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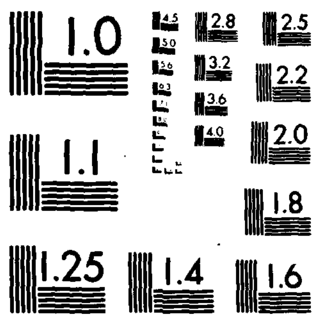


MICROCOPY RESOLUTION TEST CHART

Report No. FAA-EE-80-37

LEVEL II

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AD A092228

# A GUIDANCE DOCUMENT ON AIRPORT NOISE CONTROL

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Robert L. Miller
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Cambridge, Ma 02238

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AUGUST 1980
FINAL REPORT

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15. Supplementary Notes

16. Abstract

This guidance document contains materials involving a general discussion of noise and noise control, and sections on how humans respond to noise, noise control planning, noise descriptors that are used in the FAA's Integrated Noise Model, airport noise contours and land use planning, and citizen involvement in noise control planning. This document describes noise control actions and their benefits and costs. This document reflects the Department of Transportation/Federal Aviation Administration (DOT/FAA) Airport Noise Abatement Policy of 1976, a detailed, straightforward statement of the problems of airport noise and the shared responsibilities of those who must work to control it. This document also reviews the Federal legislature and administrative mandates for noise control.

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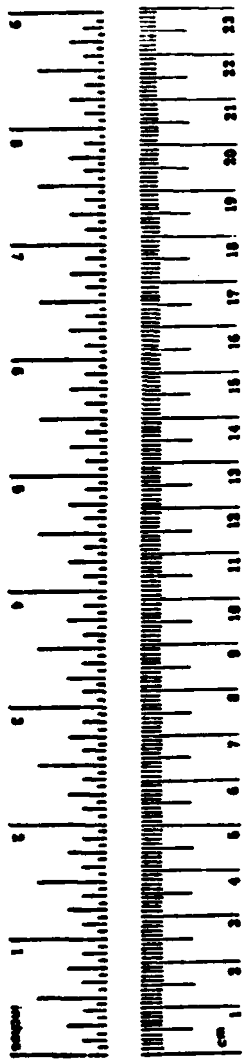
# METRIC CONVERSION FACTORS

## Approximate Conversions to Metric Measures

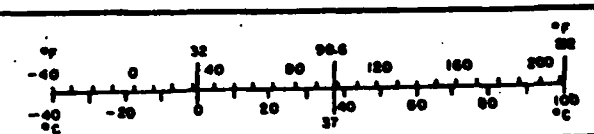
| Symbol | When You Know | Multiply by | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| in | inches | *2.5 | centimeters | cm |
| ft | feet | 30 | centimeters | cm |
| yd | yards | 0.9 | meters | m |
| mi | miles | 1.6 | kilometers | km |
| | | **AREA** | | |
| $in^2$ | square inches | 6.5 | square centimeters | $cm^2$ |
| $ft^2$ | square feet | 0.09 | square meters | $m^2$ |
| $yd^2$ | square yards | 0.8 | square meters | $m^2$ |
| $mi^2$ | square miles | 2.6 | square kilometers | $km^2$ |
| | acres | 0.4 | hectares | ha |
| | | **MASS (weight)** | | |
| oz | ounces | 28 | grams | g |
| lb | pounds | 0.45 | kilograms | kg |
| | short tons (2000 lb) | 0.9 | tonnes | t |
| | | **VOLUME** | | |
| tsp | teaspoons | 5 | milliliters | ml |
| Tbsp | tablespoons | 15 | milliliters | ml |
| fl oz | fluid ounces | 30 | milliliters | ml |
| c | cups | 0.24 | liters | l |
| pt | pints | 0.47 | liters | l |
| qt | quarts | 0.95 | liters | l |
| gal | gallons | 3.8 | liters | l |
| $ft^3$ | cubic feet | 0.03 | cubic meters | $m^3$ |
| $yd^3$ | cubic yards | 0.76 | cubic meters | $m^3$ |
| | | **TEMPERATURE (exact)** | | |
| °F | Fahrenheit temperature | 5/9 (after subtracting 32) | Celsius temperature | °C |

*1 in ≡ 2.54 (exactly). For other exact conversions and more detail tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.




## Approximate Conversions from Metric Measures

| Symbol | When You Know | Multiply by | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| mm | millimeters | 0.04 | inches | in |
| cm | centimeters | 0.4 | inches | in |
| m | meters | 3.3 | feet | ft |
| m | meters | 1.1 | yards | yd |
| km | kilometers | 0.6 | miles | mi |
| | | **AREA** | | |
| $cm^2$ | square centimeters | 0.16 | square inches | $in^2$ |
| $m^2$ | square meters | 1.2 | square yards | $yd^2$ |
| $km^2$ | square kilometers | 0.4 | square miles | $mi^2$ |
| ha | hectares (10,000 $m^2$) | 2.5 | acres | |
| | | **MASS (weight)** | | |
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.2 | pounds | lb |
| t | tonnes (1000 kg) | 1.1 | short tons | |
| | | **VOLUME** | | |
| ml | milliliters | 0.03 | fluid ounces | fl oz |
| l | liters | 2.1 | pints | pt |
| l | liters | 1.06 | quarts | qt |
| l | liters | 0.26 | gallons | gal |
| $m^3$ | cubic meters | 35 | cubic feet | $ft^3$ |
| $m^3$ | cubic meters | 1.3 | cubic yards | $yd^3$ |
| | | **TEMPERATURE (exact)** | | |
| °C | Celsius temperature | 9/5 (then add 32) | Fahrenheit temperature | °F |



## PREFACE

While we developed this Document, we talked to many people about its contents. We acknowledge, with gratitude, the help and support we received from staff members of government agencies, including the Federal Aviation Administration, the Department of Housing and Urban Development, and the Department of Defense, as well as representatives of the Airport Operators' Council International, the Air Transport Association, the Airline Pilots' Association, the National Business Aircraft Association, and the Aircraft Owners' and Pilots' Association.

This Document reflects the authors' interpretation of the recommendations we received. It is not a statement of official policy, and the opinions, findings, and conclusions expressed in it are those of the authors and not necessarily those of the Federal Aviation Administration.

BOLT BERANEK AND NEWMAN INC.

Andrew S. Harris
Robert L. Miller
Joan M. Mahoney

TABLE OF CONTENTS

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List of Figures

List of Tables

# 1. INTRODUCTION

This Guidance Document is written for airport planners, airport operators, and all others who must deal with airport noise. It reflects the Department of Transportation/Federal Aviation Administration (DOT/FAA) Airport Noise Abatement Policy of 1976, a detailed, straightforward statement of the problems of airport noise and the shared responsibilities of those who must work to control it. Airport operators, according to the Policy, are responsible for planning and implementing action to reduce the effect of noise on residents in the area around the airport. This Document is one of the tools designed to help airport operators and planners reach that goal. It should aid the reader in applying the principles of noise control both to existing and to planned airports.

This Document is divided into two major chapters. In Chapter 2, 23 separate noise control actions are described, and their benefits and costs are discussed. For readers of this Document, these actions are the basic tools with which they can shape corrective measures for airport noise control. Chapter 3 contains background material needed by those who work in the field of airport noise control. This material includes a general discussion of noise and noise control, and sections on how humans respond to noise, noise control planning, noise descriptors that are used in the FAA's Integrated Noise Model, airport noise contours and land use planning, and citizen involvement in noise control planning. The chapter ends with a review of Federal legislative and administrative mandates for noise control.

## 2. NOISE CONTROL ACTIONS

Many actions exist to reduce or control noise from airport activity. The DOT/FAA Aviation Noise Abatement Policy enumerates a number of these actions, and this Document is intended to elaborate on them and offer assistance in formulating noise control plans. A successful program may include one or several of the actions described, but in either case, should:

1. Accurately assess the problem and remedial action.
2. Work with the overall community plan and meet community goals.
3. Involve the airport operators, the FAA, the aviation community, airport neighbors, and state aviation officials.

Don't overlook a particularly timely aspect of noise control: energy. All noise control actions will cause changes in energy use. Some will be increases, other decreases. For example, buildings that do a good job of protecting their occupants against noise generally use less energy for heating and cooling than buildings that offer little protection against noise.

The 23 noise control actions included here are listed in Fig. 1, a matrix subdivided into the five major areas where airport noise control can be applied: airport plans, airport/airspace use, aircraft operation, land use, and noise program management.

To use the matrix, find the source of your noise problem in the listing at the top right of the matrix. Then scan the column of actions; the solid circles indicate possible actions that address the noise source.

## SELECTING POSSIBLE ACTIONS

| CONSIDER THESE ACTIONS | | | Page | IF YOU HAVE THIS PROBLEM: NOISE FROM: TAXIING | DEPARTURE | APPROACH | LANDING ROLL | TRAINING FLIGHTS | MAINTENANCE | GROUND EQUIPMENT |
|---|---|---|---|---|---|---|---|---|---|---|
| AIRPORT PLAN | Changes in Runway Location, Length or Strength | 1 | 7 | ● | ● | ● | ● | ● | | |
| | Displaced Thresholds | 2 | 12 | | | ● | | ● | | |
| | High-Speed Exit Taxiways | 3 | 16 | ● | | | ● | | | |
| | Relocated Terminals | 4 | 20 | ● | | | | | ● | ● |
| | Isolating Maintenance Runups or Use of Test Stand Noise Suppressors and Barriers | 5 | 24 | ● | | | | | ● | ● |
| AIRPORT AND AIRSPACE USE | Preferential or Rotational Runway Use | 6 | 29 | ● | ● | ● | ● | ● | | |
| | Preferential Flight Track Use or Modification to Approach and Departure Procedures | 7 | 39 | | ● | ● | | ● | | |
| | Restrictions on Ground Movement of Aircraft | 8 | 44 | ● | | | | | | |
| | Restrictions on Engine Runups or Use of Ground Equipment | 9 | 47 | | | | | | ● | ● |
| | Limitations on Number or Types of Operations or Types of Aircraft | 10 | 49 | ● | ● | ● | ● | ● | ● | ● |
| | A Curfew<br>Rescheduling<br>Move Flights to Another Airport | 11 | 54 | ● | ● | ● | ● | ● | ● | ● |
| | Raise Glide Slope Angle or Intercept | 12 | 58 | | | ● | | ● | | |
| AIRCRAFT OPERATION | Power and Flap Management | 13 | 61 | | ● | ● | | ● | | |
| | Limited Use of Reverse Thrust | 14 | 63 | | | | ● | | | |
| LAND USE | Land or Easement Acquisition | 15* | 66 | ● | ● | ● | ● | ● | ● | ● |
| | Joint Development of Airport Property | 16* | 69 | ● | ● | ● | ● | ● | ● | ● |
| | Compatible Use Zoning | 17* | 71 | ● | ● | ● | ● | ● | ● | ● |
| | Building Code Provisions and Sound Insulation of Buildings | 18* | 74 | ● | ● | ● | ● | ● | ● | ● |
| | Real Property Noise Notices | 19* | 78 | | ● | ● | ● | ● | ● | ● |
| | Purchase Assurance | 20* | 81 | | ● | ● | ● | ● | ● | ● |
| NOISE PROGRAM MANAGEMENT | Noise-Related Landing Fees | 21 | 83 | ● | ● | ● | ● | ● | | |
| | Noise Monitoring | 22 | 86 | | ● | ● | | ● | ● | |
| | Establish Citizen Complaint Mechanism<br>Establish Community Participation Program | 23 | 89 | ● | ● | ● | ● | ● | ● | ● |

*See Discussion of Land Use, Page 65

FIG. 1. MATRIX OF NOISE CONTROL ACTIONS.

As an example, your airport's problem is noise from approaching aircraft. Under "Approach," two solid circles appear immediately. They suggest two means of controlling approach noise: changes in runway location, length, or strength, and displaced thresholds.

You will find details about those two suggestions and all other flagged items in the remainder of this chapter, where each of the 23 actions is discussed in terms of:

- What Is the Action?
- What Are the Benefits?
- How Effective Is the Action?
- What Are Issues of Implementation?
- What Are the Costs?
- Where Is It Being Implemented?

Note that one of the questions addressed is, "How Effective Is the Action?" Here, effectiveness is defined primarily in terms of population exposed to levels of cumulative noise exposure [$L_{eq(24)}$, $L_{dn}$, or NEF]. This is because cumulative exposure measures correlate well with community response. Other means of judging effectiveness can be related to changes in the noise of single events using Sound Exposure Levels (SEL), or Effective Perceived Noise Levels (EPNL), or maximum A-weighted sound levels. Finally, effectiveness may be judged by changes in the cumulative duration above various A-weighted sound levels (times above threshold, or TA). (See the discussion of noise descriptors in Chapter 3 for elaboration of these metrics.)

Five means of describing a project's effectiveness are suggested below.

1. By the change in number of people living within various 5-dB increments of exposure (such as between $L_{dn}$ 75 and 80, $L_{dn}$ 70 and 75, $L_{dn}$ 65 and 70, and so on.

   This method can also be applied to numbers of sensitive sites (schools, churches, hospitals, and nursing homes, for example) or to acres of park land, open space, and so on.

2. By the change in number of people living in areas exposed to more than a specified level of noise.

   Many noise analyses, for example, identify numbers of people moderately or severely impacted (people exposed to $L_{dn}$ values greater than 65 and 75 dB, respectively). This measure is useful for establishing the general effectiveness relative to specific, well-established criteria, such as the U.S. Department of Housing and Urban Development (HUD) noise limits. (Again, see Chapter 3.)

3. By the change in number of people in specific neighborhoods around the airport in 5-dB increments of exposure.

   This refinement of the first method allows decision makers to see exactly how individual communities will be affected by the project, thus offering political insight to the decision-making process. The approach is similar to that suggested by (1) above, but the population counts are limited to town boundaries or definitive areas off the end of each runway.

4. By the change in number of people within contours depicting times above given A-weighted sound levels.

   As more experience is gained relating times above thresholds to community response, specific values may hold significance similar to the implications associated with $L_{dn}$ 65 and 75. Now, however, the method can be applied to a variety of threshold values and times of exposure. Effectiveness in terms of TA is perhaps most appropriate for describing projects where communities are sensitive to changes in operations. Changes in *times* above sound levels may have more meaning to people than changes in *levels* of cumulative noise expressed in decibels, when, for example, in describing the effectiveness of a preferential runway project.

5. By changes in levels at specific points.

   This method offers little information about the extensity of the impact created by a project, but instead supplements the other methods by focusing on changes in the intensity of the impact at particularly sensitive sites.

Which method or methods should you use? The choice depends on the technical understanding and familiarity of an audience with airport noise analysis, and also on the sensitivity of the project.

NOISE CONTROL ACTION NO. 1: CHANGES IN RUNWAY LOCATION, LENGTH, OR STRENGTH

<u>What Is the Action?</u>

Relocating or adding a runway is a basic noise control tool, because it directly affects the noise of opeations using the runway. There is seldom a need to add a runway just for noise abatement, but be aware that exposure levels can be reduced from a few decibels to 20 or more dB when expansion programs are being considered to increase the capacity of an airport.

Changing the length or strength of a runway can be a noise abatement tool if it permits the shifting of operations from one runway to another to reduce overflights of highly exposed or highly populated areas.

<u>What Are the Benefits?</u>

A new or improved runway can improve an airport's overall noise impact by:

- Reducing or eliminating overflights in relatively populated neighborhoods
- Allowing development of preferential runway and flight track usage
- Alleviating taxi noise, landing roll noise, and noise from training flights in areas having specialized noise problems unrelated to normal flight operations.

Increasing the length or strength of a runway can increase the flexibility of an airport's operation. For example, an extension may permit jet operations on a runway previously used only for light general aviation aircraft. If the runway is oriented so that flight paths avoid population centers, the extension could provide relief for more critical neighborhoods off another runway, which previously had absorbed all of the jet traffic. (See Fig. 2.)

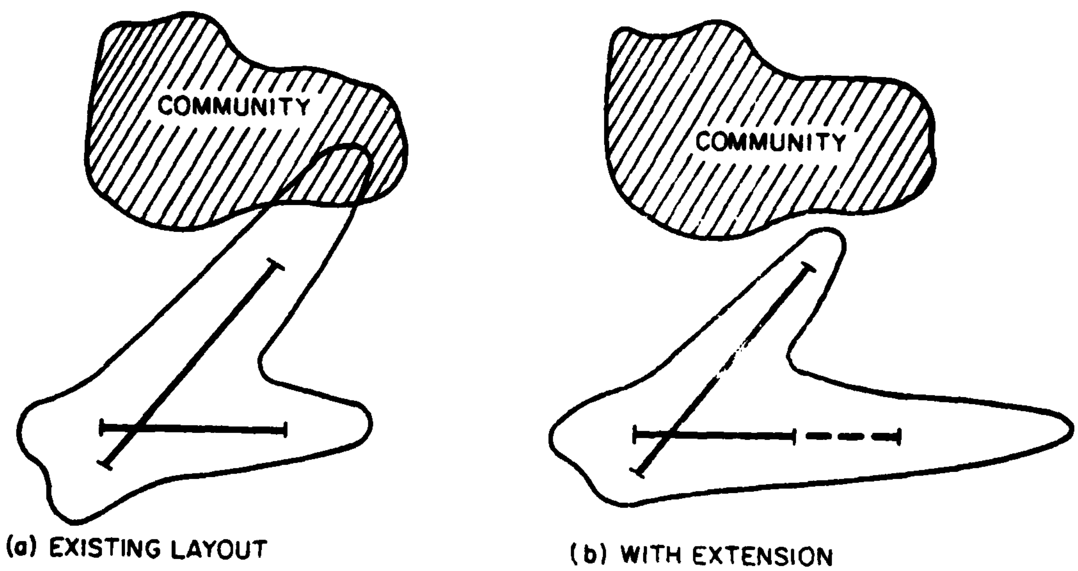


FIG. 2. POSSIBLE BENEFITS FROM A RUNWAY EXTENSION.

Historically, the trend has been to *increase* the length and strength of runways (thus increasing capacity). But similar acoustic benefits can also be achieved by *reducing* length. Shortening a runway, and thus limiting the types of aircraft using it, by designating a portion of it as an overrun or by displacing the threshold can be effective means of noise reduction in critical areas. If airports continue to be encroached upon and neighborhood response actually dictates the existence of an airport, these more restrictive measures may be required.

## How Effective Is the Action?

The usefulness of the action as a noise control measure will depend on a combination of (1) the amount of traffic the new runway will carry, (2) the reduction in traffic on existing runways, and (3) the type of aircraft using the new runway. By way of illustration, a new short GA runway may well increase impact by permitting higher capacity operation by carriers on an existing longer runway. But a new parallel air carrier runway can reduce impact by dividing noisy operations.

Effectiveness is judged best by changes in population above criteria such as those adopted by HUD (65 and 75 $L_{dn}$), or changes in population within 5-dB increments for a cumulative measure such as $L_{eq}$, $L_{dn}$, and NEF.

## What Are Issues of Implementation?

An airport operator can initiate planning for a change in the runway system. However, actual new development will require coordination with users as well as Federal, state, and local authorities. In most cases, the FAA will have to prepare an Environmental Assessment and, perhaps, an EIS.

## What Are the Costs?

Runways are usually added for reasons other than noise control, and their costs should not usually be assigned to noise control. One exception: If a particular site is chosen because of its noise control benefits and the cost of using that site is higher than using another, less beneficial site, the extra cost would be attributed to noise control.

When you add a runway, be aware of the need to control total taxiing distance. The farther a runway is from the terminal, the more expensive the taxiing and the higher the risk of overheating tires. Recent experience with wide-bodied jets has emphasized the risk of overheating tires during long taxiing periods prior to takeoff rolls.

Also, wind conditions will still dictate runway headings. A new runway that can't be used often because of prevailing winds won't yield noise benefits.

## Where Is It Being Implemented?

Douglas Municipal Airport (Charlotte, NC)

The City of Charlotte proposed addition of Runway 18R-36L to increase the capacity of its Douglas Municipal Airport. 5-23 had been the primary runway, with departures on 5 and landings on 23 overflying the more densely populated areas around the airport. Once 18R-36L opens, it will become the primary runway with 18L-36R as the main backup.

Addition of the new runway, permitting parallel use of the 18-36 pair, will shift noise exposure in the vicinity of Douglas. Both reductions and increases will occur. Changes will range from a 10-dB increase to the north and south to a 15-dB decrease to the northeast.

Combining preferential runway use with the addition of 18R-36L will result in major reductions in exposed populations. The percentage of people exposed to various levels of noise will be reduced as follows: people above $L_{dn}$ 65, reduced 39%; people above $L_{dn}$ 70, reduced 46%; and people above $L_{dn}$ 75, reduced 90%.

Honolulu International Airport (Honolulu, HI)

Honolulu's need for a new independent parallel runway suitable for simultaneous IFR landings led to the construction of its "Reef Runway" nearly a mile south of its existing primary runway. The new 8R-26L resulted in significant improvements in noise exposure not only in metropolitan Honolulu, but also in the communities of Ewa and Ewa Beach. When the original runway, 8L, was used as the primary departure runway for heavy 4-engine narrow body aircraft, such as the Boeing 707, schools in the Kalihi-Palama area (1 to 3 miles to the northeast and east of the airport) were frequently subjected to single-event noise levels of 105 PNdB and higher. Over 13,000 school children were exposed to noise levels of 85 PNdB and above for total periods up to one hour per school day. Now, with 8R as the primary departure runway, single-event noise levels at the same schools are less than 85 PNdB, an improvement of more than 20 dB.

NOISE CONTROL ACTION NO. 2: DISPLACED THRESHOLDS

What Is the Action?

A displaced threshold is a runway marking short of the physical runway end that defines the touchdown point for landing aircraft. Because the landing threshold is farther down the runway than the actual runway end, aircraft must maintain a higher altitude during approach to reach the extended touchdown point than would otherwise be necessary.

For example, an aircraft on a 3-degree approach to a normal runway end may fly at altitudes of 1155, 605, 325, and 190 feet at the 4-mile, 2-mile, 1-mile, and 1/2-mile points from touchdown. If the same aircraft were to fly a 3-degree approach to a displaced threshold, its altitude over the same points would be approximately 50 feet higher for each 1000 feet of displacement, as shown in Fig. 3.

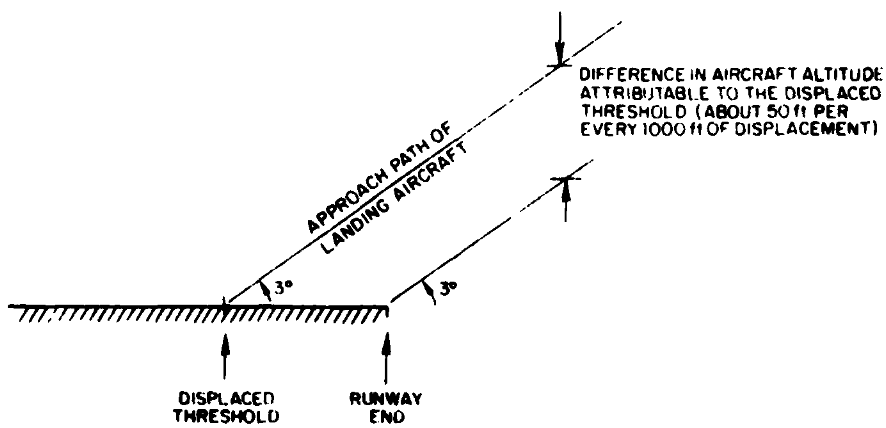


FIG. 3. A TYPICAL DISPLACED THRESHOLD.

## What Are the Benefits?

The benefits of displaced thresholds are localized. For a given thrust and airspeed, the noise exposure for an aircraft at relatively small slant distances decreases at the rate of about 4 to 6 dB for each doubling of the distance to the aircraft. One-half mile from the runway, a displacement of 1000 feet will increase the aircraft altitude by 50 feet from 190 feet to 240 feet. The increased altitude is nowhere near a doubling of the original altitude of the aircraft, so the threshold will provide a reduction in landing noise of only about 1.5 dB directly under the approach path of the aircraft. At distances farther away from the runway – 4 miles, for example – the effect of the increased altitude is only a few tenths of a decibel under the approach path. The change in single-event or cumulative landing noise for longer displacements or at other distances from the runway or to the side of the approach path can be estimated with the following relationship:

$$\text{dB} = 17 \log_{10} \frac{\text{(Distance to aircraft without displaced threshold)}}{\text{(Distance to aircraft with displaced threshold)}}$$

For a point directly under the approach path of the aircraft, the distance called for in the above relationship is simply the aircraft altitude over the point. For a point to the side of the approach path, the distance is the hypotenuse of a right triangle, one of whose sides is the altitude of the aircraft and the other, the perpendicular distance from the projection of the flight path on the ground to this point. Note, however, that, in general, a displacement of nearly 4000 feet is required to obtain a reduction of 5 dB in landing noise 1/2 mile from the runway end, Farther from the airport, or for shorter displaced thresholds, the effect will always be smaller. Note, also, that if the runway is used frequently for takeoffs in the opposite direction, any measure of cumulative noise exposure [such as $L_{eq(24)}$, $L_{dn}$ or NEF] will show a smaller change still. It is apparent, then, that the greatest potential benefit from a displaced threshold would be felt by a neighborhood located very close to a frequently used landing runway.

How Effective Is the Action?

Effectiveness would best be measured by changes in neighborhood population exposed to single-event noise levels or times above thresholds (TAs).

What Are Issues of Implementation?

An airport operator can propose a displaced threshold to the FAA. Whether it is an acceptable noise control action will depend on the affect it will have on the operation of the airport. For example, it may affect the operations specifications of an air carrier's route certificate or the economics of using certain types of aircraft. There may be a need for the FAA to conduct an Environmental Assessment.

What Are the Costs?

The costs of instituting a displaced threshold may be borne by several parties. They fall into two categories: (1) one-time costs associated with initial safety or acoustic analysis and remarking the runway, and (2) continuing operating costs, which may arise if the displacement requires greater use of reverse thrust to stop on the available runway or if the aircraft must use an alternate, longer runway for landing.

Note in the extreme that shortening a runway to the point of eliminating certain aircraft from using it at all, may also result in an economic penalty to users.

