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REPORT ON AIRCRAFT-AIRPORT NOISE

REPORT OF THE ADMINISTRATOR

OF THE

ENVIRONMENTAL PROTECTION AGENCY

TO THE

COMMITTEE ON PUBLIC WORKS

U.S. SENATE

AUGUST 1973

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LETTER OF TRANSMITTAL

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. JULY 27, 1973

Honorable Jennings Randolph
Chairman, Committee on Public Works
United States Senate
Washington, DC

Dear Mr. Chairman:

In accordance with the provisions of Public Law 92-574, the Noise Control Act of 1972, I have the honor to submit a "Report to Congress on Aircraft and Airport Noise."

Sincerely yours,

Robert W. Fri
Acting Administrator

REPORT TO CONGRESS

ON

AIRCRAFT/AIRPORT NOISE

REPORT OF THE ADMINISTRATOR OF THE

ENVIRONMENTAL PROTECTION AGENCY

IN COMPLIANCE WITH

NOISE CONTROL ACT OF 1972

PUBLIC LAW 92-574

JULY 1973

TABLE OF CONTENTS

INTRODUCTION

Noise, "unwanted sound," has been a problem throughout the history of the human race. The increasing use of noise producing machinery concurrent with vastly greater magnitudes of sound generated therefrom (of which aviation systems are a classic case) has resulted in the noise problem increasing to a point of major environmental concern. The relations between noise and man with respect to his health (well being) and welfare (in its broadest sense) are extremely complex. These are discussed in considerable detail in the EPA document, "Public Health and Welfare Criteria for Noise," issued by the EPA under Section 5 of the Noise Control Act of 1972. As discussed in that document the effects of noise cover a wide range of human response, including that (the most severe) of permanent impairment of hearing; interference with the ability to communicate or undertake desired hearing tasks; annoyance of varying degree, and other vague and difficult to define reactions. A major consideration with regard to noise as an environmental problem, and one having considerable importance in regard to aviation noise, is that hearing is one of man's main sensory contacts with his environment (being second only to vision in that regard). A part of the reaction to aircraft noise may be (and by many authorities is so considered) attributed to a number of connotations, such as fear, or social antagonism, in the "message" interpreted by its listener.

Aircraft/airport noise is not a new problem for the United

States. Virtually from the dawn of aviation, there have been complaints regarding aircraft noise. It was recognized early that noise from aircraft engines could affect the hearing of pilots and ground crew personnel, as evidenced by the fact that one of the earliest investigations conducted by the Aero Medical Laboratory of the Army Air Corps, during World War I, related to aviators' hearing (1). One of the earliest recorded official noise complaints, related to aircraft operations, occurred in 1928 at which time a farmer wrote to the Postmaster General stating that low flying aircraft were disrupting egg production (2).

Until World War II, air transportation in the civil sector developed at a very slow rate. During World War II, the extensive utilization of military aircraft for passenger and freight transportation provided an impetus to the aviation industry which laid the basis for the spectacular postwar growth of commercial transportation which has continued until the present time.

In 1946, the National Advisory Committee for Aeronautics (NACA - now enfolded into the National Aeronautics and Space Administration - NASA), the Air Transport Association and the Aerospace Industries Associated were invited by the Civil Aeronautics Administration (CAA) to participate in a joint approach to the noise problem which "threatens to undermine aviation progress" (2).

Noise from reciprocating engine, propeller driven aircraft was of major concern to the military in the World War II time period. Numerous studies were conducted by the U.S. Air Force on this problem in the period 1948 to 1951. Of considerable significance were those relating to noise levels resulting from the operation of B-36 aircraft. These studies showed that levels between 70dB to 120 dB (overall sound pressure levels) were experienced throughout an area of 144 square miles, under the takeoff and approach zones, when these large aircraft operated.

In apparent anticipation of the seriousness of jet aircraft noise, as compared with the already recognized propeller noise problem, the Port of New York Authority issued a regulation in 1951 forbidding landing or takeoff of jets, without permission from the Authority (3). Early in 1952, the problem of noise resulted in action within the air transport industry to develop a "National Air Transport Coordinating Committee" to consider problems of aircraft noise in the New York area.

The introduction of high performance, jet engine powered aircraft into military use preceded their entry into civil aviation by a considerable period of time (approximately 12 years). By 1952, the noise problem associated with military jet aircraft had grown to such proportions in regard to the reactions of civilian communities that the U.S. Air Force issued a special pamphlet "Air Force Pamphlet 32-2-1, Noise Guide for Air Base Commanders." Various elements of the Department of Defense had instituted comprehensive research programs aimed at trying to develop both noise suppression techniques associated with the engines as well as protective measures for military personnel and civilian communities directly adjacent to military installations.

There have been many additional studies over the past 25 years that have echoed the foregoing concern. These included the 1965 studies of the Office of Science and Technology Jet Aircraft Noise Panel, the 1970 joint DOT/NASA Civil Aviation Research and Development Study - CARD, the 1971 Environmental Protection Agency Report to the President and Congress on Noise under Title IV, P.L. 91-604 and the report of the Aviation Advisory Commission, established by Congress under P.L. 91-258.

Against this background of intensive inquiry and concern about noise, since 1946, civil aviation has indeed grown in a most remarkable manner. There are presently approximately 2000 large jet propelled aircraft operating in the U.S. fleet, compared with none in 1957 (4). In 1972, these aircraft served an average of almost 500 individual major terminals and carried approximately 190,000,000 passengers. In 1946, by comparison, there were only 65 airports at which jet aircraft were operating, with a then "optimistic estimate" that by 1969 jet service would be available at a total of 134 locations. Information available from the Federal Aviation Administration (FAA) indicates that in addition to the current air carrier fleet, there are approximately 130,000 other aircraft of all types in use by air taxi services, corporations, personal business and private use, which provide transportation annually for another 50 million or so persons. Even better appreciation of the order of magnitude of the growth of air travel can perhaps be obtained by a comparison of the commercial airlines revenue growth in revenue passenger miles. In 1950, there were approximately 8 billion revenue passenger miles provided by the domestic commercial air carriers, representing travel by some 17 million passengers. In 1972, the total had grown to 152 billion revenue passenger miles with the growth in numbers of passengers to 190 million.

The impact of this sharp increase in air traffic in terms of takeoffs and landings is also highly significant. In 1972, as an example, according to preliminary data of the FAA, there were approximately 660,000 takeoffs and landings at O'Hare Airport in Chicago, the Nation's busiest terminal. The faster, more comfortable mode of transportation represented by high performance commercial jets has undoubtedly contributed to the growth in utilization of the Air Transportation System both for passengers and freight. The economic competition of this mode of transportation with others has also resulted in a high utilization by ever increasing segments of the public. The concurrent increase in the size of the noise impact, in terms of numbers of people exposed and its severity, occurred at a greater rate than the apparent ability of either governmental entities or the industry to anticipate and then cope with the problem in an effective sense. This situation led to the enactment of Section 7 of the Noise Control Act of 1972.

It should also be noted that the growth of aviation in the United States (and worldwide) has coincided with the major expansion of metropolitan areas served by air transportation both in size and population. This expansion has resulted in an increase in types and severity of many other environmental problems (a situation not restricted to noise alone) such as air and water pollution. Concurrent expansion of problems has resulted, in many instances, from a lack of exercise, by the many governmental jurisdictions, of their authorities such as zoning, or other powers. This has all too often resulted in sharp increases in residential populations immediately adjacent to the major air terminals. It is fruitless at this late date to attempt to find "culprits" but it is likewise significant to highlight the fact that as early as 1964, there were warnings regarding the need for local community or state actions with regard to this issue (5).

In spite of the recurring forecasts of increasing aviation noise impact, and a substantial investment in aviation noise control research and development in the Federal and private sector, the aviation noise problem had, because of a combination of the wide variety of influences, grown to major proportions by the time of the 1971, Title IV, EPA Report on Noise. Approximately 16 million persons are presently impacted by aviation noise in the United States, and in spite of the introduction of quieter new aircraft, the number will continue to be of major proportion until the mid 1980's unless aggressive action is taken. The adverse effects of this noise range from annoyance to the possibility of hearing damage. These effects have resulted in numerous law suits and, in some cases, have prevented expansion of existing airports or construction of new ones.

It is evident that there is a need to mobilize available resources and technology, including those of providing newer and quieter aircraft for the future, to deal with this problem in a coordinated time-phased fashion. By enacting the Noise Control Act of 1972, Congress provided the Administrator of EPA with authority to coordinate Federal noise control activities, Federal research and development related to noise, and to provide technical assistance to States in the area of model codes and laws. Congress has thus established a means to integrate the activities of the Administrator under the Noise Control Act, those of the FAA under the Federal Aviation Act, and of other Federal Agencies, such as NASA, to accelerate a coordinated program of correction.

However, if noise levels protective of the public health and welfare are to be achieved around the Nation's airports in the near future, it will be necessary to establish a Federal regulatory program which effectively combines Federal controls on aircraft flight procedures, technology, and noise control options available to airport operators and local jurisdictions.

The present study is part of that action, and results from the requirements of the Noise Control Act of 1972 (Public Law 92-574) in Section 7(a), which directs the Environmental Protection Agency as follows:

> "The Administrator, after consultation with appropriate Federal, State, and local agencies and interested persons, shall conduct a study of the (1) adequacy of Federal Aviation Administration flight and operational noise controls; (2) adequacy of noise emission standards on new and existing aircraft, together with recommendations on the retrofitting and phaseout of existing aircraft; (3) implications of identifying and achieving levels of cumulative noise exposure around airports; and (4) additional measures available to airport operators and local governments to control aircraft noise. He shall report on such study to the Committee on Interstate and Foreign Commerce of the House of Representatives and the Committee on Commerce and Public Works of the Senate within nine months after the date of the enactment of this Act."

Under Section 7(c) of the Act, not earlier than the date of submission of the report to Congress, EPA is to submit to FAA "proposed regulations to provide such control and abatement of aircraft noise and sonic boom (including control and abatement through the exercise of any of the FAA's regulatory authority over air commerce or transportation or over aircraft or airport operations) as EPA determines is necessary to protect the public health and welfare."

The descriptive material on health and welfare contained in the Criteria Document and the Environmental Noise Effects Document required by Section 5 of the Noise Control Act will be considered by the Agency in developing such proposals. This present report on the studies undertaken by the Agency is the first step in the regulation process established in the Noise Control Act.

The study to develop the Section 7(a) report has been carried out through a participatory and consultive process involving a Task Force made up of six task groups. The membership of the six task groups was formed by sending invitations to organizations representing the various sectors of interest. These included other Federal agencies, organizations representing State and local governments, environmental and consumer action groups, professional societies, air traffic controllers, pilots, airport proprietors, airlines, users of general aviation aircraft, and aircraft and engine manufacturers. A press release was distributed concerning the study, and additional individuals and organizations expressing interest were asked to participate. Written inputs from others, including all citizen aircraft noise complaint letters received during the period of the study, were called to the attention of appropriate task group leaders and placed in the public master file for reference.

99-739 O - 73 - 3

A plenary session of the Task Force was held on February 15, 1973. Each of the task groups then held 4 to 6 working meetings for the duration of the study. As a result of these meetings and a final plenary session on June 21 and 22, 1973, reports were developed which represent the consolidated, but not unanimous, opinions, suggestions and specific data inputs from the participating task group members.

Each report includes the membership list for the task group and a list of the master file documents collected during the study effort. The file was maintained throughout the study for the use of task group members and other interested persons, and will continue to be maintained for public reference at the Office of Noise Control Programs, Environmental Protection Agency, Washington D.C. 20460.

The reports of the six task groups are entitled:

- "Legal and Institutional Analysis of Aircraft and Airport Noise and Apportionment of Authority between Federal, State and Local Governments"
- "Operations Analysis Including Monitoring, Enforcement, Safety, and Costs"
- "Impact Characterization of Noise Including Implications of Identifying and Achieving Levels of Cumulative Noise Exposure"
- "Noise Source Abatement Technology and Cost Analysis Including Retrofitting"
- "Review and Analysis of Present and Planned FAA Noise Regulatory Actions and their Consequences Regarding Aircraft and Airport Operations"

o "Military Aircraft and Airport Noise and Opportunities for Reduction without Inhibition of Military Missions"

The reports of the task groups' studies are the results of the efforts of a unique gathering of interested persons, experts and concerned citizens, representing a wide spectrum of interest in the development of an expeditious and effective resolution of the aircraft/airport noise problem. The reports of the task groups do not reflect official policy statements of the Environmental Protection Agency, but should be viewed as an effort to obtain as much information on all aspects and views on the subject as was possible within the time period available. They have provided most of the basic information for the analysis of the aircraft/airport noise problem. They will be considered by the Agency, together with other data such as that developed for the EPA Title IV Report to the President and Congress on Noise and in the public hearings held by the Agency associated with that report, the Report of the Aviation Advisory Commission, and such additional information as becomes available, in preparing the detail support for the proposed regulations to be submitted to the Federal Aviation Administration under Section 7(c) of the Act. Copies of the individual Task Group Study Reports will be available at the EPA Regional Offices and in the public master file of the Office of Noise Abatement and Control. They will become available for purchase later in 1973 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

In the following four sections, the essentials of the information relevant to the four specific areas called for in Section 7(a) of the Noise Control Act of 1972 are discussed. In effect, the Agency has conducted, for the Congress, a technological reassessment of the areas of concern stated in the Act. The final Section of this report provides a summary of the principal findings of the study and of the plans for regulatory proposals to satisfy the further continuing requirements of the Act, not only with reference to Section 7 but as they relate to the larger responsibilities of dealing with the problems of aviation and airport noise in accordance with other authorities of the Act.

References

1. "Doctors in the Sky," Benford, Robert L., Editor.

2. FAA Historic Fact Book, 1966.

3. Goldstein, S. and Odell, A., "Comments on the Problem of Jet Noise," Port Authority of New York.

4. ATA Annual Report, "Air Transport 1973"

5. "Land Use Planning with Respect to Aircraft Noise," Joint Publication U.S. Air Force and United States Federal Aviation Agency, Washington, D.C., October, 1964.

SECTION 1

ADEQUACY OF FEDERAL AVIATION ADMINISTRATION FLIGHT AND OPERATIONAL NOISE CONTROLS

Based on this Agency's studies, it appears that existing FAA flight and operational controls* do not adequately protect the public health and welfare from aircraft noise. Since the existing controls do not consider the levels of noise to which people are exposed or the number of people so exposed. Although existing regulations have been useful, insofar as they accomplish some noise reduction without having to change the air traffic control system, the information available to EPA indicates that there are additional flight and operational procedures which could contribute to the protection of the public health and welfare.

