United States General Accounting Office

GAO

Report to Congressional Requesters

April 2000

AVIATION AND THE ENVIRONMENT

FAA's Role in Major Airport Noise Programs

GAO/RCED-00-98

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Abbreviations

AIP	Airport Improvement Program
FAA	Federal Aviation Administration
GAO	General Accounting Office
PFC	Passenger Facility Charge

GAO
Accountability * Integrity * Reliability

United States General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

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Congressional Requesters

In response to your request, this report discusses issues related to airport noise, describing, in particular, (1) the eligibility of noise reduction and mitigation projects for federally authorized funding, (2) methods for measuring airport noise, (3) aircraft noise standards for civil subsonic turbojets, and (4) the Federal Aviation Administration's Land Use Planing Initiative, which was designed to facilitate state and local land use planning for areas near airports.

As agreed with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 14 days after the date of this letter. At that time, we will send copies to the appropriate congressional committees; the Honorable Rodney E. Slater, Secretary of Transportation; and the Honorable Jane F. Garvey, Administrator, Federal Aviation Administration. We will also make copies available to other interested parties upon request.

If you or your staff have any questions about this report, please contact me or Belva Martin, Assistant Director, at (202) 512-2834. Major contributors to this report are listed in appendix X.

Gerald L. Dillingham, Ph.D
Associate Director, Transportation Issues

List of Requesters

The Honorable John J. Duncan, Jr.
Chairman
The Honorable William O. Lipinski
Ranking Democratic Member
Subcommittee on Aviation
Committee on Transportation and Infrastructure
House of Representatives

The Honorable Bob Franks
The Honorable Frank A. LoBiondo
The Honorable Robert Menendez
The Honorable William Pascrell, Jr.
The Honorable Steven R. Rothman
House of Representatives

Executive Summary

Purpose

Since the late 1950s, noise from aircraft and other airport operations has generated controversy with many surrounding communities and has emerged as a constraint on airport development. New technology is making aircraft quieter, but expected growth in air traffic may limit the net reduction in overall noise levels generated by individual airports. The Federal Aviation Administration (FAA) is responsible for several federal programs and policies concerning airport-related noise and must consult with the Environmental Protection Agency regarding some of its responsibilities. FAA administers two programs that fund airports' capital development projects, including noise-related projects: the Airport Improvement Program (AIP), which is a federal grant program funded by appropriations from the Airport and Airway Trust Fund, and the Passenger Facility Charge (PFC) program, which allows airports to charge passengers a fee and retain these fees for their use, subject to FAA approval. Together, these programs have recently provided airports with about $3 billion a year; of that total, about $284 million was targeted in fiscal year 1999 for projects to reduce airport-related noise or mitigate its effects. FAA is also responsible for choosing the method used to measure the noise from airports and for establishing standards that limit the noise that aircraft may generate. Furthermore, FAA has recently embarked on a Land Use Planning Initiative to help mitigate the effects of airport-related noise by facilitating state and local land use planning for communities near airports.

Because of concerns about airport-related noise, the Subcommittee on Aviation, House Committee on Transportation and Infrastructure, and several Members of the House of Representatives asked GAO to determine (1) the types of projects that are eligible for federally authorized funding to reduce airport-related noise or mitigate its effects, (2) the differences in the major methods for measuring the impact of airport-related noise, (3) FAA's current noise standards for civil subsonic turbojets and the reasons some of those aircraft are not required to comply with these or earlier standards, and (4) the status of FAA's Land Use Planning Initiative and the major issues the initiative has raised about how best to address airport-related noise.

Background

Airport-related noise emanates primarily from the takeoff and landing of aircraft. Engine maintenance and the taxiing of aircraft on runways are other activities that contribute to airport-related noise. The impact of such noise on communities is usually analyzed in terms of the extent to which the noise annoys people by interfering with their normal activities, such as sleep, relaxation, speech, television, school, and business operations. According to a 1978 study that has become the generally accepted model for assessing the effects of long-term noise exposure, when sound exposure levels are measured by the method that assigns additional weight to sounds occurring at night (between 10 p.m. and 7 a.m.), and those sound levels exceed 65 decibels, individuals report a noticeable increase in annoyance.[1]

FAA implements several federal programs that address noise issues associated with civilian airports.[2] In addition to the AIP and PFC funding programs, FAA administers an airport noise compatibility planning program, for which it developed guidance on the types of land uses that are compatible or incompatible with certain levels of airport-related noise. This program encourages airports to identify nearby incompatible land uses and to develop a program to reduce and prevent such uses. Under FAA's guidance for this program, any land use is considered compatible where the average cumulative airport-related noise level is below 65 decibels, when measured by the method that assigns additional weight to sound from flights that occur at night. At noise exposure levels at or above 65 decibels, homes, schools, and hospitals are considered to be incompatible, while other uses—such as heavy and light industry—are considered compatible.

FAA has also been concerned that forecast growth in the demand for air transportation will increase airport-related noise at some airports, even as aircraft are becoming quieter. As a result, FAA has embarked on a Land Use Planning Initiative to identify federal actions that could promote compatible land use planning by states and localities. As part of that initiative, FAA sponsored a special study to identify recommended actions,

[1]T.J. Schultz, "Synthesis of Social Surveys on Noise Annoyance," *Journal of the Acoustical Society of America* 64(2): (1978), pp. 377-405.

[2]This report addresses noise issues related to civilian airports only. The Department of Defense is responsible for noise issues related to military airports.

and it requested comments and suggestions from the aviation community and the general public.

Results in Brief

Most projects that reduce airport-related noise or mitigate its impact—such as soundproofing buildings—are eligible for federally authorized funding. To be considered for funding under the Airport Improvement Program, however, a project must, with a few exceptions, be part of an FAA-approved noise compatibility program. In selecting which noise-related projects to fund, FAA gives priority to projects affecting communities exposed to noise levels of 65 decibels or higher, as determined by FAA's chosen measurement method. FAA also gives priority to projects that rank higher than other projects on the basis of factors such as airport size and project type. In contrast to projects funded by the Airport Improvement Program, projects funded by the Passenger Facility Charge program do not have to be part of a noise compatibility program; also, under the Passenger Facility Charge program airports set their own priorities for which noise-related projects they will fund, subject to FAA approval. Since the programs began, 75 percent of the grants and over 50 percent of the passenger fees approved for noise-related projects have been used to acquire land and soundproof homes and other buildings.

Measures of airport-related noise identify noise levels from a single takeoff or landing or the average cumulative noise levels that communities near airports are exposed to over time. Methods for measuring a single takeoff or landing generally identify either the maximum sound level generated by the event or the total sound of the event. Methods for measuring the average cumulative noise levels that communities are exposed to identify those geographic areas exposed to the same noise levels. The three principal methods for measuring community exposure are mathematical calculations that differ in the impact each places on noise from flights that occur during different times of a day. One method treats the impact of all flights equally whenever they occur; the second method differs from the first by assigning greater impact to the noise from each flight that occurs during the nighttime (10 p.m. to 7 a.m.) than to flights that occur during other times; the third method assigns additional impact to evening flights (flights between 7 p.m. and 10 p.m.) as well as to nighttime flights. In response to a statutory directive to establish a single system for determining the exposure of people to airport-related noise, FAA chose the second method, which gives more weight to nighttime flights.

Noise standards for regulating aircraft noise from civil subsonic turbojets are generally based on an aircraft's weight and number of engines. Essentially, the heavier the aircraft and the greater the number of engines, the more noise the aircraft is allowed to generate and still comply with the required noise limits. For example, a four-engine aircraft weighing 212,500 pounds or more is allowed to make more noise on takeoff than a lighter aircraft with the same number of engines. The standards allow heavier aircraft to be noisier than lighter aircraft because aircraft noise is generally determined by the thrust powering the aircraft—the heavier the aircraft, the more thrust it needs. The newest set of standards—known as stage 3 standards—apply to all aircraft weighing more than 75,000 pounds and to newly manufactured aircraft weighing 75,000 pounds or less. The Airport Noise and Capacity Act of 1990 mandated the retirement of heavier aircraft not meeting stage 3 standards but not of aircraft weighing 75,000 pounds or less. These lighter aircraft also did not have to be retired under earlier noise standards because FAA concluded that it was questionable whether the technology existed to modify those aircraft in a cost-effective manner.

Under its Land Use Planning Initiative, FAA announced five short-term actions in May 1999 designed primarily to provide information that state and local governments can use to improve the compatibility of land uses near airports. For example, FAA created a website on the Internet to serve as an information clearinghouse, and it plans to announce additional actions in the future. Based on comments provided by the aviation sector and the general public, there are four principal areas of concern associated with the initiative. These four areas involve determining (1) the most effective use of the agency's limited resources when addressing airport-related noise; (2) whether the 65 decibel level defining incompatible land uses should be lowered; (3) whether additional information, such as single event noise levels, should be required when analyzing noise impacts; and (4) the best use of federally authorized investment in the growth of airport capacity in view of noise and physical expansion constraints at many airports.

Principal Findings

Most Types of Noise-Related Projects Are Eligible for Funding, but FAA Policies Affect Project Selection for Grants

Most kinds of projects that reduce airport-related noise or mitigate its impact on surrounding communities are eligible for funds through the AIP and the PFC program. The types of projects eligible include such things as acquiring homes and relocating people, soundproofing homes and other buildings, and constructing noise barriers. However, federal statutes governing the AIP (1) place some restrictions on the use of grant funds to acquire land and (2) with a few exceptions, require that projects be part of an FAA-approved noise compatibility program in order to be eligible for AIP funds. Federal appropriations law prohibits the use of AIP funds for studies, maps, or environmental impact analyses needed to implement flight procedure changes made to reduce noise because these costs are paid for by other appropriated funds for air traffic control. Furthermore, FAA policy prohibits approving projects in airport noise compatibility programs if the project provides remedial noise mitigation for new buildings that were known to be incompatible with prevailing noise levels before they were built.

To select which eligible projects will receive AIP funding, the agency sets priorities for eligible projects in two ways: (1) by giving priority, among noise-related projects, to projects in communities exposed to average cumulative noise levels of 65 decibels or higher and (2) by comparatively ranking all AIP-eligible projects, including noise-related projects, on the basis of several factors. The comparative ranking of projects is based on a formula that assigns a numerical score to projects on the basis of factors such as project type and airport size. For example, more points are given for projects that increase safety and security than for noise mitigation projects, and more points are given for projects at larger airports than for projects at smaller airports. FAA also considers qualitative factors, such as state and local airport plans and airport growth, in determining a project's final ranking.

FAA officials stated that FAA has applied an annual cap on the amount of AIP grants approved for noise-related projects at a single airport—$5 million for noise mitigation projects and $3 million for insulating public buildings used primarily for educational or medical purposes. The administrative caps are imposed when the demand for funds set aside for airport-related noise projects exceeds the amount available and are

intended to ensure that all airports that need funding for noise projects have access to AIP funds.

The PFC program is a voluntary program that provides commercial service airports with a more flexible funding source than the AIP. In addition to paying for the types of projects eligible for AIP grants, PFC funds may pay project financing costs, and projects do not have to be part of a noise compatibility program. Airports can set their own priorities for project funding, subject to FAA approval.

Since the AIP and the PFC program began, most funds used for noise-related projects have been used to acquire land and to soundproof buildings. This pattern generally holds true for both large and small airports.

Noise Measurement Methods Provide Different Kinds of Information

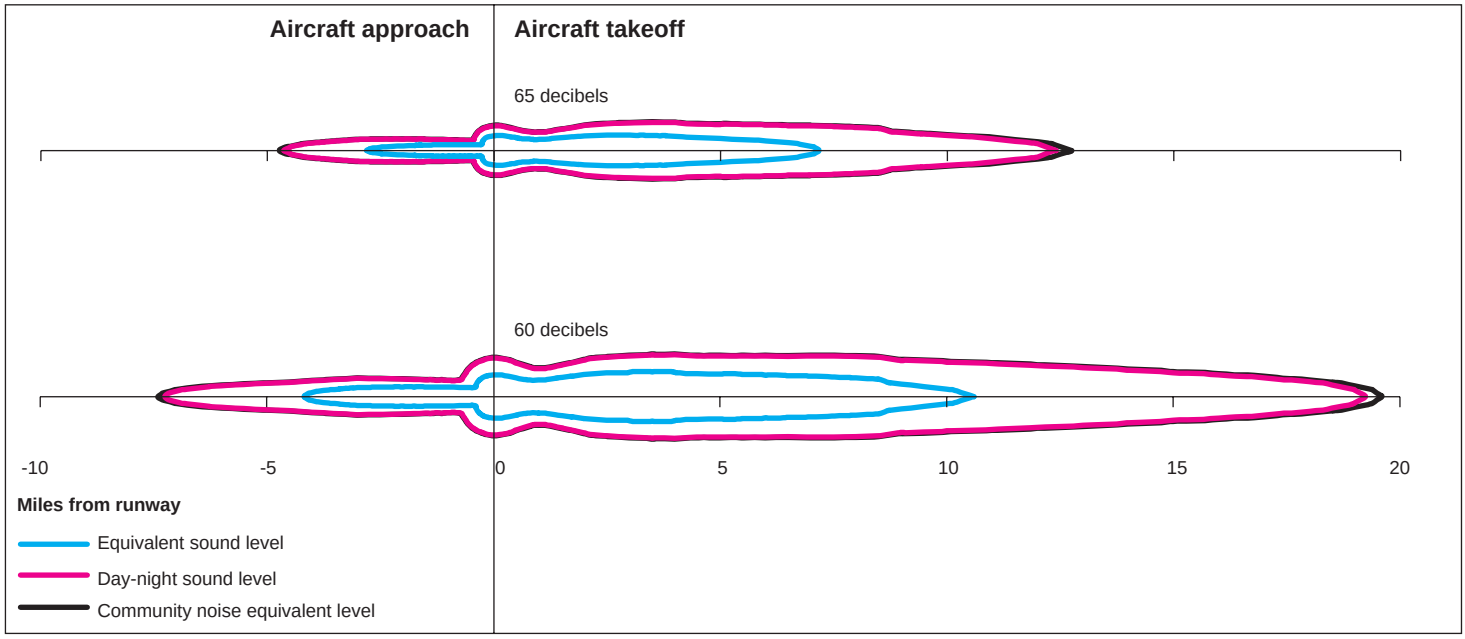
Methods for measuring airport-related noise identify noise levels from a single takeoff or landing or the average cumulative noise levels that communities near airports are exposed to over time. Within these two categories, different methods provide different kinds of information about airport-related noise.

There are two principal methods for measuring the sound generated by a single aircraft landing or takeoff: the (1) Maximum Sound Level, which identifies the maximum sound level that the event produces and (2) Sound Exposure Level, which identifies the cumulative sound that a person is exposed to during the event if the sound were compressed into one second of time.