## Where Is It Being Implemented?

Displaced thresholds are frequently used as a safety device to increase clearance over obstructions in the approach path to a runway. The fact that neighborhoods benefit slightly from the acoustic effects is usually secondary. However, this should not preclude the use of a displaced threshold solely as a noise abatement measure. Locations close in where residents have experienced lower noise from landing aircraft because of the addition of a displaced threshold include:

| Airport | Runway | Threshold Distance (in ft) | Maximum Estimated Benefit in Nearest Neighborhood for a Single Event (in dB) |
|---|---|---|---|
| Douglas Municipal | 18L | 659 | 1.8 |
| John F. Kennedy International | 13L | 1003 | 1.1 |
| | 13R | 2604 | 3.8 |
| | 22R | 3019 | 3.2 |
| | 31L | 3323 | 2.8 |
| Logan International | 15R | 890 | 2.8 |
| | 22R | 818 | 2.6 |
| Long Beach | 7L | 1306 | 4.6 |
| | 12 | 1349 | 3.2 |
| | 16L | 425 | 0.9 |
| | 25R | 531 | 1.2 |
| | 34L | 559 | 1.8 |
| | 34R | 302 | 1.1 |
| San Francisco International | 1R | 1100 | 3.2 |

## NOISE CONTROL ACTION NO. 3: HIGH-SPEED EXIT TAXIWAYS

### What Is the Action?

High-speed exit taxiways form an oblique angle to the runway. They require a turn of about 30 degrees for the aircraft to leave the active runway, while normal taxiways often require a full 90-degree turn. With the smaller turn, aircraft can taxi at higher-than-normal speeds and spend less time on the runway during landing roll.

### What Are the Benefits?

As a noise abatement measure, high-speed exit taxiways may lead to less frequent use of thrust reversal and can reduce the need to add the power than is sometimes required to exit via perpendicular taxiways. Depending on geometry, however, there may be an overall increase in taxi time and resulting air pollution.

### How Effective Is the Action?

Community annoyance attributable specifically to thrust reversal or to taxi noise is not usually the most pressing noise problem at an airport. Notice of it depends heavily on the position of a runway and its taxiways relative to surrounding communities. Complaints of this nature usually come from very close neighbors to the side and near the roll-out end of a runway, where the effect of thrust reversal is greatest and the effect of aircraft flight operations (departures and approaches) is reduced. The same neighborhoods are also likely to complain of aircraft on the start of takeoff roll, for the same reason.

Because the affected areas are so localized, the effectiveness of installing a high-speed taxiway can be identified only within the context of the immediate neighborhood. The problem is compounded by the fact that the computer programs available to predict airport noise do not generally deal with the contributions from taxiing aircraft and reverse thrust. At present, quantifying the effectiveness of the action requires a site-specific measurement program. Once the noise from these operations is quantified, the effectiveness of the taxiway can be judged by examining the change in number of people *in the specific neighborhood* who are exposed to various single-event levels before and after the project. If, instead, a cumulative measure of noise is used, such as $L_{dn}$ or NEF or even TA, the benefits of the project will be less pronounced, since the noise from other aircraft operations will normally dominate the total exposure.

Note that a high-speed taxiway also helps increase a runway's capacity. Thus, on the average, more aircraft can land on the runway than would otherwise have been possible. At the same time, of course, the noise exposure off the approach end of the runway increases. The result may be an overall increase in impact, because of the greater area affected, even though some neighborhoods at the other end of the runway could benefit from the action. Adoption of a high-speed exit taxiway as part of an abatement plan should be considered only after both aspects have been examined.

What Are Issues of Implementation?

This is a change in the runway system. Planning may be initiated by the airport operator. Actual construction will require coordination with users as well as Federal, state, and local authorities. An Environmental Assessment may be required.

## What Are the Costs?

Costs include those of planning and construction. However, since high-speed exit taxiways are added primarily to increase capacity, they should be charged to noise control only to the extent that the taxiway is required for noise abatement.

## Where Is It Being Implemented?

Most new construction at air carrier airports is designed for maximum capacity. Thus, it includes high-speed exit taxiways as a matter of course. Figure 4 shows the basic runway and taxiway layouts for LaGuardia Airport; it illustrates the changes in taxiway designs, particularly on Runway 13/31, that have occurred in recent years. High-speed taxiways also exist at Pittsburgh, Dallas-Fort Worth, Atlanta, Los Angeles, and other airports, although none was constructed solely for noise abatement.

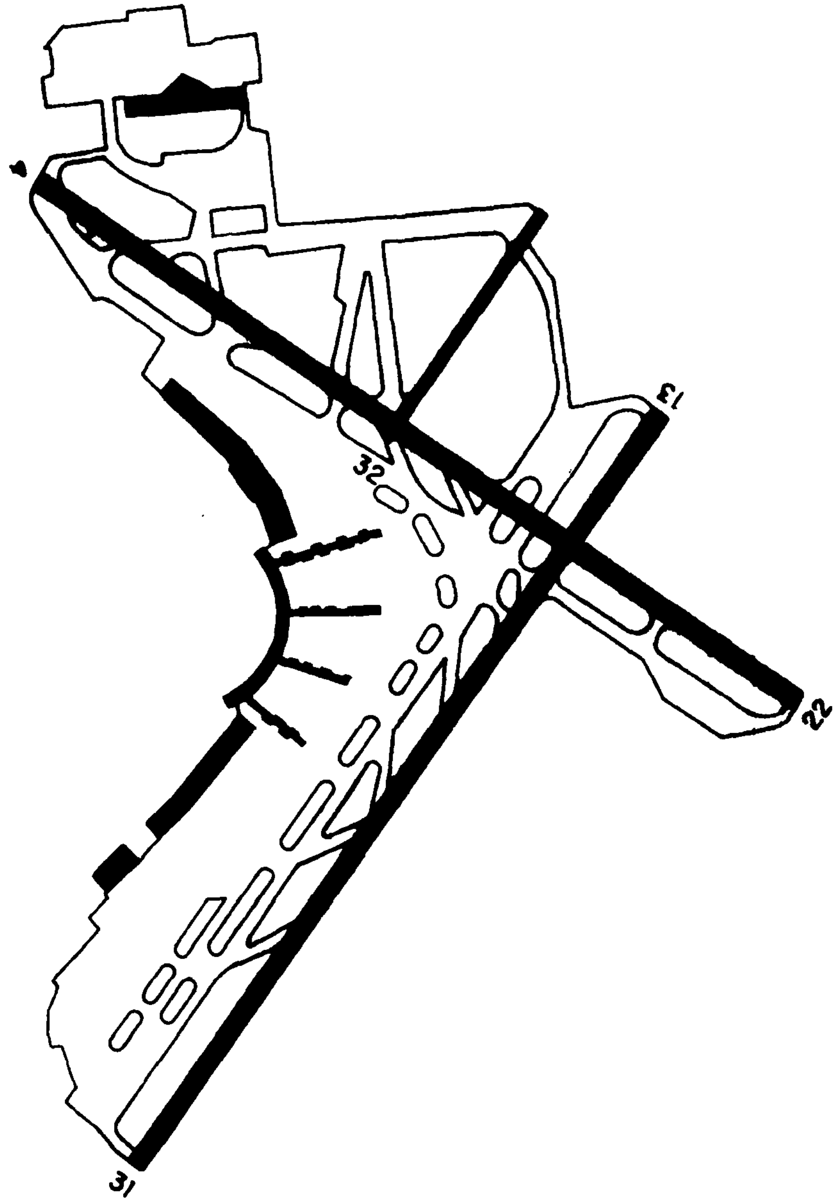


FIG. 4. LAGUARDIA RUNWAY AND TAXIWAY LAYOUTS.

## NOISE CONTROL ACTION NO. 4: RELOCATED TERMINALS

### What Is the Action?

Sometimes a neighborhood may be located off to the side of the major runways at an airport but very near a parking ramp (perhaps for general aviation aircraft). Under such circumstances, residents may be significantly bothered by ground power units, engine starts, and taxi operations, more than by flight operations – the more usual case.

Although it is highly unlikely that a terminal (or parking area) would be relocated just to reduce the noise from the very localized ground sources around it, the intent behind this action is that noise should at least be considered when the opportunity or necessity to relocate a terminal arises for some other reason in the master planning process. As a general rule, the parking ramp should be located as far as possible from residential areas.

### What Are the Benefits?

Possibly the most noticeable improvement to be realized with the relocation of a terminal and parking ramp would be a reduction in the nearly continuous noise from the power units used during the initial cockpit checkout and engine start. Some newer facilities are installing power hook-ups in the parking ramp so that independent power units are not needed, but at those facilities where the units are still used, terminal relocation could significantly improve the airport's "background" noise for some people. The degree of improvement will depend on the contribution of ramp noise to the total noise environment before and after the relocation. Quantification in terms of single-event or cumulative noise levels would probably require a measurement program and theoretical analysis since the FAA's Integrated Noise Model cannot handle alternatives of this nature at present.

As a first approximation of the improvement attributable to a relocated terminal, distances from points in the community to individual noise sources on the ramp before and after the proposed relocation can be measured and used in the following relationship:

$$\Delta dB = 20 \log 10 \left[ \frac{\text{Distance to the Noise Source with the Action}}{\text{Distance to the Noise Source without the Action}} \right]$$

If the terminal is moved away from the community, this will provide an estimate of the reduction in noise from a single operation such as an engine start at the nearest gate. If the terminal is moved closer to a community, the same relationship gives the estimated increase in noise from a single event.

## How Effective Is the Action?

The number of persons benefiting from terminal and parking relocation will probably be small relative to the total number of persons exposed to the noise from flight operations. However, since the action is intended to deal only with very specific problems in a fairly limited area near the airport, the effectiveness of relocating a terminal should be determined by examining only the population directly affected by this action. Measurements should be taken to characterize the immediate neighborhood rather than the entire airport surroundings. The analysis should concentrate on the change in single-event noise levels at various points in that neighborhood. Remember, too, that it may be difficult to compare populations exposed by various alternatives since computer modeling of terminal area noise is not available. Developing noise exposure contours to identify impact is likely to be challenging.

## What Are Issues of Implementation?

A terminal relocation project would undoubtedly originate with the airport Master Plan prepared by the airport operator. Design and construction may be funded jointly by the airport operator and FAA, perhaps with contributions from the air carriers. This is a change in the airport plan. It will require an Environmental Assessment.

## What Are the Costs?

Costs would derive from design and construction of the new facility but should be considered a noise control expense only to the extent that a particular site is selected because of the expected noise impact.

## Where Is It Being Implemented?

Few examples exist for the relocation of a terminal with consideration given to ramp noise, though Logan Airport in Boston is about to undertake a study which will do just that. To accommodate a proposed Eastern Airlines reservation center, the airport is considering moving its parking area for general aviation jets to a more remote site on the airport. Since the general aviation terminal would remain where it is, a shuttle service would take pilots and passengers back and forth to their planes. The move would keep business jets some 4300 feet from residents of East Boston, as opposed to the 300 feet which they reach while taxiing to the current parking ramp. Under the proposed plan, single-event noise levels would probably be reduced some 20 to 25 dB at the nearest residence.

NOISE CONTROL ACTION NO. 5: LOCATIONS FOR MAINTENANCE RUNUPS, AND TEST STAND NOISE SUPPRESSORS AND BARRIERS

What Is the Action?

These actions apply to maintenance facility planning. The intent of each is to reduce noise in communities caused by often late-night engine runups that are required for engine maintenance. One way to obtain noise reduction is simply to increase the distance to the noise source. Locating a runup facility near the center of an airport rather than on a perimeter road is the most obvious way to maximize the distance to neighbors if housing surrounds an airport. Where industrial or commercial property borders the airport to one side, it may be more beneficial to locate the maintenance facility nearer that compatible land use, increasing still further the distance to residential neighbors. Keep in mind, in either case, that the lowest noise levels during an engine runup occur directly to the rear of the aircraft, as shown in Fig. 5. Therefore, noise can be minimized further, if engine tests stands of aircraft tie-down points are oriented so that the engine exhaust is directed toward the nearest community.

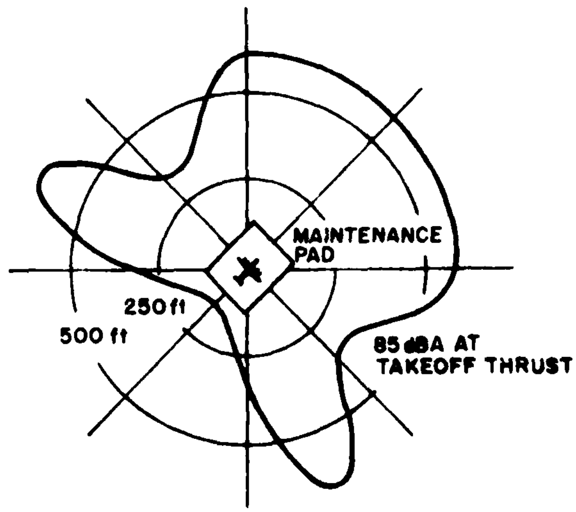


FIG. 5. NOISE LEVELS AROUND A TYPICAL AIRCRAFT DURING ENGINE RUNUP.

Noise reduction can also be obtained by obstructing the path between the source and the community. This may be done with test stand noise suppressors and barriers. In the case of suppressors, much of the noise is absorbed and the exhaust is often vented upwards away from the neighbors. With barriers, neighbors are shielded from runups as long as the barrier breaks the line of sight from the engines (and propellers, if applicable) to the listeners.

## What Are the Benefits?

Benefits from controlling engine runup noise will vary widely, depending on the types of activity that take place at an airport. A small air carrier facility that hosts a squadron of National Guard jets may find the military's engine runups a problem, particularly when maintenance is conducted at night. Test stand noise suppressors or a "hush house" can provide 20 dB or more reduction in single-event sound levels, and at airports with clearly identifiable runup noise events, such as might be expected in the example above, a 20-dB reduction can result in a significant improvement of 5 dB or more in cumulative noise exposure. On the other hand, if runup noise is masked by or cannot be distinguished from the noise from normal flight operations, a 20-dB reduction of only the runup noise will be much less noticeable when the total environment is considered.

Well-designed barriers provide less noise reduction, typically on the order of 10 to 15 dB at the closest residences, and lower barriers produce poorer results. Moving a runup pad to another part of the airport might provide a benefit of 5 to 10 dB, at most. Again, the overall effect of each of these improvements on the total noise environment is likely to be less, because flight operations will still be heard.

## How Effective Is the Action?

The overall effectiveness of moving a runup pad or building a noise suppressor will depend on the current and future locations of the maintenance facility relative to the airport's neighbors, the contribution of runup noise to the total noise environment, and the specific noise control action that is taken. The effectiveness can be described by modeling cumulative noise exposure [in terms of $L_{eq(24)}$, $L_{dn}$, or NEF, which would include all airport activity], or single-event noise levels for the runups only (in terms of dBA, $L_{eq}$ for the duration of the runup, or PNdB), and then by counting exposed population in 5-dB increments. If runups form a significant part of a neighborhood's total noise exposure, the cumulative measures would be most appropriate. If other sources dominate the total exposure, an analysis of single-event levels for the runups alone is probably the best way to describe the magnitude of the benefit, but obviously only part of the total noise environment is being considered.

## What Are Issues of Implementation?

An airport proprietor can implement this action directly if it does not involve Federal funds. Several different parties could be involved in relocating or upgrading a maintenance runup area, depending on the source of financing. An airline could propose to build a noise suppressor or barrier for an existing facility, or the recommendation could be made in the master planning process. In any case, the airport operator would have to approve the action since it affects his property. The FAA would be involved if the recommendation were a part of a master plan and would have an interest in possible conflicts with the movement of taxiing aircraft, in clearance limits, and in other factors involving safety. However, an Environmental Assessment is not required.

**What Are the Costs?**

Costs typically include those associated with design of noise suppressors or barriers as well as construction or acquisition costs and continued operating costs, such as maintenance on the test stand suppressor, replacement of materials, and minor costs of towing or taxiing aircraft to the new facility. At Hyannis, where a below-grade maintenance runup area was constructed inside a former borrow pit, consulting, design, and construction costs reached $80,000. Typical noise suppressor costs run about $200,000 for a set designed for DC-9s. Suppressors for DC-10s may cost on the order of $600,000. In each case, the suppressor's weight is approximately equal to the weight of the entire aircraft.

**Where Is It Being Implemented?**

Noise suppressors are in use at a number of major facilities around the country, including Logan International, Lambert Field in St. Louis, Duluth International, Jacksonville International, and Fresno Air Terminal. One particularly impressive group of noise suppression units is located at the airport in Zurich, Switzerland. The units are designed to handle any aircraft flown by Swissair, including DC-10s and 707s.

Barriers have been erected at many other facilities, including Islip MacArthur, Detroit Metropolitan, Indianapolis, Minnesapolis-St. Paul International, Memphis, and Stapleton, to name a few. In many cases, these barriers are louvered to act as blast deflectors as well as noise barriers, and they may not be high enough to reflect sound from the third engine on 727s, DC-10s, or L-1011s. In such instances, the degraded performance may offer only 5-dB noise reduction for individual runups, as opposed to the 10-dB to 15-dB reduction from good acoustic barriers.

One unique barrier construction project is being initiated at Los Angeles in an attempt to reduce sideline noise from aircraft still on the runway. A 1500-foot test section consisting of a 12-foot wall on top of an 8-foot earth berm is being erected to replace the shielding previously provided by houses removed under the airport's acquisition program. Cost for construction of the test section is $409,500.

NOISE CONTROL ACTION NO. 6: RUNWAY USE PROGRAMS

What Is the Action?

There are two groups of runway use programs: preferential or priority, and rotational.

A preferential or priority runway use program distributes aircraft operations around an airport to minimize overflights of either the most highly exposed areas or the most densely populated areas. Both the cumulative energy metrics [$L_{dn}$, $L_{eq(24)}$, NEF] and the Time above Metric are reduced because such a program cuts the number of times that an aircraft is heard over the neighborhood, even though the noise level from any single overflight is unchanged.

A rotational runway use program is a variation of a priority system in which an effort is made to distribute operations evenly off all runways without dwelling on any one runway for an extended period and without considering the distribution of population around the airport. High-density neighborhoods are not given special consideration at the expense of low-density neighborhoods.

What Are the Benefits?

The premise behind a runway use program is that, although an aircraft is assigned to a runway subject to constraints that include capacity limitations, runway length, wind conditions, and weather minimums, within those constraints there is often room for choice. When a choice is available, the selection of a runway should be based on minimizing noise exposure in populated areas. FAA Order 7110.81 (5 May 1978), entitled, "Runway Use Programs," permits up to a 90-degree crosswind as long as the velocity is 15 knots or less and runways are clear and dry. Greater flexibility, i.e., tailwinds, may be permitted in a formal runway use program if approved by the FAA.

Figure 6 illustrates a simple case. Here, an airport has a main north-south runway aligned with a community and a cross-wind runway directed away from the community. A preferential runway use program at that airport would maximize use of 9/27.

In fact, the "crosswind" runway could essentially be used whenever the winds are 15 knots or less. The result would be a considerably different set of runway utilizations than would occur if noise exposure were not considered in the runway assignment and full advantage were not taken of the allowable crosswind.

With more complex runway layouts and with residential neighborhoods located off several runway ends, additional consideration must be given to the relative noise exposure to which residents are exposed, to population density in each neighborhood, and to issues of capacity and delay. In these cases, tradeoffs between runways must be made to achieve a desired goal.

To achieve specific runway utilizations that result in predetermined cumulative noise exposure levels for each runway end, a set of implementation procedures is generally required. It varies in complexity with the airport. For the simple case of Fig. 6, a tower bulletin stating that 9/27 should be used whenever winds are within 90 degrees of the runway heading and the velocity is 15 knots or less may be all that is necessary to establish an informal runway use program.

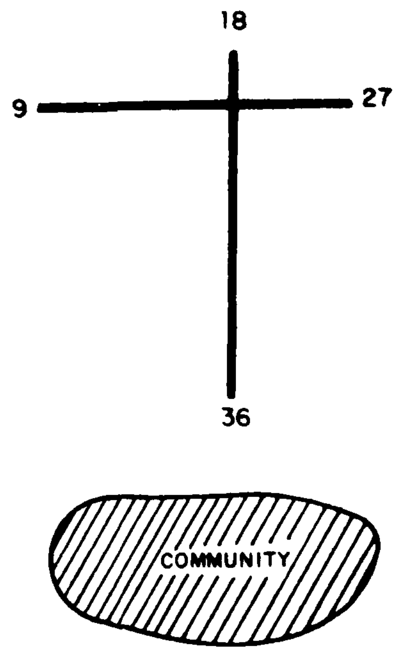


FIG. 6. 9-27, 18-36, COMMUNITY.

In more complex situations, formal runway use programs may actually specify the wind, weather, and demand conditions (or hours of the day) during which a runway or runway pair should be used, and would require coordination with FAA Flight Standards Service and with all operators who routinely use the airport.

How Effective Is the Action?

The decibel change in noise exposure is determined by the relationship below, which assume that the fleet mix on the runway does not change:

$$\text{Change in noise exposure, in dB} = 10 \log \frac{\text{new utilization}}{\text{old utilization}} .$$

You can achieve a 5-dB change (increase or decrease) in cumulative metrics by preferential runway use, but not much more. Even a 5-dB change in the noise environment requires a change by a factor of 3 in the effective operations using a particular runway, such as, for example, reducing the utilization from 21% to 7%. It is quite difficult to get a 5-dB improvement off a highly utilized runway, because more operations have to be shifted. (A reduction in utilization from 63% to 21% gives a 5-dB improvement but requires shifting 42% of the effective operations to other runways. Where utilization is reduced from 21% to 7%, only 14% of the operations must be shifted.) It is interesting to note in this case that because times above threshold values change in direct proportion to changes in operation, the TA metric would indicate that shifting 42% of the operations from a runway is three times better than shifting 14%, yet the decibel change in a metric such as $L_{dn}$ is the same (5 dB). In many cases, the changes will be much less than 5dB. While community reaction tends to relate best to cumulative levels, the TA analysis may be very useful in this situation to complement discussion of effectiveness.

Also, remember that not all neighbors will realize a benefit from a runway use program. People in low-density areas are likely to experience an increase in cumulative noise exposure because the preferential runway systems are designed to protect either the largest number of people or those most highly impacted.

## What Are Issues of Implementation?

Developing a runway use program involves nearly everyone concerned with an airport. The airport operator, the FAA, and the community may determine desired utilizations and specify runway selection criteria that will result in those utilizations. Neighbors and members of the adjacent community need to understand the tradeoffs involved in such a program.

Implementing the program requires the assistance and cooperation of FAA (Air Traffic Control) and the users (carriers, pilots, FBOs, etc.). A constant flow of information, a thorough review of the plan, and total agreement on the program's feasibility *must* be obtained from these groups, because the air traffic control tower makes the final runway assignment and the pilots hold the ultimate responsibility for safe operation of their aircraft.

An airport operator can propose a runway use program. However, if the FAA is to participate, full coordination with users as well as Federal, state, and local users will be required. Also, implementation by the FAA would require an Environmental Assessment.

## What Are the Costs?

The costs of a preferential runway use program fall essentially into two areas: development costs and operational costs. Both may vary widely, depending on the sophistication of the system and the current airspace use. At airports such as Kennedy or Logan, where the preferential runway use programs involve or will involve continuously updated monitoring systems and the computer software to go with them, development costs may be on the order of several hundred thousand dollars.

Actual implementation of the program would alter taxi times and flight times, since aircraft would be using a different runway more frequently. These changes, in turn, would affect fuel costs and air pollution, and would perhaps have some effect on crew costs or other operational expenses. The costs would not necessarily increase, however.

At Logan, for example, the average mileage from each approach fix to each runway threshold, weighted for the percentage of traffic using each fix, was found to be lowest for the most (acoustically) desirable runway and highest for the least desirable runway, the total difference being 9 nautical miles. The difference in distances to the most desirable runway and to the most frequently used runways was 3 nautical miles. If these distances were also weighted to account for the various runway utilizations, the differences would be even less, but they would still reflect the fact that more aircraft would fly a shorter distance to get to the preferred runways.

## Where Is It Being Implemented?

The most comprehensive preferential runway study to date took place at Logan. Alternative sets of runway utilizations were developed, each set reflecting a different stated goal. Goals included:

A. Minimizing the number of people exposed to $L_{dn}$ values above 65 dB

B. Minimizing the number of people exposed to $L_{dn}$ values above 75 dB

C. Minimizing the number of people exposed to $L_{dn}$ values above both 65 and 75 dB.

The compromise that evolved after public meetings in each community results in a total reduction in the number of people above $L_{dn}$ 75 and 70 by 65% and 29%, respectively. However, the number of people above $L_{dn}$ 65 increased by 11%. The decrease in population at the highest noise exposure levels is possible because the airport is buffered by a small expanse of water at the ends of three runways whose utilizations could be increased slightly. A fourth runway end is protected by almost 6 miles of water, and its use is maximized even to the point where takeoffs and landings are made in opposing directions during late-night hours when demand is very low, as long as tailwinds do not exceed 5 knots. It should be noted that use of any runway for opposing operations by arriving and departing aircraft must be considered very carefully because of obvious safety factors.

Similar, though less complex, runway use programs exist at other airports, several of which are listed below. All have in common at least one runway that can be used to reduce overflight of a highly populated or sensitive area.

### Jackson Hole Airport

Jackson Hole is located in the southern end of Grand Teton National Park and as such is one of the most environmentally sensitive airports in the country due to the pristine nature of the setting. To minimize operations over the park, the airport, as a part of its noise abatement plan, has adopted a preferential system encouraging departures on Runway 18 and landings on 36. Runway use will be as prescribed unless the tailwind component for any aircraft is exceeded or traffic conditions totally preclude such opposing operations with acceptable aircraft spacing.

### Baltimore-Washington International

Baltimore-Washington International Airport has a preferential runway system designed to reduce overflights to the northeast, east, and southeast where residential development is most dense. Under the new program, air carrier jets no longer use Runway 4/22 (a relatively short runway), and operations have been significantly shifted toward the west. The numbers of people exposed to levels in excess of $L_{dn}$ 65 and $L_{dn}$ 70 each decreased 65%, and the number of people exposed to $L_{dn}$ 75 decreased 17%.

### LaGuardia

LaGuardia's preferential runway system has been structured to operate on a maximum crosswind component of 15 knots rather than on the criteria specified in FAA Order 7110.81. Figure 7 shows the graphic aid published as a part of the tower bulletin, which translates the component-based system into a practical means of making runway selections.