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* The FAA has adopted two Federal Aviation Regulations (FAR's) and two Advisory Circulars (AC's) related to flight and operational noise controls. (Advisory Circulars inform the aviation public of nonregulatory material of interest. They are not binding as are regulations.)

These are:

o FAR 91.55 prohibits flight at speeds in excess of Mach 1 and thereby prevents the occurrence of sonic booms unless a specific authorization is given.

o FAR 91.87 regulates operation at airports with operating control towers. FAR 91.87(d) and (f) specify that the minimum altitude for turbine powered or large aircraft is 1500 feet above the surface of the airport except when lower altitudes are necessary for takeoff or landing. FAR 97.87(d) further requires that such aircraft when approaching to land remain on or above the glide slope (if available). In addition FAR 91.87(g) requires pilots of these aircraft to use, whenever possible, the preferential noise abatement runways designated by FAA. (Footnote continued on page 15.)

Flight and operational noise controls alone, however, cannot be expected to totally resolve the noise problem. At best, they must be considered as only one element of what must be a more comprehensive plan which also includes controls on the source of the noise, the number and time of day of flights, and the location of people exposed to noise.

Implicit in this discussion is the fact that flight safety is of paramount importance in developing flight and operational noise controls. It is the FAA's legal responsibility to ensure that

o AC 90-59 describes the FAA "Keep-em-High" program wherein controllers issue clearances to keep high performance aircraft as high as possible as long as possible (1). This program was initially introduced for the purpose of collision avoidance, but it also provides some noise relief by preventing unnecessary low altitude flight. The program is not regulatory in nature, although pilots must follow clearances once accepted. The Keep-em-High program does not require the use of any specific noise abatement takeoff or approach procedure.

o AC 91-36 encourages pilots flying in visual weather conditions to maintain at least 2000 feet altitude above noise sensitive areas (2).

In addition to the above system-wide controls, there are specific noise abatement procedures in effect at Washington National Airport, which is operated by the FAA. There the airlines use a thrust reduction during climbout from a point 3 nautical miles northbound or 4 nautical miles southbound until reaching an altitude of 6,000 feet or a distance of 10 nautical miles, whichever occurs first. Aircraft on approach must follow the Potomac River. A jet curfew is in effect from 10 p.m. to 7 a.m. Only certain types of aircraft are permitted to use the airport (the largest being Boeing 727's), and trip lengths are limited to 650 miles with exceptions for nonstop flights to 7 cities within 1,000 miles (3,4,5).

flight and operational procedures are consistent with the highest degree of safety, and EPA, therefore, cannot conclude that specific flight and operational noise controls are either safe or unsafe. This Agency has, however, studied a number of noise abatement flight procedures which the Agency believes merit consideration for rule-making or implementation by the FAA.

The discussion which follows is based primarily on the data contained in the EPA aircraft/airport noise study report (6).

Takeoff

There are at least two distinct types of takeoff noise problems: noise alongside the runway and noise under the climbout flight path. They are distinct in that reducing one generally results in increasing the other.* For most airports, the climbout noise is more critical, but there are some locations where sideline noise is the dominant departure problem** (7).

At present there are no FAA controls relating to noise abatement takeoff procedures. There are, however, several different noise abatement takeoff procedures employed by various segments of the aviation industry. Each of these procedures provides noise benefits for different areas in relation to the departure runway. Unfortunately, at the present time, (except at Washington National Airport), the actual location of noise sensitive areas is not considered in selecting the takeoff procedure.

For residential areas very far from the airport (more than approximately 10 miles), the most beneficial procedure is generally to climb at the steepest angle possible with nearly full power. Such a procedure is recommended by the Air Transport Association (ATA)

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* On takeoff, the factors of distance and power setting work against one another: lower power settings mean less noise output but also lower altitudes, so the location of noise sensitive areas must be carefully considered in determining whether any given procedure will provide a noise benefit.

** Los Angeles and Boston are examples of airports where the critical departure noise problem is sideline.

and is in use by American Airlines and United Airlines, among others (8). Similar procedures are also recommended by the National Business Aircraft Association (NBAA) (9).

For areas approximately 2 to 10 miles from the airport, the most beneficial procedure is generally to climb steeply and then, at an altitude of approximately 1500 feet, reduce power to not less than that required to maintain safe flight in the event of an engine failure. Power is not re-applied until the aircraft reaches an altitude of approximately 4000 feet. This procedure is recommended by the Airline Pilots Association (ALPA) (10). It is similar to procedures currently in use by Northwest Air Lines at all airports it serves and by all airlines using Washington National Airport* (11,5). Compared to the maximum angle (full power) climbout, this power cutback procedure reduces noise approximately 2 to 7 EPNdB** (depending on aircraft type and weight) in the distance range of 2 to 10 miles from the airport. It causes a noise increase, however, for approximately one mile prior to the

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* Although one can calculate that the noise impact at Washington National Airport could be much greater without the noise abatement flight procedures, to EPA's knowledge there has been no on-going program of noise monitoring to document the noise benefit. In spite of the noise abatement procedures, National Airport noise has been the subject of recent litigation although the court concluded that there was not actionable noise damage (12).

** Throughout this section, noise reductions will be stated in terms of single event Effective Perceived Noise Level (EPNdB). A 10 EPNdB noise reduction would be perceived as a halving of the noise. See Section 3 for additional discussions of single event and cumulative noise measures. In general, the cumulative noise level at a given location will be reduced by the same amount as the reduction in average single event noise level (energy average).

cutback (while flaps are being retracted) and then again after power is reapplied (6,13).

The procedure which is most beneficial for sideline noise reduction is to use reduced thrust from the start of the takeoff roll when the takeoff weight, runway length, and other conditions permit. Many FAA-approved aircraft flight manuals allow this for the purpose of reducing engine wear. This procedure can decrease sideline noise by up to 2 EPNdB (6). The procedure results in lower altitudes and higher noise levels under the climbout path, however, so it is not optimum when near-downrange noise is the critical problem.

On a national basis, the maximum benefit would be achieved by having the takeoff procedure tailored to each specific runway/community configuration. On the other hand, some pilot and industry groups feel that a single, standard procedure rather than multiple standards is necessary to insure safety (14). Countering arguments suggest that every takeoff is different anyway because of runway, wind, weight, and other factors rendering the concept of a "single" standard meaningless (15).

Based on all of the above considerations there seems to be compelling evidence that several noise abatement takeoff procedures could be standardized for selective use at specific airports. This Agency believes that this merits further evaluation through the FAA rule-making process and therefore intends to propose, to the FAA, appropriate regulations as provided in Section 7(b) of the Noise Control Act of 1972.

Approach

At present, other than the glide slope requirement of FAR 91.87(d), there are no FAA regulations or other controls relating to noise abatement approach procedures. There are, however, several different noise abatement approach procedures currently employed by various segments of the aviation industry or undergoing flight tests.

Most air carrier approaches (under instrument weather conditions) are made on an electronic Instrument Landing System (ILS) glide slope.* The standard approach angle for new ILS installations is 3 degrees. A few existing installations are at greater angles,** but most (65%) were installed before the 3 degree standard was adopted and are between 2.5 and 2.9 degrees (16). The requirement of FAR 91.87(d) to remain on or above the glide slope is therefore less effective than it could be (a one-half degree increase in approach angle reduces noise 2 to 3 EPNdB) (6). The reason that all glide slopes have not been raised to at least 3 degrees appears to be one of economics: one FAA estimate indicates an adjustment cost of $62,000 per installation (17).

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* The ILS glide slope is often followed in visual weather also, although considerably more leeway exists for pilot or controller initiated deviations.

** These airports have glide slope angles above 3 degrees for the purpose of terrain clearance: San Diego, California (3.22°); Fort Worth (Meacham Field), Texas (3.33°); Annette Island, Alaska (3.27°); Berlin (Tempelhof) Germany (3.5°) (6).

The two segment approach seems to hold the most promise for significant approach noise relief. In this procedure, the initial descent is accomplished at a fairly steep angle (nominally 6 degrees) and at associated reduced power settings; then transition is made to a normal glide slope at an altitude (500 to 1,000 feet) sufficient to safely reduce the initial high descent rates. Visual weather versions of this procedure are currently in use at certain airports with 727 and 737 aircraft by National Airlines, Pacific Southwest Airlines, and Air California, and by all airlines (with aircraft types as large as DC-8's) at the San Diego Airport (the latter because of high terrain) (18, 19, 20, 21). The National Business Aircraft Association also recommends use of two-segment approaches in visual conditions (9). Flight tests of two-segment approaches have been conducted during the last 10 years by FAA, NASA, and the airline industry, many using prototype instrumentation for all weather operations (22, 23, 24, 25). Tests are currently being conducted in scheduled airline passenger service by United Airlines under contract to NASA (25). This further testing should result in suitable instrumentation and pilot acceptance so that all weather use of two-segment approaches can be instituted throughout the civil air carrier fleet.

The noise benefit from two-segment approaches has been measured to be as high as 17 EPNdB under the steep portion of the flight profile (6). The noise reductions become smaller as the aircraft gets closer to the airport, becoming zero when the transition to the final glide slope is complete (approximately 2 to 3 miles from touchdown). Information available to this Agency indicates that the two-segment visual approach used by Pacific Southwest Airlines has received favorable community support in California (26,27).

The main objections to two-segment approaches come from ALPA pilots and some segments of the airline industry. They desire more testing to be certain that safety will not be degraded by the higher descent rates in the steep segment (28). They are also concerned that introduction of a "visual conditions only" two-segment approach would erode standardization and thereby safety 28, 29). Countering arguments suggest that adequate testing has already been accomplished, and that "standardization" does not in fact exist at present, every landing being unique and different. Specific charts are published for every runway, and air traffic control procedures differ from visual to instrument weather conditions (30). A further concern, expressed by the Aircraft Owners and Pilots Association (AOPA) is that small aircraft without two-segment instrumentation may experience wake turbulence if following behind and below a large aircraft conducting a two-sgement approach (31). The FAA is currently planning flight tests to investigate this potential hazard.*

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* The wake turbulence hazard can be minimized or eliminated by providing a sufficient separation distance between the large and small aircraft, or by assigning them to widely separated runways. Such procedures are already in effect even for standard ILS approaches.

It appears that two-segment approaches may require either ground based or airborne instrumentation, or both. Distance Measuring Equipment (DME), co-located with the glide slope on the airport, is likely to be a prerequisite. Only 10 such DME's had been commissioned by FAA as of December 31, 1972; 6 were approved but not commissioned, and FAA planning documents indicate a slow-down in the installation rate for new DME's (32,33).

Cost estimates for DME range from $26,400 to $60,000 per installation (1973 dollars) (34,17). Airborne equipment estimates range from zero for visual procedures to $31,400 per aircraft for a glide slope computer relying upon the airport DME (34,35).

On any approach, noise reductions can be achieved by using a flap management program where thrust is minimized (provided the runway length is sufficient to accommodate the increased landing speeds). Noise levels may be 3 to 5 EPNdB lower than on a full flap approach (6). This flap management approach is recommended by ATA and is in use by American Airlines, United Airlines, and Northwest Airlines, among others (29).

At some airports, thrust reverse noise on landing contributes to noise annoyance (7,36). In cases where the runway is long, it is possible under certain weather conditions to avoid the use of thrust reversers (36). The pilots are concerned, however, that limitations on the use of thrust reversers for noise abatement purposes may erode safety margins (14). Environmental groups believe, on the other hand, that pilot indoctrination in the proper use of thrust reversers and their noise effects could be beneficial in minimizing their use where not necessary (15). Consideration must be given to possible increases in aircraft ground taxi time with resultant increase in air pollutant emissions.

Based on all of the preceding, there seems to be compelling evidence that several noise abatement approach procedures could be standardized for use under certain conditions and that existing ILS glide slopes could be raised to at least 3 degrees. This Agency believes these merit further evaluation, and insofar as this can take place through the FAA rulemaking process intends to propose to the FAA appropriate regulations as provided in Section 7(b) of the Noise Control Act of 1972.

Minimum Altitudes

Turbine powered or large aircraft can make significant amounts of noise at the minimum altitude of 1,500 feet permitted by FAR 91.87 (105 EPNdB for a Boeing 707) (6). Increasing this altitude to 3,000 feet would reduce the noise level by approximately 10 EPNdB (6). The FAA "Keep-em-High" program may help prevent overflights at unnecessarily low altitudes but its primary application is for altitudes between 5,000 and 10,000 feet (1). The EPA does not have documentation on the effectiveness of either FAR 91.87 or AC 91.36 related to visual flight rule (VFR) operations near noise sensitive areas, but its staff has received some citizen complaints regarding low flying aircraft (37,38).

One potential disadvantage of increasing the regulatory minimum altitudes is that it may cause some aircraft to travel farther (on a circling approach) in order to intercept the glide slope at a higher altitude. This could spread noise over a larger area (although at lower noise levels). The experience at San Jose Airport, however, indicates that pilots may simply elect to fly a steeper approach, in effect shortening the distance and further reducing noise (39). Another potential disadvantage is that higher minimum altitudes may reduce the available maneuvering airspace and thus contribute to increased air congestion. This problem may be overcome by issuing specific clearances for reduced altitude operations, where necessary, but doing so may increase controller workloads.

Because of the potential noise relief, increased minimum altitudes seem to merit further evaluation through the FAA rulemaking process and this agency therefore intends to propose appropriate regulations to the FAA.

From the foregoing, it can be seen that a number of noise abatement flight procedures are available for implementation. Although, by themselves, they cannot totally resolve the noise problem, they play an important part in any comprehensive plan for noise reduction. EPA therefore intends to propose regulations to FAA in accordance with Section 7(b) of the Noise Control Act of 1972. In the process

99-730 O - 73 - 3

of proposing such regulations, the Agency will fully take into account the safety or other implications of adopting these regulations as determined by the FAA, which has the final authority.

References

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SECTION 2

ADEQUACY OF NOISE EMISSION STANDARDS ON NEW AND EXISTING AIRCRAFT; RECOMMENDATIONS ON THE RETROFITTING AND PHASEOUT OF EXISTING AIRCRAFT.

Existing FAA noise emission regulations did not utilize public health and welfare considerations as a basic constraint in their development, since this was not required by the Federal Aviation Act of 1958, until its amendment by the Noise Control Act of 1972. Based upon the EPA studies under the Noise Control Act, the present aircraft noise emission standards do not provide adequately for such needs, as shown in the analyses of the extensive data considered and cited in this report.