There are three principal methods for measuring the average cumulative exposure of nearby communities to airport-related noise. Those three methods identify noise contours on a map of the area surrounding an airport, similar to the lines on a map that illustrates land elevations. Each method produces different noise contours for a given airport because each assigns different weights to flights occurring during different times of day. One method, known as the Equivalent Sound Level method, treats the impact of noise from all flights equally regardless of the time of day. A second method, the Day-Night Sound Level method, adds weight for flights occurring between 10 p.m. and 7 a.m. (nighttime flights). The third method, the Community Noise Equivalent Level method, adds the same weight to nighttime flights as the second method but also assigns added weight for flights occurring between 7 p.m. and 10 p.m. (evening flights). The added

weight to evening and/or nighttime flights is designed to reflect the higher degree of annoyance such flights are believed to cause by interfering with sleep, conversation, or similar activities. Figure 1 shows the differences in the measurements produced by the three methods. These noise contours are based on an airport model GAO developed.

Figure 1: Noise Contours at 65 and 60 Decibels for Three Measurement Methods



Note: These diagrams illustrate the comparative geographical size of the noise contours produced by the aircraft that land at and take off from the airport structure used in our model. As the mileage markers indicate, aircraft are approaching the airport runway from the left of the diagram and are taking off towards the right of the diagram. The vertical demarcation at zero miles is the beginning of the airport runway. For a specific airport, these contours would be delineated on a geographic map that illustrates the airport and identifies the communities around the airport.

FAA chose the Day-Night Sound Level method for measuring the impact of airport-related noise. Aviation experts generally agree that this method best meets the statutory requirement that FAA establish a single system for determining the exposure of people to airport-related noise.

Civil Subsonic Turbojet Aircraft Noise Standards Vary by Aircraft Weight and Number of Engines

Pursuant to statutory directive, FAA establishes the noise standards—limits on the noise that aircraft may generate—for civil subsonic turbojet aircraft. Since the late 1960s, FAA has set increasingly stringent noise standards for those aircraft. Noise standards are generally based on an aircraft's weight and the number of engines. Different standards are prescribed for takeoff, landing, and sideline emissions.[3] Noise standards were first applied to new aircraft designs, later to newly manufactured aircraft, and finally, retroactively to some existing aircraft. As a result, some aircraft are in operation that are not required to meet the most recent noise limits.

The current standards, known as stage 3 standards, permit higher noise levels for heavier aircraft because the noise generated by an aircraft is generally determined by the thrust powering the aircraft—the heavier the aircraft, the more thrust it needs. Also, aircraft with more engines are generally permitted to have higher takeoff noise levels than aircraft weighing the same but with fewer engines. According to a 1990 act, all civil subsonic turbojet aircraft weighing more than 75,000 pounds had to be retired from operations by December 31, 1999, if they did not meet stage 3 standards.

However, the statute did not impose this requirement on such existing aircraft weighing 75,000 pounds or less. These aircraft also did not have to be retired if they did not meet earlier noise standards, known as stage 2 standards, which FAA imposed in 1977, because FAA determined that the cost-effectiveness of implementing the necessary modifications was questionable.

As of October 1, 1999, there were just over 9,000 civil subsonic turbojets weighing 75,000 pounds or less that FAA had certified as airworthy, and about 31 percent of these are not required to meet stage 3 standards.

FAA's Land Use Planning Initiative Focuses First on Improving Access to Information

Land use planning is one way that communities can alleviate the impact of airport-related noise. For example, communities may prohibit the construction of schools within a certain distance from an airport so that airport-related noise will not interrupt classes. While the federal

[3]Sideline noise is measured at points equidistant from both sides of an aircraft when the aircraft reaches the altitude where sideline noise is at a maximum.

government has no decision-making role in land use planning, FAA reviews and approves, as required by statute, airport noise compatibility programs and identifies land uses that it considers compatible or incompatible with various noise exposure levels. FAA has recently embarked on a Land Use Planning Initiative, which is intended to encourage and assist state and local governments to prevent future incompatible land uses near airports.

Under this Initiative, FAA requested—in a May 1998 *Federal Register* notice—suggestions for promoting compatible land use planning by state and local governments. After reviewing the submissions, FAA announced in May 1999 five short-term actions it would undertake: (1) develop an information package on land use planning, (2) develop an information package on land use statutes, (3) establish an information clearinghouse, (4) develop procedures to rapidly respond to inquiries from local communities and airports, and (5) clarify the actions it will consider when noise levels begin to rise in certain areas. As of April 26, 2000, FAA had implemented the third and fifth actions and expected the remaining actions to be implemented by May 2000.

In reviewing public comments on the initiative and discussing it with aviation officials and other experts, GAO found that the initiative has highlighted some key questions about how best to address airport-related noise: (1) Should FAA's role in land use planning be more proactive or should it focus its limited resources on activities over which it has direct jurisdiction? (2) Should the noise exposure level defining compatible land use be lowered or retained at 65 decibels using the Day-Night Sound Level method? (3) Should the use of supplemental information, such as single event noise measures, be required when measuring noise impacts for environmental impact analyses of airport development projects? and (4) How should federally authorized investment in the growth of airport capacity be directed in view of the noise and physical expansion constraints facing so many of the nation's airports?

Agency Comments

GAO provided the Department of Transportation, the National Association of State Aviation Officials, an advisory panel of five experts, the Airports Council International-North America, the General Aviation Manufacturers Association, and the Air Transport Association of America, Inc. with copies of the draft report for their review and comment.

GAO met with officials from the Department of Transportation, including FAA's Manager, Community and Environmental Needs Division, and spoke

with FAA's Manager, Noise Division. These officials generally agreed with the facts in the report and provided clarifying comments, which were incorporated as appropriate. The National Association of State Aviation Officials and the advisory panel of experts generally agreed with the facts in the report and provided technical and clarifying comments, which were incorporated as appropriate. The Airports Council International-North America provided no comments.

GAO spoke with the President of the General Aviation Manufacturers Association, who stated that the report reflects a good effort to make a difficult topic understandable, but was concerned that the draft report (1) implied that aircraft not subject to phased compliance with operating noise limits were not subject to any noise standards; (2) did not explain that the exception of lighter aircraft from compliance with stage 3 operating noise limits was consistent with international operating rules; and (3) overestimated how many aircraft weighing 75,000 pounds or less still operate in the United States. The President further believed the general aviation aircraft selected for the airport model were not representative of the operating fleet.

With regard to the Association's first concern, while GAO believes the draft report accurately explained the progressive application of noise standards to aircraft, it revised the draft to clarify this point. Regarding the second concern, this report focuses on FAA's role rather than on international activities. Nevertheless, the draft report was revised to clarify that the United States is a member of the International Civil Aviation Organization and as such participates in that organization's activities regarding aircraft noise standards. Concerning the final issue, data in the draft report on the number of aircraft weighing 75,000 pounds or less include all such aircraft certificated by FAA as airworthy. In contrast, data provided by the Association include only the operating business fleet, which is a subset of FAA's list of certificated aircraft. With regard to the selection of aircraft for the model, GAO began with the universe of certificated aircraft and selected two general aviation aircraft from this list, as well as four others. The draft report was revised to clarify that aircraft were selected from the list of certificated aircraft.

GAO met with officials from the Air Transport Association of America, Inc., who stated that the draft report was generally very good, but who expressed concern that the draft report (1) did not fully recognize the significant progress that the Congress, FAA, airports, and the airlines have made in reducing the number of people exposed to noise from aircraft;

(2) did not fully reflect the role of international agreements and obligations related to noise control; (3) was overly broad in its discussion of flight procedures for abating noise; (4) included only two aircraft in the airport model, one of which is no longer being produced, and did not address current production aircraft; and (5) did not fully reflect the potential trade-offs between noise stringency standards and aircraft emissions.

With regard to the first concern, GAO agrees that the aviation industry and the federal government have made substantial progress in reducing noise generated by airports. However, forecast growth in aviation activity could reduce or eliminate the benefits at individual airports. The draft report was revised to clarify these points. With regard to the second issue, GAO agrees that the international administrative and regulatory framework for developing and implementing aircraft noise standards is important for the aviation industry. However, this report focuses on FAA's role rather than on international activities. Nevertheless, the draft report was revised to clarify that the United States is a member of the International Civil Aviation Organization and as such participates in that organization's activities regarding aircraft noise standards. Regarding the third concern, GAO's draft report provided FAA's rationale for not applying a retirement deadline to stage 1 aircraft weighing 75,000 pounds or less. As noted in the report, FAA did not consider flight operations to be an appropriate operational noise abatement procedure for the purpose of meeting aircraft noise standards. Accordingly, GAO did not revise this discussion in the draft report. With regard to the fourth concern, the Association incorrectly concluded that the airport model included only two aircraft. The model was designed to provide a reasonable facsimile of an airport for use in comparing and illustrating the various noise measurement methods. Six aircraft were selected from FAA's list of certificated aircraft to represent categories of aircraft operations. With regard to the final concern, the draft report was revised to acknowledge that reducing aircraft noise may result in higher aircraft emissions. A more detailed discussion of the agencies' comments is presented at the end of chapter 5.

Introduction

Since the introduction of turbojet aircraft in the late 1950s for commercial passenger service, airport-related noise has generated controversy with many surrounding communities and emerged as a constraint on airport development. Airport-related noise emanates primarily from the takeoff and landing of aircraft, but engine maintenance and the taxiing of aircraft on runways are some of the other activities that also contribute to airport-related noise. New technology has been making aircraft quieter, and since 1969 the Federal Aviation Administration (FAA) has been limiting the noise that various aircraft are allowed to make. As a result, FAA estimates that the population exposed to very high noise levels will have declined from 7 million in 1975 to an estimated 600,000 in 2000. But in spite of the recent transition to quieter aircraft, expected growth in air traffic may result in little or no net reduction in overall noise levels generated by individual airports. Furthermore, concerns about airport-related noise may impede the development of any needed additional capacity in the national network of airports.

The Congress has recognized the importance of developing a safe and efficient national airport system that meets the nation's present and future aviation needs. As a result, federally authorized investment in a national airport system, including noise reduction projects, has totaled about $3 billion a year in recent years. FAA has primary responsibility for implementing federal programs addressing noise issues associated with civilian airports.[1]

The Federal Role in Addressing Airport-Related Noise

In order to facilitate the development of a safe and efficient national airport system, FAA undertakes several activities that help airports and communities reduce airport-related noise or mitigate its effects. FAA must consult with the Environmental Protection Agency regarding some of its responsibilities. FAA's activities focus on three areas: (1) reducing aircraft-generated noise at its source—the aircraft; (2) changing an airport's use of its runways and/or implementing different flight operations; and (3) mitigating the effects of existing noise levels on surrounding communities.

[1]This report addresses noise issues related to civilian airports only. The Department of Defense has responsibility for noise issues related to military airports. FAA, the Department of Defense, and other federal agencies coordinate their noise mitigation efforts through the Federal Interagency Committee on Noise.

Reducing Airport-Related Noise at Its Source

Airport-related noise can be lowered by reducing the noise that aircraft emit when they take off from and land at airports. New technology allows aircraft manufacturers to design and construct quieter aircraft. For aircraft already in service, noise levels can be reduced by (1) installing quieter engines, (2) installing equipment that reduces the noise of existing engines, and (3) modifying aircraft use and operations in ways that reduce aircraft-generated noise.

FAA has actively engaged in efforts to reduce aircraft noise since the 1960s. The agency sets the noise standards aircraft must meet to be certified as airworthy and establishes the regulations that govern the operation of those aircraft at U.S. airports.[2] The Federal Aviation Act of 1958, as amended in 1968, gave FAA the authority to regulate aircraft design and equipment in order to reduce noise. Pursuant to that act, FAA issued regulations in 1969 that established noise standards for new designs of civil subsonic turbojet aircraft. According to an aircraft design expert, the purpose of those noise standards was to ensure that the best available noise reduction technology was used in new aircraft designs.

Initially, these regulations prescribed noise standards that applied only to new types or designs of turbojet aircraft (as well as certain propeller aircraft). In 1973, FAA amended its regulations to apply the noise standards to all newly manufactured aircraft, whether or not the aircraft design was new. In 1977, additional amendments established lower noise standards for all new aircraft, as well as the concept of noise "stages." Aircraft meeting the original 1969 standards were categorized as "stage 2" aircraft; those meeting the more stringent 1977 standards were categorized as "stage 3" aircraft; and aircraft meeting neither standard were categorized as "stage 1" aircraft.

In addition to establishing noise standards, FAA controls aircraft noise by regulating aircraft operations. In 1976, FAA amended its regulations to prohibit all certificated stage 1 subsonic turbojet aircraft weighing more than 75,000 pounds from flying into or out of U.S. airports after January 1, 1985, unless their engines had been modified or replaced to enable them to

[2]FAA is responsible for certifying aircraft as being airworthy, with regard to noise standards, under regulations in 14 C.F.R. Part 36. Under 49 U.S.C. 44709(b), FAA is specifically authorized to use noise reduction as a criterion for issuing and revoking certificates relating to the airworthiness of aircraft. FAA regulates which aircraft may operate at U.S. airports under regulations in 14 C.F.R. Part 91.

meet the stage 2 or stage 3 noise standards. However, the Aviation Safety and Noise Abatement Act of 1979 directed FAA to grant exemptions from compliance until January 1, 1988, to turbojet aircraft with two engines and fewer than 100 passenger seats.

In 1990, the Airport Noise and Capacity Act required civil subsonic turbojet aircraft weighing more than 75,000 pounds to comply with stage 3 noise standards by December 31, 1999, or be retired from service. To meet this requirement, the engines on stage 2 aircraft could be modified or replaced.

In addition to regulating aircraft-generated noise, FAA supports aviation research related to noise. In particular, FAA is working with the National Aeronautics and Space Administration to develop new technology to reduce aircraft noise.

Changing an Airport's Use or Operations

By changing use and/or operations, airports can reduce airport-related noise or mitigate its effects. For example, an airport can restrict noisy aircraft maintenance activities to areas where noise barriers can muffle the sound. Aircraft arrival and departure flight paths, as well as runway use, can be changed to minimize flights over densely populated areas. Airports can also mitigate noise impacts by seeking FAA approval to restrict certain aircraft to takeoffs and landings during the day, when their impact on nearby communities is considered less than during the night.[3]

FAA is involved in many of these activities. For example, FAA must approve any restriction on an aircraft's access to an airport or on allowable noise levels if the restriction involves stage 3 aircraft or is beyond those imposed by federal regulations. Thus, if an airport wants to restrict any stage 3 aircraft to daytime operations, it must obtain FAA's approval. FAA must also approve and implement changes in flight paths. Furthermore, FAA administers airport development funding programs, which can finance the construction of runways and taxiways that enable aircraft to use different takeoff and landing routes to minimize flights traveling over densely populated areas.