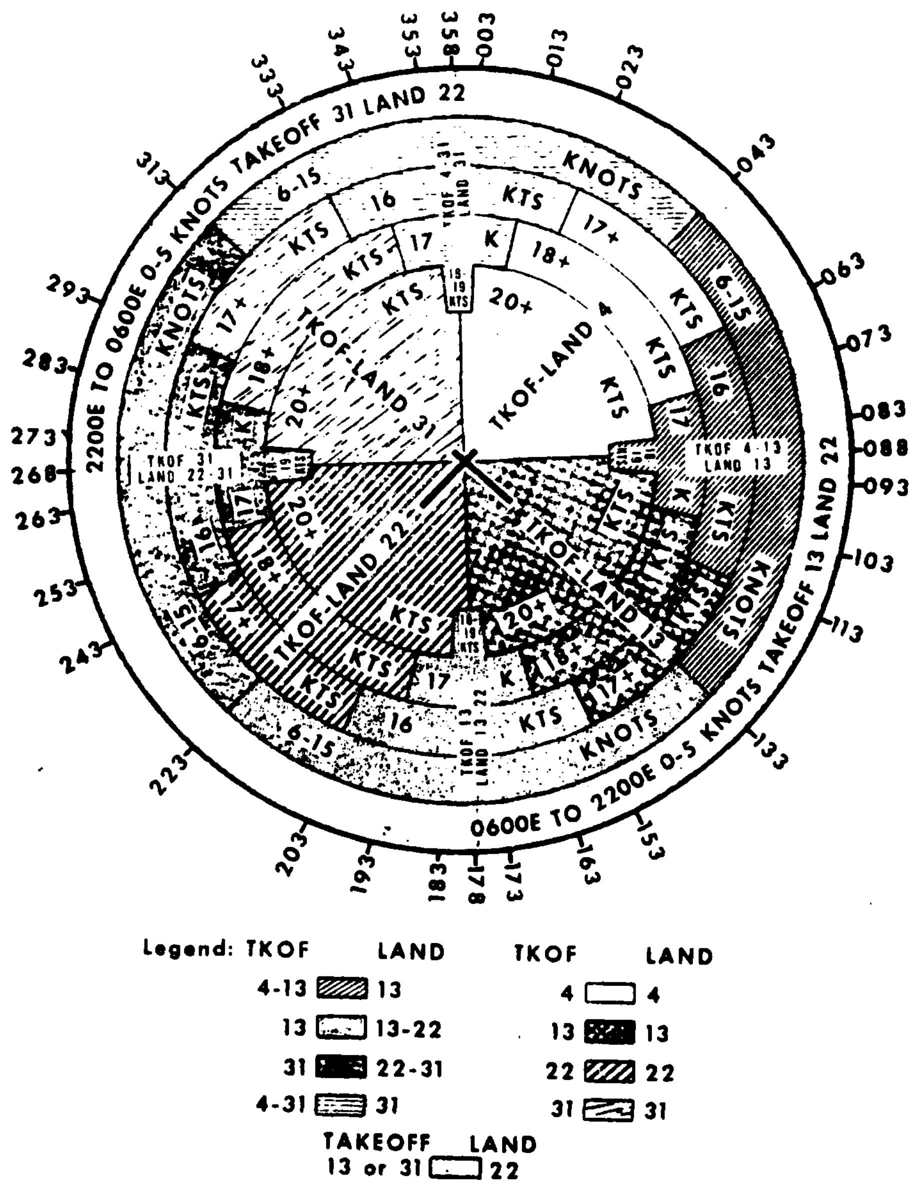


FIG. 7. LAGUARDIA NOISE ABATEMENT RUNWAY SYSTEM.

Under this rule, use of Runway 22 for takeoffs and Runway 4 for landings is minimized.

Douglas Municipal

At Douglas Municipal Airport, the addition of a new 10,000-foot Runway 18R/36L will permit changes in utilizations for noise abatement that result in a 90% reduction in population exposed to levels above $L_{dn}$ 75.

Other airports such as Salt Lake City, Buffalo International, Dulles, LaGuardia, Newark, Phoenix, Atlanta, New Orleans, and San Jose also have preferential runway use programs. O'Hare has a preferential system for nighttime operations. Kennedy International, bordered by dense residential development on three sides, uses a rotational runway system.

## NOISE CONTROL ACTION NO. 7: PREFERENTIAL FLIGHT TRACK USE AND CHANGES IN APPROACH AND DEPARTURE PROCEDURES

### What Is the Action?

Preferential flight track use and changes in approach and departure procedures affect how, where, and often aircraft fly over which neighborhoods, once they are assigned to a given runway. The action can apply to both arriving and departing aircraft, but the intent is always to minimize overflights of the most populated or most noise-sensitive areas, sometimes at the expense of convenience. However, actually achieving this goal requires very careful analysis — not a simple task.

### What Are the Benefits?

As with most of the noise control actions discussed here, preferential flight tracks and changes in approach or departure procedures must be tailored to an individual airport. Any improvement in exposure level will depend on the location of a community relative to the track and also whether changes are made to both arrival and departure tracks over the same neighborhood. Where nearby communities are located slightly off centerline of a runway used heavily for departures, it would not be unreasonable to find as much as a 5-dB improvement in cumulative noise exposure if aircraft are given a change in heading of 20 or 30 degrees. That benefit is reduced, however, if landing noise also affects the communities' exposure and cannot also be abated.

For smaller airports having significant touch-and-go activity and few commercial flights, preferential flight track use can produce changes in overall exposure levels of 1 or 2 dB

2000 to 4000 feet to the side of a runway by switching from standard (left turn) to nonstandard (right turn) traffic patterns or *vice versa*, so that all aircraft fly only to one side of the airport. This is a relatively simple means of concentrating activity over the least populated area at essentially no inconvenience to pilots.

## How Effective Is the Action?

For most airports, changes to approach plates or changes in departure headings will result in a decrease in noise exposure in one area but will increase the noise somewhere else. Unless the change takes aircraft over some totally unpopulated area (e.g., water), this action is really just a means of redistributing the noise to less populated areas. The effectiveness of the action should therefore be measured in terms of people impacted. Emphasis should be on changes in population in 5-dB increments [using $L_{eq(24)}$, $L_{dn}$, or NEF], limiting the study area to the particular runway end affected. It may also be of political interest to know how these populations are affected within specific jurisdictions or neighborhoods. Additional examination of times above 75 or 85 dBA may be useful in discussing proposed flight track changes with airport neighbors.

## What Are Issues of Implementation?

Because this action involves changes in airspace use, the responsibility for implementing the action rests with FAA, although the action may be proposed by the airport operator. Consideration must be given to factors such as aircraft separation, radar hand-off procedures, and possible changes to letdown plates or Standard Instrument Departure procedures (SIDs) before flight tracks can be altered. Coordination with the air carriers or other users is essential and perhaps most important is the involvement of affected communities. An Environmental Assessment will be required.

## What Are the Costs?

Following an alternate flight track generally requires more time and hence increases fuel consumption as well as other operating costs. Although it may be possible to pass those costs on to passengers, operating costs are borne, at least in part, by the users and, in particular, the carriers.

In a study of alternative tracks from Runway 22R at Logan*, the impact of the increased distances and flight times on annual aircraft operating expenses ranged from $452,000 to $4,103,000. Additional fuel consumption was estimated to increase from 585,000 gallons to 5,310,000 gallons depending on the alternative.

## Where Is It Being Implemented?

### Logan International

To elaborate on the evaluation of flight tracks at Logan, aircraft departing Runway 22R have for several years made a slight deviation to 210 degrees after takeoff so as to remain over water for a longer time before turning west over the city. Still, heavily populated areas immediately south of the runway were being severely impacted by the noise above $L_{dn}$ 75. Thus,

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*Supplemental Draft Environmental Impact Statement, Departing Procedures, Runway 22 Right, Logan International Airport, Document No. ANE-500-79-2, published by the FAA, New England Region, December 1979.

the FAA, working with the Massachusetts Port Authority, began experimenting with larger turns toward the water, first to 195 degrees, then to 180 degrees. Each turn brought aircraft back over the city at a different point, and resulted in a great many noise complaints from new areas, each time generating new alternatives. One option eventually considered required that aircraft departing 22R make a *left* turn of about 320 degrees to head west. Planes crossed the shoreline north of the airport at anywhere from 7000 to 10,000 feet MSL. After final examination of six alternatives, the FAA, on 14 March 1980, issued a record of decision selecting a procedure involving a left turn after takeoff to an eventual heading of 100 degrees out the mouth of the harbor. It is expected to reduce the 7900 people originally exposed to levels above $L_{dn}$ 75 down to 0. This population exposed to levels of noise above $L_{dn}$ 65 is estimated to be reduced from 91,300 down to 2,800. Improvements in exposure levels at the location closest to the airport are estimated to range from 11 to 14 dB.

Washington National

A second example of a noise abatement flight track is the approach to Runway 18 at Washington National Airport. The procedure requires that during VFR weather, pilots fly a visual approach to the runway, making turns on final so as to follow the Potomac River. The highest noise levels then occur over water. Assuming that the approach does not require higher power settings, 4 miles from the runway end the procedure reduces the worst single-event noise levels by about 2 dB compared to straight-in arrivals. Closer to the airport, about 2 miles from touchdown, the benefit could increase to about 5 dB. Cumulative measures of exposure would reflect smaller benefits because departure noise on Runway 36 would be unchanged.

## Los Angeles International

A third example of a noise abatement flight track is the "Daggett Loop" at Los Angeles International Airport. Before the procedure was instituted, aircraft departing to the west but routed eastbound were given left- or right-hand turns crossing the shoreline near Palos Verdes at about 6000 or 7000 feet or Santa Monica to the north at about 6000 feet. Under the new procedure, aircraft now climb on a heading of 250 degrees over water, then make a left turn of 210 degrees so as to cross over the airport between 10,000 and 13,000 feet heading 040 degrees to Daggett. The procedure reduces noise in Pacific Palisades, Santa Monica, Redondo, and Palos Verdes, but aircraft fly approximately 26 additional miles and use about 2000 additional gallons of fuel daily.

## NOISE CONTROL ACTION NO. 8: LIMITED REPOSITIONING OF AIRCRAFT

### What Is the Action?

Restricting ground movements of aircraft is an action aimed at reducing the need to use ground power units, make engine starts, and taxi. An appropriate regulation might require that an aircraft not be moved to alternate gates or not be moved from a maintenance hangar to a gate under its own power. Aircraft movement would require towing instead. Hours during which the action would be in effect may or may not be specified. Other types of restrictions on ground operations could require aircraft to check for delays with ground control prior to engine start. Such "gate hold" procedures reduce idling time, taxi noise, and fuel consumption.

### What Are the Benefits?

Under this action, normal arrivals and departures are presumed to continue operation as usual, going through their start, taxi, and shutdown procedures as required. But the same operations for maintenance purposes or schedule changes would require towing. This would not reduce the noise from an individual ground operation, however, the *number of times* each of these operations is carried out is reduced and, thus, so is total noise exposure.

Improvements from adoption of this kind of measure will be small though, noticeable only to residents quite near the ramp areas who can identify significant noise from ground sources.

### How Effective Is the Action?

Effectiveness can be determined by examining changes in cumulative noise exposure measures at a few specific points in nearby neighborhoods. The number of people affected by the action can be estimated, but determining specific noise exposure contours may be difficult. Most computer models do not include provisions for engine start and taxi noise.

## What Are Issues of Implementation?

Adoption and enforcement of a regulation of this nature can be implemented directly by the airport operator. In general, the air carriers would be responsible for seeing that their procedures met the regulation.

## What Are the Costs?

Full compliance with a regulation that prohibited gate switching, as well as taxiing for maintenance, would require towing of aircraft at least from hangars to gates. Towing costs (perhaps including additional equipment) would be balanced against small fuel savings since aircraft engines would not be started. Secmafer has recently developed a new tractor now being tested for high-speed towing by Air France. It's cost is estimated to be in the vicinity of $330,000.

## Where Is It Being Implemented?

The only airport known to have a regulation against repositioning aircraft under power is Logan International, where, as of 1 July 1977, no aircraft could be repositioned under self-propulsion at any time during the day or night.

The Massachusetts Port Authority, operator of the airport, has also proposed in the past that even aircraft involved in normal operating movements from one of their terminals be towed to a staging area near the runway before starting engines.

Initial analysis of this more comprehensive proposed regulation indicated that the time required for towing was excessive and costly, and that certain factors, such as safe towing speed, were subject to neglect. As a result, the regulation has yet to be adopted.

Such options might be plausible in the future, however, once testing of Secmafer's new tractor is complete. It actually carries aircraft by their nose gear, and can operate up to 38 mph. Previous tests with tow-bar tractors at 20 mph resulted in a severe yaw for both a 747 and 707.

NOISE CONTROL ACTION NO. 9: RESTRICT TIMES FOR MAINTENANCE RUNUPS, AND CONTROL NOISE FROM GROUND EQUIPMENT

## What Is the Action?

This action is aimed at accomplishing by regulation what Action No. 5 (Locations for Maintenance Runups, and Test Stand Noise Suppressors and Barriers) accomplishes by physical changes to the airport plan. In either case, the goal is to reduce the noise from maintenance operations, and both actions can be applied simultaneously toward that end. The regulation simply establishes a curfew or some time limitation for engine runups so that residents will not be interrupted by late night or perhaps weekend maintenance activity. Action No. 5 actually reduces the noise levels of the runups.

Noise from ground equipment can also be controlled by regulation. Startup and shutdown times for ground power units can be tied to scheduled block times so that equipment is not kept running unnecessarily. Alternatively, all new equipment can be required to meet a given sound level specification based on manufacturer-supplied noise data. Regardless of the means, the intent is to reduce noise from other than flight operations when such activity represents a source of annoyance.

## What Are the Benefits?

Improvements in the noise environment attributable to either of these abatement measures would occur only in areas where runups and parking ramp noise were identifiable problems. Quantifying the improvement for a specific situation is difficult with either modeling or a measurement program, usually because the noise environment is also affected and often dominated by flight operations. In such instances, justification for the action is usually examined in terms of the noise for individual events.

How Effective Is the Action?

Because of the difficulty in quantifying the exposure before and after the action, it will also be difficult to quantify effectiveness. One possible way is to examine changes in noise complaints after the measure is adopted, or, if the action is arrived at following discussions with community interest groups, it's at least likely that the effectiveness will be viewed as positive.

What Are Issues of Implementation?

Adoption and enforcement can be implemented directly by the airport operator. The responsibility for compliance rests with the carriers or other users of the airport.

What Are the Costs?

One cost that might result from restricting times for engine runups is the possible loss in revenue that could be attributed to maintenance delays while waiting for a curfew to end. Incremental costs of noise control on ground equipment purchases would also be expected.

Where Is It Being Implemented?

Time restrictions on engine runups are an abatement measure currently in use at more than 30 airports throughout the country. They include Albany County, Cleveland-Hopkins International, Duluth International, O'Hare, Seattle-Tacoma, San Diego International, Los Angeles International, and Tampa. Restricted hours typically range from 10:00 p.m. to 6:00 a.m. Van Nuys Airport prohibits maintenance runups and engine tests from 7:00 p.m. to 7:00 a.m.

NOISE CONTROL ACTION NO. 10: LIMITING NUMBER OR TYPES OF OPERATIONS, AND LIMITING TYPES OF AIRCRAFT

What Is the Action?

This action encompasses a wide range of measures for reducing airport noise through regulated limits on operations and on aircraft. Quotas can be set on the number of annual or daily operations through slot allocations or lease agreements; restrictions can be placed on formation flying by military aircraft, on practice instrument approaches by air carrier aircraft, or on touch-and-gos; or regulations can prohibit aircraft that do not neet some specified noise limit (such as the lowest Stage 3 limit in Federal Aviation Regulation Part 36). Many other examples exist. Some apply only to operations on a particular runway rather than to the entire airport, but in all cases, the basic principle behind the limitation is to reduce noisy operations.

In applying such rules, however, consideration must be given to constitutional issues such as Federal preemption, unjust discrimination, or burden to interstate commerce.

What Are the Benefits?

Unlike the other actions discussed to this point, the measures included here can reduce noise for large numbers of people without increasing noise for anyone. This achievement is different from preferential flight track use, for example, where a reduction in noise in one area is usually accomplished by increasing the noise in some other less populated area.

The change in exposure that will result from a use restriction can be quantified by running two sets of noise contours for comparison. Alternatively, the best approximation of the benefit attributable to a use restriction is simply the difference between the cumulative noise before the action and the cumulative noise after the action computed at several individual points. To estimate the benefit in terms of $L_{dn}$, calculate values on a point-by-point basis, using the handbook method.* The procedure involves logarithmic addition of the sound exposure level at each point for each aircraft operation on each flight track.

Of course, the magnitude of the benefit will depend on how restrictive the limitation is and how much the restricted activity contributes to the total noise environment. At Washington National, for example, nighttime operations (after 10:30 p.m.) are permitted but only by those aircraft that meet the lowest stage 3 noise limits. Since no existing air carrier aircraft and only a very few business jets can meet that limit, the restriction is nearly equivalent to a full curfew. The measure is less effective at National than it would be at many other airports, however, since National already operates with a voluntary curfew. In general, the largest reductions in exposure would probably occur at small airports that placed limitations on noisy jet activity. An improvement on the order of 5 dB could be achieved in cumulative noise exposure levels in such cases.

One word of caution: Some limitations may end up allowing noise exposure to increase! Airports that prohibit touch-and-gos may increase their capacity to handle more noisy jet traffic. Quiet airplanes can get replaced by noisier ones.

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*Bishop, D.E., *et al.*, "Calculation of Day-Night Level ($L_{dn}$) Resulting from Civil Aircraft Operations," U.S. Environmental Protection Agency Report 550/9-77-450, Arlington, VA.

## How Effective Is the Action?

Since the benefits of operational and type limitations generally occur in all areas surrounding an airport, effectiveness can be determined by changes in number of people exposed above accepted land use criteria ($L_{dn}$ 65 and 75 or their equivalents in other cumulative measures), by changes in number of people in 5-dB increments of cumulative exposure, by changes in the number of people within various TA categories, or by reductions in exposure levels at particular points. Only if the action applies to a single runway would it be necessary to examine changes in impact by neighborhood or other jurisdiction so that communities could compare relative benefits.

## What Are Issues of Implementation?

The airport operator is generally responsible for any noise abatement regulation limiting the number or type of operations at his airport. The regulatory process typically involves input from all affected parties, however, including the users, communities, and the FAA.

One very important point to note is that although the operator does retain this authority to impose use restrictions, the U.S. Constitution prohibits him from taking any action that imposes undue burden on interstate or foreign commerce and unjustly discriminates between different categories of airport users.

## What Are the Costs?

Costs are generally derived from the increased time that it takes to operate to or from a nearby airport where operations are not restricted. For an isolated small airport, a touch-and-go limitation may raise training costs enough that flight schools will lose enrollments. For a company with a based aircraft that does not meet a regulated noise limit, the inconvenience of using an alternate field is weighed against the cost of obtaining a quieter aircraft.

## Where Is It Being Implemented?

Aircraft type restrictions exist at Logan International, which prohibits supersonic jet transports.

Noise level limits exist at Kennedy International, LaGuardia, and Newark all of which have adopted a violation level of 112 PNdB and monitor all departing aircraft for compliance. Santa Monica has established a maximum single-event noise exposure level (SENEL) of 100 dB. Torrance has adopted both a maximum dBA limit (82 dBA) as well as an SENEL limit (88 dBA), each of which is reduced by 6 dB for nighttime operations. Other airports such as Lake Tahoe have noise level restrictions tied to FAR Part 36 noise limits. "Fleet Noise Rules" in effect at several larger airports are simply variations on this kind of restriction. Los Angeles and San Francisco require a phased program of compliance with FAR Part 36 such that by 1 January 1985, an aircraft will be permitted to operate at the airport only if it meets the Federal noise standards. Also, any new operations must be in aircraft certificated under Part 36. Logan also has a phased compliance program. Each operator is required to compute a monthly FAR Part 36 compliance ratio and achieve 84% compliance for 1979 and 100% compliance for 1980.

Quotas on numbers of operations exist at O'Hare, LaGuardia, JFK, and National. These are maintained through slot allocations originally established because of constraints on capacity but have the side benefits of limiting noise from flight operations and of reducing ground delays and excessive taxi noise. A quota also exists on operations at Stewart Airport. The Orange County legislature established limits of 50,000 air carrier movements per year through 1985 and 60,000 per year from 1985 to 1995 to allay concern that the airport would become New York's fourth major facility.

At Beverly Municipal Airport in Massachusetts, where touch-and-gos contribute significantly to community noise exposure, those operations are restricted by regulation. Touch-and-gos can be made only on weekdays before 9:00 p.m. or two hours after sunset, whichever is later. On weekends and holidays, they cannot be made before 8:00 a.m., and on weekends during the summer they cannot be made after sunset or on Sunday afternoons. Santa Monica has a restriction on helicopter training flights.

Historically, the FAA has opposed certain other use restrictions. San Diego's one year moratorium on service by new carriers was deemed discriminatory in that it gave existing carriers unfair economic advantage. Santa Monica's jet ban was also found to be discriminatory since some jet aircraft are quieter than some props.

The FAA has also generally opposed aircraft noise limits requiring monitoring of individual events for enforcement but prefers, instead, limitations based on already published levels in their advisory circulars (36-1B, 36-2A, and 36-3). The latter approach, now being proposed as a part of Washington National's noise abatement plan, reduces any tendency for pilots to deviate from normal procedures to avoid a monitoring station.

## NOISE CONTROL ACTION NO. 11: CURFEWS, RESCHEDULING, AND MOVING FLIGHTS TO ANOTHER AIRPORT

### What Is the Action?

During late night and early morning hours, when community noise levels decrease significantly, aircraft operations become more intrusive and tend to be more annoying. Curfews reduce or eliminate these operations. Typically, restrictions last from 10:00 p.m. or midnight until 6:00 or 7:00 a.m. and may or may not apply to all aircraft.

A second kind of action, rescheduling of flights, may occur in connection with a curfew. When nighttime restrictions are adopted at smaller airports, some of the arrivals and departures are merely rescheduled to a time either side of the curfew. For many night flights, this means a shift of less than an hour, and although schedule changes have far-reaching effects at many other airports in the system, often these shifts are accommodated. Moving flights to another airport is just another form of rescheduling, though it need not apply only to night operations. The FAA is concerned about the disruptions to commerce caused by curfews, and they are generally considered to be actions of last resort.

### What Are the Benefits?

Qualitatively, for many airport neighbors, a curfew means 8 hours of relative peace and quiet, even if they do spend most of that time asleep. Quantitatively, the benefit depends somewhat on the measure of noise exposure that is used to describe the environment. Cumulative measures such as $L_{dn}$ or NEF that penalize nighttime activity for being more annoying generally show fairly significant improvements in the environment as a result of a curfew, as might be expected. The benefit would be on the order of 2 or 3 dB at many medium or large air carrier airports and would extend to everyone in areas adjacent to the airport. A cumulative measure that does not penalize night operations, such as $L_{eq(24)}$, would show essentially no benefit to a curfew (or only about 1/2-dB improvement). An analysis that used times above thresholds would also show little benefit for a 24-hour period. In each of these cases, the large majority of daytime operations dominate the measure of exposure. Estimation of the nighttime period only would, however, indicate rather dramatically the benefits achievable.

## How Effective Is the Action?

Because the benefits of a curfew can vary quite significantly, depending on the measure used to describe the noise exposure, and because the number of affected operations may also vary from one airport to another, the action may or may not be judged effective. A curfew does represent a definite improvement in the environment, however, and its benefit extends to all neighborhoods surrounding the airport so that effectiveness is probably best determined by changes in the number of people exposed to various $L_{dn}$ or NEF values. Time-above-threshold analysis could also be used as long as effectiveness is based on changes in numbers of people exposed to sound levels occurring during evening and nighttime hours.

## What Are Issues of Implementation?

An airport operator can adopt and enforce a curfew. He must, however, work very closely with the airport users to identify economic impacts or hardships that might accrue, and weigh them against the benefits. Since the impetus for a curfew probably comes from neighboring communities, and since tower operations will undoubtedly change, representatives of surrounding towns and the FAA must also be included in the decision-making process.

The airport operator must also be sure that a proposed curfew places no undue burden on interstate or foreign commerce and that it does not unjustly discriminate between different categories of airport users.

An airport operator who wishes to have operations rescheduled or moved to another airport must make such a proposal to the affected users.

What Are the Costs?

The economic impact of a curfew will vary widely from one airport to another. A small general aviation facility with less than 10 late-night operations would probably impose very minor economic repercussions. At a major facility, on the other hand, many parties could be severely affected. Most cargo activity takes place at night, and deliverable items might well experience unacceptable delays. During a conference held at MIT's Flight Transportation Laboratory in 1979 to guage the economic penalties imposed by curfew, Delta Airlines reported that 70% of its 50 million annual freight shipments move at night, and Flying Tiger Line estimated that curfews at major airports would add an estimated 11% to the cost of the airline's domestic service. Seaboard World Airlines estimated that curfews would increase their costs by $80,000 per month. Pan Am emphasized that a curfew at JFK alone would require the addition of a 747 to its present fleet of six freighters to compensate for loss of flexibility.* Air carriers would have to revamp schedules completely to insure an adequate supply of aircraft and flight crews in each city to handle passenger demand.

Where Is It Being Implemented?

Nearly 40 airports in the U.S. have curfews. The most common time period is from 10:00 p.m. to 6:00 a.m. Examples include Des Moines Municipal, Patrick Henry International (Virginia), Aspen-Pitkin County Airport, Tucson International, Ontario International, and Palm Springs Municipal in California. The longest curfew is from 10:00 p.m. to 8:00 a.m., applicable to jets at Lake Tahoe Airport. (Note in the discussion of Action 11 – limiting operations – that the FAA favors restrictions based on the actual noisiness of aircraft rather than on the presumption that jets are noisier than other aircraft.)

Also, many airports have less than full curfews. Minneapolis-St. Paul, for example, has a voluntary restriction limiting nighttime operations (from 11:00 p.m. to 6:00 a.m.) to 26 flights per week, and additional flights can be approved only by the Metropolitan Airports Commission. Logan's nighttime restriction applies only to aircraft that are not certificated under FAR Part 36. Current hours during which the restriction applies are 10:30 p.m. to 6:30 a.m., but these will be extended to 10:00 p.m. to 7:00 a.m. in 1981.

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*Lev, H. and B. Sturken, "Aircraft Noise: The Talk is of Curfews," *Air Cargo Magazine*, May 1979.

## NOISE CONTROL ACTION NO. 12: RAISE GLIDESCOPE ANGLE OR INTERCEPT

### What Is the Action?

Raising the glidescope angle accomplishes essentially the same objective as a displaced threshold (Action No. 1) via a different mechanism. The pilot flies a steeper-than-normal approach that keeps the landing aircraft higher over a community and above the normal glidescope, but always converging to it. Additionally, an airplane on a steeper-than-normal approach can use a reduced power setting and can thus be quieter. Glidescopes have generally been raised from the old norm of 2.5 degrees to the new norm of 3 degrees. Pilots, however, are reluctant to fly steeper approaches than 3 degrees because of the increased sink rate.

Intercepting the glidescope at a higher altitude simply means that the aircraft will be producing slightly lower noise levels on the ground prior to beginning descent for landing. Glidescope intercept usually occurs far enough from the airport, however, that the effect on most airport neighbors is negligible.

### What Are the Benefits?

An aircraft on a 4-degree glidescope 4 miles from a runway would be approximately 370 feet higher than an aircraft on a 3-degree approach. If the two aircraft are operating at the same power setting, noise from the higher aircraft would be about 2 dB quieter directly under the approach path and less than that off to the side or closer to the runway. Since the higher aircraft can also be operated at reduced power during its approach, there is an additional benefit of approximately 2 dB.