Technology

The Report of the Aviation Advisory Commission and the present EPA Aircraft/Airport Noise Study clearly indicate that currently available technology is capable of being translated into equipment that, together with employment of noise abatement flight procedures, can significantly decrease the noise impact from aircraft (1,2.3). Current source noise abatement technology can be applied as a retrofit option for existing aircraft, as a modification to newly produced airplanes of older type designs, and also, be included in the design and development of new aircraft systems. The latter application provides the most effective use of technology to achieve maximum source noise control. Continued source noise abatement research and development is required, therefore, if civil aviation systems are to evolve with effective noise emission controls (4.5).

The combined research, design, and development efforts of the National Aeronautics and Space Administration, Department of Transportation, Department of Defense, and industrial members of the aviation community have provided a demonstrated technology base which, if fully exploited, can provide a family of new aircraft for both the commercial and business jet fleets starting in the 1978-1980 time frame (4). The noise characteristics of these new aircraft (depending upon aircraft type and measurement point) could be 5-10 decibels below the present values in Appendix C of FAR 36 and thus, significantly quieter and more acceptable than the current narrow-body jets (3, 6).

These more favorable conditions are the result of approximately $138 million of Federal research and development (R&D) funds invested in noise control in the period 1969 to date which is in addition to the large military and industry expenditure prior to and during this time. However, even if the decision to proceed with their development were to be made today, the noise from the narrow-body jets would dominate until the late 1980's (7) due to the relatively long structural and probable economic life of the equipment which would encourage their retention in the fleet.

For instance, in 1972, the U.S. jet powered air carrier fleet was comprised of approximately 2,000 aircraft of which more than 90% did not meet the current noise standards for newly certified aircraft

(FAR Part 36, Appendix C) (7, 8). The fleet has been projected to increase by 30% over the next 10 years. This growth will be accomplished by new procurement of current aircraft (747, DC-10, L-1011, 707, advanced 727, 737 and DC-9), the majority of which will comply with the current FAR 36 noise criteria. However, during this period, and possibly beyond, there will still remain 1100-1500 operational aircraft that will not meet the above limits (7).

Therefore it follows, that if there are to be significant reductions in the impact of aircraft/airport noise prior to the 1980's, quieting or replacing current aircraft will be required.

Noise Emission Regulations

The FAA, in its fifteen years of existence, has devoted substantial effort to the technological, economic, and legal background necessary to propose seven noise emission regulations capable of effecting significant noise reductions in a safe and economically reasonable manner (9).

As of this writing, the FAA has issued two regulations:

1. "Federal Aviation Regulation (FAR) Part 36: Noise Standards: Aircraft type Certification", effective 1 December 1969.

2. "Federal Aviation Regulation (FAR) Part 91.55: General

Operating and Flight Rules: Civil Aircraft Sonic Boom", effective 27 April 1973.

In addition to these two regulations, the FAA has issued two Notices of Proposed Rule Making (NPRM) and three Advanced Notices of Proposed Rule Making (ANPRM) that have not yet resulted in regulations as proposed. The notices, the general titles, and the dates of issue are:

1. ANPRM 70-33; Civil Supersonic Aircraft Noise Type Certification Standards, 4 August 1970.
2. ANPRM 70-44; Civil Airplane Noise Reduction Retrofit Requirements, 30 October 1970.
3. NPRM 71-26; Noise Type Certification and Acoustical Change Approvals, 13 September 1971.
4. NPRM 72-19; Newly Produced Airplanes of Older Type Design; Proposed Application of Noise Standards, 7 July 1972.
5. ANPRM 73-3; Civil Airplane Fleet Noise (FNL) Requirements, 24 January 1973.

FAR 36, issued as a new part to the Federal Aviation Regulations, prescribed noise standards for the issue of type certificates, and changes to those certificates, for subsonic transport category airplanes, and for subsonic turbojet powered airplanes regardless of category. This regulation initiated the noise abatement regulatory program of the FAA under the statutory authority of PL-90-411.

FAR 36 made a significant contribution in the form of three appendixes that have come to be used as standards or recommended practices in the measurement and evaluation of aircraft noise. Appendix A of the regulation prescribes the conditions under which noise type certification tests for aircraft must be conducted and the noise measurement procedures that must be used. Appendix B of the regulation prescribes the computational procedures that must be used to determine the noise evaluation quantity designated as effective perceived noise level (EPNL). Appendix C of the regulation provides the noise criteria levels, noise measuring points, and airplane flight test conditions for which compliance must be shown with noise levels measured and evaluated as prescribed, respectively, by Appendixes A and B.

The criteria levels of Appendix C provide an "umbrella" for aircraft propelled by the new high-bypass ratio engines in the sense that the noise from such aircraft can be controlled to levels below that criteria (3). However, these criteria levels are technologically practical for aircraft that are propelled by the existing turbojet and low-bypass ratio turbofan engines which can comply with the criteria only with the aid of some sort of retrofit modification.

The Appendix C levels if applied to the existing turbojet and low-and high-bypass ratio turbofan fleet at this time would result in an improvement in the airport noise situation. Future types of FAR 36 category aircraft and possibly the current widebody, high bypass ratio jet aircraft should be regulated by the FAA to levels more protective of health and welfare as more specific data is developed. Consideration must be given for the approach condition, however, to ensure that such levels are not lower than those that can be achieved by available technology for control of the airframe aerodynamic noise (4).* It would be appropriate to include, in any revised FAR 36 regulation, the "Acoustical Change" adjustments proposed in NPRM 71-26 as determined necessary to make the rule clearer and more effective. Also, a revised FAR 36 should contain requirements to produce certified noise and flight performance data sufficient to compute noise contours for a wide range of noise levels associated with both the take-off and the approach procedures which represent normal modes of operations, and the requested health and welfare requirements in the form of new limits.

The FAR Part 91.55, sonic boom rule, is adequate and will be effective in protecting the public from routine sonic boom exposure created by civil supersonic aircraft (9).

The five proposed regulations had evidently satisfied (at least under preliminary examination by the FAA or they would not have been proposed) the four basic requirements of PL 90-411 (10), that is:

- o consistent with the highest degree of safety in air transportation in the public interest,
- o economically reasonable,
- o technologically practicable, and

* There is available information which shows that such technology is available for significant reductions in these levels, which must be considered by EPA and FAA in the proposed rule making to follow this study.

- o appropriate for the particular type of aircraft, aircraft engine, appliance, or certificate to which it will apply.

As stated earlier in this section, the studies of the Aviation Advisory Commission and the EPA clearly indicate that practical and appropriate technology is available for applications to current and future aircraft types (1, 3).

Aircraft safety as a regulatory constraint is the responsibility of the FAA solely and the EPA has no responsibility in that area. However, if the major impediment to the issuance of any or all of the five proposed noise regulations is the inability to determine the economic reasonableness of noise control in the absence of health and welfare criteria, such an obstruction will be avoided with the publication of the health and welfare documentation called for by Section 5 of the Noise Control Act.

The Aircraft/Airport Noise Study included a cost-effectiveness analysis that compared the costs of source noise control (technology) with the costs of compatible land use noise control for several zones of noise exposure (11). The results clearly indicated that technology alone was capable of complete noise control (no residential exposure) only for the highest noise level zone. However, the combined costs of source and land use noise control for all other zones were reduced by a significant amount with applications of the available technology options.

A regulation being considered for civil supersonic aircraft (ANPRM 70-33) solicits public comment on a number of issues and problems and does not include suggestions or recommendations (9). Consequently, if SST noise is to be adequately controlled, a regulatory plan must be developed and implemented (12). In this regard, the following discussion related the findings of the EPA study.

The noise of existing SST aircraft types (Concorde and TU-144) is not capable of being controlled by available technology to levels as low as the criteria of FAR 36 (4). Therefore, the Agency will take this into account in proposing regulations to the FAA regarding SST noise control to protect public health and welfare. Future SST aircraft types should at least be regulated to noise levels conforming to the original FAR 36 levels. As more advanced noise control technology becomes available, limits should be reduced accordingly.

The regulation being considered for newly produced airplanes of older design (NPRM 72-19) would require that these aircraft meet the noise criteria of FAR 36. Such a regulation would require the use of available technology to ensure that all new production aircraft either by design, retrofit, or both can comply.

<u>Retrofit and Phaseout of Existing Aircraft</u>

There are two retrofit options that can reduce the noise of the existing turbofan aircraft to levels equal to or below those specified in FAR 36. These retrofit options can be accomplished at less cost and elapsed time than is predicted for fleet replacement (phaseout) (1, 3, 7).

(1) Application of sound absorption material (SAM) in the engine nacelle and bypass duct. This concept has been in development since the early 1960s under the sponsorship of FAA and NASA. The results of the NASA program established conceptual validity for JT3D engines by a series of successful flight demonstrations of 707 and DC-8 aircraft with experimental ("boiler plate") hardware. Subsequently, the results of the FAA program established conceptual and feasible validity for JT3D and JT8D engines by a series of successful flight demonstrations of 707 and 727 aircraft with practical (flight weight, flightworthy, and capable of being certified) hardware.

Boeing is currently in production on SAM-treated 727 and 737 aircraft which have been certified in conformance with the requirements of FAR 36, Appendix C (3). McDonnell-Douglas has contracted to sell SAM-configured DC-9 aircraft as well. The aircraft industry has demonstrated that these retrofit options are technologically feasible. A program to retrofit the existing fleet of JT3D and JT8D engine powered aircraft can be initiated immediately.

In discussions with the Agency during the course of this study, some members of the aviation community asserted that the application of SAM treatment will not produce any discernible relief, in terms of public awareness. However, the EPA Studies indicate that for the 707 and DC-8 aircraft powered by the JT3D engine, (currently the worst noise offender), the reductions would be significant, both for the takeoff and approach modes (3). For the JT8D powered aircraft (727, DC-9 and 737), the assertion is correct for those airports that are takeoff-sensitive. At approach-sensitive airports, however, the SAM treatment for the JT8D would result in significant reductions in community noise impact (3).

(2) Modification of the existing JT3D and JT8D engines (Refan). By replacing the present low-bypass ratio fan with a slightly higher bypass, larger diameter fan, in conjunction with some degree of SAM treatment, noise reductions in excess of those achievable with only SAM treatment are predicted (3). The fan modifications and change in engine airflow bypass ratio are the primary design parameters that influence the source noise characteristics. However, other components of the engine (e.g., turbine, fan duct, and nacelle) and possibly the airframe (e.g., pylon and landing gear) also require modifications. The refan program is considered to be technologically practicable. However, the modified engine designs for the JT3D and JT8D engines have yet to be ground and flight tested to confirm their predicted noise and aerodynamic performance characteristics.

Source noise control for the smaller business jet aircraft fleet presents a somewhat different problem. Eighty percent (80%) of the aircraft in this fleet are powered by turbojet or very low bypass turbofan engines (with noise characteristics similar to that of the turbojet) (7). The noise problem is primarily associated with the jet exhaust characteristics. The options available to reduce this noise are installation of exhaust suppressor kits with weight increase and some performance loss, or by re-engining the aircraft with moderate bypass ratio turbofan engines which may improve performance.

Both of these options are being tested and evaluated by the business jet aircraft manufactures at this time with substantial indication that satisfactory noise reduction programs are technologically feasible for this category of aircraft (3).

Two of the previously identified proposed regulations have essentially the same objective, that is, retrofit of the currently type-certificated subsonic low bypass ratio turbofan powered aircraft. The earlier "straight retrofit" notice (ANPRM 70-44) merely discusses the need for noise reduction and emphasizes that current technology is available for a feasible retrofit program. The later notice (ANPRM 73-3) on fleet noise level (FNL) was published after consideration of comments received in response to the first notice and presents a detailed methodology and implementation procedure that permits and encourages other alternatives as well as retrofit. The FNL proposal is well developed and could be converted to a regulation in a short time, while the straight retrofit proposal might require considerable additional development before it could be structured as a regulation.

The concept and structure of the FNL proposal is adequate to effectively exploit the current technology (nacelle retrofit), to encourage the use of near future technology (refan retrofit) as it becomes operable, to provide incentives for the phaseout of aircraft not amenable to retrofit by the introduction of new quieter wide-body aircraft, and to require full implementation of future technology as it becomes feasible (12). In addition, the FNL concept would periodically provide a great deal of useful information to the Government on air carrier fleet size, mix, and utilization. However, there are several features in the proposal that weaken its effectiveness and should be removed, and there are several that would add strength if included. They are:

- Omit exemption for airplanes engaged in foreign air commerce.
- Omit exemption for airplanes engaged in overseas air commerce.
- Omit expiration date of 1 July 1978 and continue the FNL concept indefinitely to permit the implementation of technological advancements (e.g., refan) as they become available.

69-739 O - 73 - 4

- Include airplanes engaged in intrastate air commerce.
- Include FNL requirements for sideline noise as well as takeoff and approach.

The FNL proposal (ANPRM 73-3) with the above exceptions could be prescribed as a regulation that would be an effective retrofit rule for the immediate noise problem and also be an effective rule for insuring that future technology is adequately exploited. A fleet noise level rule would be superior to and obviate the need for a straight retrofit rule such as considered in ANPRM 70-44.

Differences in opinion exist on most of the above subjects, as reflected in the EPA Aircraft/Airport Noise Study master file documents and task group reports.

A primary question, not addressed by the Agency in any of its Task Group's studies because of its policy rather than technical nature, is that of the degree of implementation of the Administrator's responsibilities for coordination of aviation noise research under the responsibilities and authorities established for the Administrator in Section 4(c) of the Act. Following the recommendations of the Office of Science and Technology (OST) "Jet Aircraft Noise Panel" discussed in the Introduction of this present report, an "Inter-Agency Aircraft Noise Abatement Program" has been conducted under the combined overview and coordination within the Executive Branch of the Office of Science and Technology, the Office of Management and Budget, and the National Aeronautics and Space

Council. This latter entity has perhaps had the most direct influence in the coordination of R&D efforts of NASA and of the Department of Transportation and FAA. It also has undertaken in its latter existence, recommendations relating to the application of military technology to civilian aviation use.

The Administrator recognizes that with the abolition of the Office of Science and Technology, and the National Aeronautics and Space Council, his coordinating role established in the Noise Control Act will have vastly important implications regarding major decisions yet to be made as to the degree and allocation of investments of Federal funds in apparently competing, but in fact perhaps compatible (if dealt with in a comprehensive time sequence), programs for retrofit and development of new and quieter air transport systems. Because of the magnitude of the questions involved, and the evolving situation with regard to the assumption by the National Science Foundation of some of the advisory functions formerly conducted by OST, additional time is needed by the Agency to develop a complete protocol as to how these important responsibilities will be undertaken. In the interim, communications have been established among the responsible level officials of DOT, FAA, NASA and EPA, to provide for continuing necessary exchanges of information and, as appropriate, action by EPA. These informal arrangements will be translated into an effective formalized procedure before the end of FY 1974. They will be reported to the Congress in a periodic report on Federal activities as called for by Section 4(c)(3) of the Act.