[3]The method FAA has chosen for measuring the impact of airport-related noise on communities places greater weight on noise from flights occurring between 10 p.m. and 7 a.m.

Mitigating the Effects of Airport-Related Noise

Mitigation activities can reduce the impact of airport-related noise on the communities surrounding an airport. For example, buildings in nearby communities can be soundproofed and building codes can be changed to require improved sound suppression construction; noise barriers can be constructed; and airports can acquire land to prevent uses that are incompatible with the prevailing noise exposure levels.[4] Communities can also exercise their authority over land use planning to help prevent the future development of land for activities that are noise-sensitive—such as those occurring in residences, schools, churches, and hospitals—in areas exposed to high noise levels.

FAA supports mitigation efforts through two programs that provide federally authorized funds for airport projects that mitigate the effects of noise, and one program that encourages airports to identify and address the noise impacts of their airports on nearby communities.

FAA Administers Two Programs That Fund Noise Mitigation Projects

The Airport Improvement Program (AIP) and the Passenger Facility Charge (PFC) program provide federally authorized funding that, among other purposes, can be used to help mitigate the effects of airport-related noise. The AIP, established by the Airport and Airway Improvement Act of 1982, provides federal grants—funded by congressional appropriations from the Airport and Airway Trust Fund[5]—for developing airport infrastructure, including projects that reduce airport-related noise or mitigate its effects. Airports must provide a "matching share" for AIP-funded projects, ranging from 10 percent to 25 percent of a project's total cost, depending on the type of project and the size of the airport.[6]

[4]FAA guidance defines certain land uses, such as homes, schools, and hospitals, as being "incompatible" in areas where the exposure to noise is 65 decibels or higher, as measured in accordance with FAA requirements, because of the degree to which the noise in those areas interferes with activities associated with those kinds of uses. FAA's guidance considers all land uses compatible where the exposure to noise is below 65 decibels when measured by the method FAA chose in accordance with the statutory requirement that it select one method for measuring the exposure of communities to airport-related noise.

[5]The Airport and Airway Trust Fund is the repository of revenues collected from taxes on domestic and international travel, domestic cargo transported by air, and noncommercial aviation fuel.

[6]For noise-related projects funded under the noise "set aside," the percentages are 20 percent for large airports and 10 percent for small airports.

Two categories of AIP grants are available—apportionment and discretionary. Apportionment funds are distributed by a statutory formula to commercial service airports according to the number of passengers served and the volume of cargo moved, and to the states according to a percentage of the total amount of the appropriated funds. Discretionary funds—for the most part, those amounts remaining after apportionment funds are allotted and certain other amounts are "set aside" for special categories, including noise-related projects—can generally be awarded for eligible projects at any eligible airport, including general aviation airports, which do not receive apportionment funds.

Only airports included in FAA's National Plan of Integrated Airport Systems are eligible for AIP grants. The National Plan of Integrated Airport Systems identifies those U.S. airports that constitute the national airport system, which is designed to ensure that every part of the country has an effective aviation infrastructure. There are 529 commercial service airports—those that receive apportionment funds—and 2,815 general aviation airports (for a total of 3,344 airports) in the current national plan. Furthermore, all projects funded with AIP funds—whether apportionment or discretionary—must be approved by FAA. However, FAA will not approve any grant for any kind of project without written assurances that the airport will take appropriate action, to the extent possible, to restrict the use of land near the airport to uses compatible with airport operations.

The AIP funds noise mitigation projects in two ways. First, a specified portion of AIP appropriations is "set aside" by statute specifically for projects that address airport-related noise levels and their effects. Only projects relating to noise may be funded from this set-aside. Table 1 identifies the portions of AIP funds that have historically been set aside for noise. In addition to being eligible for these set-aside funds, projects addressing airport-related noise may compete with other airport development projects for other AIP grants.

Table 1: Portions of AIP Funds Set Aside for Noise Mitigation Projects, Fiscal Years 1982 Through 1999

Fiscal year	Amount set aside for noise-related projects
1982 through 1986	8 percent of total AIP
1987 through 1991	10 percent of total AIP
1992 through 1995	12.5 percent of total AIP
1996 through 1999	31 percent of AIP discretionary funds
2000	34 percent of AIP discretionary funds

Source: P.L. 97-248, section 508(d); P.L. 100-223, section 107(a); P.L. 102-581, section 108; and P.L. 104-264, section 123; P.L. 106-181, section 104(e).

The second program providing federally authorized funds for mitigating airport-related noise—the PFC program[7]—is a voluntary program that enables airports to impose fees on boarding passengers—known as passenger facility charges—and retain the money for airport infrastructure projects, including noise reduction. Under this program, authorized by the Aviation Safety and Capacity Expansion Act of 1990, commercial service airports may charge boarding passengers a $1, $2, or $3 fee.[8] Airports are not required to impose the fee, but airports wishing to participate in the program must seek FAA's approval both to levy the fee and to use the revenues for particular development projects. Airlines collect the fees from passengers and transmit them directly to the appropriate airports.[9] FAA officials told us that as long as a project is eligible, meets one of the statutory objectives, and is adequately justified, they do not have the authority to reject an airport's proposal for the collection or use of passenger facility charges.

[7]See *Passenger Facility Charges: Program Implementation and the Potential Effects of Proposed Changes* (GAO/RCED-99-138; May 19, 1999).

[8]On April 5, 2000, the President signed the Wendell H. Ford Aviation Investment and Reform Act (P.L. 106-181), which includes a $1.50 increase in the maximum fee that may be charged, bringing the maximum fee to $4.50.

[9]Thus, PFC funds are not deposited in the U.S. Treasury or subsequently appropriated.

FAA Defines Land Use Compatibility and Administers an Airport Noise Compatibility Planning Program to Facilitate Noise Mitigation

Although the federal government has no jurisdiction over land use decisions (that authority lies with state and local governments), FAA can facilitate compatible land use planning at the state and local level. The Aviation Safety and Noise Abatement Act of 1979 directed FAA to define land uses that it considers compatible or incompatible with the various noise levels that nearby communities are exposed to. The act also directed FAA to administer a new program that encourages airports to develop maps identifying areas in nearby communities where land uses are considered to be incompatible. The program also encourages airports to develop individual airport noise compatibility programs that include those maps and the projects that have been implemented, or planned, to reduce any existing or potential incompatible land uses identified. The act also requires FAA to approve an airport's noise compatibility program[10] as long as the program

- does not place an unreasonable burden on interstate or foreign commerce,
- is reasonably consistent with achieving the goal of reducing incompatible land uses and preventing the introduction of new incompatible land uses, and
- authorizes needed revisions to the program's planned projects when noise exposure maps are updated.

Programs, except as they relate to flight procedures, are automatically approved if FAA has not acted within 180 days after receipt of the proposed program. Once an airport's program is approved, the airport can apply for AIP grants to fund the types of projects included in the program that are eligible for federal grants. Through fiscal year 1999, 195 airports had FAA-approved noise compatibility programs, while 212 had approved noise exposure maps.[11] Appendix I describes the process for obtaining FAA approval of the maps and airports' noise compatibility programs.

[10]The statute, however, does not require FAA to approve changes in flight path procedures just because these conditions may be met, even though flight path procedures are included in the compatibility program. While FAA has jurisdiction over the approval of changes in flight paths, other criteria govern the approval of those changes.

[11]An airport may prepare and submit to FAA noise exposure maps even though it does not develop a noise compatibility program.

Objectives, Scope, and Methodology

The Subcommittee on Aviation, House Committee on Transportation and Infrastructure, and several Members of the House of Representatives asked us to address four sets of questions about federal programs for airport development and the alleviation of airport-related noise:

- What kinds of projects that reduce airport-related noise or mitigate its effects are eligible for federally authorized funding, how do FAA's selection criteria affect which projects are funded, and to what types of projects have the funds been historically distributed?
- How do major methods for measuring the impact of airport-related noise compare with each other, and what method has FAA selected?
- What aircraft noise standards apply to civil subsonic turbojets, and why are some civil subsonic jets not required to comply with these and earlier noise standards?
- What actions has FAA announced under its Land Use Planning Initiative, what is the status of their implementation, and what issues has the Initiative raised?

To address the first set of questions—on the eligibility of noise-related projects for federally authorized funding—we (1) reviewed the statutory provisions and FAA's regulations, policies, and procedures for funding projects under the AIP and the PFC program to identify project eligibility; (2) reviewed the statutory requirements for airport-related noise compatibility programs, as well as FAA's regulations and processes for implementing those requirements; (3) obtained FAA's data on federal grants awarded for noise-related projects and passenger facility charges approved for noise-related projects to identify the types of projects and the total project funding by fiscal year for each type of noise-related project. We also interviewed officials from FAA headquarters in Washington, D.C.; the Airports Council International-North America; the Air Transport Association; and the National Association of State Aviation Officials; as well as other experts on these issues. In 1999, we independently validated the PFC project database and found it to be very reliable (a 0.3-percent error rate). We did not independently review the validity of the grant program database, but it is the only database for that information, and we have used data from it extensively during the conduct of several reviews that have looked at various aspects of the grant program.

To address the second set of questions—on comparing methods that measure airport-related noise—we (1) discussed noise measurement methods with FAA, airport officials, the Airports Council International-

North America, the Air Transport Association, the National Association of State Aviation Officials, and the Federal Interagency Committee on Noise, as well as other aviation experts, to identify the kinds of methods being used to measure noise levels and the strengths and weaknesses of these methods; (2) reviewed the major noise measurement methods, as well as written descriptions and analyses of them, to determine how each method measured airport-related noise; and (3) identified the statutory requirements for FAA to select a method for environmental impact and land use analyses and the method that FAA chose. To compare and illustrate the kinds of information produced by each method, we designed a model airport and test scenarios; FAA then conducted noise measurements for us for the test scenarios using its Integrated Noise Model, its computerized program for applying noise measurement methods. The methods that were compared are the Maximum Sound Level and the Sound Exposure Levels methods used to measure the noise of a single event, and the Equivalent Sound Level, the Day-Night Sound Level, the Community Noise Equivalent Level, and the Time-Above methods used to measure the levels of noise that nearby communities are exposed to. We discussed the reliability of the Integrated Noise Model with FAA officials and found that they had used appropriate methods—including an independent assessment—to ensure the model's reliability for measuring noise experienced at certain distances from the source.

To address the third set of questions—on aircraft noise standards—we reviewed the statutes, policies, and regulations governing noise levels for civil subsonic jets, and we discussed these statutes, policies, and regulations with FAA officials, representatives of the General Aviation Manufacturers Association, the National Business Aviation Association, and the Regional Aviation Association, and other experts. Through interviews and document review, we identified activities under way in the United States, Europe, and the International Civil Aviation Organization to address the issue of a new level of more stringent aircraft noise standards—commonly referred to as "stage 4" noise standards. To determine the number of aircraft weighing less than 75,000 pounds that were not required to meet FAA's most recent aircraft noise standards, we determined, from FAA's list of aircraft in the United States that it has certified as airworthy, the number of civil subsonic jets weighing 75,000 pounds or less. To identify the noise standard that those aircraft met, we reviewed FAA documentation identifying noise stages for certain aircraft, *Jane's All The World's Aircraft*, and aircraft manufacturers' specifications for aircraft types. While we did not test the validity of FAA's aircraft database, it is the only source for the information we sought.

Finally, to address the fourth set of questions—on FAA's Land Use Planning Initiative—we identified the overall objective of the Initiative, the initial short-term actions that FAA announced in May 1999, and the status of FAA's implementation of those actions. To determine if any issues were raised by the Initiative, we reviewed and analyzed the public comments submitted in response to FAA's request for comments and suggestions on its land use planning effort under the Initiative, as well as published comments analyzing the Initiative. We also interviewed officials at FAA, the Airports Council International-North America, the National Association of State Aviation Officials, and airport and community officials for Dulles International Airport (a large hub without a completed noise compatibility program) and Manassas Regional Airport (a general aviation airport with an approved noise compatibility program), both in Virginia, and other aviation experts to obtain their views.

A panel of five experts reviewed the design and methodology for our work. These experts were selected because of their knowledge about aviation and airport-related noise issues and FAA's noise programs. A list of the panel members appears in appendix IX.

We conducted our review from July 1999 through April 2000 in accordance with generally accepted government auditing standards.

Project Eligibility for Federally Authorized Funding Is Broad, but Other Factors Affect Project Selection

Most types of projects to reduce airport-related noise or mitigate its effects on nearby communities are eligible for federally authorized funding through the Airport Improvement Program (AIP) and the Passenger Facility Charge (PFC) program. Under the AIP, however, statutes require that, with a few exceptions, projects be part of an airport's noise compatibility program. Once an airport applies for AIP funding, FAA sets priorities for projects using two types of project selection criteria before awarding the grants. The PFC program is a more flexible funding source than the AIP, in part because projects do not have to be part of an approved noise compatibility program and because airports set their own priorities, subject to FAA approval. Since the programs began, the majority of funds have been used to acquire land and soundproof buildings.

Most Types of Projects Are Eligible for AIP, but They Generally Must Be Part of an FAA-Approved Airport Noise Compatibility Program

The types of noise-related projects eligible for AIP funding include such efforts as developing information to prepare planning and noise compatibility program documents, acquiring land, acquiring air rights or other easements, purchasing noise-monitoring equipment, constructing noise barriers, and soundproofing buildings. The construction or expansion of runways and taxiways, which can reduce noise levels affecting some communities by enabling flights to avoid densely populated areas, is also eligible for AIP funding.

There are some statutory restrictions on eligibility. AIP grants may not be approved for land purchases unless the airport provides written assurance that the following conditions will be met:

- the land will be sold at fair market value as soon as possible once it is no longer needed to help mitigate the effects of noise;
- an airport will retain a legal interest in the land when it is sold in order to ensure that its use remains compatible; and
- the government's share of the cost of purchasing the land will be reimbursed when the land is sold.[1]

In addition, federal appropriations law prohibits the use of AIP funds for studies, maps, or environmental impact analyses needed to implement

[1]The reimbursement is to be paid to the Secretary of Transportation for deposit in the Airport and Airway Trust Fund or, as the Secretary prescribes, reinvested in approved noise compatibility projects. When land is purchased with AIP grants for other airport purposes and is resold, an interest in it must also be retained to ensure noise compatible land use.

flight procedure changes made to reduce noise. These costs are paid for by other appropriated funds for air traffic control.

In addition to these statutory restrictions, FAA policy prohibits using AIP funds for remedial noise mitigation—such as soundproofing buildings—for buildings that were known to be incompatible with prevailing noise exposure levels before they were built.

To qualify for AIP funds that are set aside for noise-related projects, an airport must have an FAA-approved noise compatibility program that includes the projects the airport wants funded, except that projects to insulate public buildings used primarily for educational or medical purposes can be funded even though an airport does not have such a program. Nevertheless, FAA approval of an airport's program does not guarantee that the projects in it will receive AIP noise set-aside funding because an airport must apply for AIP funding separately once its program is approved.