As with displaced thresholds, however, the overall benefit is reduced in areas exposed to takeoff noise as well as to approach noise. The overall improvement in terms of a cumulative measure of exposure (that also accounts for takeoff noise) will probably be less than 2 dB.

How Effective Is the Action?

Effectiveness would best be measured by changes in *neighborhood* population exposed to single-event noise levels or times above thresholds (TAs) off the particular runway end. Despite the benefits, safety must not be compromised.

What Are Issues of Implementation?

Overall responsibility for approving and changing the glidescope angle lies with the FAA, because the action involves airspace, FAA facilities, and results in changing approach procedures. However, analysis of the benefits of the action may be initiated by the airport operator and certainly should involve airport users (the carriers, in particular), as well. An Environmental Assessment may be required.

What Are the Costs?

The costs of raising a glidescope or intercept may be borne by several parties. They fall into two categories: one-time costs associated with initial safety or acoustic analysis or new runway instrumentation, and continuing operating costs of instrumentation.

Where Is It Being Implemented?

Glidescope angles have been raised for noise abatement at Islip MacArthur, Cuyahoga County, and Ontario International airports.

## AIRCRAFT OPERATION: AN INTRODUCTORY NOTE

The next two actions deal with noise control through modification of the way the aircraft is flown. Aircraft operation is the responsibility of the pilot and is not under the control of the airport operator. Thus, the proprietor is unable to implement changes in aircraft operation as part of a noise control plan. Nonetheless, these actions are presented here so that their significance can be understood.

## NOISE CONTROL ACTION NO. 13: POWER AND FLAP MANAGEMENT

### What Is the Action?

Power and flap management is a general noise abatement action concerned with basic flight procedures and pilot techniques. Much effort on the part of carriers, air frame manufacturers, and the FAA has gone into the development of standard noise abatement takeoff procedures and noise abatement approach procedures. To be acceptable, a procedure must also be fuel-efficient. The desire for standard procedures comes from a concern that proliferation of procedures for each airport could compromise safety. The FAA anticipates issuing an advisory circular describing a noise abatement departure procedure to be used where noise-sensitive areas are near the airport. The procedure will include a power cutback at 1000 feet above field level (AFL). Departure procedures for airports where the noise-sensitive areas are at a greater distance from the airport will not include a power cutback and will emphasize selection of low-impact flight tracks.

Power and flap management can also be utilized during landing, although, for noise abatement, turbojet-powered airplanes are already required by FAR Part 91.85, Para.(C) to use the minimum certified landing flap setting on final approach to the runway.

### What Are the Benefits?

The anticipated FAA advisory circular procedures will achieve benefits near the airport because of the power reduction at 1000 feet AFL. The extent of the benefit will vary from aircraft to aircraft.

## How Effective Is the Action?

Because of the counterproductive decrease in climb performance that comes with a decrease in power setting, the overall effectiveness of a particular climb profile must balance the benefits close in with the increase in exposure that occurs at some distance from the airport. The most appropriate ways to compare procedures in this case include comparisons of level weighted population and comparisons of numbers of people in 5-dB increments to understand where the differences in impact occur.

## What Are Issues of Implementation?

An airport operator may only suggest noise abatement flight procedures to the FAA and to airport users. However, the airport operator has no direct involvement with cockpit procedures. Airlines and other users are basically responsible for the procedures used by their pilots, although the ultimate responsibility for the manner in which the plane is flown rests with the pilot in command.

## Where Is It Being Implemented?

No examples exist of use of power and flap management at a specific airport.

## NOISE CONTROL ACTION NO. 14: LIMITED USE OF REVERSE THRUST

### What Is the Action?

The higher power settings required to slow a landing airplane to a safe speed for taxiing off the runway are loud enough that they can be mistaken for the engine runups that occur at the start of takeoff. If these applications are not really needed to stop the aircraft in the available runway length, but are used only to expedite turnoff from the active runway, the potential for noise control exists. Reducing the use of reverse thrust and extending the landing rollout in these cases can help to improve noise exposure levels slightly for residents living to the side of a runway.

### What Are the Benefits?

If reverse thrust is not used during a landing rollout, single-event noise levels might be reduced 10 to 20 dB or more at homes very close to the runway. However, since there is so much variability in the position of the aircraft on the runway and in the power settings used in the application of reverse thrust, the average benefit is likely to be less. Whether the level difference with and without thrust reversal is noticeable may well depend on other flight activity in the vicinity. Under the most advantageous conditions, with homes located beside a landing runway and with takeoffs using a second runway heading, the difference in sound exposure levels is probably measurable. In that case, the benefit is quantifiable. Otherwise the improvement can only be subjective; the Integrated Noise Model and other computerized airport noise models do not have the capability to handle this phase of landing.

## How Effective Is the Action?

If the benefit of reduced reverse thrust is at all measurable, its effectiveness can be identified either in terms of changes in single-event sound levels or cumulative levels or times above thresholds. Estimates of the number of people exposed to various levels might also be made if measurements are available for empirical analysis.

## What Are Issues of Implementation?

Regulation of thrust reversal is a controversial issue because of concern about possible compromises of safety expressed by pilots and air carriers. They are the ones responsible for the safety of their airplanes. Thus, an airport operator may be able only to request that pilots use discretion and continue their landing roll to the runway end. If daytime traffic cannot permit delays that result, the proprietor might make the request apply only to night operations. Responsibility for adhering to the restriction would have to remain with the pilot in command of the aircraft.

## Where Is It Being Implemented?

Only two airports are known to have operational restrictions affecting the use of reverse thrust. They are the Youngstown Executive and San Jose Municipal airports.

## LAND USE: AN INTRODUCTORY NOTE

The next seven actions deal with very specialized elements of community planning: land use and land planning to control airport noise. We discuss their nature, benefits, and costs from one viewpoint – the airport's – rather than from the viewpoint of the community in which the airport is situated. But we remind you not to allow your connection with, or interest in, airports to slant your thinking about land use. Keep the following points in mind as you read the next seven actions; they will help you place land use for noise control in the context of general land use, which you can never ignore.

- Always remember that land use or land planning by airports should be one – important, but only one – element of community planning in general.
- Before a community can plan land use, community goals must be clearly defined. Toward those goals, all interested parties, including officials, citizens, and airport personnel, must work together.

In this Document, we do not address the total issue of airport/community compatibility. For an informative and detailed discussion of this subject, we refer you to "Airport-Land Use Compatibility Planning," DOT/FAA Advisory Circular No. 150/5050-6 (Dec. 30, 1977), available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

NOISE CONTROL ACTION NO. 15: ACQUISITION OF LAND OR EASEMENT

## What Is the Action?

Ownership provides the full right to use the land, including exposing it to noise, while a noise easement only gives the operator the right to expose land to noise by compensating the landowner for less than full use of his property in the future. However, if the proprietor only needs the right to expose the land to noise, an easement may be fully adequate.

## What Are the Benefits?

By acquisition of land or easement, the airport operator insulates himself against noise suites (perhaps limited in extent of exposure allowed) and extends a buffer between the airport and noise impacted neighborhoods. Although frequently viewed as the ultimate though very expensive noise abatement measure, purchase and conversion of use must be undertaken carefully since it may destroy existing community patterns, create excessive open space, and thus may not be suitable for many airports.

## How Effective Is the Action?

The effectiveness of this action can be determined by the number of persons who are removed from a certain noise level or by the extent of the area that can be retained for uses compatible with the airport's operations.

## What Are Issues of Implementation?

An airport operator can purchase land or easements without any Federal action if no Federal money is involved in the purchase.

He must act in accordance with applicable state and local laws. If Federal money is involved and the acquisition involves relocation or 4(f) land, an Environmental Assessment is required.

What Are the Costs?

Purchase costs include the cost of the land itself and perhaps costs associated with relocation. Indirect costs are expenses incurred in changing land uses in a way that may be contrary to the regional plan.

Easement costs are those of the easement itself. Note: This kind of easement is relatively new, and the value may be hard to establish. In addition, if it turns out that the noisiness or frequency of operation increase, the owner may have the basis for an action to recover more money.

Where Is It Being Implemented?

Land acquisition has been used as a successful means of airport noise control in Los Angeles, Phoenix, and Oklahoma City's Will Rogers Airport. Also, Atlanta has recently undertaken a $10.5 million project to relocate 311 families under flight paths at Atlanta-Hartsfield. Homes are being purchased at fair market value, moving expenses will be paid, and offers of up to $15,000 are being made to homeowners to buy a comparable residence in another neighborhood. Partial financing for the first phase of the relocation will come from a Community Development Block Grant offered by the U.S. Department of Housing and Urban Development. It is anticipated that the 80 acre tract will eventually be developed into an industrial complex to include air cargo facilities.*

*AOCI, "Airport Highlights," 4 February 1980.

At SEA-TAC, the "Communities Plan" for the Port of Seattle, King County, calls for the acquisition of 481 acres identified as expected to remain above NEF 40 through 1993. The area to the north involves some 305 acres, 702 single-family homes, and 2 schools. To the south, 176 acres (including 46 acres of park land), 285 homes, and a 21-unit mobile home park will be purchased.

## NOISE CONTROL ACTION NO. 16: JOINT DEVELOPMENT OF AIRPORT PROPERTY

### What Is the Action?

In this action, a sister agency joins an airport in developing land compatibility, *not* for airport use.

### What Are the Benefits?

The benefits are obvious: compatible development of land that allows use of the land without excessive landholding by the airport.

### How Effective Is the Action?

A relatively new concept, this action can be very effective.

### What Are Issues of Implementation?

Joint development can be proposed by the airport operator or the proposed developer. The nature of the specific development and the identity of the developer would determine whether an Environmental Assessment would be required.

### What Are the Costs?

There may be no direct costs. Indirectly, costs might be reflected in loss of tax revenue. Be aware that such development, even if appropriate to the airport and adjacent property, may differ from local plans, and may have to be discussed and negotiated.

Where Is It Being Implemented?

At Baltimore-Washington, airport officials worked with state Department of Natural Resources staff to set up a forestry development on airport land. Property of the Raleigh-Durham (NC) Airport Authority will be developed for a flood control lake and associated recreation uses.

## NOISE CONTROL ACTION NO. 17: COMPATIBLE USE ZONING

### What Is the Action?

This action implies that zoning of land is based on compatibility of the use with the noise environment in addition to the other factors normally considered in planning community development. Its legal basis exists in a community's police power to regulate the public's general safety, health, and welfare. As in any zoning decision, however, there must be a *need* for the zoned use.

Zoning that considers noise sensitivity can preserve existing compatible uses, and perhaps more importantly, prevent future incompatibilities with the environment. But it offers nothing to improve existing incompatibilities. It's also subject to change. For noise-related zoning to be successful over the long run, there must be a continuing community consensus to support the zoning.

### What Are the Benefits?

When noise sensitivity is a consideration in zoning, the airport is an integral part of community planning, and both airport and community profit. The airport benefits by not becoming cramped and by not being encroached upon by neighborhood developments. The community benefits by maintaining a comfortable environment for its residents.

### How Effective Is the Action?

Well-planned compatible land use zoning is probably the best way to avoid having an airport impact undeveloped property.

But zoning laws can be changed. Special uses and variances may also undermine plans. The effectiveness of the action will depend most heavily on the extent to which towns are willing to go to implement the plan over the long run.

What Are Issues of Implementation?

Zoning for compatible use is the responsibility of the city or town zoning authority. The airport operator nevertheless has an obligation to assist in this action and may, in fact, have to initiate interest in the idea. The operator's task may be simplified if the airport is owned by the jurisdiction having the zoning authority, but, in many cases, the impact of an airport will extend across jurisdictional boundaries. The operator's role is indispensable in those situations.

What Are the Costs?

The costs of compatible use zoning are not easily defined. In general, they will depend on whether the compatible use has higher value than might otherwise exist.

Where Is It Being Implemented?

Many airports have worked with communities in various degrees to establish compatible use zoning. Dallas-Fort Worth Regional Airport is perhaps the most dramatic example, simply because of its size. In fact, the airport was designed, in part, so that severely impacting noise exposure levels would remain on the airport property. Most of the off-airport property exposed to moderate noise exposure levels was then zoned for commercial or light industrial use. Despite the fact that the airport is only 5 years old, surrounding towns are already beginning to be pressured by developers who want variances for housing. Similar encroachments have occurred at Dulles, an airport that once was considered to be "out in the country."

Oregon's Department of Transportation, Aeronautics Division, has taken a substantive role in that whole state's land use planning by publishing [illegible] and Procedures for Airport Land Use Planning and Zoning, [illegible] In it, moderate noise impact is defined as occurring between $L_{dn}$ 55 and 65 and such areas are to be given special attention when located outside of urban development. New residential use is discouraged and low densities are to be maintained. Noise insulation is suggested for schools, hospitals, nursing homes, theaters, and residences. In substantially impacted areas above $L_{dn}$ 65, residential development and other noise sensitive uses are to be precluded.

Other airports having compatible use zoning are Kansas City International, Greater Pittsburgh International, Bishop Airport (Flint, Michigan), Portland International, Seattle-Tacoma, Tampa, and some 70 other fields in the United States.

## NOISE CONTROL ACTION NO. 18: BUILDING CODE PROVISIONS AND SOUND INSULATION OF EXISTING BUILDINGS

### What Is the Action?

Building code provisions are intended to insure that new construction will incorporate adequate sound insulation techniques to keep interior noise levels at acceptable levels. The second part of the action, sound insulation of buildings, refers to the "soundproofing" of existing sensitive sites that are already impacted by airport noise. This often includes techniques such as air-conditioning, replacing single-glazed windows with double-glazing, lining ventilation ducts, caulking, adding storm windows and storm doors, and so on.

### What Are the Benefits?

Building code provisions are written to insure that interior noise levels from exterior sources (including aircraft) are compatible with a building's use. An apartment building, for example, will then have better sound insulation construction the closer it is to an airport. Codes written in this way thus typically provide lists of construction details that must be used in particular noise environments and will result in known noise reductions from outside to inside the structure, usually 25, 30, and 35 dB (10, 15, and 20 dB greater than typical residential construction with open windows). These noise reduction values are usually required in areas where $L_{dn}$ values are 65 to 70, 70 to 75, or 75 to 80, respectively [or where $L_{eq(24)}$ is 62 to 67, 67 to 72, or 72 to 77 dB].

Obtaining comparable noise reduction values from sound insulation after a building is already constructed may be more difficult. The most common "soundproofing" technique is simply to install air-conditioning and keep windows closed year round. This measure may offer 25-dB reduction from outside to inside, typically a 10-dB improvement over open windows. To gain additional reduction would require replacement of windows, caulking cracks, and so on.

## How Effective Is the Action?

Basically, building code provisions can be very effective as a noise abatement measure, but be aware of two possible problem areas. First, towns will be reluctant to alter their codes without support from their own building department. It is the town's building officials who will be faced with enforcing the changes. Inspectors must be convinced that alterations in the code are necessary and workable. Second, a building code can affect interior noise levels only. Residents will still be spending time outdoors, and their outdoor activities may continue to be interrupted to one degree or another. Complaints can still occur frequently.

## What Are Issues of Implementation?

Local jurisdictions write their own building codes or, frequently, simply adopt their state code. Provisions for sound insulation of exterior noise sources will have to be added through local rulemaking channels, but the airport operator can and must be an active participant in the process, drawing upon support from airport neighbors or other residents whenever possible. Under Sec. 18(4) of the Airport and Airway Development Act of 1970, the operator is obliged to obtain compatible land uses in the vicinity of the airport.

## Where Is It Being Implemented?

The most comprehensive building code provisions addressing exterior noise sources are those adopted by California applicable to all airport communities in the state. All building plans for new construction in the vicinity of an airport are reviewed by local building departments. If a structure is in a noise-impacted area, the builder must then retain a recognized acoustical consultant to review the plans, make recommendations for noise control, and certify that the structure will provide the required noise reduction. Only then is a building permit issued. After completion, the building can be tested by the inspector if he has reason to believe that construction details were not followed.

While airports such as Kansas City International, Portland International, and Dallas-Fort Worth Regional have worked with communities to get similar provisions in local building codes, none is as comprehensive as the California code.

Sound insulation programs have been adopted at SEA-TAC and also at London's Heathrow and Gatwick airports. While the SEA-TAC program has not yet been implemented, new grant schemes have just recently been approved by the British Airports Authority to cover nearly 31,000 homes at an estimated cost of £25.7 million ($57.3 million). Grants will cover costs of providing insulation to the living rooms and all bedrooms in each house constructed before 1 April 1980. Earlier programs initiated in 1966 at Heathrow and 1973 at Gatwick have since expired.*

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**Airport Highlights*, Airport Operators Council International Inc. publication, Vol. XVII, No. 15, 7 April 1980, Washington, DC.

SEA-TAC's program involves cost sharing of sound insulation and should eventually be available to 5017 residential units exposed to levels above NEF 35.

NOISE CONTROL ACTION NO. 19: REAL PROPERTY NOISE NOTICES

## What Is the Action?

Real property noise notices serve to notify prospective buyers of homes near airports that they will be living in a noise-impacted area. The notice in no way abrogates an individual's right to take later action against the airport, but it at least gives the buyer a fair warning.

## What Are the Benefits?

The major benefit of a noise notice is that buyers find out about the presence of an airport *before* they purchase a home off one of its runways. Numerous stories are told of realtors who wait for bad weather or a day when winds favor a different runway before they show prospective buyers a severely impacted home. Some buyers may not feel, on the basis of a short visit through a house, that the noise will bother them. In either case, the official notice may offer useful information.

No substantive information is available regarding the effectiveness of such disclosures nor their impact on house value or other measures of cost.

## What Are Issues of Implementation?

An airport operator may propose real property noise notices subject to state or local restrictions, if any.

## Where Is It Being Implemented?

St. Mary's County, Maryland, requires that a purchaser of land be told if the property is exposed to levels in excess of

$L_{dn}$ 65. The disclosure statement identifies the airport, its operating schedule, and the level of exposure. It also defines the acceptability of the site in accordance with standard HUD classifications. The purchaser is required to acknowledge the information he received and accept the right of the airport to continue operation.

Cook County, Illinois, has also adopted a requirement for disclosure statements in its 1976 zoning ordinance. Though not dependent on a particular noise exposure level, the statement is required to be presented by the seller to each potential purchaser of property within 1 mile of the airport boundary of any airport in the county. The statement acknowledges that the land in question is a certain distance from an airport and "that residents of the property may be subjected to high noise levels."

Two other jurisdictions are considering disclosure statements due to their proximity to Cherry Point Marine Corps Air Station. The City of Havelock and Craven County, both in North Carolina, are considering provisions that would require parcels of land within the CNR 100 contour (equivalent to $L_{dn}$ 65) to be identified as being in a designated area of concern because of high noise. Each statement would further require disclosure regarding the location of the property relative to approach and takeoff zones (as defined in the current AICUZ study for MCAS Cherry Point) deemed to be potentially hazardous because of aircraft accidents.

Finally, the California Business and Professions Code includes a section requiring the state's Real Estate Commissioner to examine all subdivision plans and issue a public report on his findings, a copy of which is to be made available and read by any prospective purchaser. These reports may contain special notes regarding the noise environment of the tract, as in the case of San Diego development where buyers were warned "This tract lies beneath the primary jet departure route of Naval Air Station Miramar and is subject to very high noise levels produced by low flying jet aircraft taking off and landing. It is located where the composite noise rating is in excess of 115. A maximum composite noise rating of 100 is considered to be the normal tolerance level. The tract is not considered satisfactory for residential use, and you may find the noise objectionable. NAS Miramar operates seven days a week, 24 hours a day, and there are no plans for curtailment of this flight activity in the foreseeable future."* One would hope this was sufficient warning for any prospective homeowner.

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*"Final Subdivision Public Report on the Applicable of Saramark Developers, San Diego County, California," File No. 32312, issued 2 November 1972.

NOISE CONTROL ACTION NO. 20: PURCHASE ASSURANCE

## What Is the Action?

Purchase assurance is a guarantee from the airport operator that if a homeowner in a noise-impacted area is unable to sell his house, the airport will buy the property at its appraised value or pay the difference between the appraised value and the amount the owner is actually able to get on the market. The airport can then retain the property for development as a compatible use or it can require an assessment for noise.

## What Are the Benefits?

The benefit of a purchase assurance is that an airport can acquire property or interest in property, thereby reducing its liability for making noise. Property acquisition can also be part of a joint development plan on the airport.

## What Are Issues of Implementation?

The airport operator would be responsible, both financially and legally, for property transfers and easements obtained by this mechanism.

## What Are the Costs?

Costs are generally limited to the acquisition costs of land and easements, but those must be balanced against the income from sale of properties or income derived from and compatible land use development of the purchased property.

Where Is It Being Implemented?

SEA-TAC has adopted a purchase assurance program as a part of its Communities Plan. Some 770 homes experiencing "sustained" exposure to NEF 40 or above have been identified as qualifying for this program. (Here, "sustained" means a level that is expected to fall below NEF 40 at some point during the 20-year planning period. Homes "permanently" exposed to NEF 40 or above are being purchased.)

NOISE CONTROL ACTION NO. 21: NOISE-RELATED LANDING FEES

## What Is the Action?

At most airports, aircraft weight is used to determine landing fees. Heavy aircraft, which generally require a longer runway, thicker pavement, and larger terminal areas, thus end up paying a larger share toward the cost of the facility. A similar argument could be made for noise. Many airports have lost Airport Development Aid Program (ADAP) funds or experienced construction delays because of legal and political actions by airport neighbors concerned with noise. To recover those costs or to fund other noise abatement efforts, an airport could base a portion of the landing fee on the noise produced by aircraft. One approach to this charge might be to assess aircraft in proportion to the noise they produce relative to FAR Part 36 noise standards. The higher the noise levels above Stage 2 limits, the more the aircraft must pay. The formula used to determine fees could also be set up so as to provide a discount to those aircraft that are quieter than FAR Part 36 limits. An example is given below:

$$\text{Fee} = \frac{cw}{2}(1+R) \quad ,$$

where c = the rate in cents/1000 pounds

w = the landing weight of the aircraft in 1000s of pounds

R = the ratio of the average takeoff, sideline, and approach noise levels as certified to the average of the FAR Part 36 noise limits (here the averages should be the energy averages of the 3 decibel levels).

If the aircraft just meets the Part 36 limits, R = 1 and the plane neither benefits nor is penalized by the noise.

Alternatively, landing fees could be structured to penalize nighttime operations, generally deemed to be more annoying than daytime activity.

## What Are the Benefits?

There are two basic benefits to be derived from noise-related landing fees. First, the income accrued from the noise portion of the fee could be used to fund other noise abatement actions. The money could be used for purchase of property as a buffer, soundproofing noise-impacted buildings, installing a noise monitoring system, or instituting any other measure suitable to the needs of the airport. Second, the fees might add an incentive to airlines to use quieter equipment. In either case, the result is a reduction in noise impact around the airport.

## How Effective Is the Action?

It is not clear how effective this action would be, since no U.S. airport has as yet adopted a noise-related landing fee and the elasticity of the market is unknown. It is very likely, however, that with the possible exceptions of Northwest and PanAm, which have relatively quiet fleets, airlines would object to such a fee structure, and without the penalty for noise the action is obviously ineffective.

## What Are Issues of Implementation?

An airport operator can establish noise-related landing fees directly subject to contracts with users and subject to unjust discrimination or unreasonable burdens on commerce.

## What Are the Costs?

The highest penalties under a fee structure weighted for noise would be paid by airlines flying planes such as the BAC 111, the 707-320B, and most versions of the DC-8. Reductions in fees (using the formula as given here) would be realized by airlines flying planes such as the DC-10-10, and newer or retrofitted 727s and DC-9s.

## Where Is It Being Implemented?

Heathrow, Gatwick, and Stansted Airports in Great Britain have recently implemented increased landing fees but with a rebate policy for operators of aircraft meeting ICAO Annex 16 noise limits (equivalent to FAR Part 36). The 15% rebate on the weight based charges will mean that a 707s fee will go up by about $76 while the fee for an A-300 will only increase about $2.25.

NOISE CONTROL ACTION NO. 22: NOISE MONITORING

## What Is the Action?

Noise monitoring is a means of identifying those aircraft that contribute most to a community's cumulative noise exposure. Data from a monitoring system can be used to check specific incidents when a particular noise levels is exceeded, or they can also be used to identify the noisiest (or the quietest) airline. But more than just monitoring is required to achieve improvement. The airport operator must follow up. Letters can be and are sent to an airline's chief pilot identifying the specific flight number than caused the exceedance and requesting that the incident be discussed with the pilot of the aircraft in question. The operator can also work with the noisiest airline to identify possible changes in procedures, reductions in takeoff weight, or use of quieter equipment at the airport. Possible economic benefits, or at least good public relations, can be derived from publishing the name of the quietest airline, as is done in

## What Are the Benefits?

Besides being a tool to identify the noisiest operations at an airport, a noise monitoring system can be used as a subtle means of getting aircraft away from particularly sensitive areas. If microphone locations are strategically selected and then publicized, pilots will tend to fly their planes so as to avoid overflying the station.

Permanently installed systems can also be used to check cumulative noise exposure levels as well as single events.

Data can be used to corroborate or identify discrepancies in computer-generated contours or in TA calculations.

Except for those general aviation airports in California that have installed monitoring systems in response to the California law, most monitoring systems are at major air carrier airports. Portable systems and small permanent systems may be useful elements of noise control programs at busy general aviation airports that have noise problems.

## How Effective Is the Action?

A noise monitoring system alone will do little to reduce noise at an airport. Its value is ultimately dependent on what the airport operator does with the information.

## What Are Issues of Implementation?

Installation and operation of a system, and use of the data are all the prerogative of the operator.

## What Are the Costs?

Costs of a permanent monitoring system may include system design as well as purchase of equipment, such as microphones or hydrophones, computer hardware for processing data, analog recorders, and display systems. These costs are generally proportional to the number of monitoring stations, and for existing systems have ranged from about $26,000 for a single station to $159,000 for 16 stations. The new monitoring package recently installed at Los Angeles cost about $218,000 for permanent measurement locations. The system will also incur operating and maintenance costs, and manpower costs associated with data handling. Burbank's new 9 station system s costing $214,000. The same types of costs would be associated ith a portable monitoring system but at a fraction of the level. single, fully equipped, portable monitoring unit might cost n the order of $8,000.

here Is It Being Implemented?

Monitoring systems have been installed at approximately 0 airports in the U.S. Half are in California, the result of tringent state regulations regarding airport noise. The umber of monitoring stations ranges from 1 at Reid-Hillview Santa Clara County) Airport to 16 at San Franciso International.

New York's three airports were the first in the country o get monitoring systems (Kennedy's first was installed in 961). The Port Authority of New York and New Jersey has stablished a limit of 112 PNdB for aircraft operating at its irports, and the limit is enforced through jawboning and even ines based on lease agreement obligations.