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SECTION 3

IMPLICATIONS OF IDENTIFYING AND ACHIEVING LEVELS OF CUMULATIVE NOISE EXPOSURE AROUND AIRPORTS

Measure of Environmental Noise Exposure

Section 7(a) of the Noise Control Act of 1972 directs the Environmental Protection Agency to study the "--implications of identifying and achieving levels of cumulative noise exposure around airports." This section discussed selection of a method of measurement of cumulative noise exposure appropriate to public health and welfare effects, and considers the principal legal and economic implications resulting from its use.

These implications are discussed in terms of the day-night average sound level adopted for this report as the measure of cumulative noise exposure. However, the implications are insensitive to minor variations in the definition of the measure selected, and would be essentially unchanged if discussed in terms of other possible measures of cumulative noise exposure.

Measure of Cumulative Noise Exposure

A physical measure of cumulative noise exposure applicable to evaluation of airport noise should be based on consideration of the following requirements:

1. The measure should correlate with the human responses regarding hearing loss, speech interference, and annoyance due to noise exposure.
2. The measure should be capable of assessing the accumulated effect of all noises over a specified time period.
3. The measure should be simple enough that it can be obtained by direct measurement without extensive instrumentation or elaborate analysis equipment.
4. The required measurement equipment, with standardized characteristics, should be commercially available.
5. The measure for airport noise should be closely related to measures currently used for noise from other sources.
6. The single measure of noise at a given location should be predictable, within an acceptable tolerance, from knowledge of the physical events producing the noise.

Every scientific investigation of airport/community noise, regardless of the country of origin, shows that the impact of aircraft/airport noise is a function not only of the noise intensity of a single event (i.e., each takeoff or landing), but also a function of its duration and the number of events occurring throughout the day and night* (1). This fact is recognized in the documents of the

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* Other factors have been considered in some studies to be relevant to particular effects, for example: attitude and prior experience with the intruding noise, residual or background noise, season (windows open or closed).

International Standards Organization, the International Civil Aviation Organization, and the Organization for Economic Cooperation and Development relating aircraft noise to community response (2, 3, 4).

A number of methodologies for combining the noise from individual events into measures of cumulative noise exposure have been developed in this country and in other developed nations, e.g., Noise Exposure Forecast, Composite Noise Rating, Community Noise Equivalent Level, Noise and Number Index, Noise Pollution Level. These methodologies, while differing in technical detail (primarily in the unit of measure for individual noise events), are conceptually very similar and are highly correlated with each other. Further, using any one of these methodologies, the relationships between cumulative noise and community annoyance (5, 6) are also highly correlated.

The day-night average sound level (L_{dn}) adopted for use in the present EPA studies is consistent with existing methodologies and meets the previously stated requirements for a measure of cumulative noise exposure. It has been defined for this study as the average A weighted* sound level during a 24-hour time period with a 10dB penalty applied to nighttime (2200-0700 hours) sound levels.

The day-night average sound level especially excels, as a

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* The use of an A weighted sound level precludes the assessment of penalties for the existence of tones in the noise in the interest of simplifying the measure procedure. When appropriate, penalties for tones and other subjective attributes should be made in source regulations such as in FAR 36.

measure of cumulative noise among the several available measures, in that it can be easily measured with simple, relatively inexpensive equipment, and because it is appropriate to the wide variety of sources which create community noise environments. As has been shown in Reference 1, it can be used for interpreting cumulative noise exposure in terms of known health and welfare effects.

Health and Welfare Effects of Cumulative Noise Exposure

The currently established specific effects of noise on the health and environmental welfare of humans were considered for the purposes of this report* to provide the best ways of identifying and evaluating the impact of noise around airports. The primary effects of noise, identified at this time, on public health and welfare are the potential for producing a permanent loss of hearing, interference with speech and the generation of annoyance. Although the possibility of indirect effects of noise on health and well-being exists, there is insufficient evidence at this time to include any such indirect effects in noise impact analyses.

The documented scientific data available** were considered

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* The analyses on the effects of noise performed were in direct response to the requirements of the aircraft/airport noise study. Concurrent with this analysis, the Environmental Protection Agency is preparing a genal document of criteria for the effects of noise on people, as required by Section 5(1)(1) of the Noise Control Act. While it is believed that the conclusions on the effect of noise reached in this study will be consistent with the criteria report, the position of the Environmental Protection Agency on noise criteria, and any regulatory action proposed for noise, will be based on the criteria reoort and not on the Task Group report generated in this study.

** Citations for the scientific data utilized in the Task Group analyses are contained in Reference 1.

sufficient to establish the potential for hearing damage in various proportions of the population exposed to different values of the day-night average sound level. The hearing threshold for an individual at a specific frequency is determined by measuring the level of the quietest sound that can be heard by the individual. The amount of hearing loss at any frequency is measured by the amount by which the hearing threshold has shifted upward from a previous value, or from the population norm.

Noise can interfere with one of the chief distinctions of the human species--speech communication--thereby disturbing normal domestic activities, creating a less desirable living environment, and therefore acting as a source of extreme annoyance. Of chief concern in this study is the effect of noise on speech communication in the home, for face-to-face conversation indoors or outdoors, telephone use, and radio or television enjoyment. Research over a number of years since the late 1920's has made great progress in quantifying the effects of noise on speech communication, data from which has been used in this study to relate the quality of listening conditions for speech in the presence of noise to various values of the day-night average sound level. Finally, the proportion of a population expected to be highly annoyed when exposed to various noise environments was related to the day-night average sound level. The word annoyance is used in this report as a general term for reported adverse responses of people to environmental noise. Studies of annoyance are largely based on the results of sociological surveys. Such surveys have been conducted among residents in the vicinity of airports of a number of countries including the United States (7, 8, 9, 10).

The results of these surveys are generally related to the percentage of respondents expressing differing degress of disturbance or dissatisfaction due to the noisiness of their environments. Some of the surveys involve a complex procedure to construct a scale of annoyance, some report responses to the direct question of "how annoying is the noise." Each social survey is related to some kind of measurement of the noise levels (mostly from aircraft operations) to which the survey respondents are exposed. Correlation between annoyance and noise level can then be obtained.

The results of the social surveys show that individual responses vary widely for the same noise level. Borsky (11) has shown that these variances are reduced substantially when groups of individuals having similar attitudes about "fear" of aircraft crashes and "misfeasance" of authorities are considered. Moreover, by averaging responses over entire surveys, almost identical functional relationships between human response and noise levels are obtained for the entire surveyed population as for the groups of individuals having neutral attitudinal responses. In deriving a generalized relationship between reported annoyance and day-night average sound level, the average overall group responses were used, recognizing that individuals may vary considerably, both positively and negatively compared to the average depending upon their particular attitudinal biases. The table on the following page summarizes the effects expected for different noise environments.

EFFECTS OF NOISE FOR DIFFERENT VALUES
OF OUTDOOR DAY-NIGHT AVERAGE SOUND LEVEL, L_{dn}, IN DECIBELS

	HEARING		SPEECH		ANNOYANCE	
Outdoor Day-Night Average Sound Level in Decibels re-20 micronewtons per square meter	Hearing Risk for Speech in % of Exposed People	Percent of Exposed People With Permanent Threshold Shift (5 Decibels at 4000 Hertz)	Maximum Speech Interference* in Percent OUTDOORS**	INDOORS***	Highly Annoyed in % of Exposed People	Complainants in % of Exposed People
50	0	0	0.8	0.1	13	1
60	0	0	2.5	0.1	23	2
70	0	0	53	0.1	44	10
80	0	4	100	1.5	62	20
90	8	66	100	3.2	-- UNKNOWN	--

*Percentage of key words misunderstood in spoken sentences.
**Normal voice effort and 2 meter separation between talker and listener. When speech interference is excessive the average communication can be improved by reducing separation distance and/or raising voice level.
***15 decibels noise reduction through partially opened windows, and relaxed conversational effort.

Example: When the day-night average sound level is 90 decibels outdoors:

HEARING RISK:
The percentage of people suffering a hearing handicap in a group exposed to this level of noise is expected to be 8 percentage points higher than the percentage of people with hearing handicaps, in a group, otherwise similar, who are not exposed to noise levels of this magnitude. (This column refers only to hearing impairment in the frequency range most important to understanding speech frequencies of the 500, 1000 and 2000 Hertz (cycles per second) bands.)

66% of the entire population is expected to have a noise induced permanent threshold shift greater than 5 decibels at a frequency of 4000 Hertz (cycles per second). The average human ear is most sensitive at this frequency and hence more easily damaged.

SPEECH INTERFERENCE:

For conversation outdoors, the percentage of key words misunderstood in spoken sentences will be 100%, and for conversation indoors, 3.2%.

ANNOYANCE:

The number of noise exposed people who are highly annoyed and the number who are expected to complain about the noise are unknown for this level of exposure, but they are greater than 62% and 20%, respectively, which are the values appropriate to an outdoor L_{dn} of 80 decibels.

An important consideration in assessing the relative impact of airport noise is its contribution to the national noise environment, considering the contributions of other sources of noise. The following Table, developed in Reference 1, provides an estimate of the population presently exposed to different levels of cumulative exposure from different major sources of urban noise:

Number of People (In Millions) Exposed to
Day-Night Average Sound Levels Above the Stated Value

Day-Night Average Sound Level Decibels	Freeway Traffic	Aircraft Operations	Urban* Traffic	Total**
60 dB and above	3.1	16.0	18.0	37.1
65 dB and above	2.5	7.5	7.5	17.5
70 dB and above	1.9	3.4	3.2	8.5
75 dB and above	0.9	1.5	0.6	3.0
80 dB and above	0.3	0.2	0.1	0.6

These estimates indicate that, of those 92 million people included in this calculation living within moderate to high levels of environmental noise, aircraft are a major cause of the noise exposure received by approximately 30 to 40 percent of these people. The estimates further indicate, however, that complete elimination of aircraft noise in the urban community will still leave a large proportion of the population exposed to high levels of environmental noise unless control of these non-aircraft noise sources is also obtained.

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* Cities with population in excess of 25,000 used in this estimate - total population at 92 million.

** Some duplication may exist in this total.

Public Health and Welfare

Cumulative noise exposure levels as defined by such methodologies as day-night average sound level, NEF etc. are believed to be the best available means of identifying and evaluating the impact of noise around airports. Cumulative noise exposure levels can also serve as the basis for generally applicable environmental standards designed to control the noise exposure of members of the general population, as well as the most critically exposed individuals, to levels that will protect their health and welfare with an adequate margin of safety.*

Finally, establishing values for cumulative noise exposure must be contingent on an appropriate balance between desirable noise levels and varying economic capability, and sociological effects among communities. The study reported in a following subsection (economic implications) estimated the approximate economic costs to achieve various values of the day-night average sound, and considered aircraft activity as the only source of noise. However, as inferred from the preceding table this may not be the case for selected levels at specific airports. Identifying the broader sociological implications of achieving, various levels of cumulative noise exposure was not possible during the time period available for this study. These implications include such questions as:

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* With regard to "welfare" effects, there is a wide range of degree of human response to noise; and thus there may be a range of such levels taking this into account.

What is the effect of possible residential relocation to achieve compatible land use on neighborhood social structures?

What are the contributions of the other potential noise sources in the community?

What, if any, are the long-term effects on the social structure of residential neighborhoods if they remain in a high noise environment?

Can conversion of noise impacted, lower density residential housing into renewal, high density residential areas be acceptable if adequate noise control is incorporated in the new structures, as contrasted with conversion to possibly higher value commercial and residential uses?

Consideration of these and other social costs and benefits will be made by the EPA in its preparation of proposed regulations for airport noise.

There are several main "implications"* of adopting mechanisms for identifying and then achieving cumulative noise measures as a means of controlling aircraft noise. The most important, beyond

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* As used here, "implications" applies to the relationship of the proposal to possible consequence of its adoption.

those of public health and welfare, are discussed in the following subsections, and include those relating to legal, economic and fundamental policy considerations. In examining these, others have been noted which require further study and which will be addressed by the agency in greater depth in developing details of proposals on this measure.

Legal Implications

This discussion deals with the legal implications of identifying and achieving levels of cumulative noise around airports adequate to protect the public health and welfare. Although the nuances of the governing case law are extremely complex, the following legal implications must be kept in mind:

- Identification of cumulative noise levels at airports to protect public health and welfare could be used to support additional liability against airport owners. This could follow from the mere act of "identification."
- Under the Burbank decision, achievement can be accomplished to great extent only by overall Federal regulation.
- Identification of Federal regulations and establishment of cumulative noise levels may shift liability from airport owners to the Federal Government; but achievement should reduce airport noise liability.
- Any shift in liability to the Federal Government will create a problem during the period between Federal identification and the achievement of noise levels requisite to protect the public health and welfare.

- o If the Court were to hold that liability had shifted by reason of preemption, a legislative solution for the interim period is unlikely, because liability is largely based on the constitutional requirement that just compensation must be paid for the taking of property.

Three decisions of the Supreme Court of the United States are in point. These cases are: United States v. Causby, 328 U.S. 256 (1946); Griggs v. Allegheny County, 369 U.S. 84, (1962); and City of Burbank v. Lockheed Air Terminal, Inc. ______________ U.S. ______________(1973). The rule in the Causby case was that the Federal Government (either as the partial lessor of the Winston Salem, North Carolina, Airport or as the operator of the military aircraft in question) had "taken" in the constitutional sense of the Fifth Amendment, a property interest or "aviation easement" in the land the military aircraft overflew. The United States was required to pay just compensation for the diminution of the value of the overflown property. In practical effect the result was that compensation was paid for the right to continue the damaging noise.