In addition, AIP funds may pay for projects that mitigate the noise impact of other airport development projects—such as the construction of a new runway—even if the noise-related projects are not included in an approved noise compatibility program. The airport, however, would have to use its AIP apportionment funds for those projects or the projects would have to compete with other airport development projects for AIP discretionary funds.

Selection Criteria Influence Which Eligible Projects Receive AIP Funding

In deciding which eligible projects to fund, FAA sets priorities using (1) its guidance on land use compatibility and (2) a national priority system that comparatively ranks all projects eligible for AIP funding. When awarding AIP funds for projects included in an airport's noise compatibility program, FAA gives priority to projects located in areas where noise exposure levels are 65 decibels or higher (when measured under a method that assigns greater weight to flights occurring between 10 p.m. and 7 a.m.).[2] Projects are eligible for funding in areas with lower noise exposure levels. However, according to FAA officials, nearly all of the AIP funds set aside for noise-related projects in the past have been awarded for projects where incompatible land uses occur in areas exposed to noise levels of

[2]FAA Order 5100.38A, section 710.

65 decibels or higher under FAA's chosen method for measuring community exposure to airport-related noise.

FAA also sets priorities for AIP-eligible projects through a national priority system that comparatively ranks all projects, including noise-related projects, in order to identify those projects that most warrant funding. First, FAA applies a formula that assigns projects a numerical score from 0 to 100—the higher the score, the higher the priority. The formula ranks projects by assigning points for each of four factors:

- the project's purpose (for example, safety, security, capacity, planning, reconstruction), with, safety and security projects, for example, receiving more points—higher priority—than projects to develop airport capacity;
- the size of the airport (for example, large, medium, or small commercial service airports), with projects at larger airports receiving more points than projects at smaller airports;
- the project's component (for example, apron, equipment, building, financing), with runway projects, for example, receiving more points than projects for equipment or taxiways; and
- the project type (for example, noise, by noise exposure level; airport access; construction; de-icing facility; aircraft rescue; or fire-fighting vehicle), with noise-related projects in areas exposed to high noise levels, for example, receiving more points than noise-related projects in areas with lower noise exposure levels.

FAA officials then consider other factors—such as benefit-cost analysis, risk assessment, environmental issues, regional priorities, state and metropolitan system plans, airport growth, and market forces—in determining the final ranking of a project. FAA officials have discretion over the relative importance of the formula and other factors in deciding the final ranking of projects.

According to an FAA official, projects competing for AIP funds set aside for noise-related projects are ranked on the basis of project type and airport size because the values of the other two factors in the formula are the same for all noise-related projects. As a result, projects in areas with higher noise exposure levels and for larger airports will score higher under the formula than projects in areas with lower noise exposure levels and for smaller airports. When noise-related projects compete for other AIP discretionary funds, however, all four factors in the formula contribute to determining the project's comparative ranking.[3]

Even if an airport's project ranks relatively high, however, it may not be funded in a given year. According to an FAA official, for the past few years FAA has applied an administrative cap that limits the amount of AIP funding awarded to any single airport in one year for noise-related projects. The limit is $5 million for projects included in an airport's noise compatibility program and $3 million for insulating public buildings used primarily for educational or medical purposes (whether or not the airport participates in the noise compatibility program). According to the FAA official, FAA imposes the limits when the demand for AIP funds set aside specifically for noise-related projects exceeds the amount of AIP funds available. The limits are intended to ensure that all airports that need funding for noise-related projects have access to AIP funds. The FAA official explained that the agency has exceeded the limit for an airport when sufficient funds were available to meet all demand and the airport was able to document its ability to spend more in that year. The official also said that each year FAA reevaluates whether the limits are needed; if the total cost of the noise projects submitted for funding substantially exceed the money available, the limits will generally remain in effect.

The PFC Program Can Fund Some Project Costs Ineligible for AIP Grants

The statutes define eligible types of noise-related projects under the PFC program as anything eligible for AIP funding. Unlike most projects funded with AIP grants set aside for noise-related projects, however, PFC projects do not have to be part of an FAA-approved noise compatibility program. Nevertheless, according to FAA officials, FAA requires airports to demonstrate that the projects will provide noise reduction or mitigation

[3]According to an FAA official, such noise projects are usually implemented as mitigation of the environmental impacts of other types of airport development projects and their comparative ranking is based on the type of development project rather than on the noise project itself.

and would qualify for inclusion in a noise compatibility program. In addition, unlike AIP funds, PFC funds may be used to pay the financing costs for an approved project and the nonfederal share of projects funded with AIP grants. Airports can set their own priorities, subject to FAA approval, regarding which noise-related projects to fund through the PFC program.

Land Acquisition and Soundproofing Projects Receive the Majority of AIP and PFC Noise-Related Funding

More than 75 percent of all AIP funds and over 50 percent of all PFC funds spent on noise reduction or mitigation have been used to acquire land and to soundproof buildings.[4] This is generally true for both large and small airports. In this report, "large" airports are those airports categorized in FAA's National Plan for Integrated Airport Systems—those airports eligible for AIP grants—as large and medium hub airports. "Small" airports are those categorized as small hub, nonhub, other commercial service, and general aviation airports.

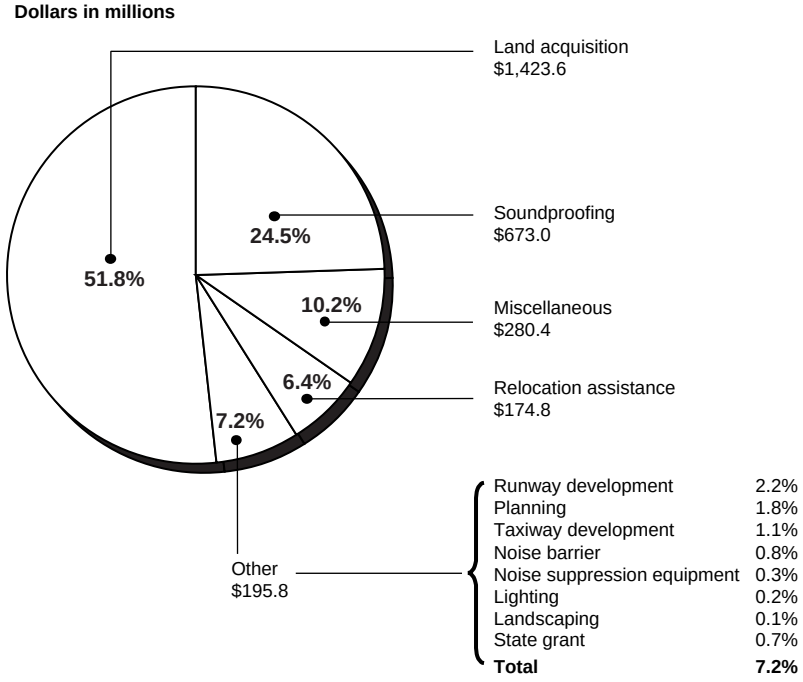
AIP Projects

Of the nearly $24 billion in AIP grants awarded for fiscal years 1982[5] through 1999, over $2.7 billion, or 11.5 percent, were for noise-related projects. Of this amount, $1.4 billion (over 50 percent) was used to acquire land for noise mitigation purposes, and $673 million (nearly 25 percent) was used to soundproof buildings. Figure 2 shows the distribution of total AIP funds for noise-related projects by project type for fiscal years 1982 through 1999. Appendix III provides AIP funding data for noise-related projects for each fiscal year, from 1982 through 1999, by project type.

[4]According to an FAA official, most land acquisition projects involve acquiring homes and relocating the people displaced.

[5]This is the first fiscal year of funding for the AIP.

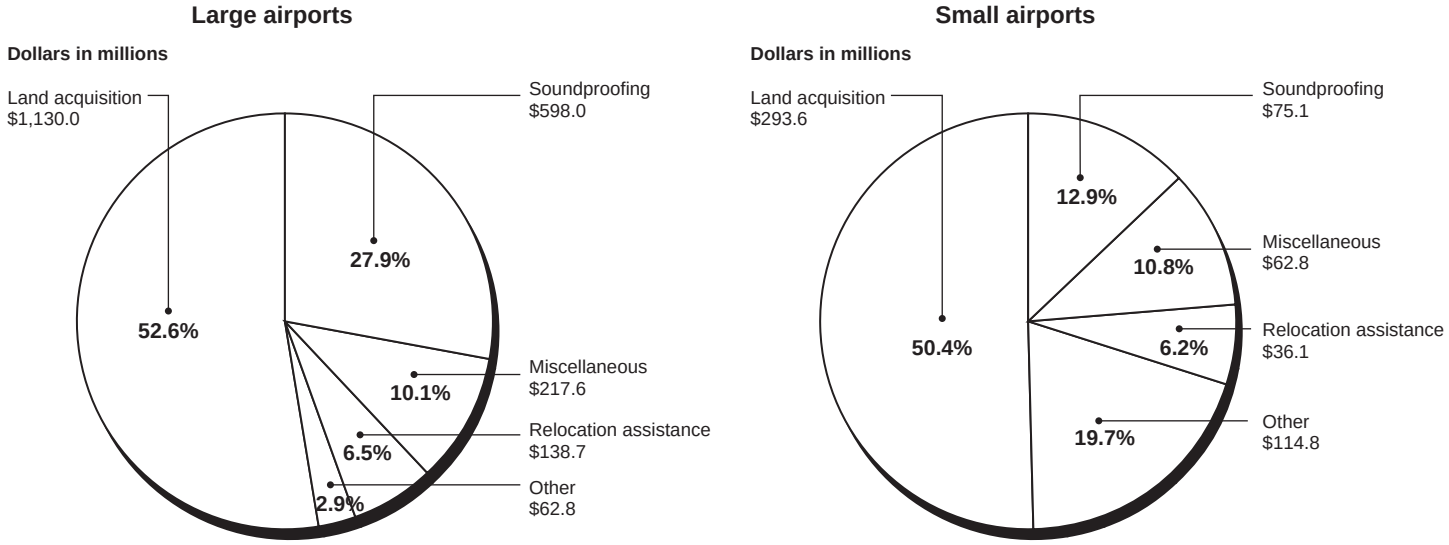
Figure 2: AIP Noise-Related Projects, Fiscal Years 1982 Through 1999 (Total: $2.7 billion)



Note: Percentages do not total 100 percent because of rounding. Projects in the category of miscellaneous include such things as acquiring and installing noise monitoring equipment.

About $2.1 billion of the $2.7 billion in AIP noise-related grants went to large airports and about $582 million went to small airports for noise-related projects. As figure 3 shows, both large and small airports targeted their AIP grants for land acquisition and soundproofing buildings.

Figure 3: AIP Noise-Related Projects, Fiscal Years 1982 Through 1999 for Large Airports (Total: $2.1 billion) and for Small Airports (Total: $582 million)



Note: State block grants of $18 million (0.7 percent of total AIP) are not included in this figure because data do not show the use of these funds by large versus small airports.

PFC Projects

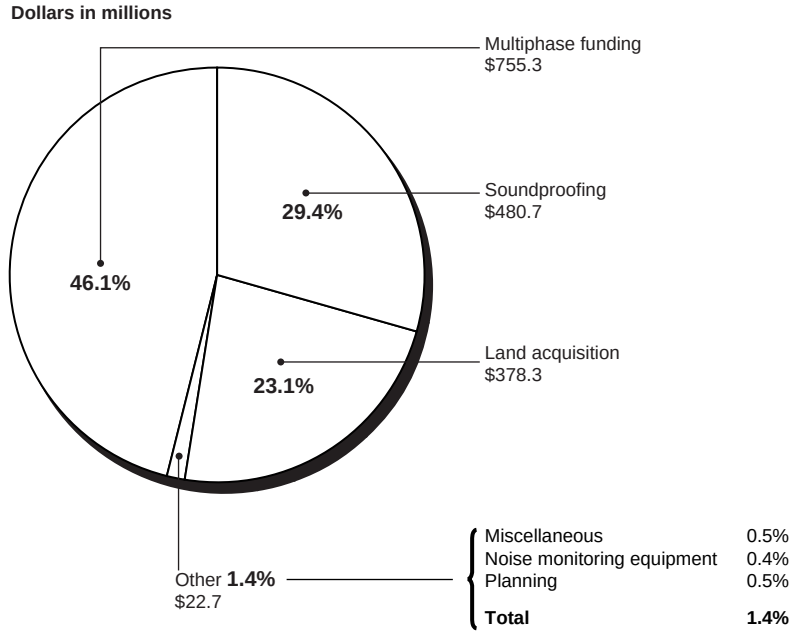
For fiscal years 1992[6] through 1999, FAA approved the collection of nearly $24 billion in passenger facility charges, with over $1.6 billion, or 6.9 percent, approved for noise-related projects.[7] About $755 million (46 percent) of this funding has been approved for projects that will require multiple phases to complete. These projects consist of one or more different types of projects that are approved together—usually combinations of soundproofing and land acquisition, according to an FAA official. About $481 million (just over 29 percent) has been approved for projects to soundproof buildings, while $378 million (23 percent) has been approved for projects to acquire land. Figure 4 shows the distribution of noise-related projects approved for fiscal years 1992 through 1999, by

[6]The Passenger Facility Charge program was authorized by the Congress in 1990, but approved collections did not begin until fiscal year 1992.

[7]Approved collection periods have been as short as 6 months and as long as 40 years or more.

project type. Appendix IV provides data on the amount of PFC funds approved in each fiscal year, from 1992 through 1999, by project type.