Torrance Municipal Airport in California utilizes its onitoring system both for enforcement and for education. Pilots an talk directly to personnel operating the system and get mmediate feedback on the effectiveness of different power cut-acks or other pilot techniques to minimize noise exposure from heir individual aircraft.

Other airports having noise monitoring equipment include ansas City, Minneapolis-St. Paul, Logan, Jacksonville, Los ngeles, San Francisco, and Tucson.

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A GUIDANCE DOCUMENT ON AIRPORT NOISE CONTROL.(U)

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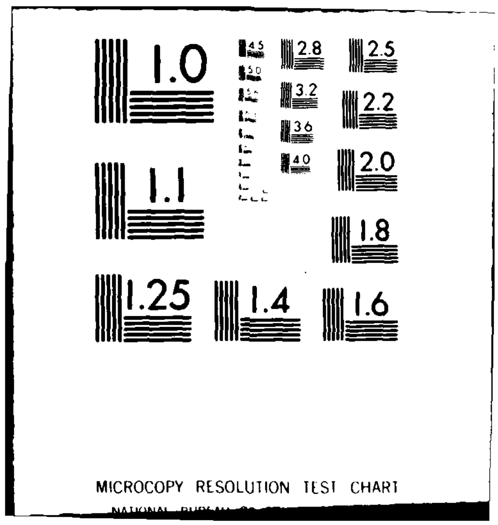
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MICROCOPY RESOLUTION TEST CHART

## NOISE CONTROL ACTION NO. 23: ESTABLISH CITIZEN COMPLAINT MECHANISM, AND ESTABLISH COMMUNITY PARTICIPATION PROGRAM

### What Is the Action?

Community and citizen involvement in an airport's operation and overall development has become a political and legal necessity over the last 10 years. Communities can stop construction if they are not included in the planning process or if they don't think environmental issues have been adequately addressed. They can, for instance, sue for quieter schools, and they cannot be ignored.

More than that, airport communities can be a valuable asset to airport planning, and airport operators can make a contribution to community planning. The FAA now requires that they be participants in the master planning process so that airport development plans are coordinated with community interests. Another way of getting citizens involved is to establish a complaint mechanism that responds positively to callers. Response generally means more than just logging the complaint. It might include trying to identify the actual aircraft, getting in touch with the pilot to obtain additional information, and calling the complainant back. While that effort may not be possible for every airport, where it is done, it does help community relations.

A second means of getting airport neighbors involved is a community participation program. Regular meetings with the airport operator and other "pro-airport" parties during all planning projects will allow open exchanges of ideas and concerns. Further discussion of these concepts is included in Section 3.6: "Citizen Involvement in Noise Control Planning."

## What Are the Benefits?

Citizen complaint mechanisms, if handled with a genuine concern for the complainant, offer several major benefits. Complaints can provide the airport proprietor and the FAA with information as to the kinds of noise abatement measures needed at the airport. Complaint records can also be used to identify the effectiveness of a noise abatement program as various actions are implemented. And, if complaints are handled to the satisfaction of callers, the operator benefits from improved community relations that can ease the way for other well-planned airport improvement projects.

The same kinds of benefits are derived from a more formal community participation program. The action provides the operator and the FAA with information about community concerns, and with feedback as to effectiveness of actions. It provides, too, a means of maintaining a structure forum for presentation of new ideas and programs.

## How Effective Is the Action?

At a time when many airport expansion plans are being thwarted in their development phase and even during their construction, community participation is practically essential. Without it, the chance of failure of a major project is significant. With community participation, there is at least the opportunity for the airport to develop in a direction acceptable to all affected parties.

## What Are Issues of Implementation?

An airport operator can establish a citizen complaint mechanism directly. He can also initiate a community participation program directly. FAA orders include community participation as a required element in Environmental Assessments. Similar requirements exist in certain states.

## What Are the Costs?

The costs of a community participation program are time and money. The whole direction of a project may change from that initially conceived as community input is incorporated into an environmental assessment of Master Plan study. New alternatives may have to be analyzed. The entire study process must be subject to review.

## Where Is It Being Implemented?

During a recent master planning effort for a general aviation airport in the northeast, Boston's Hanscom Field, 12 public meetings were initially planned to review findings. At the start of the project, that degree of involvement seemed more than adequate. By the time the master plan was complete, 23 public and committee meetings had taken place, the original schedule had expanded more than a year, and the final document was tailored to Hanscom although it bore little resemblance to a normal Master Plan.

At other airports, committees have been established not only to review a specific project but also to follow up on airport plans. Sky Harbor Airport in Phoenix and Wiley Post Airport in Oklahoma City now have permanent noise abatement committees which work constantly with the airport operator and the FAA to develop and analyze noise abatement actions.

Other examples of community participation programs are detailed in Section 3.6.

## 3. BACKGROUND INFORMATION

### 3.1 Noise: A General Introduction

**What is Noise Control?**

Noise control is the term used to describe reducing the level of noise at its source, or reducing the impact of noise on people. Note that this document is about airport – not aircraft – noise control. When we talk about noise control in this document, we are discussing control of *where* and *how* aircraft operate, both in the air and on the ground. We are not talking about reduction of the noisemaking parts of aircraft themselves.

Noise control can apply to existing airports, to airports that are expanding, and to new airports that are being planned. As indicated in Sec. 2, there are five major mentions of noise control:

- Changes in airport plans
- Changes in airport and airspace use
- Changes in aircraft operation
- Changes in land use
- Changes in noise program management.

**Is There One Simple Solution for the Problem of Noise Control?**

No. As we noted previously, you will have to assess each airport and each community separately, and the set of actions you choose may be unique to that set of problems.

## The Language of Noise

You don't need to know the entire vocabulary of acoustics to understand and discuss airport noise control. But you should know the basic technical terms:

- Levels
- Decibels
- A-Weighting
- Duration
- NEF, $L_{dn}$, $L_{eq}$, CNEL, TA.

## Levels

The human ear is sensitive to such a wide range of sound pressures that we can hear sounds ranging from the faintest murmur to those with one million times more energy, such as the amplified music of a rock band. To reduce the range of numbers we have to deal with and to account for the nonlinearity of our ears, we talk about sound pressure levels. The term "level," in acoustics, refers to the logarithmic value of the ratio of a sound pressure quantity relative to a reference quantity. Figure 8 shows a number of common sound levels.

## Sound Pressure Level

Sound pressure level refers to the relationship between the sound you're interested in and a referenced sound. As an airport planner or operator, you will hear a lot about sound pressure levels, because it is the sound pressure level to which people respond, pro or con. (In the next section, we discuss human response to noise.)

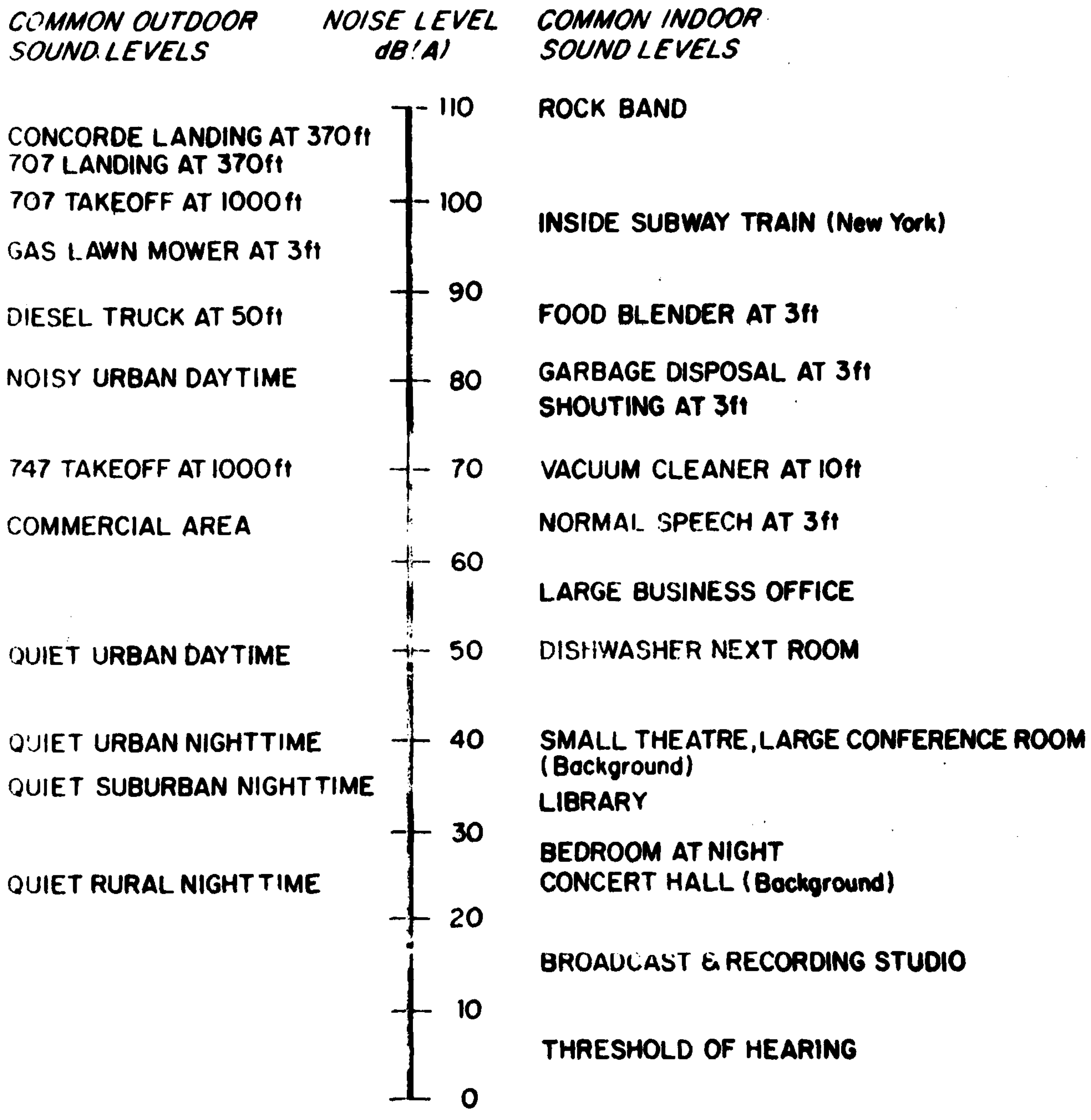



FIG. 8. COMMON SOUND LEVELS.

The fact to remember about sound pressure level is that it always refers to sound that is in an environment and the characteristics of the environment (outdoors, indoors, in a large space, in a small room) affect the level.

## Decibels

Sound levels are measured in decibels (abbreviation: "dB"). Decibels are used to express the ratio of two quantities in logarithmic terms, thus avoiding the use of cumbersome numbers, as the following example shows.

| Decimal Notation | Logarithmic Notation |
| --- | --- |
| 10,000,000.00 | 70 dB |

Acousticians use decibels to describe the measurement of sound pressure levels, usually made with a sound level meter. A sound pressure level of 0 dB represents approximately the weakest sound that can be heard by the average young human ear, under ideal conditions. When the sound pressure is one million times greater, humans feel physical pain or great discomfort in their ears. A soft whisper would be rated at about 40 dB; the sound you'd hear, standing next to the amplifiers of a hard rock band, about 120 dB, one million times greater than 0 dB.

## Addition of Decibels

You should know not only how to express noise in decibels, but how to add several noises, all expressed in decibels. Let's say the noise from one airplane engine, as you hear it on the ground outside the plane, is measured at 100 dB. The noise from the plane next to it is measured at 95 dB. How much, in decibels, is the total amount of noise the two planes are generating?

Is your answer 195 dB? Wrong. Decibels cannot be added algebraically. They are logarithmic values, and they must be added logarithmically.

There are two relatively simple ways to add decibels; they are shown in Table 1 and Fig. 9.

TABLE 1. ADDITION OF DECIBELS (1).

| When two decibel values differ by: | Add the following amount to the higher value: |
|---|---|
| 0 or 1 dB | 3 dB |
| 2 or 3 dB | 2 dB |
| 4 to 8 dB | 1 dB |
| 9 dB or more | 0 dB |

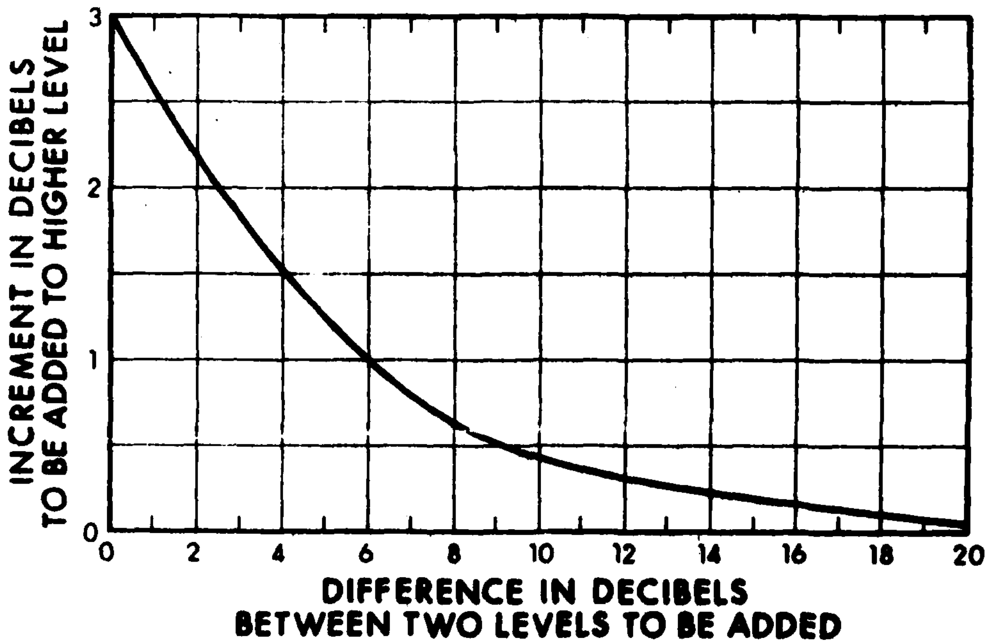
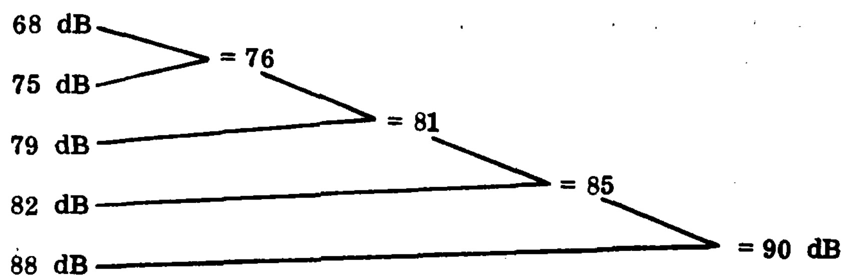



FIG. 9. ADDITION OF DECIBELS.

The combined noise of the two engines, then, is 101 dB.

When there are several decibel levels to be added, add them two at a time, starting with the lower valued levels and continuing, two at a time, until only one value remains. To illustrate, suppose that the sound levels of five fans, side by side in a mechanical room, are 68 dB, 75 dB, 79 dB, 82 dB, and 88 dB, respectively. They would be added this way:




If there are several levels of the same value to be added together – several engines, all measured at 85 dB, for instance – add them this way:

| No. of Equal Levels | Add to that Level |
|---|---|
| 2 | 3 dB |
| 3 | 5 dB |
| 4 | 6 dB |
| 5 | 7 dB |
| 6-7 | 8 dB |
| 8 | 9 dB |
| 9-10 | 10 dB |
| N | 10 log N dB |

## A-Weighting

Acousticians, who use sound level meters to measure sound, know that people hear better in certain frequencies (from about 500 to 5000 Hz), and that they are most annoyed or disturbed by noise in that range. Sound level meters are therefore equipped with frequency-weighting networks that filter out sound to approximate the way the human ear hears.

The most commonly used network is the A-scale network, which filters out as much as 20 to 40 dB of sound below 100 Hz. When a sound level meter is switched to the "A" position, the meter gives a single-number-reading that filters the incoming noise at the microphone, then indicates a numerical value of the total sound passed by the filter. The resulting value is called the "A-weighted sound level." It is expressed in units called "A-weighted decibels," abbreviated "dBA."

## Duration

One of the characteristics of sound – an important one for you to understand – is duration, or how long the sound lasts. You hear an airplane approaching; its sound peaks as it flies overhead; and its sound dies away as the plane disappears. The change in sound pressure level of such a fly by can be charted as a hill-shaped curve, as shown in Fig. 10. In a discussion of airport noise, durations are often defined as the amount of time the sound pressure level remains within 10 dB of the maximum sound pressure level during the fly by. At other times, the duration describes the amount of time the sound pressure level is above a level of particular interest, such as 85 dBA.

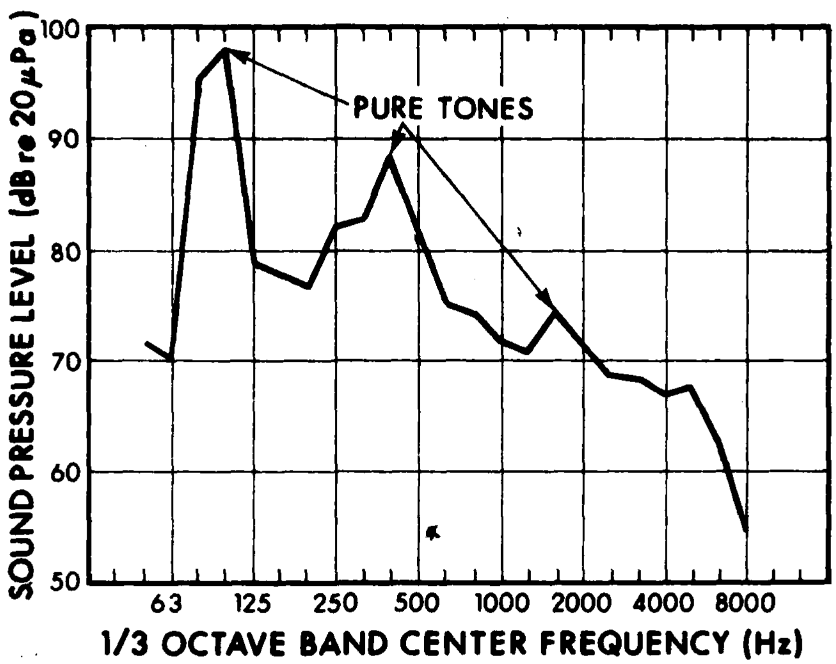



FIG. 10. AN EXAMPLE OF DURATION.

NEF, $L_{dn}$, $L_{eq}$, TA

You are probably familiar with these abbreviations. They stand for four different ways in which airport noise is described: Noise Exposure Forecast (NEF), Day-Night Average Sound Level ($L_{dn}$), Equivalent Sound Level ($L_{eq}$), and Time Above Threshold (TA), all of which are discussed in detail later in this chapter.

## 3.2 How Humans Respond to Noise

For many years, scientists have been studying, measuring, and reporting on the kinds of noise to which humans respond, the amounts of noise to whicy they respond, and how they respond. They have identified a range of group responses to airport noise, from acceptance of the noise all the way to litigation.

A variety of factors influence the response of people to a noise environment. They include the potential for damaging people's hearing, the potential for interfering with activities such as speech and sleep, or just the creation of annoyance. Within a group of people any one or a combination of these factors results in reaction referred to as "community response." Below, we summarize the basic principles of human response to noise.

## Hearing Damage

Everyone experiences some hearing loss with age. But noise-induced hearing damage is a loss in sensitivity of the ear because of exposure to noise. It is measured by the upward shifting of an individual's hearing threshold defined by the faintest sound that he can detect. The loss can be temporary, as when the ear is exposed to a sudden loud sound (such as a firecracker explosion), and then recovers its sensitivity, or it can be permanent, as when the ear is exposed, over long periods of time, to high sound levels (such as found in noisy factories) and never has the opportunity to recover).

While most data on hearing loss are based on long term continuous exposure to noise in the workplace, hearing damage from aircraft noise is not likely to be a problem in the community. At an airport, noise levels vary widely from one minute to the next, and the ear has a chance to recover between noisy events. This has been confirmed by at least one study conducted by doctors at Massachusetts General Hospital.*

*Andros, W.J. *et al.*, "Hearing in Para-Airport Children," *Aviation, Space, and Environmental Medicine*, May 1975.

Audiometric tests on over 3300 school students living in the vicinity of Logan Airport showed no significant differences in hearing impairment among children living directly under flight paths and adjacent to runways as compared to children exposed to much lower levels of aircraft noise. And, except for line crew members, no one at an airport or in the surrounding community is exposed to steady high levels of sound.

## Speech Interference

Of all the effects of noise, people recognize and understand speech interference best. When noise masks conservation, telephone calls, or radio or TV listening, it has interfered with speech. The degree of speech interference depends on several factors — how loud the speaker's voice is, how far he is from his listener, whether the conversation is indoors or outdoors, what the level of the interfering noise is, and whether that noise is constant or intermittent. Figure 11 illustrates the relationships for several of these factors in the case of steady noise.*

At airports, with their fluctuating noise levels, aircraft operations interfere with speech for varying periods, but Fig. 11 is useful for indicating the minimum interference likely when the sound levels of aircraft exceed the steady state values shown at the left. The severity of the interference is related directly to how long the interference lasts.

Note that Fig. 11 applies to speech outdoors, not inside buildings. Aircraft noise frequently interferes with conversation inside buildings. How much? Determining that answer

*Webster, J.C., "Effects of Noise on Speech Intelligibility," *Noise as a Public Health Hazard*, American Speech and Hearing Association, No. 4., February 1969.

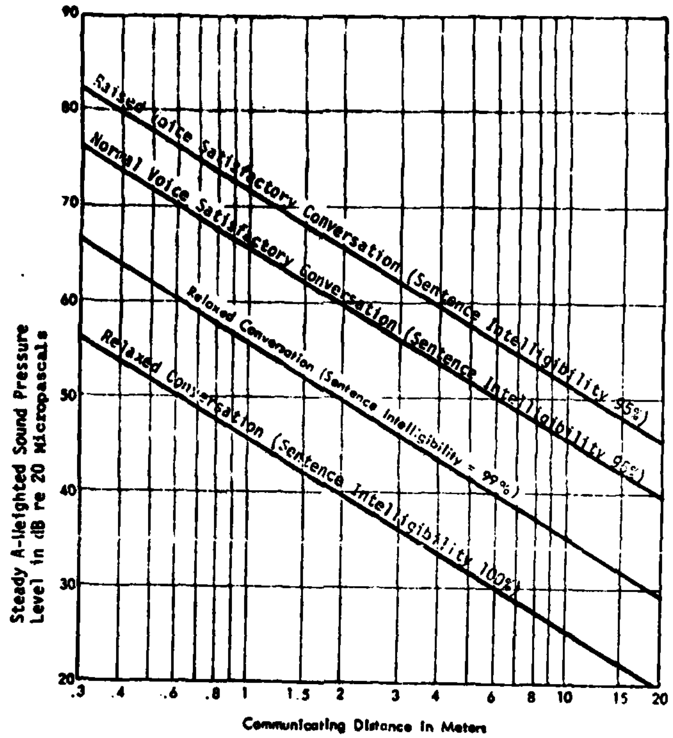



FIG. 11. MAXIMUM DISTANCES OUTDOORS OVER WHICH CONVERSATION IS CONSIDERED TO BE SATISFACTORILY INTELLIGIBLE IN STEADY NOISE.

can be complex except in residential spaces; it involves knowledge of the building's ability to protect against aircraft noise, information about the level of aircraft noise, and knowledge of the kind of activity taking place in the building. Each situation should be studied with care. We do not discuss generalizations here because they could be misleading.

However, in houses we can make a good estimate of the environment for communication with the help of Fig. 12.*†

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*Ibid., J.C. Webster

†"Method for the Calculation of the Articulation Index," American National Standards Institute, ANSA 53.5-1969, New York.

Figure 12 shows the percentage of sentences a listener should be able to understand in various noise environments. The relationship is valid when the room is normally furnished and the listener is more than a meter away from the speaker.

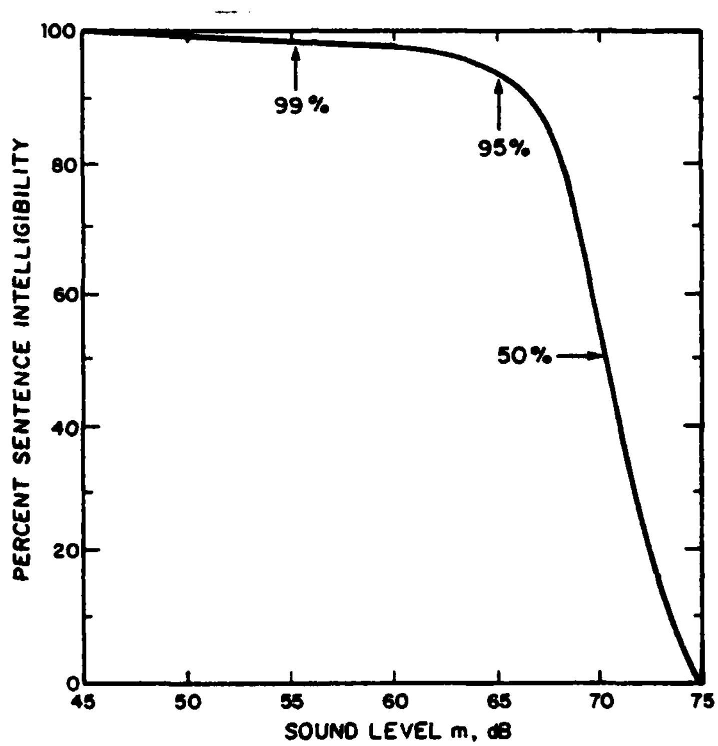


FIG. 12. NORMAL VOICE SENTENCE INTELLIGIBILITY AS A FUNCTION OF SOUND LEVEL IN AN INDOOR SITUATION.

## Sleep and Other Activity Interference

Common sense, as well as research, confirms that noise interferes with sleep and other activities. One definitive study published by the National Aeronautics and Space

Administration* on sleep interference from aircraft noise and simulated sonic booms shows that:

- The sensitivity to supersonic jet aircraft noise increases with increasing age. The sleep of young children was essentially unaffected by aircraft noise over a wide range of intensities, while middle aged men were awakened by 18% of the flyovers and older men were awakened by about 30% of the flyovers.
- Variations in intensity produce different response patterns, but the differences are also dependent on the relating sensitivity of the subjects. That is, highly sensitive sleepers awoke more frequently to higher levels than did low sensitivity subjects.
- Some adaptation to the flyovers appears to take place at least among the highly sensitive middle aged subjects.