In the Griggs case the Supreme Court had before it another overflight damage/taking case. The airport was owned by a political subdivision of Pennsylvania. The aircraft generating the overflight noise were those of commercial scheduled air carriers, the flight patterns and paths of which were regulated by the FAA. It was clear that there could be no Fourteenth Amendment taking by the commercial carriers (analogous to the Fifth Amendment taking of

90-739 O - 73 - 5

Causby) since the carriers who used the airport and generated the noise were not state bodies. The majority of the Court, per Mr. Justice Douglas, held that the local government, as owner of the airport, has responsibility and authority to acquire adequate approach land to the airport (using the analogy of a governmental bridge builder who must acquire by condemnation sufficient land to build approaches to the bridge) and was therefore in the position of having taken property consisting of an aviation easement from Mr. Griggs whose property had been directly overflown by the air carriers' aircraft. The Court thus held that the local governmental owner of the airport must compensate the property owner for the taking. In the dissent, Mr. Justice Black noted that the airport construction including landing layouts and approach ways had been supervised and approved and in large part paid for by the FAA under its Federal Aid to Airports Program; and that since the airport approaches were both placed and limited by the Federal Government rather than the airport owner, the former should be liable for the resulting just compensation under the Fifth Amendment.

In Burbank, the Court had before it a municipal ordinance that made it unlawful for a privately owned airport located within the jurisdiction of the municipality to permit the operation of jet aircraft between 11 p.m. and 7 a.m. The Court held that curfew was an unconstitutional exercise of the municipalities' police power because the "pervasive nature of the scheme of Federal regulation of aircraft noise. . . leads us to conclude there is Federal preemption." This was based on the Court's analysis of the Noise Control Act of 1972 which determined "that FAA, now in conjunction with EPA, has full control over aircraft noise, preempting state and local control."

The holding in Burbank means that a state, or any political subdivision thereof, cannot use it police power to protect its citizens from aircraft noise because the Federal government has preempted the power to do so. However, more than 99% of the noise impacted airports used by scheduled air carrier aircraft are in fact owned by the states, or political subdivisions thereof. Can these governmental owners exercise their own property rights to achieve noise abatement? This questions is a very real one. Would, or could, the FAA permit one of the large international or hub airports to curfew operations at night as a matter of proprietary right? The Court in Burbank cited action by the FAA in 1960 which "rejected a proposed restriction on jet operations at the Los Angeles airport between 10 p.m. and 7 a.m. because such restrictions could create critically serious problems to all air transportation." However, in a footnote, the Burbank opinion declines to determine whether "proprietary" rights such as curfews and nondiscriminatory quotas would either stand or fall under the preemption doctrine.

The footnote in question deals with the legislative history of the 1968 Act (PL 90-411). The text of the footnote is as follows:

> "The letter from the Secretary of Transportation. . . expressed the view that 'the proposed legislation will not affect the rights of a State or local public agency, as the proprietor of an airport, from issuing regulations or establishing requirements as to the permissable level of noise which can be created by aircraft using

the airport. Airport owners acting as proprietors can presently deny the use of their airports on the basis of noise considerations so long as such exclusion is non-discriminatory.'" (Emphasis in opinion.) "Appellants and The Solicitor General submit that this indicates that a municipality with jurisdiction over an airport has the power to impose a curfew on the aiport, notwithstanding Federal responsibility in the area. But, we are concerned here not with an ordinance imposed by the City of Burbank as 'proprietor' of the airport, but with the exercise of police power. While the Hollywood-Burbank Airport may be the only major airport which is privately owned, many airports are owned by one municipality yet physically located in another. For example, the principal airport serving Cincinnati is located in Kentucky. Thus, authority that a municipality may have as a landlord is not necessarily congruent with its police power. We do not considere here what limits if any apply to a municipality as a proprietor."

As discussed earlier, the "identification" of a noise level standard requisite to protect the public health and welfare may generate Griggs type litigation against airports. For example, assume EPA were to identify "X units" of some cumulative measure of noise as completely unacceptable to public health and welfare. Without further Federal action, such identification could be used by lawyers to attempt to define a cause of action based on the health damage to their clients which would, of course, then be subject to proof on an individual basis. Without more, the sole act of identifying a Federal noise level would not necessarily shift Griggs type liability to the Federal government. However, if in addition to identification, the airport owner is denied the right unilaterally to limit the use of its airport to defend itself from litigation based on the Federally identified noise level, the possibly of a shift in liability cannot be ruled out.

In short, achievement would appear to EPA to be most feasible through noise certification of airports which would enable the FAA to work out a national system of noise abatement options for each airport to achieve the identified levels locally and prevent local action inconsistent with the national air transportation system. To the extent the airport owner would be required to, and did, comply with the Federal noise certification system, the owner might be immune from noise nuisance litigation because of the defense of legalized nuisance. It will also mean that in taking litigation, the defendant might be the Federal Government, since the airport operator would be acting in compliance with and under the mandate of a Federal regulation.

The above legal implications have been summarized and then discussed in the context of the governing case law. The acts of identification, airport certification for noise, and the statutory goal of achievement are all presently mandated by Congress (12). Thus, Section 5 of the Noise Control Action of 1972 directed EPA to (1) develop and publish by July 27, 1973, "criteria with respect to noise. Such criteria shall reflect the scientific knowledge most useful in indicating the kind and extent of all identifiable effects on the public health or welfare which may be expected from differing quantities and qualities of noise;" and (2) by October 27, 1973, to "publish information on the levels of environmental noise the attainment and maintenance of which in defined areas under various conditions are requisite to protect the public health and welfare with an adequate margin of safety."

Next, EPA was directed by Section 7 of the Noise Control Act of 1972 to "submit to the FAA proposed regulations to provide such control and abatement of aircraft noise and sonic boom (including control and abatement through the exercise of any of the FAA's regulatory authority over air commerce or transportation or over aircraft or <u>airport operations</u>) as EPA determines is necessary to protect the public health and welfare."

In summary, the EPA has the duties to define noise criteria, to publish and thus identify levels of environmental noise requisite to protect the public health and welfare with an adequate margin of safety, and, after reporting to Congress, to propse regulations to the FAA for the abatement and control of aircraft noise as EPA deems necessary to protect the public health and welfare.

With respect to the authority to achieve FAA's explicit regulatory authority over <u>airport operations</u>, Section 611 added noise to the criteria that must be taken into account in issuing any certificate under Title VI. More specifically, the new

Section 611 directed the FAA, after consultation with DOT, to prescribe:

> "Standards for the measurement of aircraft noise. . . and prescribe and amend such rules and regulations as the FAA may find necessary to provide for the control and abatement of aircraft noise. . .including the application of such standards, rules and regulations in the issuance of any certificate authorized by . . .(Title VI)."

In 1970, the Airport and Airway Development Act (AADA), also by way of amendment to the Federal Aviation Act, required that every airport serving civil air carriers operating under a CAB certificate of public convenice and necessity must obtain an airport operating certificate under Section 612. Then, as noted earlier in this report, the Noise Control Act of 1972, amended Section 611 to require the FAA after consulation with DOT and EPA, "in order to afford present and future relief and protection to the public health and welfare from aircraft noise. . .(to) prescribe and amend standards for the measurement of aircraft noise and sonic boom and shall prescribe and amend such regulations as the FAA may find necessary to provide for the control and abatement of aircraft noise. . .including the application of such standards and regulations in the issuance, amendment, modification, suspension, or revocation of any certificate authorized by this title."

The Agency has concluded that the timely adoption and implementation of an airport noise certification regulation is the keystone of a comprehensive program to dimish aircraft noise in communities to level adequate to protect public health and welfare.

The FAA's airport certification process appears to EPA to be the proper mechanism for administering the airport noise regulation, and no new legislation is needed. The process envisioned is as follows:

After the promulgation of the Federal airport noise regulation, the existing airports with jet aircraft operations would be reviewed, and those not in compliance with the regulation identified. A number of large air carrier airports could be so identified immediately after promulgation of the regulation. Proprietors of identified airports would be given a specified amount of time to develop, and submit to the FAA, their implementation plans. Development of implementation plans for each airport should be done by a consultive local process, involving governments and concerned persons in the airport vicinity. Testing the effectiveness of various alternative operational modes for the airport should be carried out as part of the local development of the implementation plan.

The agreed-upon implementation plan for the airport would then be submitted to the FAA for approval. Any final adjustments of the plan required during the approval process would be incorporated, and the implementation plan adopted as a Federal regulation for the airport. Elements of the plan dealing with aircraft operations would be promulgated as FAA regulations and thus become subject to FAA enforcement. Airport proprietors that fail to propose an implementation plan by the specified deadline would have implementation plans imposed upon them at the Federal level. This would follow FAA development of a plan, including participation by all concerned persons. Progress in implementing approved plans would be reviewed on a periodic basis.

Two additional legal implications deserve comment. They arise under different authority and therefore are discussed separately. The first concerns the application to airport and airline employees (as well as other employed persons whose work place noise environment may be dominated by aircraft noise) of the occupational noise exposure standards as promulgated by the Secretary of Labor pursuant to the Occupational Safety and Health Act of 1970 (29 CFR Section 1910.95). The OSHA occupational noise exposure standards require protection against the effects of noise when sound levels exceed a limit value, e.g. 90 dBA for an 8 hour work day. This is a hearing impairment standard not geared to "public health and welfare." Rather, the OSHA standard is derived from the replacement of the old common law concepts of master-servant and assumption of risk, which denied all work-incurred liability with the concept of workman's compensation, which while limiting recovery, made recovery easy.

The only area of conflict that could arise would be where the airport employee, for example, were to work at the maximum OSHA standard for an 8 hour day and reside in a maximum noise impacted area under an EPA identified level. It is possible that this could lead to additional liability, particularly if hearing impairment were proven.

The second implication concerns the identification by EPA of levels of noise requisite to protect the public health and welfare and the application of such levels to noise impacted areas adjacent to military airports. As noted earlier in discussion of the Causby case, the Federal government is liable under the Fifth Amendment for takings of property by military aircraft overflight noise. Such liability might be extended by identification of a public health and welfare level in a particular case since it could be used to assert that the overflown property was damaged to the extent it could not be safely used as a residence. However, the cause of action would have to remain one for a constitutional taking, because the Federal government is subject to suit in tort only by reason of the Federal Tort Claims Act. The act bars suits arising out of actions taken under the "discretionary function" of the Federal government. Thus a litigant would have to prove that the flights of the military aircraft were pursuant to a negligent decision of the Federal government and not pursuant to a responsible decision. Such proof would be difficult, it not impossible, under the prevailing case law.

The extension of Federal noise liability at military airports is also countered by the present DOD compatible use programs, "Air Installations Compatible Use Zones (AICUZ). AICUZ seeks to assure that the use of privately owned real property near military airports is used in a manner compatible with both mission accomplishment and protection of the public. As is set forth in Reference 13, AICUZ uses a cumulative noise criterion to determine noise impacted property, and if local zoning or other desired action is not forthcoming appropriate Federal action would be required.

Economic Implications

The objective of this discussion is to delineate the economic costs and problems of identifying and achieving several specified levels of cumulative noise exposure, by various methods of noise control and abatement. In analyzing the implications of identifying and achieving such levels of noise exposure, the following issues are examined:

- economic implications of identifying cumulative average day-night noise exposure levels (L_{dn} used in this study),
- the costs of achieving such levels for each of the entities contributing to the airport environmental noise problem,
- cost allocation and financing options.

(a) Economic Implications of Identifying Cumulative Noise Exposure Levels

Identification of cumulative noise exposure levels embodies several implications with the potential for economic costs apart from the costs required to achieve such levels through noise abatement and control strategies. The implications arise in two areas of interest: (1) the cost of monitoring airport noise and measuring noise exposure levels around airports and (2) the cost or liability which might be incurred by responsible institutions if cumulative noise exposure levels are used to define causes of action for personal or property damages resulting from aircraft/airport noise.

Costs of Monitoring

With the identification of cumulative noise levels and their statistically expected population effects, responsible local government organizations can be expected to attempt to determine the extent of their respective airport noise environment problems. Necessarily, such actions will require resources. Based on current information (15), the cost of establishing and maintaining a monitoring program for approximately 500 commercial airports, representing 99 percent of all commercial aviation operations, are estimated at 5 million dollars per year*. This estimate does not cover the cost of monitoring, if desired, at smaller general aviation airports which do not serve commercial carriers.

Possible Compensation Liability

As indicated in the discussion of legal implications of identifying airport noise exposure levels, it is possible that any cumulative noise exposure measure, and the statistically expected population health and welfare effects identified by

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* This figure (in 1973 dollars) includes the cost of purchase or lease of monitoring equipment and labor, calculated on the basis of four man days and one 24-hour monitoring period per 1000 annual operations.

the Federal Government, will be used by private litigants to define causes of action for the recovery of personal or property damages resulting from aircraft noise.

Any discussion of potential liability or litigation recovery resulting from identification of noise exposure levels is highly speculative. Past experience regarding compensation suits against airports indicates that the threat of litigation is much greater than the actual judgments resulting therefrom. To date, several billion dollars of airport litigation has been filed against just one air terminal (LAX). Recoveries, nationally, for noise related damages have amounted to approximately one tenth of one percent of the claims.

Identification of cumulative noise exposure levels is not a new concept. The Noise Exposure Forecast methodology, developed by the FAA, was introduced in the late 1960's, and although later withdrawn by FAA, has continued to be used by HUD and other state and federal agencies. Only in one state, California, were such NEF forecasts used as evidence of the extent of airport noise impact. Thus, it is uncertain, at best, whether mere identification of cumulative noise exposure levels will in fact result in substantial airport noise compensation recoveries (12).

Assuming, however, that such noise exposure levels were adopted by the Courts as means for defining a cause of action for noise related damages, the most likely use would come in personal damage suits. If it were determined that a given level of cumulative noise exposure resulted in a potential risk of hearing loss to those exposed for long durations to such levels, a new type of airport litigation might evolve. Such suits would be brought by airport neighbors asserting damages resulting from anticipated impaired hearing and/or substantial diminution of property value in areas made "unhealthy" by aircraft noise.

Approximately four percent of the persons living for long periods in areas subject to cumulative noise levels equivalent to the L_{dn} 80 used in the EPA study are subject to a potential risk of hearing loss above that which would normally be expected (1). If this level were the ultimate standard, and assuming these individuals sued for damages for hearing loss caused by airport noise, the upward bound of possible litigation can be estimated from experience in workman's compensation cases arising out of occupational noise related deafness.

If each litigant recovered the average amount ($2500) paid to workmen suffering occupational caused hearing loss (16), airport, airlines or the United States government might be subject to liability on the order of 20 millions of 1973 dollars.