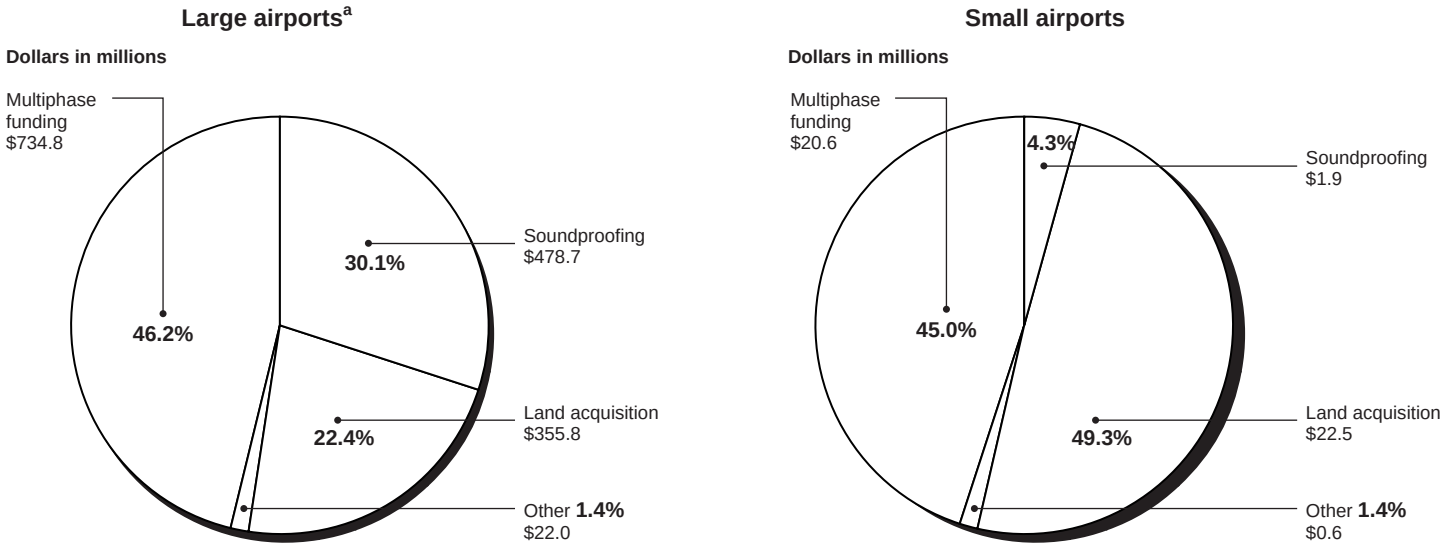
Figure 4: PFC Noise-Related Projects, Fiscal Years 1992 Through 1999 (Total: $1.6 billion)



Note: PFC funds used to pay interest costs for project financing are categorized as "interest" projects, and not on the basis of the type of projects being financed. Any interest projects related to noise, therefore, are not reflected in these data. According to an FAA official, very few, if any, interest projects are related to noise.

Of the $1.6 billion in PFC funds approved for noise-related projects, nearly all was approved for large airports, while about $46 million was approved for small airports. FAA has approved about the same portion of multiple-phase projects for large and small airports at 46 percent ($735 million) and 45 percent ($21 million) respectively. However, large and small airports differ in their use of PFC funds for other types of projects. For example, large airports had a much larger portion of their funds approved for soundproofing buildings. Figure 5 illustrates the funding pattern by project type for large and small airports.

Figure 5: PFC Noise-Related Projects, Fiscal Years 1992 Through 1999 for Large Airports (Total: $1.59 billion) and for Small Airports (Total: $45.6 million)



Note: PFC funds used to pay interest costs for project financing are categorized as "interest" projects, and not on the basis of the type of projects being financed. Any interest projects related to noise, therefore, are not reflected in these data. According to an FAA official, very few, if any, interest projects are related to noise.

[a]Percentages do not total 100 percent because of rounding.

Noise Measurement Methods Provide Different Kinds of Information

Methods for measuring airport-related noise assess noise either from a single takeoff or landing or from the cumulative average noise that nearby communities are exposed to over time. Required by law to select a single method for measuring the impact of airport-related noise on communities, FAA chose a method that measures community exposure levels and that gives greater weight to the impact of flights occurring during the nighttime. While subsequent studies have confirmed that this method best meets the statutory requirement that FAA establish a single system for determining the exposure of people to airport-related noise, a federal interagency committee addressing airport-related noise issues found that supplemental information, such as measures of noise from a single aircraft takeoff or landing, is also useful in explaining the noise that people are likely to hear. In addition, experts and community groups believe FAA's chosen method provides insufficient information because it does not effectively convey to people what they can actually expect to hear in any given area.

Measuring Sound and Its Effects

To understand the methods used to measure noise, it is necessary to have some understanding of how sound is measured and how it affects humans. Some basic concepts include (1) sound waves and their measurement in decibels, (2) human ability to hear the entire range of sounds made, and (3) noise as a source of interference in people's activities.

First, sound radiates in "waves" from its source and decreases in loudness the further the listener is from the source.[1] As sound radiates from its source, it forms a sphere of sound energy. Sound waves exert sound pressure, commonly called a "sound level" or "noise level," that is measured in decibels.[2] The higher the number of decibels, the louder the sound appears to someone hearing it. But because decibel levels are measured logarithmically, an increase of only 10 decibels—for example, from 50 decibels to 60 decibels—doubles the loudness that people believe they hear.[3] Continuing the increase from 60 to 70 decibels would again

[1]The number of times the waves crest within one second is referred to as the frequency of the sound, and is expressed in cycles per second, called hertz. The general range of human hearing is between 20 to 20,000 hertz. However, the clearest range of human hearing is between 1,000 and 4,000 hertz.

[2]A decibel is a unit of sound pressure used to measure noise.

[3]An increase of 3 decibels represents a doubling of sound energy, but an increase of 10 decibels corresponds to the perception by people that the sound level has doubled.

double the perceived loudness of the sound. Which sounds are considered to be noise, however, is subjective.

In terms of aircraft noise, sound levels generated by takeoffs or landings vary depending on several factors, particularly the aircraft's weight and the number of engines. While airport-related noise levels decrease quickly with distance from an airport, the accuracy of noise measurement also decreases because it is more difficult to distinguish between airport-related noise and other noise in the environment.

Second, while the human ear can hear a broad range of sounds, it cannot hear all sounds. Sounds with very low pitches (low frequencies) and sounds with extremely high pitches (high frequencies) are generally outside the hearing range of humans. Because of this, environmental noise is usually measured in "A-weighted" decibels. The A-weighted decibel unit focuses on those sounds the human ear hears most clearly and deemphasizes those sounds that humans generally do not hear as clearly. Table 2 illustrates the typical sound levels of some common events.

Table 2: Typical Sound Levels of Common Occurrences

Event	Sound level in A-weighted decibels
Rock band (indoors)	108-114
Food blender	88
Vacuum cleaner	70
Conversation (indoors)	60
Dishwasher on rinse cycle at 10 feet	60
Bird calls (outdoors)	44

Source: *Federal Interagency Review of Selected Airport Noise Analysis Issues* (Federal Interagency Committee on Noise; August 1992).

Finally, the impact of noise on communities is usually analyzed or described in terms of the extent to which it annoys people. Annoyance refers to the degree to which noise interferes with activities such as sleep, relaxation, speech, television, school, and business operations. While it is difficult to predict how an individual might respond to, or be affected by, various sounds or noises, some studies indicate that it is possible to estimate what proportion of a population group will be "highly annoyed" by various sound levels created by transportation activities. The findings of a 1978 study that related transportation noise exposure to annoyance in communities has become the generally accepted model for assessing the effects of long-term noise exposure on communities.[4] According to this study, when sound exposure levels are measured by a method that assigns additional weight to sounds occurring between 10 p.m. and 7 a.m., and those sound levels exceed 65 decibels, individuals report a noticeable increase in annoyance.

Measures of Noise Identify Noise Levels of Single Aircraft Operations and Community Exposure

Methods for measuring airport-related noise provide different kinds of information. First, airport-related noise can be measured from single events—such as an individual aircraft's takeoff or landing—or as the cumulative average level of noise that communities near airports are exposed to over time. Principal methods for measuring cumulative average noise levels identify geographic areas exposed to the same noise levels but apply different weights to flights occurring during different times of the day.

Single Event Measures Provide Short-term Information

The noise from a single takeoff or landing usually starts when the sound can be heard above the background noise; it reaches a maximum sound level and then recedes until the sound is hidden below the background noise level. One of two measures of the noise from a single takeoff or landing is commonly used: (1) the Maximum Sound Level method, which identifies the maximum sound level produced by the event, and (2) the Sound Exposure Level method, which measures the total sound energy that a listener is exposed to during a single event.

[4]T.J. Schultz, "Synthesis of Social Surveys on Noise Annoyance," *Journal of the Acoustical Society of America* 64(2) (1978), pp. 377-405.

The Maximum Sound Level method is usually expressed in A-weighted decibels when measuring aircraft events. It does not provide any information, however, about the duration of the event or the amount of sound energy produced.

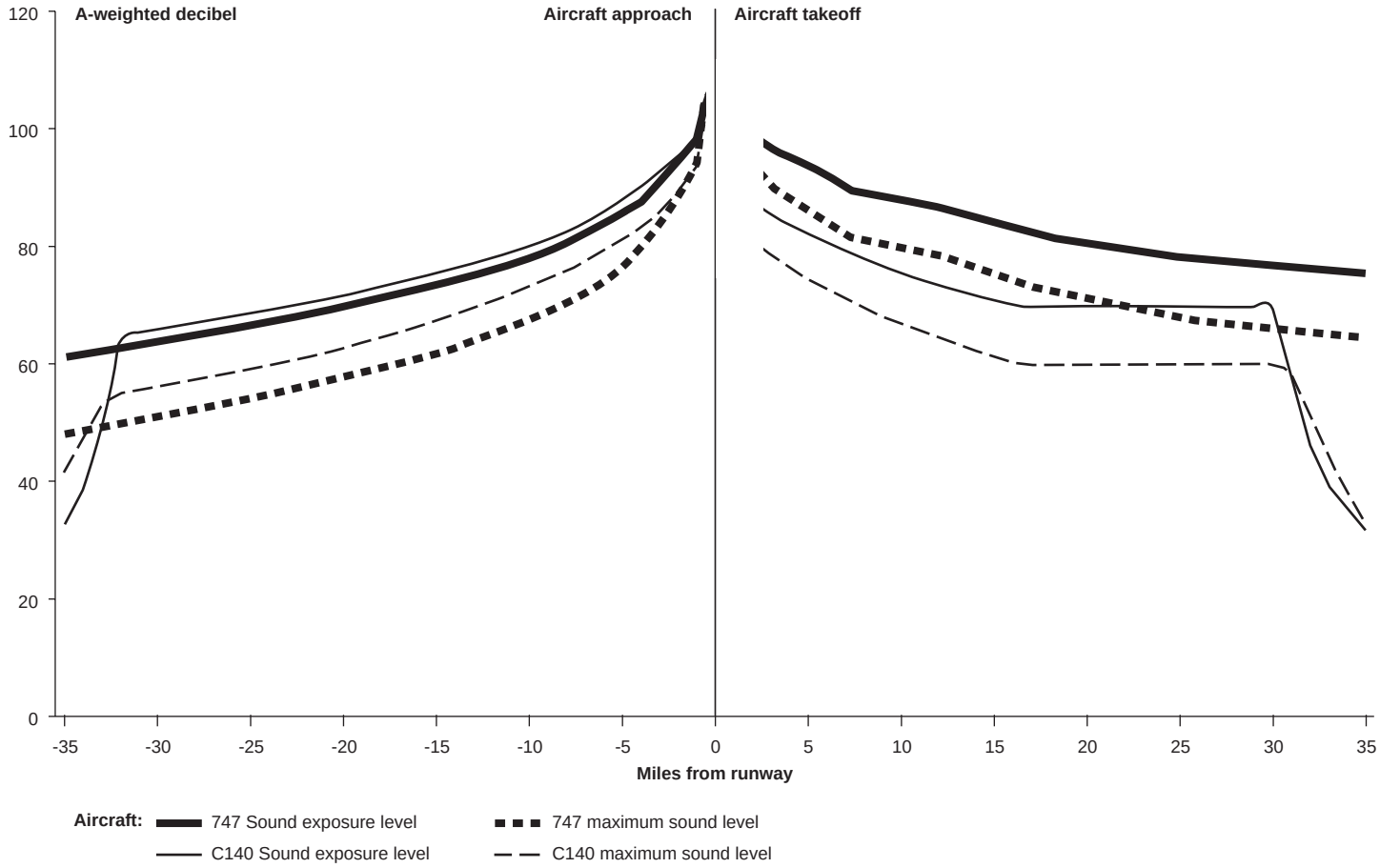
In contrast, the Sound Exposure Level method measures all of the sound energy from the duration of a takeoff or landing to produce the sound level that a person is exposed to from that event. Thus, this method reflects both the intensity and the duration of the sound that the takeoff or landing produces. For aircraft events, this method also usually uses A-weighted decibels. Because this method measures the cumulative sound energy averaged over a single second of time, the sound exposure level for an event that lasts longer than one second will be higher than the maximum sound level for that same event. Also, two events can have the same maximum sound level but different sound exposure levels. The event that lasts the longest will have a higher decibel measure than the shorter event, even though both may have the same maximum sound level.

To compare the different kinds of information these methods provide, FAA calculated maximum sound levels and sound exposure levels for single aircraft takeoffs and landings using an airport model that we designed.[5] The results illustrate the different concepts embodied in the two measures of single events. Figure 6 illustrates the measures produced by both methods at one-half mile from the runway and at 1-mile intervals from the runway, for both approach and takeoff operations, for the Boeing 747 and C140 aircraft included in our model. Similar figures for the four other aircraft in our model appear in appendix VI.[6]

[5] FAA performed a variety of calculations based on input data we selected to compare single event and community exposure measurements methods in the following three contexts: (1) a single set of measures to illustrate the outputs of the different methods under the same airport conditions; (2) a series of measures using changing flight schedules to illustrate the impact of the time of day when flights occur; and (3) a series of measures using changing numbers of total aircraft operations to illustrate the impact of the number of takeoffs and landings. FAA calculated the measurements using its Integrated Noise Model (Version 6)—FAA's preferred computer model for measuring airport-related noise when conducting environmental impact or land use compatibility analyses. App. V describes the airport model.

[6] A third method for examining single events, known as the Third Octave Band Sound Pressure Level method, separates the noise from a single event into about 30 segments covering the full range of noise generated, including the low and high frequency sounds that the human ear generally does not hear as well. Because it covers the full range of sound, this method does not use A-weighted decibels. However, according to a noise expert, A-weighted sound levels can be, and often are, computed from one-third octave band sound levels. FAA's Integrated Noise Model does not produce measures for this method.

Figure 6: Single Event Noise Levels Using the Maximum Sound Level Method and the Sound Exposure Level Method, Approach and Takeoff—Boeing 747 and C140 Aircraft



Measuring the noise from a single takeoff or landing does not reflect or measure the impact of the noise from several takeoffs or landings in comparison with the impact of just one aircraft operation. According to FAA officials, although some research correlates the health and welfare effects of noise generated by certain kinds of single events, the Federal Interagency Committee on Noise pointed out in 1992 that there is no accepted methodology for aggregating the information on the noise levels of single events in a way that would explain the cumulative impact of those events on people in the communities surrounding airports.[7] Thus, by themselves, methods to measure the noise from single events are not considered to describe the overall noise environment.

Noise in Communities Is Measured in Terms of Overall Exposure

The level of noise from airports that nearby communities are exposed to depends on several factors, including the types of aircraft using the airport, the overall number of takeoffs and landings, the time of day those aircraft operations occur, the runways that are used, weather conditions, and airport-specific flight procedures that affect the noise produced by a takeoff or landing. There are two approaches to measuring community exposure to noise: (1) identifying geographic areas on a map that are exposed to the same noise levels or (2) determining the length of time that a specific geographic area is exposed to particular noise levels.