Regarding other activity interference, the results of one British survey† are particularly interesting. Residents in the vicinity of London's Heathrow Airport were asked about the effects of airport noise on everyday activities and responded as follows:

- For an outdoor $L_{dn}$** of 75 dB (or NEF** 40) – when aircraft noise impact begins to become severe – at least 50% said they were disturbed during some activity, and as many as 80% said their TV listening was disturbed;

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*Lukas, J.S., *et al.*, Disturbance of Human Sleep by Supersonic Jet Aircraft Noise and Simulated Sonic Booms, NASA Report CR-1780, prepared by Stanford Research Institute, July 1971.

†"Noise – Final Report," Appendix XI, Command 2056, Her Majesty's Stationery Office, London, July 1963 (the so-called "Wilson Paper").

**See Sec. 3.4 for a full explanation of noise descriptors including Day-Night Sound Level ($L_{dn}$) and Noise Exposure Forecast (NEF).

- For an outdoor $L_{dn}$ of 65 dB (or NEF* 30) – when aircraft noise impact begins to be moderate – more than 50% said they were occasionally awakened by the noise, and 40% had been kept from going to sleep.
- For an outdoor $L_{dn}$ of 55 dB (or NEF 20) – when aircraft noise impact is low – 50% still expressed annoyance at the interference with TV sound, and 45% said that the noise disturbed conservation;
- For all activities in which speech was significant, approximately 70% reported disturbance.

Although these data were obtained around an airport where night flights and some noisy aircraft are restricted, they agree, in general, with surveys at other airports.

Annoyance and Community Reaction

Interference with the kinds of activities we have just discussed is determined by the physical characteristics of the sound: its frequency content, duration, abruptness, and (especially in the case of aircraft) intermittency. Most interference results in annoyance, but the degree of annoyance changes from one individual to another, and depends on such factors as age, attitude towards or economic dependence on the noisemaker, fear, and even socioeconomic status.

In a recent study† comparing the data from 11 social surveys conducted over 13 years in 6 countries, the percentage

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*See Sec. 3.4 for a full explanation of noise descriptors including Day-Night Sound Level ($L_{dn}$) and Noise Exposure Forecast (NEF).

†Schultz, T.J., "Synthesis of Social Surveys on Noise Annoyance," *J. Acous. Soc. Amer.*, pp. 377-405 (August 1978).

of people highly annoyed was determined as a function of $L_{dn}$. These surveys showed that people who were questioned at different times in different countries reacted to noise with surprising similarity. Figure 13 shows the average results of the surveys. The range of response occurring at a given noise level reflects human nature. In any group of people, you will find some members are annoyed by sounds others won't even notice.

In a still more recent survey* around Burbank Airport in California, observed proportions of respondents highly annoyed by aircraft noise was much greater than those predicted by the curve in Fig. 13 and perhaps indicated that exposure had reached a saturation level above which further increases could not elicit additional annoyance.

When does such annoyance result in action? And how much action? Response cannot be pinpointed, but the range of response can be quite well predicted. One widely based relationship between community response and noise exposure is derived from 55 case histories of impacts from various noise sources.† The relationship is shown in Fig. 14. The major normalizing factor is that all environments were adjusted so that the residual (or background) noise level – the noise that you hear, but whose source you cannot determine – was at the level found in urban residential areas. This is $L_{dn}$ 60.

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*Fidell, J., *et al.*, Community Sensitivity to Changes in Aircraft Noise Exposure, BBN Draft Report 4212 to the National Aeronautics and Space Administration, March, 1980.

†Eldred, K.M., "Community Noise," U.S. Environmental Protection Agency Report NTID300.3, Arlington, VA, 31 December 1971.

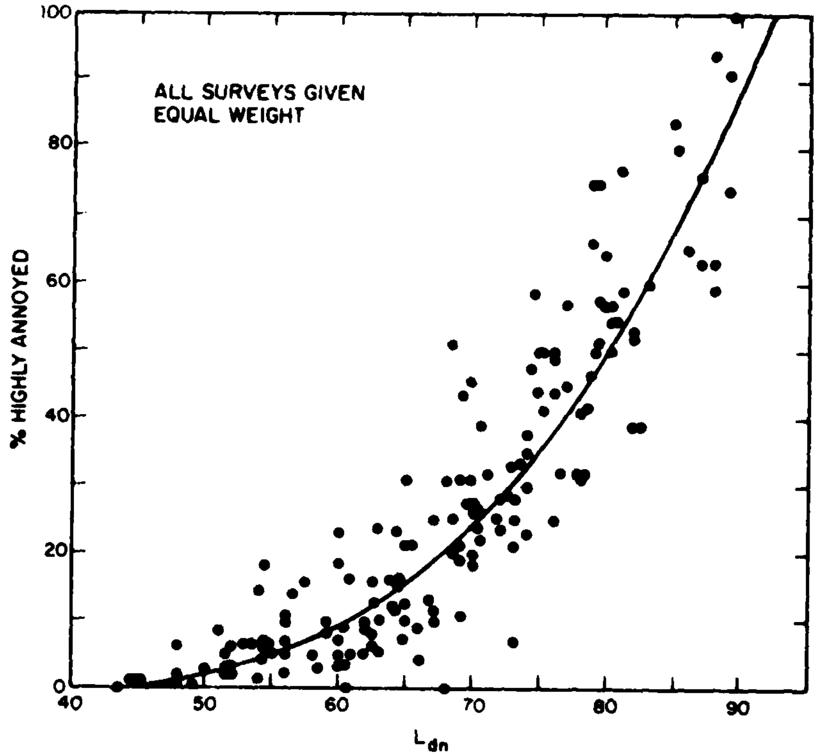


FIG. 13. RESULTS OF 11 SURVEYS IN 6 COUNTRIES OVER 13 YEARS.

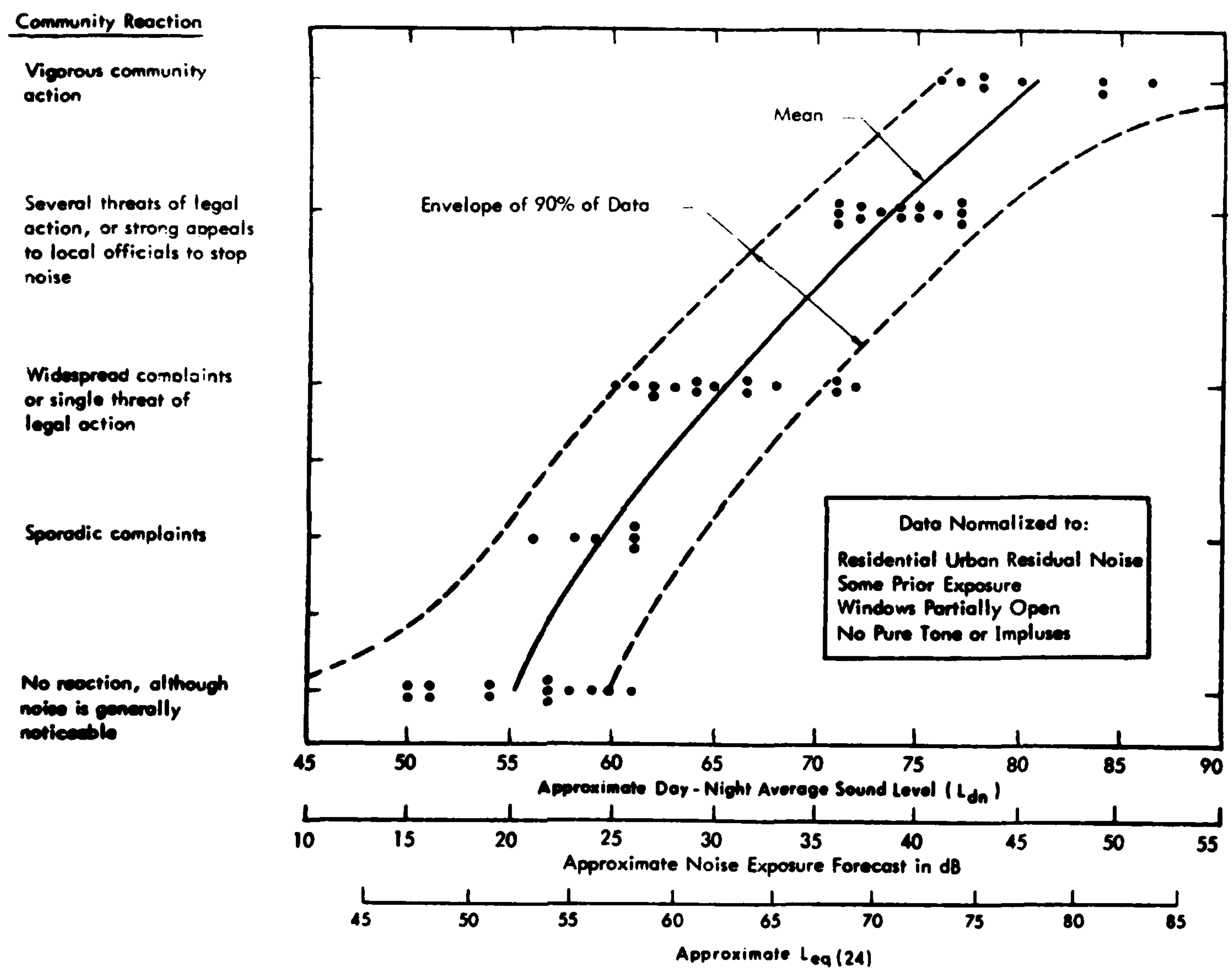


FIG. 14. COMMUNITY REACTION TO INTRUSIVE NOISES.

When the residual noise level differs from that found in urban residential areas, the impact of aircraft noise will also differ. For example, in quiet residential areas (an $L_{dn}$ of 50, 10 dB below urban residential) the impact is as if the aircraft noise were 10 dB higher. From Fig. 14, we would expect aircraft noise at $L_{dn}$ 65 in a quiet residential area to cause the reaction of aircraft noise at $L_{dn}$ 75 in an urban residential area – vigorous community reaction.

How does Fig. 14 apply to airports? It helps predict reaction, yet makes clear that, as stated previously, one can expect a range of responses from the people who live around airports. For example, at $L_{dn}$ 60 responses range from "no reaction" to "widespread complaints or single threat of legal action." Many factors influence community response and account for the range of reactions found at a single level of exposure.

### 3.3 Developing the Noise Control Plan

Development of a noise control plan may be a stand-alone project at an airport or it may be an on-going portion of the airport's effort to improve its environmental posture. Formal noise control planning may well start as a special effort and evolve into a continuing program that deals with changing problems and opportunities.

This section examines noise control planning generically. It considers basic questions of planning administration, then breaks the planning process into ten separate steps and looks at each of the steps. An airport-specific plan will contain all of these elements, but it is likely that the emphasis on the different steps will vary from airport to airport.

## Noise Control Planning: Administration

Development and implementation of a successful noise control plan is never a one-man job. As you already know, many persons and many organizations are interested in how the airport functions and even more in how the airport's operations affect the people, the activities, and the use of the land around it. To be successful, noise control planning must involve all these interests from beginning to end – from the first discussions of the noise control plan through its implementation. Remember, too, that a noise control plan may have to be updated, and don't forget to include all the affected groups in the updating.

How are those varying groups involved and coordinated? That's the job of the project administrator, who is responsible for

- Maintaining an open participative planning process, and
- Documenting that process as he guides planning committee members toward
- Producing a workable noise control plan.

The project administrator should be a member of the airport staff. This provides the best assurance that the planning effort will mesh with airport operation during its development stage. Also, a member of the airport staff is in the best position to coordinate implementation of the plan.

### Maintaining an open, participative planning process

The best advice for a project administrator is "Keep everyone informed." Many groups will be represented on the noise control planning time, but they will probably not all be involved all of the time. For instance, the airport operator's staff and consultants may spend two months investigating possible plan components. During those two months, the rest of the committee will be waiting to hear the results of the work. It's up to the project administrator to keep the waiting members informed about the work that is underway and the schedule for its completion. How can he do so? By memoranda, newsletters, personal letters, or even telephone calls: by any medium, in other words, that keeps members of the team from feeling ignored.

Simultaneously, the project administrator must keep the public informed. News releases, newsletters, and radio and television interviews are excellent ways to communicate, but perhaps the best way is through public meetings, which allow the administrator and team members to talk with public, telling people about the progress of the planning program and hearing, first-hand, what people have to say about it. The classic public meeting is a hearing or forum in a large hall, like a New England town meeting. Radio or television question-and-answer programs are potentially useful; they can reach audiences larger than any hall can hold. Citizen involvement is discussed more fully in Sec. 3.6.

Document the Planning Process

Planning means paperwork, and the project administrator must be prepared to preserve a lot of paper. If the final noise plan is challenged in court, the administrative record of the planning process will be of major importance, for the court will typically be concerned with the process of achieving the plan, rather than the plan itself. The administrator will be expected to produce complete records, not only of the makeup of the planning team, and the goal and the components of the plan, but - most important - of the issues addressed and decisions made.

## Noise Control Planning: The Process

The project administrator and the people and organizations he will work with will vary from airport to airport, but the basic steps of planning won't. The 10 steps of the planning process are listed below and shown in Fig. 15; a discussion of each follows.

1. Identification of noise problems
2. Decision to undertake a noise control planning effort
3. Funding
4. Setting up a working team
5. Defining the role of the team members
6. Defining the scope of the planning effort
7. Considering noise control opportunities
8. Evaluating possible actions
9. Creating the final plan
10. Adopting and implementing the final plan.

### Step 1: Identification of Noise Problems

Why noise control? Every plan starts with that question and its answer. Does the airport have present noise problems, or anticipate future problems? Has the issue of noise been recognized by the airport operator, a neighboring community, a group involved with the airport? Perhaps a suggested solution to one isolated noise problem has evoked concern about piecemeal planning and planning at cross purposes. The obvious response to these concerns is an overall noise control plan.

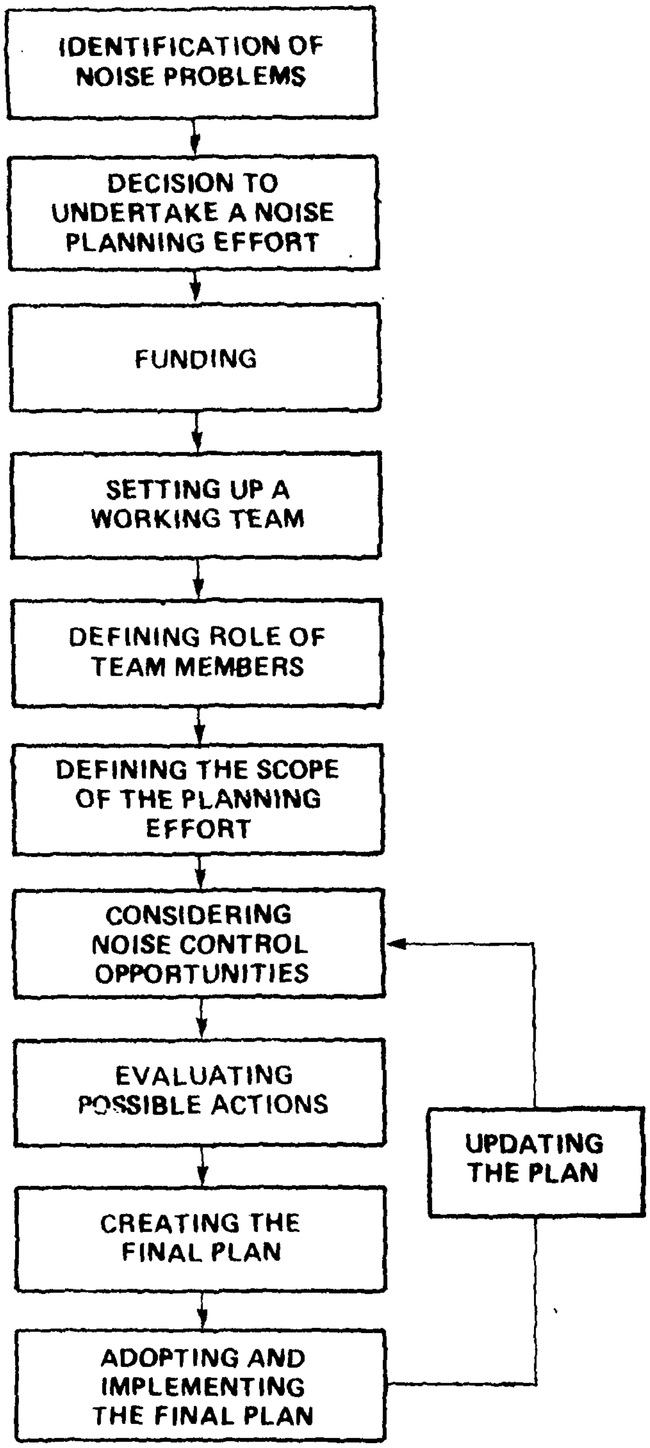


FIG. 15. PLANNING PROCESS.

Step 2: Decision to Undertake a Noise Control Planning Effort

Only one entity is involved in Step 2: the airport operator. Even though the idea or the goal of a noise control plan may not be his (and even though the job cannot be done without the participation of dozens of others), only the airport operator can commit the airport, its facilities, and its staff to a noise control plan, and he will take the lead in developing and implementing it.

Step 3: Funding

Without funding, there can be no planning effort – or rather, there can be one that ends only in frustration. Even though the technical scope of the plan is not concrete at this point, the operator must set up an approximate budget and ensure funding for it – such as local airport funds, ADAP, and local or state monies.

NOTE: With Steps 1, 2, and 3 completed, the noise control plan moves out of the *conceptual* into the *development* stage.

Step 4: Setting up a Working Team

The planning team must represent all affected persons or organizations; the technical skills of airport operation, noise control, and land use; and all other interests and skills applicable to that specific airport's needs. If those requirements sound to you as if they call for a big team, you are probably right. The larger group within the team will be representatives of interested groups, and it's up to the project administrator to identify those groups. They, and their possible representatives, will include:

Airport Operators - manager, engineering, staff members, board and committee members;

The FAA - ATC, facilities, flight standards, and planning staffs;

Neighbors - Municipal officials, community groups, business associations, residents of airport-adjacent properties;

Airport Users - air carriers, pilots, general avaiation groups, FBO's, the military, associations of businesses who use the airport indirectly, such as shippers;

Government other than the FAA - Those branches of government concerned with the problem of airport noise, such as the EPA, HUD, state aviation officials, state environmental officials.

The project administrator should not assume that any part of one group necessarily knows or represents another part of the same group. For instance, a city official may represent city government - but not a specific neighborhood, which may not have its own association.

To the core group of representatives of various interests, the project administrator must add persons with technical skills needed in the planning process: specialists in noise control, in airport planning, in land use, or in communication. Some of these experts will be needed on the team from the first planning discussion. Others will be added as the planning progresses and the need for them becomes evident.

Step 5: Defining the Role of Team Members

Team members' roles must be clearly defined, and sometimes participants will require definition of their roles before they agree to join the team. Usually, one section of the team takes responsibility for establishing *planning policy and plan direction.* Another section takes responsibility for *technical support* of the planning effort. The final decision to accept the plan remains, of course, with the airport operator.

Gathering the team and giving team members a chance to meet and talk with each other is time consuming, but not inefficient in the long run. This is the "participatory" approach, and, though slow at the start, it has proved more effective than a fast-paced, narrowly developed noise control plan that fails because it is not supported by all the groups that must implement it. What's more, it gives outsiders an opportunity to bring fresh new ideas to meld with the technical skills and knowledge of experts. Both experts and outsiders are needed for a complete planning process.

## Step 6: Defining the Scope of the Planning Effort

This is when the step-by-step planning effort is designed. (It is also the time when the effort must be funded and contracts prepared.) During Step 6, the team will define objectively

- The noise problems
- The noise goals.

Noise problems should be defined in terms of the present exposure and noise impacts; for example, "More than 3500 persons in residential areas are exposed to noise levels in excess of $L_{dn}$ 75," or "We receive regular complaints about training flights from residents of the Woodholm development, where the noise level ranges from $L_{dn}$ 50 to $L_{dn}$ 55." Similarly useful information would be conveyed by a statement such as "If the Deer Hill East Development is constructed, 2800 persons will be exposed to levels ranging from $L_{dn}$ 65 to $L_{dn}$ 70." These descriptors of noise problems lead to discussion of noise goals. A goal "to eliminate noise levels in excess of $L_{dn}$ 75 in residential areas" is more meaningful than one whose objective is defined only as "to reduce the noise impact in residential areas."

Noise goals must be objective, and realistic, too. All planning team members should understand the reality of noise control goals from the beginning of the process. They should know that the benefit from some individual actions will probably be very small and that an airport can suffer from noise problems so severe that even a very comprehensive planning effort can fail to achieve desired goals.

They must understand, too, that all gains will exact costs. These may be tradeoffs rather than financial costs, but there will be cost of some kind. For example, a runway use program generally involves changes in the way the burden of airport-related noise is shared. People who have experienced little impact may, after introduction of a runway use program, have to accept more noise – and they may object. Even within the airport, there may have to be tradeoffs: Air carriers must pay for quieting old aircraft or buying new ones. That cost will be borne by users of the airlines or, more indirectly, by all taxpayers when depreciation is an allowable cost.

The planning team should start by obtaining a set of airport noise contours. The contours must be precise, because levels of noise exposure can affect the value of a piece of land or the freedom of a community to plan development.

The contours must represent, as far as feasible, the absolute noise levels. Although sound levels must change by 3 to 5 dB before a change in sound is noticeable, a 1-dB change is significant for land use planning, since a 1-dB change may represent as much as 1000 feet on the ground.

For an existing airport, contour locations can be:

- Computed, using complex computer programs such as the FAA's Integrated Noise Model, or
- Determined by on-site measurements.

For future planning, contour locations must, of course, be computed.

Though team members may think of measurements as being more accurate, more "real" than computer modeling, they should be aware that contour determination by measurement has drawbacks:

- Many points must be measured to define a contour;
- Many days of measurements will be required at each point to assure that the values used represent the long-term environment;
- Measurement is an expensive method;
- Measurements can describe only the present environment, not that of the future.

And even if the measurements are made carefully, it is improbable that the accuracy will exceed 1 dB; 2 dB is more likely.

Not that computer modeling is a perfect technique. Inaccuracies result from (1) imperfect knowledge of airport operations and (2) characteristics of the modeling process and program. However, refinements in programs and experience in modeling how airports operate have made computer calculations the most reliable approach for contour development.

Where operations data are good, computer calculations are generally within 1 to 2 dB of long-term measured levels.

Once the team has set overall noise goals, the members should start asking questions about the noise contributions of various airport operations. How much of the noise comes from landings? From departures? From night operations? These types of noise data are as important as overall noise contours.

## Step 7: Considering Noise Control Opportunies

At this point, the team should be open-minded, ready to consider the fullest possible range of actions for noise control. Accept all suggestions; remember that *any* member of the planning team – regardless of his or her special interest or skill – may contribute valuable insights. The discussions of noise control actions in Sec. 2 provide detailed information about the benefits, costs and implications of specific noise control opportunities.

Planning team members should keep in mind that each airport has its own set of noise problems and noise control opportunities. A successful noise control plan will focus on the issues relevant to a particular airport and avoid inappropriate approaches. For example, a preferential runway program may yield major benefits at an airport with runways that lead to overwater routes, but be nearly useless at an airport that is uniformly surrounded by densely populated residential development. A noise control plan that places high hopes on a preferential runway program at the second kind of airport will have ignored the airport's basic characteristics. However, a rotational runway use program may provide some relief for residential areas near the second airport.

Step 7 will have a concrete result; a set of possible noise control actions to be evaluated in detail in Step 8.

## Step 8: Evaluating Possible Actions

For each action, team members should ask, and answer, a series of questions to find out how the action would work at the airport for which the noise control plan is being created.

The planning team should also recognize that airport planning is an element of overall community planning, not an isolated activity related only to the needs of the airport. Clearly, the design and operation of an airport must respond to aviation needs, but they should also be responsive to other community needs.

Airport noise control planning is one of the ways an airport can tailor its operations to respond to community goals. In doing so, however, the planners must not neglect technical, legal, and financial constraints. The airport must continue to function as an airport, and safety, legal obligations, and financial obligations must not be compromised.

### What Are Its Benefits?

Describe the benefits in terms of achieving the noise goals. For example, how many people will be exposed to noise levels in excess of $L_{dn}$ 75 after the action, compared with the number exposed before the action?

## What Are Its Costs?

Costs may be in dollar values for a new physical plant, in operating costs for aircraft, or in tradeoffs – the shifting of the noise burden, for instance. The planning team must guard against overlooking tradeoffs. A statement that "There is a 50% reduction in the number of persons exposed to noise levels in the range from $L_{dn}$ 55 to $L_{dn}$ 75" may obscure the fact that different people are involved.

## What Issues Are Involved in Implementing the Action?

Who would be required to implement the action? Are several groups involved? The team should make sure that the responsible entity or entities are involved in reviewing it.

## What Are the Constraints?

A potential action, no matter how suitable otherwise, cannot threaten the airport's safe operation or its ability to function. Constraints may include:

- *Safety*: Aviation has an admirable safety record, and safety must not be compromised by any noise control effort. On the other hand, "unsafe" should not become a label used simply to block change.

- *Laws*: Environmental laws, zoning laws, and laws that define the rights of affected parties may define limitations on noise control. The team should be very familiar with national and local laws relevant to noise control planning at their airport.

- *Costs*: Implementing any part of a comprehensive noise control plan will cost money. The overall plan must be evaluated against the ability of the airport, the airlines, and local communities to finance the program and the availability of state or Federal assistance.

Step 9: Creating the Final Plan

When the team has evaluated all potential noise abatement actions applicable to their airport, the members are ready to put together the final plan. This is a two-step job; they must (1) select the actions to be incorporated into the plan and (2) design the method by which the actions will be implemented.

They'll start with a list of actions appropriate for their airport. The actions must be (or may already have been) considered not only alone, but as interrelating parts of a comprehensive airport noise control plan. For example, a new runway will change the kind and number of options available for noise abatement runway use plans and noise abatement flight tracks. Do the actions fit together well? (An otherwise effective action may be ineffective by a combination of situations. For example, reducing the number of landings over an area may provide no real relief if the area is still overthrown by a large number of departure aircraft.) Do they produce the greatest possible benefits? When the answer is "Yes," the team will move on to design of an implementation plan.

There are five phases to the design of an implementation plan:

- Establishing responsibilities under the plan
- Set a budget with costs assigned by dates

- Set dates for achieving noise goals
- Establish methods for monitoring the plan
- Make provisions for receiving feedback and updating the plan.

## Establish Responsibilities Under the Plan

As is stressed throughout this document, airport noise control involves many persons and many groups. Once again, in this part of the noise control planning process, all five groups of participants – airport operator, airport users, airport neighbors, state and local government representatives, and the FAA (planning, ATC, and perhaps other regions or activities) – are going to be fully involved. And once again, their responsibilities should be made very clear, and lines of communication among them should be very strong. There should be no doubt, in other words, about the job each person or group is doing, and what its end result will be.