A bound on the possible recovery for property value losses which might be claimed if cumulative noise exposure criteria are adopted by the courts in inverse condemnation litigation may be calculated from the costs of soundproofing or relocating noise-sensitive land uses subject to the L_{dn} levels used as examples in this study. Table I below sets forth such estimates, indicating that, for example, if 60 L_{dn} were held to define a right to compensation for property value diminution, recoveries might total as much as 33 billion dollars.*

Table I

Estimates of the National Extent of the Current Airport Environmental Noise Problem

Day-Night Avg. Noise Level (L_{dn})	1972 Population Exposed (1) (Millions of people)	Compatible Land Use Costs (17)** (Billions of 1973 dollars)
Greater Than 80	0.2	2.0
70	3.4	19.0
60	16.0	33.0

These figures assume (1) that every court adopts such levels as defining proper causes of action for compensation; (2) that every person living in such noise impacted areas sues for damages; (3) that every litigant could show substantial diminution of property value to the maximum amount--e.g., that their land was not more valuable for other purposes; and that no obstacles to litigation, such as statutes of limitation, exist to bar recovery.

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* It should be noted that with noise conditions such as that described by the L_{dn} 60 value - other sources of noise may be of equal or more importance.

** In the re-development of incompatible land uses, public investment recoveries from high density commercial and industrial land uses can result in off-setting, if not exceeding, the total costs of such land use conversion, given the demand for such uses; but note, the Federal Government has no police power or other direct authorities in this regard.

Furthermore, it is rare that compensation litigation is the first step taken by aggrieved airport neighbors. Rather, law suits often appear as a reaction to frustrated efforts to lessen noise impacts via other methods. The compensation implications discussed here therefore should not be expected to be realized immediately upon identification of cumulative noise exposure levels requisite to protect public health and welfare. When identification of such levels is not followed by a viable program to achieve necessary noise control and abatement, however, airport neighbors and courts may be inclined to take more precipitous action as discussed herein. When and if such actions can be taken, local governments should be expected to try to minimize the extent of their respective noise environment problems with the methods available to them. Among the set available, if they are the owners of the airport, are curfews on operations and aircraft type restrictions, which, if instituted, can affect the levels of air and mail service to a community and increase the cost of operations to the civil aviation industry.* Note that such local actions could severely distort the operations and costs of the national transportation system. Thus, if cumulative noise exposure levels are identified, expeditious development and implementation of a coordinated program to achieve such levels must be pursued. Such a program should include a complementary effort relative to populations adjacent to large military airports.

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* As is discussed earlier, there is a question as to whether such proprietary acts would not adversely affect interstate air commerce.

99-739 O - 73 - 6

(b) Costs of Achieving Cumulative Noise Exposure Limits

The Noise Control Act of 1972 establishes the ultimate goal of reducing noise exposure--from aircraft as well as other sources--to levels which adequately protect the public health and welfare. In terms of aircraft/airport noise, achievement of this goal will require action to:

(1) Reduce source noise impact - through application of aircraft and engine noise abatement takeoff and approach procedures. In addition, possible airport operational controls may be applied, such as the selection of approach and departure routes; realignment of airport runways; limitation in the use of certain aircraft types at some airports; imposition of partial or total curfews; restrictions on flight frequency, etc., and/or

(2) Protect noise-sensitive receivers - through the soundproofing of residential and other sensitive structures or through the relocation of existing incompatible land uses.

Achievement of a desired cumulative day-night noise exposure level, for the purposes of this discussion, infers separation of incompatible, noise-sensitive land uses from specified levels of noise impact. This may be done by reducing the noise impact at the noise-sensitive receiver and/or by insulating or relocating the receiver. Often achievement of a given L_{dn} level will require a combination of these actions, which will result in a change in the shape of, or diminish, the area around an airport which is subject to the given cumulative noise exposure. Similarly, modifications of flight routes around airports may be used to shift noise impact zones to areas containing fewer or no noise-sensitive receivers. Yet, actions to reduce sound levels through such aircraft source abatement and operational options may not totally solve the problem at a given L_{dn} level. These options alone may not be capable of separating all noise sensitive land uses from incompatible noise impacts as defined by the given cumulative noise exposure level. In such cases, additional actions must be taken to soundproof the structures in the noise-sensitive areas, or relocate incompatible land uses which remain, after other options have been implemented.

However, there is a limit to the effectiveness of structural treatment or (soundproofing) technology. For those noise-sensitive receivers exposed to noise which cannot be effectively reduced to compatible levels by soundproofing the only remaining alternative is relocation (17). Furthermore, the application of soundproofing does not address the problem of outdoor noise levels. For purposes of this discussion, it has been assumed that all noise-sensitive receivers which involve outdoor as well as indoor activities, e.g., all residential uses, must be relocated from the area subject to cumulative noise levels which would result in eventual hearing loss. The cost of achieving any given L_{dn} level, therefore, will be the cost of implementing noise source abatement technology and airport/aircraft operational options plus the expense of soundproofing or relocating those noise-sensitive receivers which remain impacted by such noise exposure levels after technological and operational options have been employed. Clearly, the more extensive the implementation of source and path noise reduction, and airport operational options, the lower the requirements for receiver or land use controls to "achieve" a given L_{dn} goal. The economic question raised by the discussion here is what combination of these options form the most efficient, or cost-effective and timely resolution of the civil airport noise exposure problem. There do not exist sufficient data at this time to estimate the extent and costs of achievement for impacted areas around military airports.

Source noise reductions, requiring retrofit into the existing fleet, necessitate time to fabricate, demonstrate, certify and install such kits on the aircraft. This time element plays an important role in the dynamics of noise level achievement in that the fleet mix, levels of operations, and cost of achievement will vary with time. For example, future production versions of the current narrow body commercial aircraft will most likely be in compliance with current FAR 36 standards; new wide body aircraft will be even quieter. Consequently, by 1980 the expected trend is towards a gradual reduction in airport environmental noise as these relatively quieter aircraft constitute an increasing portion of the operating fleet. Note also that the retrofit candidate set of noisy aircraft will decrease with time which means that lower source abatement cost may obtain. The timing of the retrofit implementation then has a significant impact on when a level of achievement can be realized and the costs of achieving a particular day-night average noise level.

For the situation where no source abatement options are implemented, there will be reductions with time in the constant dollar costs of achieving average day-night noise environments using as examples the values 60, 70, and 80 decibels for the 1978-1980 time period as compared to those for achieving the same results in 1972 (Option A, Table 2 and Table 1). Essentially, the gradual retirement of noisy narrow body jet aircraft and their replacement with new quieter aircraft results in a reduction of the 1972 impacted areas to the extent that the impacted 1972 populations for the 60, 70, and 80 example levels of day-night average noise are reduced by 19, 17 and 50 percent respectively.*

Various flight path and source noise reduction options have been investigated (15, 17). Table 2 reflects the preliminary results of a complementary DOT study (18) which included representative technological options as indicated in column 1 of this Table. Table 2 also contains derived data from the EPA Task Force study (17). Some of the data in this Table may be revised in the final DOT study report but the relative relationships shown are expected to obtain.

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* This assumes no change in population distributions with time in the impacted areas.

TABLE 2

NATIONAL ESTIMATES OF PERCENTAGE REDUCTION OF AIRPORT NOISE EXPOSED POPULATION AND COST IMPLICATIONS (BILLIONS OF 1973 DOLLARS) OF PROVIDING RELIEF TO THREE DAY-NIGHT AVERAGE SOUND LEVELS USING VARIOUS OUTDOOR NOISE REMOVAL OPTIONS***

1 TECHNOLOGY OPTION	2 STATUS	3 DATE	4 TOTAL TECHNOLOGY COST[1]	5 DAY-NIGHT AVG. NOISE LEVEL DECIBELS	PERCENT 1972 POPULATION EXPOSED - IN EXCESS OF LEVEL	6 COMPATIBLE LAND USE COST[1,3]	7 COST OF ACHIEVING NOISE LEVEL AT COMPLETION DATE[4,1]
a. Null (Do Nothing)	N. A.	1978-1980	0.0	80 70 60	**50 83 81	1.0 15.5 24.6	1.0 15.5 24.6
b. Two-Segment Approach[2]	In Service Flight Test of Prototype	1976	0.1	80 70 60	**50 77 78	1.0 13.2 22.3	1.1 13.3 22.4
1. SAM JT8D	727 & 737 in Production, DC-9 in Prototype	1976	0.3	80 70 60	- 71 75	- 12.2 20.9	0.3 12.5 21.2
2. SAM JT3D	707 & DC-8 Prototypes Demonstrated	1976	0.4	80 70 60	- 71 79	- 11.5 20.8	0.4 11.9 21.2
3. SAM JT8D & SAM JT3D	See Above	1976	0.6	80 70 60	* 65 75	- 10.2 19.5	0.6 10.8 20.1
4. REFAN 727 & SAM All Others	REFAN: Design Studies SAM: See Above	1979	1.5	80 70 60	* 29 19	- 5.5 7.6	1.5 7.0 9.1
5. REFAN JT8D Only	Design Studies	1979	1.7	80 70 60	* 29 14	- 6.9 8.2	1.7 8.6 9.9
6. REFAN JT8D & SAM JT3D	REFAN: Design Studies SAM: See 2 Above	1979	2.0	80 70 60	* 24 11	- 4.3 5.5	2.0 6.3 7.5
7. REFAN JT8D & JT3D	Design Studies	1980	2.3	80 70 60	* 18 9	- 3.1 4.3	2.3 5.4 6.6

NOTES:

* Modeling and computational methods allowed estimates of population to the nearest 100 thousand people. Particular airport problems will result in a residual population, estimated to be less than 50,000 people, within the 80 day-night average noise level zone.

** These population impact and resulting cost estimates have been adjusted to reflect expected results rather than depending upon modeling and computational method results which predict identical results for all options.

*** Costs, availability dates and population impact estimates are based upon Department of Transportation preliminary data of the 23 airport study.

1. All costs are stated in billions of 1973 dollars. Technology costs include following elements: investment, operating costs, down time and lost productivity.

2. Operational effects and implementation costs of the two-segment approach are included in each subsequent option. The estimated costs of this Technology Transfer is 67 millions of dollars. The 100 million shown here results from rounding to the nearest significant digit in billions.

3. The costs for compatible land use include soundproofing and/or relocation and land development depending on the noise reduction requirement.

4. 0.3 billion to cover only the cost of noise retrofitting the general aviation jet fleet may have to be added to each option in order to insure population reductions indicated in the Table.

5. Airport administrative and operational options may be optimized for the airport's specific problems and thus reduce impacted residential land areas by as much as 50%. Consequently, values shown in column 6 could be reduced approximately 50 percent.

One noise reduction option not investigated in detail was the complete replacement of the commercial aviation fleet with quieter current technology aircraft. Implementation of this option was found to be impractical since there does not currently exist a replacement alternative for the JT8D powered portion of the fleet (17). If a replacement alternative were available, the cost of total fleet replacement has been estimated to be in excess of 8 billions of 1973 dollars (19).

Before discussing the effectiveness and environmental noise level achievement cost estimates, two basic shortcomings in the data must be outlined. Briefly, the set of airport noise reduction options, which minimize the population exposed, is unique at each airport due to the local topography, demography, runway orientation, flight frequencies, etc. This uniqueness precludes a quantitative extrapolation to a national estimate at this time because sufficient data on the effectiveness of each option for an adequate number of airports are not available. The "best estimate" of the combined national effectiveness of these airport options is that as much as a 50 percent reduction in the remaining impacted land area can be expected (15); the remaining impacted land area is that residual remaining after adjustments for source and path alternatives have been made. Implementing these options will incur additional costs which are not estimated here, such as increased operating costs resulting from possible curfews or flight frequency limitations.

The second shortcoming in the data was the inability to locate or develop data on the extent to which general aviation aircraft activity contributes to the national and/or individual airport noise environment problem. There are several types of business jet aircraft whose noise output exceeds the current FAR 36 levels and for which there exists source noise reduction technology. To insure consistency in the alternative effectiveness estimation and in computing the costs of achievement, the assumption was made that these aircraft would have the appropriate technologies retrofitted into the respective airframes by 1978. The total investment costs under this assumption are estimated to be on the order of 300 millions of 1973 dollars (17). Down-time and lost productivity cost estimates for retrofitting this portion of the civil aviation fleet are not available at this time.

One final point, land use cost, as used in the subsequent discussion, includes the costs associated with local government action, in the remaining impacted area, of zoning, relocations, redevelopment and/or some degree of structure treatment.

To implement a national, all weather, two-segment approach (option B of Table 2) the aircraft must be retrofitted with the requisite instrumentation and the airports must also adjust and/or install attendant instrumentation. These requirements are estimated to cost some 67 millions of 1973 dollars to implement (shown as 100 million in Table 2 due to rounding) (15). Implementing this option will reduce the number of people exposed to the L_{dn} levels of 60, 70, and 80 decibels by 22, 23 and 50 percent respectively in 1978 as compared with 1972 estimates. The cost to achieve outdoor environments of L_{dn} 60, 70 and 80 decibels for those people still impacted are estimated to be 22.3, 13.2, and 1 billion dollars respectively. Note the achievement costs for a 70 L_{dn} environment have dropped from 15.5 billions to 13.3 billions of 1973 dollars. Thus, if 70 L_{dn} was the level to be achieved, implementing a two segment approach would be desirable since the savings in achievement costs more than offsets the implementation costs of the two segment approach.

Retrofitting the entire commercial fleet with SAM kits and implementing the two segment approach, all of which can be accomplished by 1978, will reduce even further the levels of 1972 impacted population and the achievement costs. The combined costs of implementing the requisite hardware and instrumentation, plus the resulting increase in operating expenses and lost productivity to the airlines, are estimated to be some 600 millions of 1973 dollars. To realize the impacted population estimates, some portions of the business jet fleet will also have been retrofit with available technology as was discussed earlier. For these technology transfer costs, the 1978 impacted populations at 60, 70 and 80 L_{dn} reflect a reduction of 25, 35, and 100 percent*,

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* Due to the estimating procedure it is acknowledged that particular airport problems will result in residual population remaining. For 80 L_{dn} it is estimated that less than 50,000 people will be exposed to such levels where the percent reduction is stated as 100.

when compared to 1972 estimates respectively. Costs of achieving the L_{dn} levels for the remaining population are estimated to be 20.1, 10.8 and 0.6 billions of 1973 dollars. Again it should be noted that these achievement costs can be significantly reduced by the effective implementation of airport operator options.

Retrofitting Refan kits into aircraft will require a longer period to implement. In addition, the investment and operating costs of this technology option are significantly higher than those of the previous options discussed. Offsetting these costs is their increased effectiveness in reducing the 1978 impacted population estimates. Consequently, the total implementation costs (including residual land use costs) of achieving various outdoor noise levels decreases. In every case, the savings in achievement cost exceeds the costs of aircraft modifications. These data may also be found in Table 2.