Key Measurement Methods Use Contour Maps to Identify Geographic Areas Exposed to Noise Levels

The three main methods for measuring airport-related noise levels that nearby communities are exposed to include (1) the Equivalent Sound Level method; (2) the Day-Night Sound Level method; and (3) the Community Noise Equivalent Level method. These methods provide long-term, or cumulative, measures of exposure to noise. For each method, the key factors that determine the noise exposure level affecting a community are the types of aircraft using the airport, the number and type of engines on an aircraft, the number of takeoffs and landings that occur during an average day,[8] and the time of day during which those aircraft operations occur. The measures are generally presented in the form of "noise contours" on maps—lines around an airport that connect all the areas exposed to the same average sound level. A series of contours are drawn, usually at 5-decibel decrements from the airport, to produce a map that looks similar to a land elevation map. All three methods incorporate both the intensity of sounds produced by single events and the average frequency of those events.

The first method—the Equivalent Sound Level—measures the average noise level over a specified time using A-weighted decibels. Because the method is based on a logarithmic average, it gives greater weight to higher noise levels than to lower ones. For example, if sound is measured at 50 decibels for a half hour and 100 decibels for a half hour, the Equivalent Sound Level measure for the entire hour is 97 decibels, not the 75 that would result from simple averaging. Any time period can be used, with typical time periods being 1 hour, or 1 day (24 hours). Under this method,

[7] *Federal Agency Review of Selected Airport Noise Analysis Issues* (Federal Interagency Committee On Noise; Aug. 1992).

[8] The operations profile for an average day is based on operations that occur during a calendar year period.

all flights are weighted equally regardless of when they occur during the day.

The second method—the Day-Night Sound Level—is the same as the Equivalent Sound Level method for a 24-hour period, but it gives greater weight to flights occurring during the nighttime—between 10 p.m. and 7 a.m. Additional weight is given to nighttime flights because they are more likely to interrupt sleep, relaxation, or other activities and because the background noise level during those hours is lower. To reflect that greater impact, the Day-Night Sound Level method equates 1 nighttime aircraft operation to 10 equivalent daytime operations. This effectively adds 10 decibels to the noise produced by each takeoff or landing that occurs during those nighttime hours. That is, the noise impact of each single nighttime takeoff or landing is reflected in the noise exposure level as if it were 10 daytime takeoffs or landings. For example, if eight takeoffs and eight landings occur between 7 a.m. and 10 p.m., they are reflected in the noise exposure level as 16 aircraft operations. If those same eight takeoffs and eight landings all occur between 10 p.m. and 7 a.m., they are reflected in the noise exposure levels as the equivalent of 160 aircraft operations.

Finally, the Community Noise Equivalent Level modifies the Day-Night Sound Level method by adding additional weight to flights occurring between the evening hours of 7 p.m. and 10 p.m. to account for an assumption that greater interference with activities may be occurring during the early evening than during the daytime.[9] The second and third methods are considered to have only small differences.

Under each of the three methods, several different combinations of flights can produce the same noise exposure level because factors such as the total number of flights and the type of aircraft affect the noise exposure levels. For example, each of the following three scenarios will produce the same 65 decibel noise exposure level under the Day-Night Sound Level method:

[9]According to FAA officials, the value of the added weight differs for airport calculations depending on whether it is decibels or "equivalent number of operations." The State of California, which uses the Community Noise Equivalent Level method, equates each evening flight to three 3 daytime flights. This results in added weight of 4.77 decibels for each flight between 7 p.m. and 10 p.m. The Community Noise Equivalent Level method may also be calculated by applying a 5-decibel penalty, which would equate each flight to 3.1623 daytime operations. FAA's Integrated Noise Model uses the approach applied by California.

- 500 aircraft operations with an average sound exposure level of 87.4 decibels;
- 100 aircraft operations with an average sound exposure level of 94.4 decibels; and
- 50 aircraft operations with an average sound exposure level of 97.4 decibels.

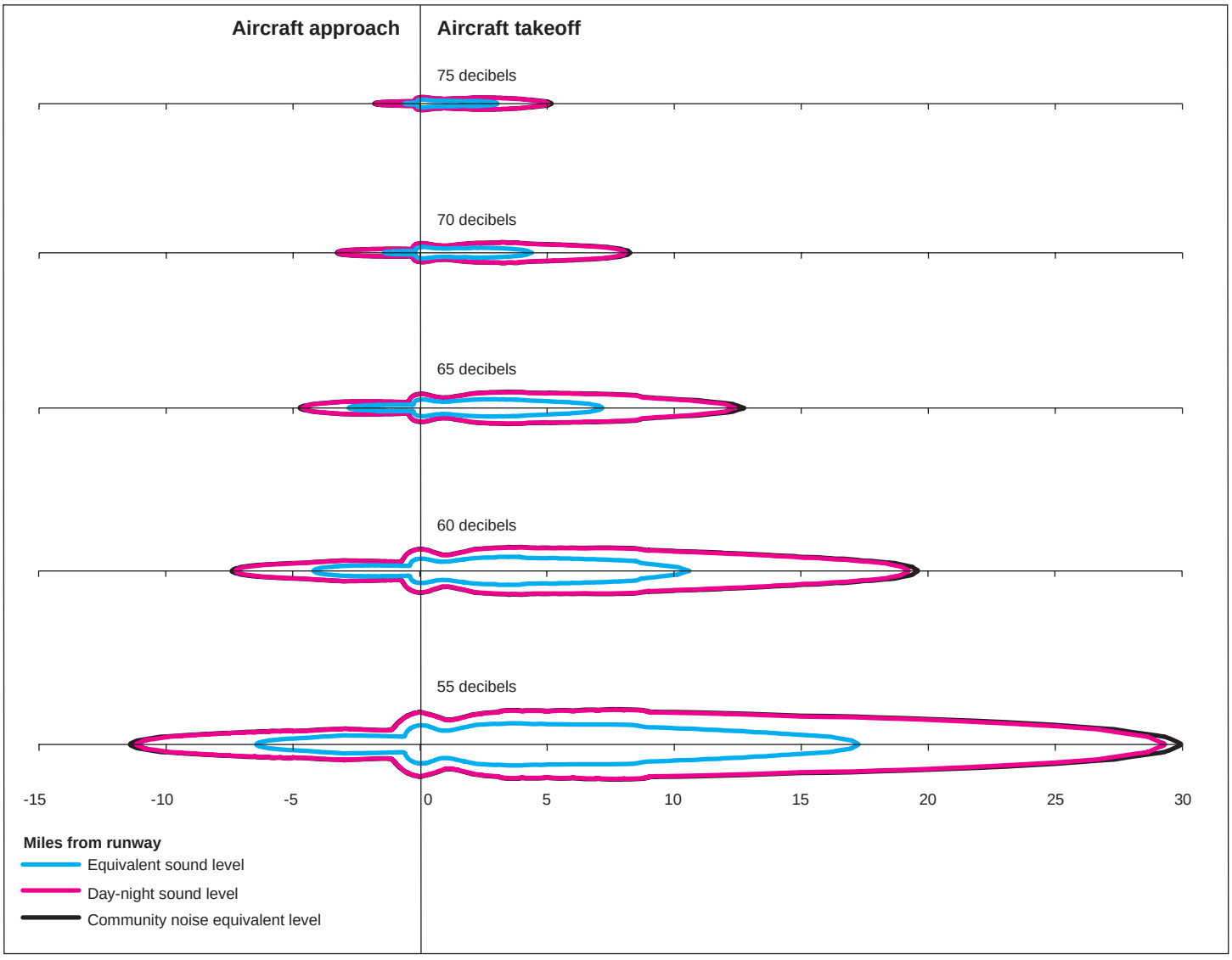
Because different combinations of flights can produce the same noise exposure level, and because these methods use additional weighting for evening and/or nighttime flights, FAA does not consider these methods to be good estimators of the noise level produced by a single event.[10]

We compared the noise contours produced by these three methods at various decibel levels using our airport model. As figure 7 illustrates, the Equivalent Sound Level method, which does not add weighting to evening or nighttime flights, produced not only the smallest areas exposed to various noise levels but also markedly smaller areas than the other two methods, which include the effects of additional weighting. The noise contours produced by the Day-Night Sound Level method identified areas that ranged from about 2-½ times as large to 3-½ times as large as the areas exposed to the same noise levels under the Equivalent Sound Level method. On the other hand, the size of the areas exposed to the same noise levels were almost identical under the Day-Night Sound Level method and the Community Noise Equivalent Level method. The latter produced a 5 percent or less increase in the size of those areas.[11]

[10]See FAA Brochure entitle *Aircraft Noise: How We Measure It and Assess Its Impact.*

[11]All three methods produced a similar proportional distribution of land areas exposed to the various noise levels. The area exposed to noise levels from 65 to 85 decibels is generally 20 percent or less of the total area within the 55 to 85 decibel noise exposure range. The portion exposed to 60 to 64 decibels is about 25 percent of the total area, while the portion exposed to 55 to 59 decibels is generally between 55 percent and 60 percent of the total area.

Figure 7: Noise Contours for Sound Equivalent Level, Day-Night Sound Level, and Community Noise Equivalent Level Measurement Methods, at 75, 70, 65, 60, and 55 A-weighted Decibels



Note: These diagrams illustrate the comparative geographical size of the noise contours produced by the aircraft that land at, and takeoff from, the airport used in our model. As the mileage markers indicate, aircraft are approaching the airport runway from the left of the diagram and are taking off towards the right of the diagram. The vertical demarcation at zero miles is the beginning of the airport runway. For a specific airport, these contours would be delineated on a geographic map that illustrates the airport and identifies the communities around the airport.

At our request, FAA also used our airport model to examine the results from the different measurement methods when (1) flights were shifted by time of day and (2) more aircraft operations were added.

In the first scenario, our model illustrated the effect of assigning additional weight to flights occurring during different times of the day. In this scenario, FAA calculated the noise exposure levels for seven different flight schedules.[12] All three methods produced the exact same contours when all flights occurred during the day because no method applies additional weighting to daytime flights. However, when all flights occurred during the nighttime, both the Day-Night Sound Level and the Community Noise Equivalent Level produced contours that quadrupled the size of the areas exposed to the different noise levels.[13] Table 3 illustrates the impact of changing flight schedules.

Table 3: Effects of Scheduling Changes on Noise Exposure Levels Using Three Measurement Methods

	Flight Schedule		
Method	**All daytime flights**	**All evening flights**	**All nighttime flights**
Equivalent Sound Level	Areas exposed to noise[a]	No change	No change
Day-Night Sound Level	Areas exposed to noise[a]	No change	More than quadrupled size of areas
Community Noise Equivalent	Areas exposed to noise[a]	Doubled size of areas exposed to noise	More than quadrupled size of areas

[a]When all flights occurred during the day, all three methods produced the exact same size areas exposed to the various noise levels.

[12]The following flight schedules were used: (1) all flights in the daytime (7 a.m. to 7 p.m.), (2) all flights in the evening (7 p.m. to 10 p.m.), (3) all flights in the nighttime (10 p.m. to 7 a.m.), (4) half of the flights in the daytime and half in the evening, (5) half of the flights in the evening and half in the nighttime, (6) half of the flights in the daytime and half in the nighttime, and (7) half of the flights during the daytime, one-fourth in the evening, and one-fourth in the nighttime.

[13]Scheduling all flights at night produces the same contours for both the Day-Night Sound Level method and the Community Noise Equivalent Level method because there are no flights scheduled during the evening, when the latter method applies additional weighting to flights.

In the second scenario, to understand how the number of aircraft operations at an airport can affect the noise contours, we looked at the results under each of the three methods, for seven cases in which the total number of takeoffs and landings were increased at various increments.[14] The results showed that increasing the number of operations produced a consistent increase in the size of the exposure area at each noise level under each method. That is, the greater the number of operations, the further out each exposure level contour extended from the airport under each method. Consistent with the results illustrated in figure 7, the total area affected by the Equivalent Sound Level method under each scenario was noticeably smaller than that of the other two methods. Also, the size of the areas exposed to each noise level under the Community Noise Equivalent Level method, for each level of operations tested, was less than 5 percent greater[15] than the area affected by the Day-Night Sound Level method.

Some Measurement Methods Provide Other Kinds of Noise Level Information

Two other measurement methods can provide additional kinds of information about the noise exposure of a community. The Time-Above method can identify how much time during a designated time period—such as a day—the noise exposure levels will exceed a specified decibel level. The sound level must be specified—for example, 60 decibels. This method can then determine the length of time during a 24-hour period that noise levels will exceed 60 decibels.

To illustrate the Time-Above method, our model produced data on how many minutes in a 24-hour day the noise levels would be above 60 and 80 decibels at points one-half mile from each end of the runway and at 1-mile increments from the runway for both approach and takeoff operations. Table 4 illustrates the measures.

[14]We examined noise measures when total aircraft takeoffs and landings equaled 26 operations, 78 operations, 234 operations, 468 operations, 702 operations, 1,056 operations, and 1,586 operations. The different levels of total operations illustrate the impact of the growth in aircraft operations at an airport, and the differences in noise impacts of airports of different sizes, holding all other elements constant. Representatives of the Air Transport Association of America, Inc. noted that if quieter aircraft replace noisier aircraft, increasing the number of aircraft operations will not necessarily expand noise contours and may reduce them. The impact of the quieter aircraft on noise contours will depend, however, on the extent to which aircraft are replaced, the extent to which operations increase, and when those operations occur.

[15]The size of the geographic areas affected by the Community Noise Equivalent Level method at each contour level ranged from 3.6 percent to 4.2 percent greater than the areas affected by the Day-Night Sound Level method.

Table 4: Time-Above Noise Measurements for 60 and 80 A-weighted Decibels

	Minutes per day above noise level—takeoff		Minutes per day above noise level—landing	
Miles from the runway	60 decibels	80 decibels	60 decibels	80 decibels
1/2	143.2	34.3	81.6	20.0
1	135	29.8	84.4	18.0
2	124.2	21.8	90.1	12.8
3	114.9	18.9	86.5	7.7
4	106.3	15.2	76.2	0.4
5	101.8	10.2	70.1	0.2
6	95.1	8.7	62.0	0
7	89.0	5.4	54.4	0
8	84.3	3.9	44.3	0
9	79.7	1.7	29.2	0
10	74.7	0	26.9	0
11	66.8	0	24.9	0
12	63.9	0	22.4	0
13	61.2	0	19.8	0
14	59.8	0	16.6	0
15	57.9	0	13.3	0
16	55.4	0	8.7	0
17	53.7	0	0.8	0
18	51.3	0	0.7	0
19	49.0	0	0.6	0
20	46.2	0	0.6	0

Another variation of this kind of information is the Lpercent method, which identifies the noise level exceeded for a portion of a time period. The portion must be specified—for example, only 15 percent of a day. This approach might determine, then, that for 15 percent of the day, the noise level exceeded 60 decibels—that is, for the rest of the day the noise level was at or below 60 decibels. FAA's Integrated Noise Model does not produce measures using this method. Neither the Time-Above method nor this method identifies the time of day the higher noise levels will occur.