## Set a Budget with Costs Assigned by Dates

Plan implementation will cost money. How – and when – money is available will influence and perhaps even determine the timing of the plan. Levels of funding, sources of funding, and timing of funding must each be clearly stated. Thus, the result of this step is a schedule and a firm basis for financial support of the plan.

## Set Dates for Achieving Noise Goals

Once a schedule is set, the team can predict what the noise benefits of the program will be and when they will occur. The primary method for describing these targets will the future cumulative noise environment. Changes can also be described in other ways as a supplement to the cumulative description. These supplemental descriptions can respond to concerns expressed while problems were being defined (Step 6). For example, if the number of approaches over an area was identified as a problem, the team may want to describe the change as a reduction in numbers of approaches. Remember that when a method of describing benefits is selected, the descriptor chosen should be one that can be verified as part of the monitoring plan.

## Establish Methods for Monitoring the Plan

The team will want to monitor the noise abatement plan to judge (1) its overall effectiveness and (2) the effectiveness of each element. Noise monitoring is one way to assess changes in overall noise, but it may not provide the kind of detail needed for evaluation of individual actions. Also, building and running a permanent noise monitoring system may involve capital costs of more than $200,000 and annual costs in excess of $50,000.

There are alternative ways of obtaining even better detail at lower cost. For example, records of runway use by aircraft type and time of day and records of when planes fly can provide valuable information. With these data, the team can develop noise contours or data grids and examine in detail the noise exposure from each kind of operation. Similar methods can be used to monitor actions such as maintenance restrictions. The team can, with some ingenuity and without excessive cost, develop a monitoring plan that provides all needed information in the most useful form.

The results of the monitoring process should be publicized during implementation. Tell the public about the results, compare them with the goals, and note where the plan stands in its time schedule.

## Make Provisions for Receiving Feedback and Updating the Plan

A noise control plan is a dynamic program that functions in a changing environment. New opportunities and new challenges will arise that even the best planning process cannot anticipate. What can be anticipated is the *need* for change, and the project administrator must set up with the planning team a method of receiving feedback from members of the planning team and those affected by noise and the noise control plan. In addition, he must work out, with the planning team, ways to incorporate and evaluate future changes.

The planning team has now reached a major goal - it has a plan. The plan embodies benefits, costs, and tradeoffs, and it can be implemented. All that remain, now, are the adoption and the implementation of the plan.

## Step 10: Adopting and Implementing the Final Plan

The airport operator has the responsibility of adopting the plan. The "operator" can be a city, an authority, or a board. Regardless of the number of persons the term "operator" may cover, the plan - once it has reached this stage, with full participation by all concerned persons and groups - should be adopted automatically. Implementation should follow, also automatically, though it will require not only the continued coordination of participants, but also their continuing commitment.

### 3.4 Noise Descriptors in the FAA's Integrated Noise Model

As we have said before, airport community noise is made up, primarily, of a series of separate events. Between events, the environment may be relatively quiet. Over the years, various noise descriptors have been developed to describe the noise environment. These descriptors can be divided into two basic kinds: (1) those that reflect in a single number the amount of sound energy during a 24-hour day and (2) those that reflect in a single number how much of the time a noise level is exceeded. In the following pages, we describe five airport descriptors, four of which are in the first category, and one in the second:

| | |
| --- | --- |
| • Noise Exposure Forecast | Category 1 (Cumulative Energy Measures) |
| • Equivalent Sound Level | |
| • Day-Night Average Level | |
| • Community Noise Equivalent Level | |
| • Time Above Threshold | Category 2 (Cumulative Time Measure) |

Noise Exposure Forecast (NEF)

Noise Exposure Forecast (NEF) is a cumulative energy measure of noise exposure. It represents a technical upgrading of a land use planning tool developed for airports in the early 1960's – the Composite Noise Rating (CNR). NEF uses Effective Perceived Noise Levels (EPNL). Calculations of EPNL not only weight frequencies according to the sensitivity of the human ear, they also account for higher-than-normal annoyance at the presence of pure tones in aircraft noise signals (such as characteristic compressor whine of a jet engine during landing), and they account for greater annoyance at a sound that has a longer duration.

Although these refinements make EPNLs difficult to calculate without computer analysis of the noise, the resulting values are highly correlated with studies of annoyance.

Many people feel that annoyance caused by flyovers increases during these hours because background noises are lower at night, thus making aircraft noise more intrusive. Therefore, to account for the supposed increased annoyance to events occurring at night, NEF adds a weighting of approximately 12 dB to each EPNL value obtained for operations between the hours of 10:00 p.m. and 7:00 a.m. The exact value of the weighting is an engineering judgement, not one for which there are conclusive community response data.

The NEF value at any point, then, is the logarithmic sum (see Sec. 3.1) of the EPNLs (including the weighting for night flights) for each aircraft operation during a 24-hour period. A constant is subtracted from the total so that the resulting NEF value will be significantly different from the EPNL value -- a help in avoiding confusion between the two measures.

Equivalent Sound Level ($L_{eq}$)

$L_{eq}$ is the steady A-weighted sound level over any specified period (not necessarily 24 hours) that has the same acoustic energy as the fluctuating noise during that period (with no consideration of a nighttime weighting.) It is a measure of cumulative energy. Because the time interval may vary, it should always be specified by a subscript [such as $L_{eq(8)}$ for an 8-hr exposure to workplace noise] or be clearly understood.

## Day-Night Sound Level ($L_{dn}$)

$L_{dn}$ is $L_{eq}$ with a 10-dB nighttime weighting; it is a measure of cumulative energy. $L_{dn}$, which is similar in concept to NEF, uses the Sound Exposure Level (SEL) as the measure of noise from each single event. The SEL accounts for the ear's reduced sensitivity to low and very high frequencies, but it employs a simple "A-filter" rather than the complex function used in the EPNL calculation. The increased annoyance caused by the presence of pure tones is not adequately accounted for by this simplified weighting, but SEL does incorporate the effect of duration.

Like NEF, $L_{dn}$ has a weighting for the nighttime operations. The reason for this weighting is the same for both measures – intuitive rather than purely scientific.

$L_{dn}$ has recently grown in popularity, partly because it is similar to measure than NEF.

## Community Noise Equivalent Level (CNEL)

California has a descriptor similar to $L_{dn}$. It is the Community Noise Equivalent Level (CNEL), which adds an evening period – 7:00 to 10:00 p.m. – during which events are perceived to be 5dB more noisy. To put it another way, $L_{dn}$ is CNEL simplified. In cases where both descriptors have been used to describe the same set of operations, the results generally are the same or within 1 dB of each other.

The following figure shows the approximate relationships between the cumulative energy measures described here. No precise relationships can be made because of the variations in the way pure tones, durations, and evening and nighttime weightings are handled, but for the majority of airport environments over the range of levels that are of concern, the relationships are reasonable within a tolerance of plus or minus 3 dB.

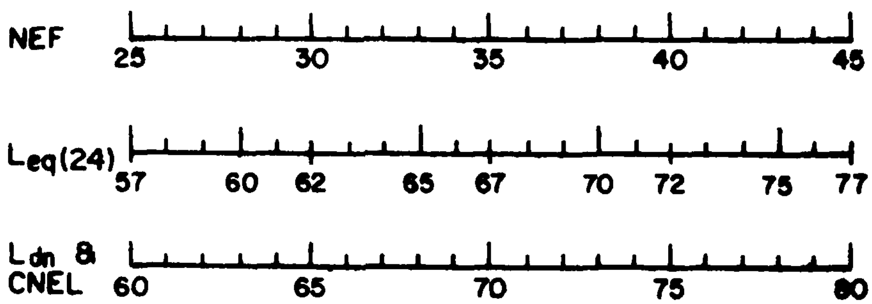


FIG. 16. RELATIONSHIPS BETWEEN CUMULATIVE ENERGY MEASURES.

Note that these four cumulative descriptors, all in the first category, do not answer the question "How loud are the airplanes?" They simply describe the total amount of noise an area receives during a day.

Time Above Threshold (TA)

One airport descriptor does answer the question "How loud?" It also answers the question "How long at that level?" To describe the total environment – an environment that, particularly at an airport, is made up of many levels of sound – a series of times above several sound levels is required. This description of the environment is referred to as time above threshold (TA).

TA is a multiple-threshold system that adds together single-event durations of noise above a number of sound levels – typically 65, 75, 85, 95, 105, and 115 dBA – for 24-hours and for evening and nighttime periods. For full use of this method, a series of numbers is required to describe the environment. However, in some instances, a single level will be of primary concern; for example, a level representing the onset of speed interferences. Data relating community response to TA are relatively sparse at this time. TA is useful to describe to people the change in the duration of sounds at those levels that would result from various alternative noise control actions. This information supplements the information contained in the cumulative noise descriptors. When TA information is presented, it may be related to specific effects by the qualitative descriptors in Table 2. Neither a cumulative energy measure nor a cumulative time measure such as TA alone can provide a complete description of the noise environment around an airport. Each provides some useful information – but not all. You need cumulative descriptors for land use planning and predictions of community reaction. You need TA for data on sound levels useful for analyzing speech interference and other activity interference and to provide an answer to that particular question "How loud?" Don't substitute one measure for another in an effort to simplify analysis.

TABLE 2. QUALITATIVE DESCRIPTORS APPLICABLE TO RESIDENTIAL AREAS.

| Threshold Exceeded [dB(A)] | Speech Communication Disturbance Indoors | | Outdoor Judgments of Single Event Maxima |
|---|---|---|---|
| | Windows Open | Windows Closed | |
| 65 | just noticeable | none | quiet |
| 75 | moderate | just noticeable | generally acceptable |
| 85 | severe | moderate | noisy |
| 95 | extreme | severe | excessively noisy |

The effect of "soundproofing" can be assessed by using TA. For example, increasing the amount of protection a building offers against noise by 10 dB has the same effect as decreasing the noise level of the source by 10 dB. In Table 2, such a change reduces the speech communication disturbance by one category — i.e., from "moderate" to "just noticeable."

### 3.5 Airport Noise Contours and Land Use Planning

Noise-related planning is an important element of the total planning process, but remember, it is only *one* element.

A recommended first step in planning land use to help control airport noise is to obtain a set of airport noise contours. The contours must be precise, because levels of noise exposure can affect the value of a piece of land or the freedom of a community to plan development.

The contours must represent as far as feasible the absolute noise levels. Although sound levels must change by 3 to 5 dB before a change in sound is noticeable, a 1-dB change is significant for land use planning, since a 1-dB change may represent as much as 1000 ft on the ground.

How do you get as accurate a set of noise contours as possible?

For an existing airport, contour locations can be:

- Computed, using complex computer programs such as the FAA's Integrated Noise Model and the U.S. Air Force's NOISEMAP, or
- Determined by on-site measurements.

For future planning, contour locations must, of course, computed.

You may think of measurements as being more accurate, more "real" than computer modeling. Be aware, however, that contour determination by measurement has drawbacks:

- Many points must be measured to define a contour;
- Many days of measurements will be required at each point in order to be assured that the values used represent the long-term environment;
- Measurement is an expensive method;
- Measurements can describe only the present environment, not that of the future.

Even if measurements are made carefully, it is improbable that the accuracy will exceed 1 dB; 2 dB is more likely.

Not that computer modeling is a perfect technique. Inaccuracies result from (1) imperfect knowledge of airport operations and (2) characteristics of the modeling process and program. However, refinements in programs and experience in modeling how airports operatve have made computer calculations the most reliable approach for contour development.

Where operations data are good, computer calculations are generally within 1 to 2 dB of long-term measured levels.

A number of lingering reservations about computer predictions deserve discussion. First, let's consider reservations expressed about programs used to compute data for cumulative descriptions. They include seasonality and factors of local climate, such as altitude, wind, temperature, humidity, and background noise levels.

Seasonality

People sometimes express concern that descriptions of airport noise consider annual averages and ignore seasonal conditions. It is true that aircraft noise levels in many communities vary from season to season. However, the decision to ignore this variability occurs when noise exposure criteria are established, not as part of a noise computation. HUD noise limits and EPA noise discussions have established a 1-year exposure as the period to be described. It is feasible to model the noise environment for any period of interest. But the results would have little use until exposure criteria were established for the same periods.

## Wind

The primary, long-term effect of wind on noise exposure is the result of runway utilization, which is included as input for all prediction models. On the basis of experimental verification, the other effects of wind on sound propagation can be ignored without sacrificing precision.

## Altitude

As airport altitude increases, the noise exposure for a given set of operations decreases below that which would occur at sea level; in other words, contour areas shrink. Although aircraft climb performance decreases with increasing altitude, the noise levels for a given distance between aircraft and observer decrease also. The net result is less noise on the ground. Modeling programs typically include airport altitude as an input variable.

## Temperature and Humidity

Noise data for prediction models assume standard temperature and relative humidity. But conditions are generally nonstandard, resulting in differences between actual conditions and predicted conditions. As noted earlier, even without program and data refinements to account for nonstandard temperature and relative humidity, predicted levels are generally within 1 to 2 dB of long-term measured levels. When noise and performance data have been adjusted to account for local environmental conditions, agreement between predictions and long-term measurements can be improved to a point where the average difference is only 1/2 to 1 dB.

Examples of this interactive process include studies at Orange County, Burbank, and NAS Miramar, all in California, and Logan in Massachusetts.

TA data can be obtained from calculations as well as from measurements. Basic concerns with accuracy are similar for TA and cumulative descriptors. In addition, there are relatively few instances of experimental verification of TA computations with long-term measurements.

Background Noise

Discussions of airport noise have generally ignored the presence of other noise in a community, usually because such studies focused on relatively high exposure levels (in excess of NEF 30 or $L_{dn}$ 65), and the airport noise was the loudest noise around. Another view of the situation is more common today. We are concerned with the total noise environment, and our concern starts at levels as low as NEF 20 ($L_{dn}$ 55). As a result, we are interested in knowing what is the background noise, that ever-present unidentifiable noise from general human activity, and how a community's perception of the airport noise is influenced by the background noise.

Table 3 shows the noise levels associated with a range of urban residential areas. As population density increases, so does the noise level. The EPA has suggested that the impact of airport noise is less if it occurs in a noisy community than if it occurs in a quiet area. They assign to airport impact only the numerical difference between the background level ($L_{dn}$ in dB) and the aircraft level. This is an appropriate concept. However, to establish the impact one must first determine the actual noise levels throughout a community. This is a complex task. Estimates derived from population density can be off as much as 8 dB and community-wide measurement programs are very costly.

TABLE 3. NOISE LEVELS ASSOCIATED WITH A RANGE OF URBAN RESIDENTIAL AREAS.*

| Description | Typical Range $L_{dn}$ in dB | Average $L_{dn}$ in dB | Estimated Percentage of Urban Population | Average Census Tract Population Density, Number of People Per Square Mile |
|---|---|---|---|---|
| Quiet Suburban Residential | 48-52 | 50 | 12 | 630 |
| Normal Suburban Residential | 53-57 | 55 | 21 | 2,000 |
| Urban Residential | 58-62 | 60 | 28 | 6,300 |
| Noisy Urban Residential | 63-67 | 65 | 19 | 20,000 |
| Very Noisy Urban Residential | 68-72 | 70 | 7 | 63,000 |

Noise from identifiable sources may also influence a community's perception of airport noise. For example, the impact of airport noise in a highway corridor should be less than the impact of the same noise in a low density housing development. So, we should attribute to airport noise impact only the numerical difference between the noise from all other sources and the total with the airport noise.

At present, there is no generally accepted way of incorporating the effects of background noise and noise from

*U.S. Environmental Protection Agency, "Population Distribution of the United States as a Function of Outdoor Noise Level," Report No. 550/9-740009, Washington, DC, June 1974.

identifiable sources into an airport noise analysis. Also, there is no provision for such analysis in any of the computer models. The best advice at this time is to keep abreast of developments that are sure to occur.

The earlier comments on seasonality apply to TA. Also, those comments on altitude, wind, temperature, and humidity that relate to the noise data base should apply to TA calculations. However, to be fully applicable to TA analysis, each environmental factor should be considered for the TA program that is being used. That information does not exist at the time this document is being published.

It is clear that absolute (zero error) precision in locating noise contours is not achievable. However, the discussion above places in context the precision of predictions and measurement. When using any noise data, airport planners should evaluate the quality of the data, and not use them blindly.

## Use of Noise Contours in Community and Airport Planning

Once you have a set of noise contours, you may need some guidance in using them. For example, you may want to decide exactly where the contours are in relation to a local planning map. For maximum success, be sure that the contours are plotted to the same scale as the map you wish to use. Then, do a careful job of registering the contours over the airport.

When contours are used for land use planning, you may run into a problem for which you will need help. The location of significant contours seldom coincides with a zoning boundary or a property line, and you will probably be asked about the accuracy of the contours by people who want to hear as little airport noise as possible at their homes or businesses. Even when you know the contour accuracy, you have no basis for deciding in which direction any error might be. One way to avoid this difficulty is to establish rules for contour interpretations as part of a zoning regulation. For example, the law in Maryland specifies that the noise zoning boundary will be established at the first property line outside the contour representing the noise limit. If such rules are set, you will have some definitive guidance.

The relevant regulations will determine which contour values you will use for planning. For HUD-assisted or HUD-insured housing projects, these will be NEF 30 ($L_{dn}$ 65) and NEF 40 ($L_{dn}$ 75).* Specific values will be set in other jurisdictions and for other land uses. Although it is probable that a contour will be least accurate for contours at the greatest distance from the airport, you still have no basis for saying whether the contours overstate or understate the actual conditions.

Contours are also used to evaluate the effectiveness of noise abatement options. For such purposes, you want to be sure that the difference between contours results only from the operational differences you are exploring. For example, if you want to evaluate the effectiveness of a preferential runway program, don't make any changes in fleet or total numbers of operations at the same time. Try to keep all parameters fluid, except for the ones related to the action you're evaluating.

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*See discussion of HUD policy, Sec. 3.7.

## Soundproofing

"Soundproofing" is the term applied to increasing the amount of sound protection, or noise reduction, offered by a building. Noise reduction is described in terms of the difference between outdoor level and indoor level for a sound source outside the building. Noise reduction can be stated at various frequencies or as A-level reductions. For typical residential construction the A-level noise reduction is 15 dB with windows open (2 sq ft opening), and 25 dB with windows closed. If normal design would achieve ventilation by opening windows, the addition of mechanical ventilation that would allow windows to be closed permanently would achieve 10 dB of "soundproofing." Noise reductions in excess of 25 dB require construction heavier than typically found in houses and will also call for reduced areas of window.

Criteria for particular uses may be given as outdoor levels - with an assured noise reduction - or indoor levels. If the levels at a location exceed the applicable criteria, alternative actions for soundproofing changes the inside, not the outside, environment. So, even if you eliminate excessive aircraft noise in a house, the outdoor space may still be too noisy for undisturbed relaxation.

Concern with energy efficiency has decreased in the past 3 years. It is useful to note that construction types that provide the best protection against sound also tend to provide the best thermal insulation. Therefore, increased thermal efficiency will be a beneficial byproduct of soundproofing.

## 3.6 Citizen Involvement in Noise Control Planning*

Citizen participation in public decision-making is no longer a matter of choice; events of the past decade clearly indicate the necessity and desirability of including citizen representatives in the public planning process. Airports are integral components of larger planning jurisdictions and airport noise control embodies issues which extend well beyond the physical boundaries of the airport and must include representatives of off-airport interests.

In general, citizen involvement in airport noise control planning falls into two categories: (1) ongoing citizen participation programs and (2) short-term, project-specific programs which focus on a particular planning issue or study. As a rule, it is desirable for airports to establish a long-term process of continuous communication with citizen groups. Ongoing communication will facilitate the structuring of a citizen involvement process for a specific noise planning project such as an ANCLUC study or an EIS for airfield expansion. The formation of a citizens' advisory council which meets regularly with airport officials to discuss noise issues and communicates it concerns and, in turn, receives information about noise abatement activities, is a familiar citizen participation technique at a number of airports. This type of organization encourages the two-way communication which is the foundation of a good relationship between the airport operator and citizen groups. It also encourages the development of a cadre of informed citizens who will, over time, build a level of expertise about noise issues which may facilitate the noise control planning process.

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*General FAA guidance can be found in Advisory Circular No. 150/5050-4, "Citizen Involvement in Airport Planning," 26 September 1975.

Another technique for establishing ongoing communication is a newsletter which is regularly circulated to citizens. Still another method of maintaining regular contact with concerned citizens is for airport staff to attend meetings of local community or municipal groups such as town planning boards in order to present information about the airport's noise planning activities.

If you are about to embark upon a noise planning program and you do not have an established line of communication to citizen groups, you face the task of structuring a participatory process for the specific project to be undertaken. It may be necessary to identify representatives of interested community groups in impacted areas and to encourage them to participate in the planning project. The roles of citizen participants in the planning process can vary widely and so can the techniques which are used for involving citizens. They can be asked to be part of an advisory group; they can serve on a review committee to evaluate the interim result of the planning work; they can organize community meetings in their respective jurisdictions to inform neighbors about the project.

It is necessary to think through the citizen participation program very carefully at the outset of the planning project so that an appropriate level of involvement is structured and provision is made for adequate contact with airport neighbors. Each airport will have a different set of needs and goals which should be considered in planning the citizen participation element of the noise control planning project. The common elements in a successful citizen participation program are:

(1) initial recognition of its importance to the planning project and (2) adequate care and attention to developing appropriate and effective techniques for gathering input from airport neighbors and transmitting information to them.

There are three important elements in directing a successful citizen participation program: PLANNING, LISTENING, and COMMUNICATING.

- PLANNING – Just as you marshal intellectual and financial resources to address technical problems, so must you approach the citizen participatory process with the same techniques. Thus, we urge you to plan carefully for citizen involvement in your noise control planning process. Allocate a percentage of the total time and dollars involved in the project to this aspect of the work. You will find that in the long run this initial commitment will pay off in an expedited process and an increased probability of implementing the policy recommendations.
- LISTENING -- This may be the hardest task of all. Noise is an emotional subject and it may not be easy to listen to some of the very vociferous expressions of disturbance which can frequently be aired at community meetings. However, it is essential to listen. Frequently, after initial emotions are vented, people are ready to get down to the more rational task of addressing the substantive areas of concern in airport noise planning. So, try to bear in mind that the initial emotional pitch usually dies down and that it may be a necessary phase to get through in the community participation process.

- COMMUNICATING - Professionals in all fields of endeavor tend to believe that nontechnical people cannot understand the subject matter with which they deal. However, if you take the time and care to develop techniques to inform community people about the issues of airport noise, you will find that they are well able to understand the subject matter. Be innovative in developing ways of communicating with the public about airport noise. The following are examples of some techniques that other airports have found useful.

  - Radio and Television: Raleigh-Durham airport officials went on radio and television for a 3-hour program in June 1978. The first hour was dedicated to background information. During the next two hours, a panel that included the airport director and consultants in noise, architecture, finance, and ecological impacts answered questions posed by or telephoned in by citizens. The goal of the program was to obtain community input for the airport planning program. Response was so great that there was time to answer only one out of every three to four questions. (The others were received and kept as part of the record.)

    For the Sea-Tac Communities Planning Project, a local Seattle station produced a public affairs television program, "How Would You Like to Sleep With a 747?" The program included a discussion of the results of a community-wide survey of noise problems.

  - Publications: Officials of Douglas Municipal Airport in Charlotte, North Carolina wanted to inform and educate Charlotte citizens about the environmental impact of a proposed new terminal complex. Faced with a great deal of very technical information to communicate, they published a concise booklet that started with a summary of the technical material, presented in question-and-answer form.* Fig. 17 shows a page from the Summary.

Sea-Tac presented preferred alternative plans to the community in a special newspaper supplement entitled, "Where Are We Going?" which was included in four local newspapers whose circulations totalled 70,000.†

- Advertisements: Fig. 18 shows an advertisement placed in the major suburban paper serving the communities adjacent to Hanscom Field (Massachusetts), notifying citizens of a public meeting to discuss the airport's Master Plan Study.

Now let us examine the ten steps of the noise control planning process which are described in Sec. 3.3 and identify how citizen involvement is necessary during each step of the process.

1. Identification of Noise Problems

It is obvious that the people who are impacted by airport noise provide valuable insight into defining airport noise problems. For instance, if nighttime runups are not creating a perceived disturbance for airport neighbors, then nighttime runups need not be defined as noise problems and actions to restrict runups need not be considered in the noise control

*"Douglas Municipal Airport New Terminal Complex: Preliminary Physical Environmental Impact Assessment Report," prepared for the City of Charlotte, North Carolina, by Bolt Beranek and Newman Inc., February 1978.

† "Planning for the Airport and Its Environs: The Sea-Tac Success Story," U.S. Government Printing Office Publication No. 1978-261-268/108.

## 1. SUMMARY

This report, "Douglas Municipal Airport, New Terminal Complex: Preliminary Physical Environmental Impact Assessment Report," asks and answers questions about the impact of the new terminal proposed for Douglas Municipal Airport. Eight subcategories of the physical environment are addressed: noise, air quality, displacement, water, land, solid waste, energy, and consistency with local and regional plans.

In this section, we summarize our findings in the form of a basic question and a concise answer for each subcategory.

*What is the noise impact of the proposed terminal?*

None. There would be no increase in community noise impact because of construction of the proposed terminal. Two changes in noise would result from the new terminal: increased traffic noise and increased noise from construction vehicles and activity. Both traffic and construction noise, however, would be quieter than noise from existing aircraft operations and highway traffic.

*What is the air quality impact of the proposed terminal?*

Two air pollutants were found to be a problem: oxidants and carbon monoxide. The problem of oxidants is region-wide; the airport will share the region's high ozone levels until the problem is corrected regionally. If the proposed terminal were built, concentrations of carbon monoxide (almost solely from aircraft and automobiles) would shift from the present terminal site to the new terminal site. Nowhere on airport property does carbon monoxide exceed allowable levels, and it is not predicted to do so, even if the new terminal were built.

*What is the displacement impact of the proposed terminal?*

No houses or businesses would be displaced at the site of the proposed terminal, although there would be some displacement resulting from construction of the entrance road. Some businesses now operating near the present terminal, particularly air-cargo-related, would remain. Others would relocate to the new site or cease to exist.

*What is the water impact of the proposed terminal?*

Without a method to control water runoff, construction of the proposed terminal would result in storm water drainage problems. Channels, basins, and a retention pond are included in the planning for the proposed project to alleviate potential problems.

FIG. 17. SAMPLE PAGE: DOUGLAS BOOKLET.

L G HANSCOM FIELD AIRPORT MASTER PLAN STUDY

**INITIAL PUBLIC MEETING**

Wednesday, February 26, 7 30 p m

Cary Hall, 1625 Massachusetts Avenue, Lexington

Sponsored by the Massachusetts Port Authority, the Federal Aviation Administration, and the Governor's Hanscom Task Force

Master Plan Consultants R. Dixon Speas Assoc. and Bolt Beranek and Newman, Inc will present their program of work for the year-long master plan study, which will begin shortly

Public participation is encouraged.

