational techniques (steep and curved approaches), and the anticipated future environmental requirements (the increasing sensitivity of the public to noise).

The noise technology developed by the aircraft and engine industry, particularly the high bypass ratio turbofan engine, has been applied successfully to the wide-body jets and significantly lower noise levels have been realized, as illustrated by the data on the DC-10 and L-1011 aircraft in Figure 5.2.

Current Policy

The current Government policy is to ensure that maximum noise-reduction techniques, consistent with the technological state of the art and reasonable economic constraints, are incorporated in future aircraft designs. The restriction will be the same for supersonic aircraft as for other aircraft. The Government's role is of necessity an aggressive one of pushing a continuing reduction of noise levels on a continuing time scale. The Government therefore finds itself in the position of sponsoring technological progress in an area where technological progress has not occurred voluntarily. This policy requires not only the establishment of acoustic standards but the promotion of the acoustic research necessary to meet these standards and to assure that the noise standards are established on a valid scientific basis.

RESEARCH AND REGULATORY GOALS

To meet the objective of acceptance of new air systems by the community and local government, and to avoid further constraints in the operation of existing systems in an era of increasing concern for the environment and the "quality of life," the most urgent need is to establish long-term research goals and regulatory standards, on a specific timetable, to attain operating noise levels that will be compatible with community and local environmental objectives.

Regulatory actions for aircraft noise abatement are governed by Public Law 90-411, which provides for applying *the results of research, development, testing, and evaluation* considering *whether any proposed regulation is economically* *reasonable, technologically practicable and appropriate.* It is important that these guidelines be projected into the future so commercial operators and manufacturers can plan future systems. It is recognized that realistic accomplishment will be a difficult task, one requiring maximum cooperation between industry and Government, and coordination with international authorities, such as ICAO. However, to delay the establishment of future regulatory goals on a time-phased basis would be to compound the current problem and severely limit the growth of commercial aviation.

Research goals should be established on the basis of the desired end result; that is, the achievement of noise levels permitting the introduction of new systems compatible with *future* environmental goals. This will require the acceptance of these systems by local communities so airports can be located, and suitable operations conducted, where they will satisfy the transportation needs in an optimum way.

At this time it appears that meeting the above criteria will require a combination of improved vehicle capability, more flexible operational procedures, and more effective land-use planning. The objectives should be aircraft operations in which the *observed noise levels, at or beyond the airport boundaries, are compatible with ambient or background levels for specified land use.* The bottom line on Figure 5.4 is the recommended maximum noise level of the aircraft perceived at the airport boundaries when operating in accordance with optimum approach and climb-out procedures; that is, 80 EPNdB for the smaller aircraft, including VTOL and STOL vehicles operating close to major activity centers, and 90 EPNdB for the larger aircraft operating at the more remote jetports. The measuring points should be at the airport boundaries with other monitoring points beyond the boundaries to make sure the background levels are not being exceeded. In the planning of future airports, where land, or land easements, may be acquired at reasonable cost, it may be possible to establish airport boundaries for this purpose several miles beyond the traditional runway and terminal area boundaries.

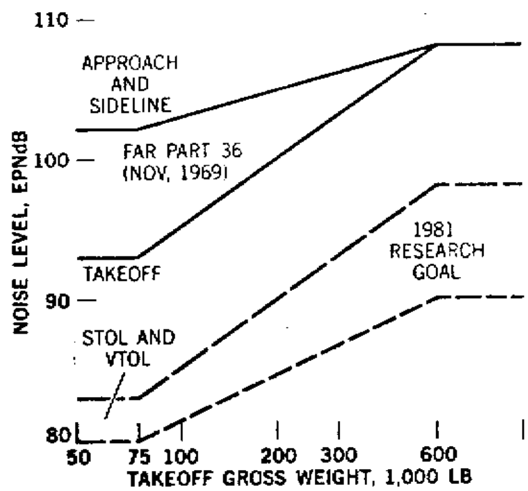


Figure 5.4. Proposed 1981 research goal.

Such ambitious research goals may be controversial, but failure to establish a low-level noise goal now could result in the use of scarce resources for R&D activities that may fail to provide the desired solution to the noise problem on a long-term basis.

The target time period to achieve the proposed research goal is dependent upon the resources made available, the effectiveness of the management of the R&D programs, and the actual rate of technological progress. A consensus of experts in the field indicates that, with appropriate funding, a reduction of about 10 dB from the current state of the art should be possible within 10 years. The upper dashed line on Figure 5.4 illustrates this objective. A more definitive evaluation of the noise-level requirements for compatibility and acceptance of new air systems should be possible as additional environmental data become available. For this reason, it is proposed that the area between the two lines be considered the broad-band objective for a 10-year research effort (i.e., the "1981 Research Goal").

Proposed regulatory standards should also be established, at least at 5-year intervals. It is important that the industry know what will be expected in 1976 and 1981 in order to proceed with confidence with new system designs. Evaluations of those standards must be projected into the future to determine the probable impact on the industry.

ACTIONS RECOMMENDED

The following actions are recommended to achieve the research goals and establish continuing future regulatory standards.

- Expand the current federally funded aircraft noise abatement program. The initial step would be a comprehensive 10-year Aircraft Noise Abatement Program Plan incorporating activities of DOT, NASA, HUD, HEW, and the Environmental Protection Agency. This plan should clearly delineate the roles and areas of responsibility of the participating agencies and require commitments from these agencies to support these activities with the appropriate resources, consistent with funding limitations. This plan should include:
    - Fundamental research on noise generation mechanisms and perception.
    - Concept definition of new vehicles, propulsion systems, and operational techniques to meet noise research goals.
    - Advanced development of vehicle and propulsion components and system demonstrations in a real environment.
    - Support of technology for traffic control and landing systems to accommodate new operating techniques.
    - Studies to define more effective methods of accomplishing long-range land-use planning, in conjunction with State and local authorities, to provide the needed sites for future airports. Strategies beneficial to the local community must be developed.
    - Compilation of a technical data base to evaluate future regulatory actions in noise abatement, taking into consideration economic, social, and environmental impacts.
- Establish monetary incentives that will encourage private industry to develop new concepts and techniques in noise reduction and control, and introduce new equipment implementing these concepts. These could include tax incentives, reduced landing and other operational fees, and loan guarantees or low-interest loans for new or retrofit equipment to meet future regulatory goals.
- Encourage personnel training and university programs in acoustics.

A DOT office to accomplish the above actions should be set up with staff drawn from NASA, DOD, and EPA. The nucleus for this office could be the participants in the current Interagency Aircraft Noise Abatement Program directed by the DOT's Office of Noise Abatement. The first objectives for this group should be:

- Agreement on 10-year research goals, such as recommended above, by the end of FY 71.
- Establishment of future regulatory goals, particularly for STOL and VTOL aircraft, projecting at least 5 to 10 years into the future. These goals should be established by the end of CY 71.
- Agreement on and approval by the NASA and EPA Administrators and DOT and DOD Secretaries, of a 10-year Aircraft Noise Abatement Program Plan. This should be completed in time for incorporation in FY 73 budget planning. The DOT–NASA funding in this area should be about $100 million per year to effectively carry out the objectives of this program.

If civil aviation is to meet the expected growth in demand for air transportation, a new approach to aircraft noise abatement is necessary. This approach must provide for research goals based not on what is technologically feasible but on what is needed to satisfy community environmental goals. These must then be implemented by coordinated action by all Government agencies, financial and program participation by industry, and concurrence by the affected public sector.