These decision data on the effectiveness and cost effects of the various noise reduction options can be used as a base to design an effective airport environment noise reduction program. Different design strategies can be developed taking into account technology transfer and total achievement costs plus various degrees of risk. Table 2 indicates that there are potentially greater reductions in impacted population with Refan retrofits than with SAM retrofit options. However, the SAM technology can be implemented earlier at lower cost and the resulting noise reductions are more reliably known. A decision to rely entirely upon Refan retrofit will result in a minimum two-year delay of relief for some of the population. In addition, if the Refan's performance is less than predicted then the final population results and costs of achievement will be less favorable than expected. The benefits of a decision to SAM retrofit are earlier relief via demonstrable technology but higher land use costs to achieve a compatible noise level. However, reliance only on the SAM retrofit may preclude the possibility of a more effective and financially equitable solution by not allowing for the technological potential of the Refan program. There is an intermediate strategy which would accommodate a continuous program of further noise relief via technology. This is to initiate prompt actions to retrofit the fleet with SAM. If the current phase of the Refan research program is successful, then that portion of the fleet which has not already been retrofitted with SAM could be retrofitted with the Refan technology.* The Refan research program should be accelerated, if evaluation of the present research program indicates that this will maximize in an efficient manner reduction in airport noise exposure.

To achieve any cumulative noise level, the more rapid the technology and airport options are implemented, the smaller will be the land use option financial requirements. This result suggests that as soon as a level of public noise exposure is selected, then to minimize the costs of achieving this level, the timing for implementation of the various options of a noise reduction program is such that an action program must shortly follow.

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* It may be economically reasonable, and desirable, to subsequently refan the entire JT8D portion of the fleet.

In terms of the economic question of which combinations of options are the most efficient to achieve a desired cumulative outdoor noise environment level, the following findings can be stated.

- o The costs of transferring aircraft source noise abatement technology into the civil aviation fleet are always less than the costs of achieving cumulative noise without such transfers.
- o Transferring the aircraft source noise reduction technology into the civil aviation fleet alone cannot eliminate the outdoor noise environment problem around the nation's airports.
- o Source technology cannot be <u>fully</u> implemented into the civil aviation fleet until 1977 at the earliest, and path technology by 1978; however, intermediate relief can occur before this period by the effective exercising of fleet operational procedures, airport operator options and local government land use options. Such intermediate relief <u>must</u> occur, especially the curtailment of further encroachment of population around airports, if the costs of achievement are to be kept at a minimum.
- o The problem of equitable treatment of populations residing near large military airports cannot be ignored and appropriate remedies and costs will have to be developed.

Finally, the achievement of cumulative noise levels around the nation's airports will require international cooperation due to the high level of foreign flag air carrier activity at a number of domestic airports. Questions as to whether, and how, these nations can comply with the domestically developed schedule of achievement, how requisite investment and operating expense enter into their cost functions, and whether such increased achievement costs will be passed through or used as a competitive advantage, must and will be addressed in the subsequent rulemaking study effort.

(c) Cost Allocation and Financing Options

In order to completely evaluate the implications of identifying and achieving given levels of cumulative noise exposure, two additional issues must be addressed: (1) who should pay for the costs of civil noise abatement programs, and (2) how should such programs be funded or financed?

There are a number of cost allocation alternatives which can be determined by various legal/institutional plans. The first is to "let the costs fall where they may." Under such a system, the airport neighbor would continue to bear the economic and social costs of aircraft noise pollution; the aircraft operator along with the passenger and shipper would absorb the cost of noise control devices; and the general taxpayer would, for example, bear the noise-related losses in delivery of public service efficiency. A second possible allocation plan would shift the cost of both noise damages and noise abatement to the general taxpayer through governmental, as opposed to airport proprietor or airline, liability for noise damage compensation and through subsidies to airlines and airports for the implementation of noise control technology and land use options. A third alternative would shift the cost of damages and noise abatement to the air transport consumer, by means of increased landing fees, taxes on air transport use, increased tariffs, etc. Due to market or institutional imperfections, the cost allocation method selected may never exist in pure form. For example, attempts to shift cost to general taxpayers or air transport consumers may not be wholly successful, due to the legal inability in either the short or long term to adjust landing fees, tax rates, or government subsidies.

Furthermore, the distinction must be made between short term financing problems vs. the issues of long-term cost allocations. To install noise abatement equipment creates serious short-term capital finance problems for the airlines. Solution of this problem is a separate though related matter from the question of how such noise abatement cost will ultimately be allocated. Both issues must be addressed and solved.

Allocation of Costs

In economic terms, aircraft noise is a "technological externality." That is, the public costs of noise are not included in the price of air transportation services. Because of this price system defect, these costs therefore fall on economic activities other than those which produce the cost. Economic "welfare" doctrines hold that if the beneficiaries of a given level of air transportation could fully compensate those persons subject to the noise impacts thereof, and still acquire some net benefit, then that level of aviation which produces the noise externality would be economically justifiable (20).

In order to promote the most efficient and rational use of air transportation, economic "efficiency" criteria dictate that air transport beneficiaries must pay the full cost of providing air service, including secondary costs such as those of abating pollution. Economic principles suggest that where such costs are fully internalized, i.e., are included in the price of the service, consumers can more rationally choose among different modes of transportation (21). Only if all costs, including those engendered by noise, are internalized into the aviation industry, will users, beneficiaries and operators of air transport be able to adequately balance all factors in making the most efficient investment and operational decisions. However, in the case of aviation, a large measure of the research and development has already been accepted as proper expenditure on the part of the Federal government, and thus that portion of the cost of control is being borne by the public at large, as a public benefit charge. Likewise, since financing of major projects such as airport land redevelopment may involve the use of traditional measures of financing, the cost of interest and bond retirement may be broadly spread beyong a purely classic internalization of costs.

The following discussion highlights the practical side of this complex issue.

Financing of Costs

Information available at this point indicates that development and implementation of noise control and abatement strategies necessary to achieve specific noise exposure levels will require substantial financial resources. While a few strategies, such as new operating procedures, would not incur large capital investment or increased operating costs, a comprehensive noise abatement program--including research and development of engine noise control technology, retrofit, insulation of residential structures, and relocation of persons within zones of remaining incompatible land uses--will necessitate a major commitment of financial resources and the development of financing methods. Without adequate financing mechanisms, expeditious implementation of a comprehensive program to alleviate even the most severe airport noise impact problems will be impossible.

Implementation of such a comprehensive program will entail commitment of financial resources in a number of public and private sector expenditure areas. For these areas of expenditure, financing methods must be found if the contemplated comprehensive noise reduction program is to be successful (22). A variety of mechanisms have been suggested to fund these expenditure areas. The basic alternative is private market funding of the program elements. However,

99-139 O - 73 - 7

depending upon the degree of noise reduction requirements, private funding capability could be exceeded (17, 22). In this case, other financing alternatives must be employed. Examples of such alternatives are:

- o A passenger head tax and freight tax, of a set amount (e.g., per person and per pound) imposed on all commercial air transport, either "at the gate," or as a surcharge on tickets and freight invoices.*
- o Head and freight tax imposed only at noise-impacted airports.
- o Expanded use of the Airport and Airway Development Act Trust Fund, for use in grants to airports and airlines for noise abatement.
- o A surcharge on the aircraft fuel tax.
- o A "dollars for decibels" landing fee.
- o A general fare increase, either by a fixed amount (e.g. $1 a ticket) or, on a percentage basis (e.g. 1 percent per ticket).
- o Grants to aircraft manufacturers, airlines and airports financed by general tax revenues.
- o Increased airport concession (e.g. parking and restaurant) rentals or fees.
- o Government-guaranteed loans to airlines and airports.

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* The head tax at the gate scheme has just been prohibited by Congress in the recent (P.L. 93-44) AADA two-year appropriation act.

- Interest-bearing loans directly to local governments to finance their options.

Different financing methods may be chosen to fund various noise abatement options and thus a matrix of possible expenditure/financing alternatives must be analyzed, and appropriate choices made therefrom.

To choose the best financing arrangements or combination of options several questions need to be addressed:

- Who has authority to adopt the plan?
- How could it be designed and administered?
- What would be the cost incidence--that is, if adopted, who would ultimately pay for the cost of the noise abatement expenditures so financed?
- How appropriate is the plan for financing the various expenditures required for the achievement of specific cumulative noise levels?

Answers to these questions for feasible financing methods will be developed during the rule making process. However, from the options delineated it appears that Federal legislation and/or administrative action might be required to: (1) establish a loan or grant fund, prescribing the uses, designating the agency responsible for disbursement, setting the amount of the charge, identifying methods of collection, and determining the life or time period of the fund (12); or (2) authorize airports and carriers, (with CAB approval) to impose various tariffs or charges to finance the noise control options for which they are responsible.

In the course of proposing regulations under Section 7(b) of the Noise Control Act of 1972, EPA will carefully explore these questions, and make appropriate recommendations thereon.

Noise and Overall Environmental Policy Implications

A major implication of adopting a cumulative noise exposure system, from the overall environmental policy viewpoint, is the relative impact, if any, on other environmental requirements (such as air quality) arising from the institution of measures to achieve such levels. As an example, if the required procedure for operational flight control to meet a cumulative noise health and welfare limit results in increases in air pollution such that primary (health) air quality standards are jeopardized, the question arises as to what balance is to be struck between these requirements, and how. The Administrator recognizes these practical questions, and will take them into account in any proposals relating to noise regulations as well as to actions regarding air quality requirements.

Adoption of a measure of cumulative noise exposures for identifying and then achieving adequate levels of noise in communities adjacent to airports represents a major environmental policy decision. This arises from the situation that it is inconsistent to utilize one such plan for a particular set of noise sources when those persons exposed thereto are also exposed to noise from a variety of other sources; either in their homes, work, or other life situations.

Congress, in the Noise Control Act of 1972, moreover, has established a division of powers in regard to noise control which assigns to the Federal government those relating to

89-730 O - 73 - 8

control of noise emissions from specific sources, but at the same time reserves to the States and their political subdivisions the power to establish and control ambient cumulative noise levels, with the exception of aviation noise which is subject to Federal preemption and domain. The Congress has charged the Administrator with the responsibility of prescribing recommended noise levels (Section 5 of the Act) to be utilized by State and local governments and also has given him authority to provide advice and assistance to the State and cities in controlling noise through the use of such ambient (and thus cumulative) noise levels. In fact, the one considered in the Aircraft/Airport Noise Study has many advantages over existing plans, due to its simplicity and ease of use for the vast majority of situations. One of the major implications of use of such cumulative noise levels for airports is that such action may make it necessary to adopt such an approach for use in characterizing other noise environments. The impact of adoption of any one system for use for all environmental situations requires further study by EPA.

Keeping in mind the divisions of power established in the Noise Control Act discussed above, there are a number of implications that arise from use of cumulative noise levels for airports; these include:

(1) Under Section 4(c)(2) the EPA has a responsibility to see that standards or regulations with respect to noise regardless of which Federal agency is the origin of such rules, are consistent with protection of the public health and welfare. The use of a common measure for assessing such effects would provide a uniform approach by EPA in dealing with such standards.

(2) A major consideration of the implications of adopting a common measure of cumulative noise exposure relates to the apportionment of responsibility for regulating aircraft noise between the FAA and EPA. By adopting a common measure of cumulative noise exposure it becomes possible to establish goals and schedules for reducing airport noise which are consistent with those for other major noise systems, thereby making possible a coordinated overall program to reduce environmental noise. Furthermore, it would become possible to evaluate regulations proposed by either agency in terms of the beneficial results to public health and welfare since their relationships to cumulative noise exposure will have been established. In summary, the arrangement between the FAA and EPA envisioned by the Noise Control Act of 1972, which allows for exercise of judgments on safety exclusively by the FAA while expecting both agencies to work cooperatively in reducing the impact of aircraft/airport noise, based on cumulative noise exposure, alleviates possible problems and facilitates communication between the agencies and is a viable arrangement.

(3) The provisions of the Noise Control Act require that the EPA establish noise emission performance standards for new products "necessary to protect public health and welfare with an adequate margin of safety." It is clear from a scientific viewpoint that such "per-

formance standards" must somehow or other relate to a general overall environmental health and welfare requirement, or else the Congressional mandate cannot be met. In devoting attention to the principal sources of noise in a specific situation such as noise from aircraft, consideration must be given to the other contributing sources of noise even through the predominate source may be the major offender. The use of cumulative noise levels affords a planning tool which, with some limitations, takes into account the relative contribution of various sources. Thus if intelligently used, it can be a major aid in the overall product regulation process the Agency is required to undertake. Use of this methodology, however, also presents some difficulty in that there are possible over-simplifications of interpretation of the relation between source emission control (the Federal responsibility) and restrictions on use or other limitations (a State and local matter).

Lastly, adoption of a cumulative noise level represents a major policy decision for the Federal government in that this will constitute its acceptance of full responsibility for establishing the limits within which aircraft noise is to be controlled. In so doing, as the Administrator now contemplates recommending, there will result preemption of the State and Local levels of government, as envisioned in the

Supreme Court *Burbank* decision, with attendant possible Federal liabilities. At the same time, those lesser powers still must be brought to bear, in juxtaposition with the Federal authority, on those elements of action needed to meet such limits for which, as described in the following section, there are no Federal police powers.

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SECTION 4

ADDITIONAL MEASURES AVAILABLE TO AIRPORT OPERATORS AND LOCAL GOVERNMENTS TO CONTROL AIRCRAFT NOISE

The types of actions which may be taken at or near individual airports, to limit exposure of people to aircraft noise, fall into two main categories: (1) actions to limit the noise environment generated by operations at the airport; (2) actions to prevent incompatible land uses from building up around the airport, thus placing people within the airport's noise environment.

The noise environment generated by activity at an airport results from a progression of actions, some of which are under the airport proprietor's control, except to the extent that there is funding and approval from the FAA. These include, for example, the initial site selection for the airport, the layout of the runways as related to surrounding land uses, the location of engine maintenance runup areas, the amount and location of land purchased for airport purposes, and the progressive additions to airport facilities which allow entry of new types of aircraft or greater numbers of aircraft. It is not clear from the Burbank decision if the airport proprietor may or may not in leases and contracts with airport tenants (including airlines, fixed base operators and others) place conditions upon the use of the airport property; e.g., restrictions on the types of aircraft which may use the airport, number of operation per day per lessee, hours of operation of the airport, noise limits to be complied with, etc. Beyond actions of this type, actions which the airport operator may devise to control the noise environment generated at the airport require either (a) the voluntary cooperation of others or (b) the imposition of a higher authority not available to the airport proprietor itself. As explained above, since the enactment of the Noise Control Act of 1972 and the decision in Burbank, it is not at all clear what further legal authority remains with the airport proprietor and what has been or will be assumed by the Federal Government. It is quite clear, however, that local governments acting in any capacity other than airport proprietor have no authority by which they can control noise environments at airports. Further detail on this subject, and the history of attempts by both State and local governments to control airport noise by a variety of legal means, are contained in the report of the EPA Aircraft/Airport Noise Study Task Force (1).