For more information Wilma Frey, Governor's Hanscom Task Force 727-8257

Tom Mann, Massport 482-2930

FIG. 18. NOTIFICATION OF AIRPORT MASTER PLAN STUDY MEETING.*

plan. Similarly, if the level of citizen complaints indicates that there is little or no noise problem during the winter months, then it may be wise to concentrate your planning efforts on seasonal, i.e., summertime, abatement policies.

## 2. Decision to Undertake a Noise Control Planning Effort

It is common for citizen protests or complaints to stimulate the initial decision to undertake a noise control planning project. However, some airport proprietors have the foresight to embark on a noise planning process in order to avoid future problems. If the impetus for the proposed plan has not come from the actions of citizen groups it is still well to involve them in the project at the earliest opportunity, i.e., when the decision to commence a planning project is being debated. Clearly, there is no point in undertaking such an effort if there is not a consensus among those who would be benefited by implementation of a noise control plan that such a plan would be appropriate and useful.

*"Hanscom, Alternative Futures for Policy Planning," prepared for the Massachusetts Port Authority in cooperation with the Governor's Hanscom Task Force by Speas Associates and Bolt Beranek and Newman Inc., June 1977.

3. Funding

Citizen support of the project may be a key to obtaining Federal or state funds to finance the project. If there is significant public opposition to the project, funding may be jeopardized. Similarly, funding may be jeopardized if an inadequate community participation component is included in the project. An astute planner should recognize the need for including endorsements from broadly based support groups in application to the funding agency. And a well-planned community participation component in the project description may be necessary to satisfy Federal and/or state guidelines.

4. Setting up a Working Team

All concerned parties including airport users, tenants, public officials, FAA staff, and community representatives must be integrated into the working team for the planning project. Exclusion of any interest group - including community representatives - will weaken the chances of successful implementation of the noise control plan.

5. Defining the Role of Team Members

This is a critical decision area for the project leadership. It is absolutely essential to clearly specify the roles and responsibilities of citizen participants in the project. There is likely to be a fuzzy area which will become increasingly muddled if a clear delinearion of roles is not made at the outset. Thus, if citizen representatives are to have an *advisory* role but not a *veto* role on matters such as consultant selection or approval of the work program, this should be clearly specified and, if possible, set forth in writing.

Similarly, if they are to participate in a review role but not as working team members, this should be clearly stated. Failure to clarify role parameters at the outset of the project can lead to real problems throughout the planning process and may even result in an aborted project.

### 6. Defining the Scope of the Planning Effort

The key concern here is to ensure that all participants feel confident that their concerns will be addressed during the planning process. Thus, the agenda of the planning effort may extend beyond the bounds that the project leadership had initially envisioned. This may be unavoidable; stringent limits on the parameters of the study can result in dissatisfaction among citizen participants who may feel that their concerns are not receiving adequate attention. Although it can result in additional expenditures of time and money, defining the scope of the planning project to include the full range of citizen concerns may be both necessary and, in the long-run, cost-effective.

### 7. Considering the Noise Control Opportunities

During this stage of the planning process, citizen input is vital in order to ensure that the full range of alternative abatement actions is included in subsequent analysis. Non-technical participants may propose a variety of actions which are, on their face, technically infeasible. These suggestions should not be dismissed at the outset but should be subjected to the evaluative process which follows in the next phase of the study. If the proposed actions are not technically sound, they will be eliminated on those grounds. However, it is important that community representatives have their suggestions on noise control actions addressed in the study.

## 8. Evaluating Possible Actions

Although this is probably the most technical phase of the planning process, citizen participants should be involved in discussions concerning the pros and cons of the alternative actions which are being evaluated. This kind of forum is the best way to inform nontechnical partipants about the range of safety, operational and economic factors which may make a desirable noise abatement alternative unworkable.

## 9. Creating a Final Plan

By this point in the planning process, the citizen participants should have been integrated thoroughly into the planning process and will, of course, have a role in contributing toward the decisions which will be incorporated in the final plan.

## 10. Adopting and Implementing the Final Plan

If you have not been able to structure a successful citizen participation process in Steps 1 through 9 of your planning process, you can be assured that you will have little chance of having the final plan adopted and implemented. It is at this point that you will find out in a graphic manner whether or not you have been effective in your efforts to integrate citizen involvement into your project. We do not imply that you must have total agreement from citizen groups on the recommendations embodied in the plan; indeed, this may be an impossible goal. However, citizens will generally support a noise control plan if the following conditions apply:

- They have been well represented in the planning process
- The planning process itself has been open and well documented

- All reasonable alternatives have been examined
- The final plan offers some noise abatement benefits.

The process outlined above may sound threatening to you. Undoubtedly, you have heard horror stories of citizen protests against airport expansion and you may even have had some unpleasant experiences with citizen groups at your own airport. Unfortunately, the horror stories always appear to get more publicity than the examples of successful citizen-airport relationships. Bear in mind that for every horror story there is at least one example of a success story to balance it. Following the process outlined in this section should help you create your own "success story."

### 3.7 Federal Legislative and Administrative Mandates for Noise Control

Federal control of aircraft noise became a necessity in the late 1960s, after jet transports had become well established in the commercial aviation fleet. Previously, community reaction to airport noise had been recognized as a problem, but the tendency was to deal with noise impact and noise problems through voluntary land use planning. In 1964, the Department of Defense and the Federal Aviation Administration supported development of the Composite Noise Rating (CNR) as a means of identifying areas of communities deemed incompatible with airport noise exposure. This planning procedure was meant to be the first major step in the formulation of a national noise abatement strategy. But though the theory was admirable, it has failed. In the absence of a legal framework to restrict development, prior to the National Noise Abatement Policy, neither airports nor communities have demonstrated much self-restraint. Encroachment of one or the other has come to be common practice.

As land use conflicts multiplied, the need for noise and land use control grew. In this section, we present, chronologically, the more important legislative and administrative actions taken by the Federal government to reduce airport noise in communities.

## Legislative Actions

### An Act to Require Aircraft Noise Abatement Regulation, PL90-411, 21 July 1968

This Act amends the Federal Aviation Act of 1958. It requires the Administrator of the FAA to prescribe regulations providing for the control of aircraft noise and sonic booms. The amendment vests ultimate responsibility for the control of noise at the source - the aircraft itself - directly with the FAA, providing the legal foundation for regulatory action.

### The National Environmental Policy Act of 1969, PL91-190, and Amendments

This Act provides for the establishment of a national policy to protect man's environment. It requires that each Federal agency be responsible for assessing the environmental impact of its major actions, and it establishes, within the executive branch, the Council on Environmental Quality to appraise the activities of the government with regard to the environment. Through the Act, agencies such as EPA and HUD, as well as the FAA, have become responsible for the environmental assessment of airport noise.

Airport and Airway Development Act of 1970, PL91-258, 21 May 1970, and Amendments

This Act describes the distribution of funds for airport development projects with the stipulation that such projects provide for the protection and enhancement of the quality of the environment. New airports, new runways, and runway extensions are not to be authorized if they are found to have adverse affects on the environment unless no feasibile and prudent alternative exists and all impossible steps have been taken to minimize the project's impact.

Noise Control Act of 1972, PL92-574, 28 October 1972

This Act establishes a means for coordination of Federal activities on noise control through the Environmental Protection Agency. EPA is charged with the responsibility of prescribing noise emission standards for products (other than aircraft) identified as major sources of noise. Under this Act, EPA was required to collect information on levels of environmental noise requisite to protect the public's health and welfare, a stipulation that led to the publication of the "Levels Document"* in 1974.

With specific regard to aircraft, the FAA was considered to have greater expertise than the EPA. The EPA is charged with recommending regulations to the FAA to abate aircraft noise and sonic booms to the extent necessary to protect health and welfare.

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*"Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," U.S. Environmental Protection Agency Report 550/9-74-004, Arlington, VA, March 1974.

The FAA must consider safety, economic responsibilities, and technological feasibility before adopting or rejecting any EPA proposed regulations. This process has been carried out on EPA proposals for two-segment ILS approaches, fleet noise level requirements minimum altitudes for turbojet airplanes in terminal areas, SST control, and so on.

The Aviation Safety and Noise Abatement Act of 1979, PL92-574, 18 February 1980

This Act has five titles. The first and third titles concern noise control. Title One directs the Secretary of Transportation, after consultation with the EAP and others, to:

- establish a single system of measuring noise;
- establish a single system for determining the exposure of individuals to noise; and
- identify land uses which are normally compatible with various exposures of individuals to noise.

It also allows noise mapping, amends the Airport and Airways Development Act to include "Airport Noise Compatibility Planning," and sets funding limits for such planning. Title Three of the Act modifies the retrofit requirements of FAR Part 91, Subpart E. It also directs the Secretary of Transportation to make foreign carriers comply with U.S. standards unless the International Civil Aviation Organization adopts essentially compatible standards.

Administrative Actions by the FAA

Federal Aviation Regulation Part 36, Noise Standards: Aircraft Type Certification, 1 December 1969, and Amendments

Following the Federal Aviation Act Amendment of 1968, FAR Part 36 was the first aviation-related action that required the prescription of aircraft noise control regulations. The original regulation specified noise limits in EPNdB applicable to new large subsonic aircraft at designated measurement locations under the takeoff and landing paths and off to the side of the runway. The positions have since been modified by amendment, and the new ones are shown schematically in Fig. 19.

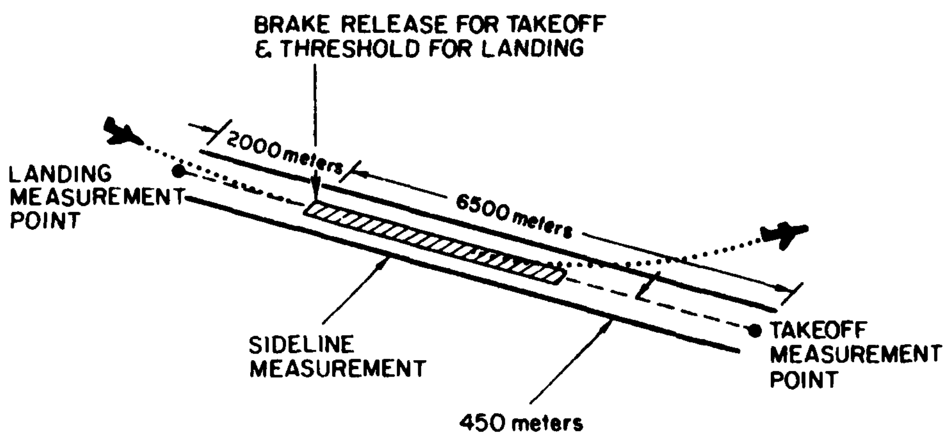


FIG. 19. FAR PART 36 NOISE LIMITS FOR AIRCRAFT AT FOUR RUNWAY POSITIONS.

The noise limits themselves have also been amended so that now the levels are progressively more stringent with time. The later an application is made for a new type of certification, the quieter the aircraft must be.

Because they predated FAR Part 36, many of the aircraft types in the present jet fleet exceed even the original noise limits defined by the regulation, as indicated by the takeoff noise level plotted in Fig. 20. To reduce the noise of these older types, additional amendments to FAR Parts 36 and 91 now require that new-production aircraft of types certificated prior to the regulation must be manufactured to meet the original limits, and old aircraft in existence prior to the regulation must be retrofitted to meet the original limits or be replaced.

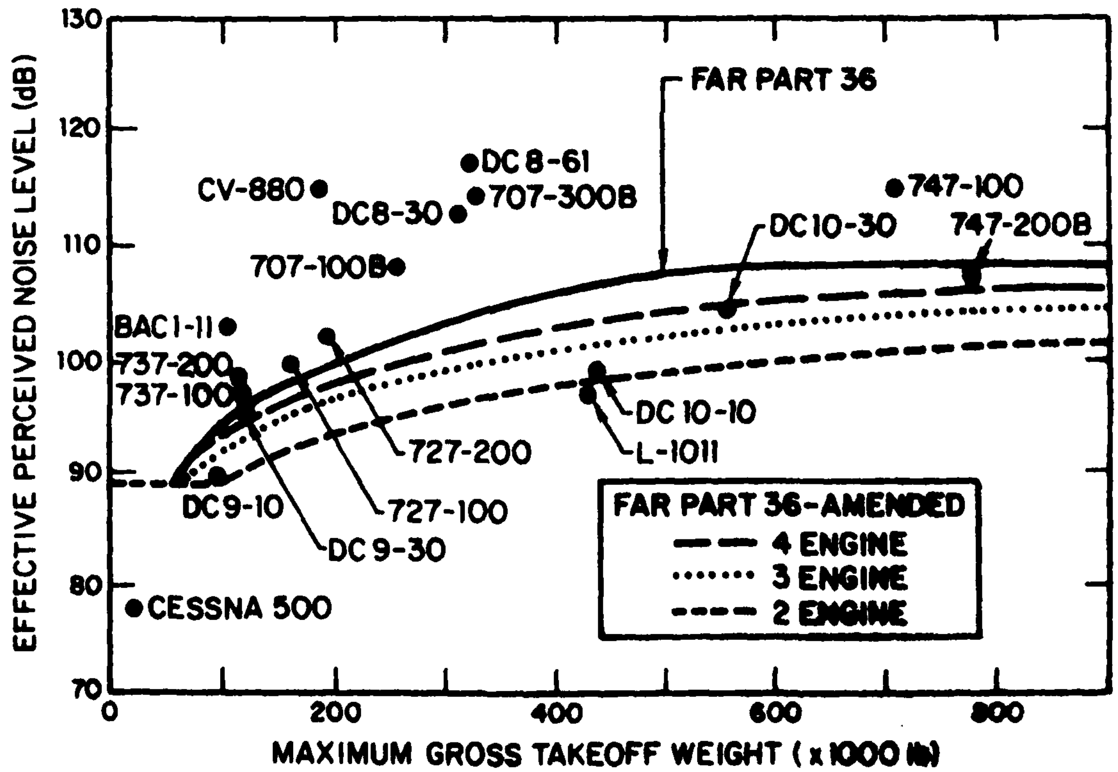


FIG. 20. TAKEOFF NOISE LEVELS OF PRESENTLY OPERATING JETS.

Still another amendment to FAR Part 36 has extended noise limits to light propeller-driven aircraft (those having maximum certificated weights less than 12,500 lb). The limits for these aircraft are specified in terms of A-weighted levels, rather than Effective Perceived Noise Levels, for simplicity. Partly because of the vast difference in performance between light propeller aircraft and heavy jets, the measurement procedure differs as well. The light propeller aircraft are measured during a level flight flyover at 1000 ft above ground level. Certificated noise levels of several of these smaller aircraft are shown in Table 4.

TABLE 4. NOISE LEVELS OF REPRESENTATIVE LIGHT PROPELLER AIRCRAFT.

| Airplane | Measured/Estimated dBA | Part 36 Limit dBA |
|---|---|---|
| Beech C 18 S | 86.0 | 82.0 |
| 56 TC | 82.0 | 82.0 |
| 95-B55 | 78.0 – 84.0* | 82.0 |
| Cessna 150 D | 67.0 | 69.7 |
| 172 | 72.0 | 74.0 |
| 310 F | 81.0 | 82.0 |
| Mooney M-20F | 75.0 | 76.6 |
| Piper PA-18-150 | 70.0 – 72.0* | 70.6 |
| PA-30 | 76.0 | 81.8 |
| PA-31-350 | 87.0 | 82.0 |

*Value depends on propeller used.

## Department of Transportation/Federal Aviation Administration Aviation Noise Abatement Policy, 18 November 1976

In recent years, the FAA has become active in dealing with the airport noise problem through means other than source control. On November 18, 1976, the DOT/FAA Aviation Noise Abatement Policy was issued jointly by the Secretary of Transportation and the Administrator of the FAA. This policy addresses itself to the shared responsibilities of those who must act to alleviate the noise problem – the industry, government, and private citizens.

### Authorities and Responsibilities Under the Policy

The Federal government has the authority and responsibility to control aircraft noise by the regulation of source emissions, by flight operational procedures, and by management of the air traffic control system and navigable airspace in ways that minimize noise impact on residential area, consistent with the highest standards of safety. The Federal government also provides financial and technical assistance to airport proprietors for noise reduction planning and abatement activities and, working with the private sector, conducts continuing research into noise abatement technology.

Airport Proprietors are primarily responsible for planning and implementing action designed to reduce the effect of noise on residents of the surrounding area. Such actions include optimal site location, improvements in airport design, noise abatement ground procedures, land acquisition, and restrictions on airport use that do not unjustly discriminate against any user, impede the Federal interest in safety and management of the air navigation system, or unreasonably interfere with interstate of foreign commerce.

State and local governments and planning agencies are responsible for land use planning and development, zoning, and housing regulation that will limit the uses of land near airports to purposes compatible with airport operations.

The air carriers are responsible for retirement, replacement, or retrofit of older jets that do not meet Federal noise level standards, and for scheduling and flying airplanes in a way that minimizes the impact of noise on people.

Air travelers and shippers generally should bear the cost of noise reduction, consistent with established Federal economic and environmental policy that the averse environmental consequences of a service or product should be reflected in its price.

Residents and prospective residents in areas surrounding airports should seek to understand the noise problem and what steps can be taken to minimize its effect on people. Individual and community responses to aircraft noise differ substantially and, for some individuals, a reduced level of noise may not eliminate the annoyance or irritation. Prospective residents of areas impacted by airport noise thus should be aware of the effect of noise on their quality of life and act accordingly.

In implementing the Aviation Noise Abatement Policy, DOT and FAA emphasize that a spirit of mutual cooperation and interdependence between all parties is essential. No single agency or party can assume the role and responsibilities of any other, since each is a vital link in the overall process of noise and land use control.

Federal Aviation Regulation Part 91, Subpart E, Operating Noise Limits, 24 January 1977

This amendment to FAR Part 91 addresses the issue of "retrofit" or the modification of aircraft built before the adoption of FAR Part 36 so that they will meet the new certification noise standards. The subpart requires that airplanes not be flown unless scheduled for replacement or shown to comply with Part 36, in accordance with the timetable in Table 5.

TABLE 5. FAR PART 91 COMPLIANCE SCHEDULE.

| | Percent of Airplanes in Each Airplane Type Required to Meet Part 36 Noise Limits | | |
|---|---|---|---|
| Aircraft | 1 Jan 1981 | 1 Jan 1983 | 1 Jan 1985 |
| Types having 4 low-bypass ratio engines | 25% | 50% | 100% |
| All other types | 50% | 100% | |

FAR Part 91's requirements were amended for two-engine and three-engine aircraft by the "Aviation Safety and Noise Abatement Act of 1979." Amendments allow the Secretary of Transportation to issue exemptions for delayed compliance for owners: (1) purchasing new-technology aircraft, or (2) serving small communities. If binding contracts for replacement aircraft meeting the amended levels of FAR Part 36 are signed by the operator of a noncomplying aircraft by 1 January 1983, noncomplying, three-engine aircraft may be operated until replaced, but not later than 1 January 1986.

The "small communities" exemption allows continued use of non-complying two-engine aircraft owned as of 1 January 1983. Use must cease on 1 January 1985 if the aircraft has more than 100 seats or less (based on the 1 December 1979 configuration).

Under these combined conditions, all subsonic aircraft operating in the United States will meet current noise limits by 1 January 1988.

<u>FAA Order 1050.11, Noise Control Plans, 9 June 1977</u>

This order sets forth the FAA's specific policy on the airport noise control plans discussed in the Aviation Noise Abatement Policy. The order reiterated the policy goals of confining severe noise exposure (NEF 40 or above) to airport property and substantially reducing the number and extent of areas subjected to significant noise exposure (NEF 30 to 40).

To that end, the FAA will encourage operators to develop and implement noise control plans, will require (as a condition of an airport aid grant) that operators take appropriate action to limit development of adjacent land uses compatible with the noise environment, will encourage notice of noise impact to purchasers and tenants of residential property, and will encourage citizen participation in development of the plans. Financial and technical assistance for these activities will be available through the FAA regional offices.

Regional offices are also charged with the responsibility to review any proprietary use restrictions considered in an abatement plan to determine the impact on air commerce and to identify whether such restrictions are unsafe, unjustly discriminatory, or incompatible with the smooth control of air traffic. Specific responsibilities of other FAA offices are also delineated to assure proper coordination and evaluation of the program.

<u>FAA Order 1050.1C, Policies and Procedures for Considering Environmental Impacts and Separate Guidance Material.</u>

Order 1050.1C identifies the specific environmental assessment requirements of the FAA, and in particular, defines the analysis procedures to be used in Environmental Impact Statements (EIS's). Requirements for analysis differ depending on the type of project or a community's sensitivity to it. The basic noise analysis required by 1050.1C is descriptions of all required conditions when the level of cumulative noise exceeds $L_{dn}$ 65. The body of 1050.1C defines the basic requirements for EIS's on a wide variety of actions. Appendix 6 of 1050.1C outlines the requirements of the Office of Airports Planning on Programming (APP) for processing airport development actions. Such actions include those under the Planning Grant Program (PGP), those under the Airport Development Aid Program (ADAP), and obligations to permit sale of airport property.

Detailed instructions for dealing with environmental aspects of airports are presented in FAA Order 5050.4, "Airport Environmental Handbook," issued by APP on 21 March 1980. 5050.4 Par 47(e)(1) prescribes the required noise analysis. It first establishes a lower "cutoff" number of operations below which noise analysis is required. It then describes basic project types for which a noise analysis is required. If a basic noise analysis, using $L_{dn}$, shows no noise sensitive areas exposed to current or existing levels of $L_{dn}$ 65 or the cumulative increase in areas exposed to $L_{dn}$ 65 is less than 3 decibels, no additional noise analysis is required. If these thresholds are exceeded, Par. 85(a) requires: (1) development of contours showing $L_{dn}$ 65 and $L_{dn}$ 75 for all alternatives and time above data for existing and planned noise sensitive areas. Par. 85(a) also describes the nature and extent of descriptive material required.

5050.4 contains a thorough discussion of environmental analysis and should be studied carefully.

## Administrative Actions Taken by Other Federal Agencies

Through provision of the National Environmental Policy Act (NEPA), the Noise Control Act of 1972, and other specific agency mandates, Federal agencies other than the FAA can control the impact of airport noise on communities. The Department of Housing and Urban Development (HUD), for example, has a very active program to reduce noise in Federally assisted or insured housing projects, and the Department of Defense is engaged in a campaign to establish compatible land uses near military airfields. Each of these programs is discussed in greater detail below.

## HUD Environmental Criteria and Standards, 24 CFR Part 51, 1979

HUD published, in 1971, circular 1390.2 defining the Department's policy toward assistance for housing projects located in high noise areas. Though the policy covered all community noise sources, specific sections pertain directly to airport environs.

After nearly eight years of experience with the policy enunciated in 1390.2, HUD issued new regulations. The new regulations provide clearer guidance and more consistent standards 1390.2. A number of changes are incorporated, several of them important for airports.

- $L_{dn}$ became the basic noise measure. However, data expressed as NEF or CNR will still be allowed. Table 6 shows the standards.
- Noise attenuation requirements relate to the noise exposure. If exposure is $L_{dn}$ 65 to $L_{dn}$ 70, attenuation must be increased 5 dB. If exposure is $L_{dn}$ 70 to $L_{dn}$ 75, attenuation must be increased 10 dB.
- If special nonacoustic benefits exist, the normally acceptable zone may extend to $L_{dn}$ 70. There are five special conditions that apply to such projects on a case-by-case basis. The conditions relate to the environmental review process and the community benefits provided (i.e., the project provides housing near employment, public facilities, and transportation; the project is in conformance with local goals and maintains the character of the neighborhood; noise attenuation measures cannot be accomplished; and other sites exposed to noise below $L_{dn}$ 65 meeting program objectives are generally not available).
- The differing situations of new construction, existing construction, and rehabilitation/modernization are recognized and made clear.
- Levels at the building, not at the site boundary, govern unless the locations of buildings are not established.

TABLE 6. SITE ACCEPTABILITY STANDARDS

| | Day-Night Average Sound Level (in decibels) | Special Approvals and Requirements |
|---|---|---|
| Normally Acceptable | Not exceeding 65 dB† | None |
| Normally Unacceptable | Above 65 dB but not exceeding 75 dB | Special approvals Environmental review and attenuation ** |
| Unacceptable | Above 75 dB | Special approvals Environmental review and attenuation ** |

*The normally acceptable threshold may be shifted to 70 dB in special circumstances proposed in the regulations.

The approvals requirements are described in the proposed regulations.

What is important about HUD's policy is that it defines a resident-oriented standard rather than an airport-oriented one. It is concerned not with the impact of the airport but with the impact on residential housing. In that respect, it has been a deterrent to Federally assisted projects in incompatible noise environments.

Department of Defense Air Installation Compatible Use Zone (AICUZ) Program, Initiated by DOD Instruction 4165.57, 30 July 1973

Under directives from the Department of Defense, each branch of the service is required to study the noise and accident potential around military airfields to identify areas of impact through acquisition of interests in land or through comprehensive land use planning implemented at state, regional, or local levels. It is then, the goal of the AICUZ program to minimize existing land-use conflicts and voice future incompatibilities. The process is intended to reflect equitable compromises between military and public interests.

Determination of impact areas is made by combining three accident zones (extending 15,000 feet from the runway end) with noise zones defined by contours in 5-dB increments from low values of 65 to 85 dB (NEF 30 to 50). For each combination of accident zone and noise zone (referred to as a Compatible Use District) a judgement has been made as to its acceptability for various land uses. Some uses are totally unacceptable within certain districts, and some are conditionally acceptable, subject to adequate sound isolation construction. Where incompatibilities exist, land may be purchased or exchanged, or base personnel may work with planning organizations to redirect growth to other areas through zoning or local ordinances, recognizing laws can change. Aircraft operational changes may also be evaluated to determine possible benefits.

Veterans Administration Policy for Appraisal of Residential Properties Near Airports, 24 September 1969

The Veterans Administration established this policy to allow for recognition of the "possible unsuitability for residential use and the probable adverse effect on livability and/or value of homes in the vicinity of major airports." It cites zones in which GI loans can or cannot be made to develop, typically, one- to three-unit properties. VA Field Officers seeking guidance about the effect of aircraft noise on residential properties in the vicinity of civil airports can request the assistance of FAA District Offices or FAA Regional Headquarters, and liaison is encouraged between the VA and the FAA. An AICUZ study would be used for a military airport. One that determines property to be in an accident potential zone (APZ) makes that property automatically unacceptable for VA consideration.

The zones used in determining whether the VA will decline to appraise residential properties appear in a Composite Noise Rating Table and are the same as those in HUD Circular 1390.2. NEF and $L_{dn}$ values may be substantiated for equivalent CNR values.