FAA Selected the Day-Night Sound Level Method for Measuring Noise Exposure

The Aviation Safety and Noise Abatement Act of 1979 required the Department of Transportation—after consultation with the Environmental Protection Agency—to establish, by regulation, a single system for measuring noise from airports and surrounding areas. The act also required the Secretary to establish a single method for measuring the exposure of individuals to noise resulting from airport operations; that method had to consider noise intensity, duration, frequency, and the time of occurrence. According to a Senate committee report, the act was intended to establish a uniform approach for measuring airport-related noise in order to facilitate the administration of a federal noise abatement program that could, in turn, lead to a uniform approach for dealing with noise problems in general. Pursuant to that directive, in 1981, FAA selected the A-weighted decibel and the Day-Night Sound Level method for measuring airport-related noise.[16]

In 1992, the Federal Interagency Committee on Noise noted that the Day-Night Sound Level method was practical and widely accepted.[17] After a comprehensive review of measurement approaches, the interagency committee determined that this method best met the statutory requirements. The committee concluded that there were no other measurement methods of sufficient scientific standing to replace this method as the primary cumulative noise exposure measurement method and that the method correlates well with analyses of community annoyance at various noise exposure levels.[18] The committee also noted that there were no new data to justify a change in the use of extra weighting for nighttime operations. These conclusions are still valid, according to the chairman of the Federal Interagency Committee on Aviation Noise (the successor to the Federal Interagency Committee on Noise), which focuses on aviation research related to noise.

A frequent criticism levied against the Day-Night Sound Level method is that it does not effectively convey to people what they can actually expect

[16]4 C.F.R. section 150.9.

[17]The Federal Interagency Committee on Noise, and its successor—the Federal Interagency Committee on Aviation Noise—include the Departments of Transportation, Defense, Justice, Veterans Affairs, and Housing and Urban Development; the Environmental Protection Agency; and the Council on Environmental Quality.

[18]*Federal Interagency Review of Selected Airport Noise Analysis Issues* (Federal Interagency Committee on Noise; Aug. 1992).

to hear in any given area, primarily because it does not identify the noise levels generated by single aircraft takeoffs or landings. The noise level produced by the Day-Night Sound Level method is not the noise level that people actually hear on an event by event basis—it is an average of the cumulative sound levels over time.

To address this concern, the 1992 interagency committee report noted that supplemental information—particularly information on noise generated by individual takeoffs and landings—has been, and could continue to be, useful, especially in characterizing specific events and in conveying a clearer understanding of the potential effects of noise on people living and working in the area. The interagency committee recommended that federal agencies continue to be allowed to use supplemental information at their discretion when dealing with environmental impact analyses and requirements. An official of the interagency committee noted, however, that while single event information is useful as a supplement, there is no methodology for aggregating the effects of a single event into cumulative impact analysis, as is the case with the Day-Night Sound Level method.

Because the interagency committee reiterated the usefulness of the Day-Night Sound Level method, all federal agencies have adopted it for analyzing airport-related noise in their environmental assessments and impact statements. Some agencies, however, such as the Department of Defense, use supplemental noise information, such as single event noise measures, to provide a fuller picture of noise conditions and their potential effects. A proposed revision to FAA's requirements for environmental analyses states that FAA will also use supplemental information where warranted.[19] The revision adds new guidance on the kinds of supplemental information available and their use.

[19]FAA Order 1050.1E. The public comment period closed on Jan. 11, 2000. Prior to this revision, the order stated only that FAA would consider the use of supplemental information.

Aircraft Noise Standards Vary By Aircraft Design and Do Not Apply to Some Lighter Aircraft

FAA establishes the standards limiting the noise that civil subsonic turbojet aircraft are permitted to generate.[1] Those standards are generally based on an aircraft's weight and the number of engines and generally allow heavier aircraft to generate more noise than lighter aircraft. The statutory deadline of December 31,1999, for compliance with "stage 3" standards did not apply to aircraft weighing 75,000 pounds or less that were already in operation. As of October 1, 1999, more than 2,750 aircraft were not subject to the stage 3 compliance deadline.

Noise Standards Generally Permit Heavier Aircraft to Generate More Noise Than Lighter Aircraft

FAA regulations establish the maximum noise levels that civil subsonic turbojet aircraft are allowed to generate for takeoff, landing, and "sideline" measurements. The standards for each of these kinds of measurements are different, but, in general, these standards vary with the weight of the aircraft. The standards allow heavier aircraft to be noisier than lighter aircraft because, according to FAA, the noise generated by an aircraft is generally determined by the thrust powering the aircraft; the amount of thrust an aircraft needs is proportional to the weight of the plane—that is, the heavier the aircraft, the more thrust it needs.[2] According to an aircraft noise expert, lower noise standards for lighter aircraft is one of the reasons that a stage 2 aircraft weighing 75,000 pounds or less may make less noise than a heavier aircraft that meets the more stringent stage 3 standards. For takeoff, stage 3 noise standards also vary on the basis of the number of engines; generally, the more engines an aircraft design has, the higher the permitted takeoff noise levels. Stage 3 standards for takeoff, sideline, and approach are shown in appendix VII.

[1]These regulations appear in 14 C.F.R. part 36. Sideline noise is measured at points equidistant from both sides of an aircraft when the aircraft reaches a certain altitude during takeoff—the altitude where sideline noise is at a maximum. Aircraft subject to regulation as civil subsonic turbojets include such aircraft as Boeing 737 and 747, MD-80, and Gulfstream IV.

[2]According to representatives of the Air Transport Association of America, Inc., there is a tradeoff between reductions in noise and increases in air emissions because modifications to aircraft to reduce noise often add to the weight of an aircraft, thereby causing it to burn more fuel.

The United States is a member of the International Civil Aviation Organization—the international authority on civil aviation standards—and as such participates in that organization's activities regarding aircraft noise standards. Members of the organization—are considering more stringent noise standards. The organization's Committee on Aviation Environmental Protection is reviewing several options, identified by its Noise Scenarios Group in a November 1999 report, including: (1) taking no action on more stringent standards, (2) adopting a standard only for new aircraft designs, or (3) adopting more stringent standards with various schedules for the phaseout of noisier aircraft. Guidance governing the Committee's work directs it to consider such factors as technical feasibility, economic reasonableness, and the environmental benefit to be achieved. The organization is expected to adopt a resolution when it meets in September 2001 on a more stringent standard and the phaseout of stage 3 aircraft. Implementation of the new standard, and phaseout of the noisier aircraft, would be up to the member nations.[3]

The European Union has banned, after May 1, 2000, stage 2 aircraft that were modified to meet stage 3 noise standards,[4] unless the aircraft were already operating or registered in a member country before that date. The European Union also adopted restrictions on operating modified aircraft after April 1, 2002. The United States filed a formal complaint with the International Civil Aviation Organization on March 14, 2000, alleging that the European Union's ban discriminates against U.S. aircraft in violation of the agreement establishing the organization.

Existing Aircraft Weighing 75,000 Pounds or Less Have Been Exempt From Operating Restrictions

Both stage 1 and stage 2 aircraft that did not meet more stringent noise standards by specified dates have been prohibited from operating after those deadlines, but that prohibition does not apply to aircraft in service that weigh 75,000 pounds or less. FAA did not require the retirement of the lighter stage 1 aircraft that did not meet stage 2 standards because FAA concluded it was not technologically practicable or economically reasonable to modify these aircraft. The statute prohibiting the operation

[3]According to an FAA official, many of the organization's member nations, particularly developing nations, have not yet imposed stage 3 standards on aircraft.

[4]Modifications can include new engines or other modifications such as hushkits. Hushkits reduce aircraft engine fan and compression noise by modifying various engine components and by adding acoustic treatment and noise suppression technology.

of stage 2 aircraft that did not meet stage 3 standards by a certain date does not apply to aircraft weighing 75,000 pounds or less.

Exemption From the Stage 1 Operating Deadline Was for Technological and Economic Reasons

When FAA amends regulations controlling aircraft noise, it must consider several factors, including whether the proposed regulations are technologically practicable, economically reasonable, and appropriate for the types of aircraft, aircraft engines, or aircraft certifications that the regulations apply to.[5] FAA must also consider the extent to which any proposed amendments protect the public health and welfare.

In 1976, FAA considered amending its regulations to require stage 1 aircraft already in service to meet stage 2 noise standards or be prohibited from operating at U.S. airports. At that time, the Environmental Protection Agency recommended that the deadline for compliance be applied to all civil subsonic turbojet aircraft regardless of weight. That agency contended that all of those aircraft were capable of meeting stage 2 standards by using various engine modifications or replacement options. It determined that because all newly produced aircraft weighing 75,000 pounds or less had to comply with stage 2 noise standards after January 1, 1975, there seemed to be no valid justification for permitting stage 1 aircraft to operate indefinitely. While some who commented on FAA's proposed amendment supported the Environmental Protection Agency's conclusion, others challenged it, contending, for example, that (1) the technology was not available to enable lighter aircraft to meet the stage 2 noise standards or (2) other sources, such as heavier aircraft or traffic from regularly scheduled passenger service flights, were the primary causes of the noise problems.

[5]Amendments to 14 C.F.R. part 36 and part 91 are governed by provisions of section 611 of the Federal Aviation Act of 1958, as amended.

FAA chose not to apply the operating deadline for stage 1 aircraft to aircraft weighing 75,000 pounds or less. FAA concluded that it could not impose operating noise limits on the lighter aircraft at that time in a manner that was fully consistent with its obligations under the law for two reasons. First, FAA determined that the cost-effectiveness of implementing the kinds of modifications needed to retrofit an existing aircraft was questionable and, therefore, not technologically practicable. It concluded that noise reduction modifications to the lighter aircraft could be applied during the original design and manufacture of an aircraft, but such modifications involved substantial redesign efforts that, while reasonable when spread over the production process, were of doubtful cost-effectiveness if accomplished by retrofitting. FAA considered only retrofitting options—engine modification or replacement—as acceptable for meeting noise standards; flight operation noise abatement procedures were not an acceptable means for complying with the noise standards.[6]

Second, FAA determined that available information was not sufficient to assess the economic impact on owners of an across-the-board requirement to retrofit the lighter aircraft. Available information was limited because the aircraft were so varied in their use and mission and were frequently the only—or one of a few—aircraft owned by the owner. In addition, FAA determined that the availability of supplies for small engine manufacturers needed further study before FAA could assess the overall economic impact of specific compliance dates on aircraft owners.

In December 1997, however, the National Business Aviation Association, a membership organization of companies that operate aircraft, passed a resolution calling for the group's 5,200 members to refrain from adding new stage 1 aircraft to their fleets beginning in January 2000 and to end the operation of stage 1 aircraft by 2005.

[6]FAA did consider flight operations, however, to be an appropriate operational noise abatement procedure to further reduce noise where circumstances warranted.

Statutory Deadline for Stage 2 Retirement Did Not Apply to the Lighter Aircraft

The Airport Noise and Capacity Act of 1990 established December 31, 1999, as the deadline for phasing out stage 2 aircraft that were not modified to meet stage 3 noise standards. The statute, however, specifically applied the phaseout only to aircraft weighing more than 75,000 pounds. The legislative history of the act provides no discussion on why the statutory phaseout was not applied to the lighter aircraft.[7] As of October 1, 1999, just over 9,000 civil subsonic turbojet aircraft that weighed 75,000 pounds or less were certified by FAA as airworthy.[8] About 31 percent of those, or just over 2,770, are stage 1 or stage 2 aircraft that may still operate at U.S. airports after December 31, 1999.

The 1990 act, however, also established federal review requirements when an airport wants to control noise by imposing more stringent limitations on aircrafts' use of the airport than federal regulations provide. The act directed the Secretary of Transportation to establish a national program for reviewing airport restrictions on the operation of stage 2 and stage 3 aircraft. It also required the Secretary to study whether federal review should be applied to restrictions on stage 2 aircraft weighing less than 75,000 pounds. The study recommended that the same procedures should apply to all stage 2 aircraft, regardless of weight.[9] FAA adopted that recommendation. Thus, an airport may impose a noise or access restriction on stage 2 aircraft, whatever its weight, if the airport operator publishes the proposed restriction and prepares and makes certain analyses available for public comment at least 180 days before the effective date of the restriction.[10] Unlike noise or access restrictions proposed for stage 3 aircraft, FAA approval is not required.

[7]According to the General Aviation Manufacturers Association, this exception is consistent with guidance adopted by the International Civil Aviation Organization.

[8]As of Oct. 1, 1999, FAA had certified nearly 300,000 fixed-wing aircraft as airworthy. About 5.3 percent, or just over 15,500, of those were civil subsonic turbojet aircraft.

[9]*Study of the Application of Notice and Analysis Requirements to Operating Noise/Access Restrictions on Subsonic Jets Under 75,000 Pounds*, Federal Aviation Administration, Office of Environment and Energy, June 1991.

[10]The statute requires analyses of such things as the costs and benefits of the proposed restriction and a description of alternatives. The airport operator also must describe alternative measures considered that do not involve aircraft restrictions and a comparison of the costs and benefits of these measures with those that do involve aircraft restrictions. (49 U.S.C. 47524).

FAA's Land Use Planning Initiative Focuses First on Improving Access to Information

Land use planning is one way that communities can alleviate the impact of airport-related noise in areas near airports. While the federal government has no decision-making authority in land use planning, FAA does have some responsibility to address land use issues in connection with its administration of airport-related noise programs. For example, as required by law, FAA has identified the kinds of land uses that are compatible with various noise levels communities may be exposed to because of a nearby airport. Looking to the future, FAA has announced five short-term actions under its Land Use Planning Initiative, which it launched to help prevent incompatible land uses. Reviewing the comments provided by the aviation sector and the general public, we identified four principal areas of concern associated with the initiative.

FAA Facilitates State and Local Land Use Planning Efforts

Through land use planning, communities determine what kinds of development—for example, residential or industrial—will occur within their jurisdictions. Communities can use such land use planning to reduce or alleviate the impact of airport-related noise. For example, communities may prohibit the construction of schools within a certain distance from an airport so that airport-related noise will not interrupt classes. While the federal government has no direct decision-making authority over land use planning, FAA can nevertheless help communities consider the impact of nearby airports as they develop their plans. For example, the Aviation Safety and Noise Abatement Act of 1979 requires FAA to identify land uses that would not be compatible with noise generated by the operation of a nearby airport. As a result, FAA identified some land uses, such as homes and schools, as being incompatible with noise exposure levels of 65 decibels or higher (using the Day-Night Sound Level method) that occur very close to an airport, while other land uses, such as industrial and commercial uses, could successfully be located close to an airport without interfering with activity.[1] Although FAA can provide land use planning guidance, it is up to the state and to local communities to apply this guidance.