On the other hand, the legal authority of local governments to control the development of land use around airports is inherent in the land use planning, zoning, building code and building permit authority which States have traditionally delegated to local government. With reference to new construction, these authorities are adequate, if applied, to permit cities and counties in the vicinity of an airport to coordinate their zoning and building codes with the projected noise environment of the airport. Thus, open space or other noise compatible uses (e.g., industrial, commercial) can be required in zones of severe noise impact and the quieter areas reserved for residential use. In the case of a new airport, the extent of land area to be so controlled may be reduced by fee purchase of the projected impact area or a large fraction thereof, with the potential for subsequent lease or resale with deed restrictions. Building construction providing a high degree of noise insulation can be required by performance standards in building codes, where exterior noise levels are high but only the interior building uses are of importance.

Major air carrier airports typically generate noise environments of such extent and scale that the land for which uses should be controlled often falls within the jurisdiction of several separate local governments. In many cases the airport property boundary itself may adjoin several municipalities or the airport property may be entirely within a jurisdiction separate from that which owns the airport. The coordinative role of regional government, local councils of governments, or some special purpose regional commission or airport development district created by the State may then be applied to guide development of airport-noise-affected land. Examples of such mechanisms in action are provided by the Dallas-Fort Worth Regional Airport; the Kansas City International Airport; the California Airport Land Use Commissions, and the Minnesota Airport Zoning Act (the latter two being in very early stages of implementation).

Zoning, however, like every exercise of police power, is limited by applicable constitutional requirements. This means at least three things. First, the restrictions imposed on property may not be so severe as to deprive the owner of all, or substantially all, of its beneficial use. Applied more particularly, this rule prohibits legislation that limits the use of property to purposes for which there is no reasonable economic demand. Second, a zoning enactment cannot be arbitrary, capricious or unreasonable as applied to any particular land owner, or group of owners; hence, noise-related zoning should be part of a comprehensive plan for the area. And third, zoning may not be employed as a substitute for use of the condemnation power when an analysis of the governmental action involved discloses that the government is, for its own purposes acquiring, using, or in the words of the courts, "taking" the zoned property. The second and third limitations have thus far been the principal impediments to effective airport land use planning based upon the zoning power.

In spite of the foregoing restrictions, zoning and building construction controls offer major potential for prevention of airport noise problems. Nevertheless, zoning and building control techniques generally have been infrequently used and continue to be ignored in most localities. This has been one of the major factors in the development of the severe noise impact problems which exist around many airports today.

When the problem to be resolved is an existing impact situation, the measures available to both airport proprietors and local governments (in land use conversion, retroactive soundproofing of homes, etc.) are most expensive, compared with the situation where new construction is involved. Also, most airport proprietors do not have authority to condemn and acquire land except for direct airport purposes or as a result of an inverse condemnation action. More importantly, local governments cannot use zoning to change a preexisting, nonconforming use, but instead must apply eminent domain powers and compensate the landowner for the taking involved.

To put the existing impact situation in its proper perspective, it must be emphasized that conversion to compatible land use can be very expensive. It requires condemnation in the form of "downward zoning" or outright taking, both of which require just compensation. In other cases, it will require sound insulation, which may cost between $3,000 and $15,000 a dwelling unit, and which provides a solution only for those indoors. But the authority exists and the subsequent conversion of the taken property to commercial or industrial use may well result in economic gain.

A discussion of the legal aspects of land use control for airport compatability purposes is contained in Reference 1 and in greater detail in Reference 2. Attention is also invited to HUD's recently published report, "Aircraft Noise Impact: Planning Guidelines for Local Agencies." Noise compatible land use as well as noise source control costs are included in cost effectiveness analyses contained in Reference 3.

It is quite evident that the actual ability of airport proprietors and State and local governmental agencies to control aircraft noise at existing airports is relatively limited. For new airports they have some additional capabilities, but again, these are extremely circumscribed in their effectiveness. In both cases, the limitations are especially acute when there are numerous political jurisdictions involved (as is often the situation), even where they have been organized into a regional council of governments structure.

The exercise of the police powers of the State and local governments and the proprietary rights of the airport operators have to date not been successful in preventing residential encroachment into aircraft noise impacted areas. Only the indirect consideration of noise as a factor in approval of Federally insured mortgages for residential development, has been shown to be of value in this regard (1).

Taking all of the above, together with the Burbank decision, it would appear that the States, local governments and airport proprietors are severely limited in ability to act and that there is an implication that the full burden of controlling aircraft noise rests on the Federal Government. The fact is, however, that the effective application of such powers and authorities, as are available outside the Federal Government, is a necessary component of a comprehensive aircraft noise control program. This is of critical importance with regard to new airport siting and construction; a major factor in relation to proposed expansion of existing facilities, and absolutely vital to any planned, orderly redevelopment of existing impacted areas.

A Federal implementation procedure is necessary for the Congressional assignment to provide technical assistance to local governments and to prepare model State and local legislation and model codes for noise control. The Agency already has initiated action, with the Council of State Governments, to develop recommended overall state noise legislation. It has plans for continuation of this activity; and is presently engaged in the development of an aggressive program of expansion of this responsibility. Likewise, under Section 14(3) of the Noise Control Act, the Administrator has the authority to disseminate to the public (and this would include airport proprietors) information on techniques for noise measurement and control. As a result of the findings of the present study, we are presently developing proposals for joint efforts with the Department of Transportation and Federal Aviation Administration and the affected interests such as the Airport Operators Council International for a more comprehensive approach to education and guidance of proprietors in this area of responsibility.

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SUMMARY

In compliance with Section 7(a) of the Noise Control Act of 1972, the Agency has examined:

(1) The adequacy of Federal Aviation Administration flight and operational noise controls;

(2) The adequacy of noise emission standards on new and existing aircraft, together with recommendations on the retrofitting and phaseout of existing aircraft;

(3) The implications of identifying and achieving levels of cumulative noise exposure around airports;

(4) Additional measures available to airport operators and local governments to control aircraft noise.

The Agency has considered the effects of noise, the magnitude of the noise problem, noise reduction by source technology and other alternatives.

Our Principal Findings Are:

o High levels of noise cause widespread annoyance and disturbance of speech and may in some cases cause hearing damage. An estimated 16 million people are presently subjected to a wide range of aircraft noise effects varying from very severe to moderate.

o A comprehensive national program for aircraft/airport noise abatement is needed to insure that the noise control options available to the aircraft manufacturers and operators, the airport operators, the Federal Governemtn and other public authorities are implemented to the extent necessary to protect the public health and welfare.

o Aircraft noise around airports is presently a principal constraint on the future growth of the air transportation system.

o Currently available technology is capable of being translated into flight worthy hardware that, together with employment of noise abatement flight procedures, can significantly decrease the noise impact from aircraft.

o While new aircraft types are presently required to meet FAR Part 36 Appendix C noise levels, only about 10% of approximately 2000 existing U.S. aircraft meet these standards. Except for the Concorde and TU 144 supersonic transports, currently available technology can permit the existing aircraft to at least meet FAR 36 noise levels and also allow for significant reductions below these levels for new aircraft (depending upon the aircraft type and the measuring point).

o With respect to retrofitting the existing air carrier fleet, the prime technological contenders are the nacelle acoustical treatment retrofit and the refan retrofit. Nacelle treatment is a demonstrated technology that can reduce aircraft noise to FAR 36 levels in the shortest time and at least cost. Refan has the potential for greater noise reduction but it has not been sound or flight tested, so the time required is longer, the risk greater, and the cost higher.

o Business jet aircraft manufacturers are developing modification kits and re-engine alternatives to enable these aircraft to meet the noise standards of FAR 36.

o A number of noise abatement flight procedures are currently in use in scattered parts of the air transportation system. These include: maximum angle (full power) climbouts, power cutback climbouts, reduced thrust takeoffs, higher approach glide slopes, flap management approaches, two segment approaches, and higher minimum altitudes. If implemented at additional airports, where appropriate, use of these procedures would provide meaningful noise relief.

o The most effective use of technology to achieve maximum noise control is in the design and development of new aircraft systems. Consequently, noise abatement research and development (both for source control and flight procedures) must continue to be adequately funded to insure that these new aircraft systems evolve with the capability for substantially less noise impact than exists for current aircraft.

o The only realistic way of adequately assessing the impact of aircraft noise at and around airports is to use a measure of cumulative noise level. Such a measure has been developed for use in this study, based on the currently established specific and direct effects of noise on the health and environmental welfare of humans. For a range of values of this measure (called "day-night average sound level" and abbreviated L_{dn}) the statistical probability of occurrence, for an exposed population, of the following specific effects have been presented: risk of permenent hearing impairment, direct interference with speech communications, and annoyance. The implications for public health and welfare protection, through achievement of the most protective level of cumulative noise considered here, amounts to approximately 16 million people, or approximately 40 percent of the persons presently impacted by transportation noise in urban communities.

o Achieving progressively lower levels of cumulative noise near airports has specific economic implications. Implementation of flight procedures, nacelle retrofit of a portion of the commercial jet fleet and sound suppression kit retrofit of business jets, where necessary, are the least expensive approaches and most expeditious to nearly eliminate public health and welfare impacts around airport environs. Complete implementation can possibly occur in five years at an estimated total investment and operational cost of less than one billion dollars. Achievement of lower cumulative noise levels around airports will require, in addition to retrofitting more effective noise reduction technology into the existing fleet, introduction of quieter aircraft, land use conversion, residential soundproofing and airport related operations control. It is estimated to cost in the range of 5-13 billion dollars to acheive levels of noise indicative of speech interference (Ldn 70)* and of 6-22 billion dollars to achieve levels of the threshold of community annoyance (Ldn 60). These 1973 constant dollar costs move toward the lower values cited, the earlier the more effective source noise.

*These values are not to be considered indicative of a specific EPA recommended value.

control hardware becomes available and is retrofit into the commercial fleet. Some forms of financial assistance may be needed by those affected by an expeditious implementation of a cumulative noise reduction program.

o Maximum cumulative noise levels around airports could be specified by the Federal Government as modifications to the FAA Airport Certification Regulation.

o Separate legal implications are associated with "identifying" and with "achieving" levels of cumulative noise adequate to protect the public health and welfare from aircraft/airport noise:

1. Identification of cumulative noise levels at particular airports to protect public health and welfare could be used to support additional litigation against airport owners. This could follow from the mere act of "identification."

2. Under the Burbank decision, overall Federal regulation is necessary.

3. Federal regulation, including Federal airport noise certification may shift liability from airport owners to the Federal Government; but "achievement" should reduce airport noise liability. There are also possible liabilities for the Federal Government as the proprietor of military airports.

4. Any shift in liability to the Federal Government may be a problem during the period between Federal identification and the achievement of noise levels requisite to protect the public health and welfare. If the court were to hold that liability had shifted by reason of preemption, a legislative solution for the interim period is unlikely because liability would probably be based on the constitutional requirement that just compensation must be paid for the taking of property.

Airport proprietors may under some conditions and depending upon in some situations interpretation by the courts either by airport rule or in leases with airport tenants, place conditions upon the use of the airport property, such as restrictions on the types of aircraft which may use the airport, number of operations per day per lessee, hours of operation of the airport, noise limits to be complied with, or a schedule of landing fees based on noise generated. However, it must be emphasized that the proprietary right to write noise conditions into leases or adopt airport rules may well be denied if they result in a substantial burden on interstate air commerce.

o Local governments can and must develop compatible land use controls around airports using appropriate cumulative noise criteria.

Based on these findings, and on the noise criteria document and environmental noise document to be published pursuant to

Section 5 of the Noise Control Act of 1972, EPA intends to take the following actions as authorized by Section 7(b) of the Act:

o In order to obtain an environment consistent with public health and welfare needs with respect to noise, the Environmental Protection Agency will propose to the Federal Aviation Administration:

--Regulations concerning flight and operational noise controls. The regulations will include options for takeoff procedures, approach and landing procedures, and minimum flight altitudes.

--Amendments to FAR Part 36 to specify lower noise levels for future aircraft.

--Regulations to control and reduce the noise emissions from existing aircraft. The FAA's proposed Fleet Noise Level (FNL) methodology will be considered as a flexible means of promoting any of the source technology options (nacelle treatment, refan, or aircraft replacement.)

--Cooperative actions to develop an airport noise certification regulation that will assure control over cumulative noise near airports.

EPA recognizes that the implementation of a national airport noise certification program encompasses a number of interrelated aspects requiring thorough and careful review. The acquisition of substantial information, in addition to that already available to EPA, is required from all parties - governmental, public interest groups, industry, private citizens - to permit evaluation and interpretation of the benefits and costs associated with the noise levels requiring certification. Of particular interest for further study, for example, are the impact of various noise levels relative to:

- interference with interstate commerce;
- cost of implementation and methods of financing;
- airport operator control over non-airport noise contributing to the cumulative noise level around airports;
- effect on existing international air-transport agreements on airport use;
- enforcement with respect to (1) existing land uses and future zoning actions around airports which are beyond the control of the airport operator; and (2) pilot flexibility necessary for aircraft operation;
- time-phasing for airports to achieve standards; and
- sensitivity to total population impact and benefits to be achieved.

EPA will vigorously undertake the responsibilities for coordinating Federal noise control and Federal noise research and development activities, as provided for in Section 4 of the Act. It will also amplify the present activities relating to assistance to State and local government model legislation, and in providing advice and information to the public.

The cumulative noise level concept is useful; not only because it summarizes the total contriution of individual noise sources, but because it also allows decision makers to take into account the total benefits associated with the achievement of a particular level.

Taking all of the above actions as a whole, the Agency will in effect be establishing a comprehensive set of national aviation noise reduction objectives. These will be critically viewed against the health and welfare criteria and environmental effects goals now being prepared, along with further information on technology, economics and other factors, and revised accordingly. In so doing the Agency will continue its present practice of consultation with the various affected interests, and with other Federal Agencies. The periodic Reports to the Congress, called for in the Act, will provide information as to an evaluation of the effectiveness of progress toward achieving a comprehensive national pattern of action to meet the objectives of the Act.