[1]FAA has issued its designation of compatible and incompatible land uses in 14 C.F.R. part 150. A summation appears in app. VIII.

The recent transition to quieter aircraft can lower noise exposure levels in some communities, but FAA has been concerned that noise levels may rise again around some airports if the number of flights increase to meet the expected growth in passenger levels.[2] According to an FAA official, even where noise levels do not rise, maintaining a buffer zone between the airport and certain land uses, such as homes and schools, serves a general interest in maintaining a quieter environment. Because of its concerns, FAA embarked on a Land Use Planning Initiative to help state and local governments achieve and maintain compatible land uses around airports. Under this Initiative, in January 1995, FAA sponsored a Study Group on Compatible Land Use, which was composed of community, airport, and aviation representatives. This group recommended federal actions that could promote compatible land use planning around airports. In May 1998, FAA issued a request in the *Federal Register* for additional suggestions to help state and local governments' planning efforts. After reviewing the submissions, FAA announced in May 1999 that it would implement five short-term actions while it continued its review of other suggestions. FAA expects to announce additional actions in the future on training, education, satellite navigation, research and development, and proposed legislation.

Short-Term Actions Aim at Improving the Communication of Information

The five short-term actions that FAA announced in May 1999 focus primarily on improving the communication of its noise policies and noise compatibility information in order to help communities and airports work together to minimize the noise impacts of airports. Table 5 provides an overview of each action, the FAA office responsible for implementation, and the implementation status of each action.

[2]FAA forecasts a 3.6 percent annual growth in passenger enplanements at airports between the years 2000 and 2011.

Table 5: Short-term Actions Under FAA's Land Use Planning Initiative

Action	Responsible FAA office	Implementation status
Develop a package of land use planning information for use by FAA regional officials and national planning organizations, primarily at local meetings. The package is to include information on FAA's noise policies; effects of a transition to quieter aircraft; testimony on noise issues and planning; examples of local zoning and information disclosure rules; and methods through which compatible land use development can be achieved around airports; and other pertinent information.	Office of Environment and Energy	Implementation goal--March 31, 2000[a]
Develop an information package on existing statutes for state aviation organizations through the National Association of State Aviation Officials.[b]	Office of Environment and Energy	Implementation goal--March 31, 2000[a]
Provide an information clearinghouse—readily accessible to federal, state, local, industry and public users—for compatible land use planning information, including FAA orders, advisory circulars, reports, studies, and other related information; and access to available land use planning resources that are applicable to aviation.	Office of Airport Planning and Programming	An Internet website was created, enabling the agency to meet the original implementation goal of September 30, 1999.
Use a rapid-response procedure within the agency to respond quickly to inquiries on FAA policies. This procedure would include a mechanism to assist airports, jurisdictions, and/or communities attempting to resolve conflicts between airport and community needs.	Office of Environment and Energy	Implementation goal--March 31, 2000[a]
Provide clearer understanding of what FAA might do to address noise exposure, particularly in relation to areas exposed to noise levels below the 65 decibel level--the level at which all land uses are currently considered compatible--and in areas outside the airport's direct control. FAA actions include providing greater FAA focus on the use of in-flight procedures to achieve noise abatement, and more consultations with airports and communities in those lower exposure areas.	Office of Environment and Energy	FAA revised its order in June 1999 that provides guidance on environmental impact analyses concerning airports, enabling the agency to meet the original implementation goal of September 30, 1999.

[a]The first anticipated implementation date was Sept. 30, 1999. As of Apr. 26, 2000, an FAA official stated that the actions were expected to be fully implemented by May 2000.

[b]This is a member organization representing the aviation departments/units in each of the 50 states, as well as Puerto Rico and Guam.

The implementation goal for these short-term actions was originally September 30, 1999. FAA has completed implementation of two of these actions. To establish the information clearinghouse, FAA created an Internet website. To provide a clearer understanding of its actions addressing certain noise exposure situations, FAA issued revisions in June 1999 to its order that provides guidance on conducting environmental impact analyses for airports. The November implementation goal for the remaining three actions was delayed until March 31, 2000, primarily because FAA was reorganizing its Office of Environment and Energy, which is responsible for the Land Use Planning Initiative. As of April 26, 2000, an

FAA official expected the remaining actions to be implemented by May 2000.

The clearinghouse that FAA established on land use information can be accessed at *www.faa.gov/arp/app600/5054a/landuse.htm*. According to FAA officials, this website will become the primary means for distributing information made available by some of these short-term actions—including the information packages—and any additional actions approved in the future. The website has links to information on Washington State's website for its land use planning program and will eventually link to other states that have similar websites. It also incorporates links to websites for land use planning associations, periodicals, and legal planning specialists. FAA plans to add information and/or links as warranted.

FAA stated that the objectives of its fifth action include (1) providing greater focus on the use of flight procedures to mitigate the effects of noise over certain areas and (2) emphasizing consultations with airports and communities. FAA's overall goal is to clarify the actions it might take to address rising noise exposure levels. FAA's revised guidance, however, does not appear to achieve its objective of providing greater focus on the use of flight procedures because the revisions contain no explicit discussion of the use of flight procedures to mitigate the effects of noise over certain areas. Furthermore, this lack of discussion contrasts with the detailed description FAA provides to incorporate other changes to that same order, including changes pending that pertain to the use of supplemental information in environmental impact analyses.

Initiative Raises Key Issues in Noise Mitigation Efforts

In reviewing the public comments on the Initiative and from our discussions with aviation officials and other experts, we identified four principal areas of concern associated with the Initiative. These areas involve determining (1) what is the most effective use of the agency's limited resources when addressing airport-related noise, (2) whether the 65 decibel level defining incompatible land uses should be lowered, (3) whether additional information, such as single event noise levels, should be required when analyzing noise impacts, and (4) what is the best use of federally authorized investment in the growth of airport capacity in view of the noise and physical expansion constraints affecting many airports.[3] Table 6 summarizes the context and scope of these issues.

[3]FAA requested suggestions and comments from the public in a May 1998 announcement in the *Federal Register*.

Table 6: Summary of Key Land Use Planning Issues Related to Airport Noise

Issue	Context of issue	Scope of issue
Should FAA's role in land use planning be more proactive or should it focus its limited resources on activities over which it has direct jurisdiction?	FAA has no direct jurisdiction over land use or zoning decision-making. Zoning authority is the province of state and local governments.	Some in the aviation community support a proactive role for FAA in land use planning and even suggest that FAA should expand its efforts to include other activities, such as playing an active role to support state legislation on compatible land use and community land use planning processes. Others question FAA's focus on land use planning when the agency has no direct jurisdiction over it. Some suggest that FAA should focus on those activities over which it has authority, such as changing flight paths or mandating new aircraft noise reductions. FAA officials believe that land use planning is an important way to prevent noise problems. They are concerned that noise reductions resulting from transition to quieter aircraft will spur development in areas closer to airports that later may experience higher noise exposure levels because of growth in aviation or may raise concerns even where noise levels remain stable. Preventing future incompatible land use will reduce future noise mitigation costs.
Should the noise level defining all land uses as compatible be lowered or retained at the 65 decibel Day-Night Sound Level measure?	FAA's regulations establish a noise exposure level below which all land uses are considered compatible with airport-related noise and above which residential and certain other development is considered incompatible with that noise. FAA uses that level to help set priorities for funding decisions for noise abatement projects, resulting in few projects being approved where all land uses are compatible under federal guidelines.	Some interested parties, particularly community and environmental groups as well as individuals, believe that the noise exposure level below which all land uses are compatible is too high and should be lowered. This is also a particular concern because that level has a very strong influence on FAA's decisions about which noise abatement efforts to fund. An FAA official noted that there are not enough federally authorized funds to pay for all planned or approved noise mitigation efforts so FAA uses the compatible land use noise exposure level to help focus funds in the most noise-impacted areas. The official noted that FAA does approve the funding of projects where the noise exposure level is lower, when warranted, but that very few have been approved.

Issue	Context of issue	Scope of issue
Should the use of supplemental information, such as single event noise measures, be required when measuring noise impacts for environmental impact analyses of airport development projects?	The law requires FAA to establish a single method for measuring the noise exposure levels in communities surrounding airports. At their discretion, federal agencies provide or use supplemental information in implementing their programs that involve assessing noise exposure levels.	Because of the way noise exposure levels are measured, the numerical values involved can be lower than the measured value of noise generated by a single aircraft's takeoff or landing. As a result, interested groups and individuals suggest that additional information be available and be used in assessing the noise exposure levels in communities for federal funding and land use compatibility determinations. FAA is required by law to select one measurement of community noise exposure. The Federal Interagency Committee on Noise noted in a 1992 report that there is no accepted methodology for aggregating single event noise levels to explain the cumulative impact on people in communities near airports. Proposed revisions to an FAA order recognize the usefulness of supplemental information where warranted, whereas before FAA policy was only to consider its use.
How should federally authorized investment in airport capacity growth be directed, given the noise and physical expansion constraints facing so many of the nation's large airports?	FAA approves federally authorized funding for projects to expand airport capacity. Forecast growth in the demand for air travel is pressuring airports to expand capacity to meet that future demand.	In view of the noise issues at many airports, as well as the physical constraints affecting capacity expansion at many airports, some—particularly individuals and community/environmental groups—suggest that FAA should direct airport expansion funds to existing or new airports that are not affected by noise or geographic constraints. Proposals for airport expansion originate at the local level. Private sector decisions, such as an airline's selection of hub airports, also affect airports' plans for expansion. FAA approves funding for airport infrastructure projects pursuant to the provisions of the Airport Improvement Program and the Passenger Facility Charge program.[a]

[a]See *Airport Financing: Funding Sources for Airport Development* (GAO/RCED-98-71, Mar. 1998) and Passenger Facility Charges: Program Implementation and the Potential Effects of Proposed Changes (GAO/RCED-99-138, May 1999).

Observations

Through its responsibilities for aviation noise, FAA plays a critical role in helping to reduce the noise that airports generate and to mitigate the effects of that noise on surrounding communities. While FAA has accomplished much in fulfilling its statutory responsibilities, the issues raised in connection with FAA's Land Use Planning Initiative are not necessarily new and show that more work remains to be done on resolving controversies regarding airport-related noise. Addressing these issues will require balancing the needs of the different—and often conflicting—interests of airports, airlines, manufacturers, passengers, general aviation, and the communities near the airports. Resolution of these issues will also need to take into account concerns about the environment, as well as advances in technology.

Agency Comments

We provided the Department of Transportation, the National Association of State Aviation Officials, an advisory panel of five experts, the Airports Council International-North America, the General Aviation Manufacturers Association, and the Air Transport Association of America, Inc. with copies of the draft report for their review and comment.

We met with officials from the Department of Transportation, including FAA's Manager, Community and Environmental Needs Division, and spoke with FAA's Manager, Noise Division. These officials generally agreed with the facts in the report and provided clarifying comments, which we incorporated as appropriate. The National Association of State Aviation Officials and the advisory panel of experts generally agreed with the facts in the report and provided us with technical and clarifying comments, which we incorporated as appropriate. The Airports Council International-North America provided no comments.

We spoke with the President of the General Aviation Manufacturers Association, who stated that the report reflects a good effort to make a difficult topic understandable. However, he said the Association had three concerns about the accuracy of the presentation. The Association believes the draft report (1) implied that aircraft not subject to phased compliance with operating noise limits were not subject to any noise standards, when in fact, all aircraft manufactured after December 31, 1974, must meet stage 3 noise standards; (2) did not explain that the exception of lighter aircraft from compliance with stage 3 operating noise limits was consistent with international operating rules developed by the International Civil Aviation Organization; and (3) overestimated how many aircraft weighing 75,000 pounds or less still operate in the United States. The Association further believed the general aviation aircraft selected for our airport model were not representative of the operating fleet.

With regard to the Association's first concern, we believe the draft report accurately explained the progressive application of noise standards to aircraft. However, we revised it to clarify the distinction between noise standards for the certification of aircraft as airworthy and the application of those standards to operating aircraft. Regarding the second concern, this report focuses on FAA's roles and responsibilities rather than on international activities. Nevertheless, we revised the draft report to clarify that the United States is a member of the International Civil Aviation Organization and as such participates in that organization's activities regarding aircraft noise standards. Concerning the final issue, data in our

draft report on the number of aircraft weighing 75,000 pounds or less include all such aircraft certificated by FAA as airworthy as of October 1, 1999. In contrast, data provided by the Association include only the operating business fleet, which is a subset of FAA's list of certificated aircraft. With regard to our selection of aircraft for the model, we began with the universe of certificated aircraft and selected two general aviation aircraft from this list, as well as four others, to reflect both stage 2 and stage 3 aircraft, and lighter and heavier aircraft. We revised the draft report to clarify that we selected aircraft from the list of certificated aircraft.

We met with officials from the Air Transport Association of America, Inc., who stated that the draft report was generally very good, but who expressed five concerns. They believe the draft report (1) did not fully recognize, in its discussion of the potential impact of growth in air traffic, the significant progress that the Congress, FAA, airports, and the airlines have made in reducing the number of people exposed to noise from aircraft, nor did it recognize that aircraft used to achieve additional growth may be quieter; (2) did not fully reflect the role of international agreements and obligations related to noise control; (3) was overly broad in its discussion of flight procedures for abating noise when explaining why FAA did not require aircraft weighing 75,000 pounds or less to be retired if they did not meet stage 2 standards; (4) included only two aircraft in the airport model, one of which is no longer being produced, and did not address current production aircraft; and (5) did not fully reflect the relationship and potential trade-offs between noise stringency standards and aircraft emissions. The Association also provided technical and clarifying comments, which we incorporated as appropriate.

With regard to the first concern, we agree that the aviation industry and the federal government have made substantial progress in reducing noise generated by airports. However, forecast growth in aviation activity could reduce or eliminate the benefits at individual airports. If current aircraft are replaced with quieter aircraft, the impact of the quieter aircraft on airport-related noise will depend on several factors including the extent to which aircraft operations increase and when operations occur. We revised the draft report to clarify these points.

With regard to the second issue, we agree that the international administrative and regulatory framework for developing and implementing aircraft noise standards is important for the aviation industry. However, this report focuses on FAA's role in major noise-related programs rather than on international activities. Nevertheless, we revised the draft report

to clarify that the United States is a member of the International Civil Aviation Organization and as such participates in that organization's activities regarding aircraft noise standards.

Regarding the third concern, our draft report provided FAA's rationale for not applying a retirement deadline to stage 1 aircraft weighing 75,000 pounds or less. As noted in the report, FAA did not consider flight operations to be an appropriate operational noise abatement procedure for the purpose of meeting aircraft noise standards. As also noted, however, FAA did consider flight operations to be appropriate for further reducing noise where circumstances warrant. Accordingly, we did not revise this discussion in our draft report.

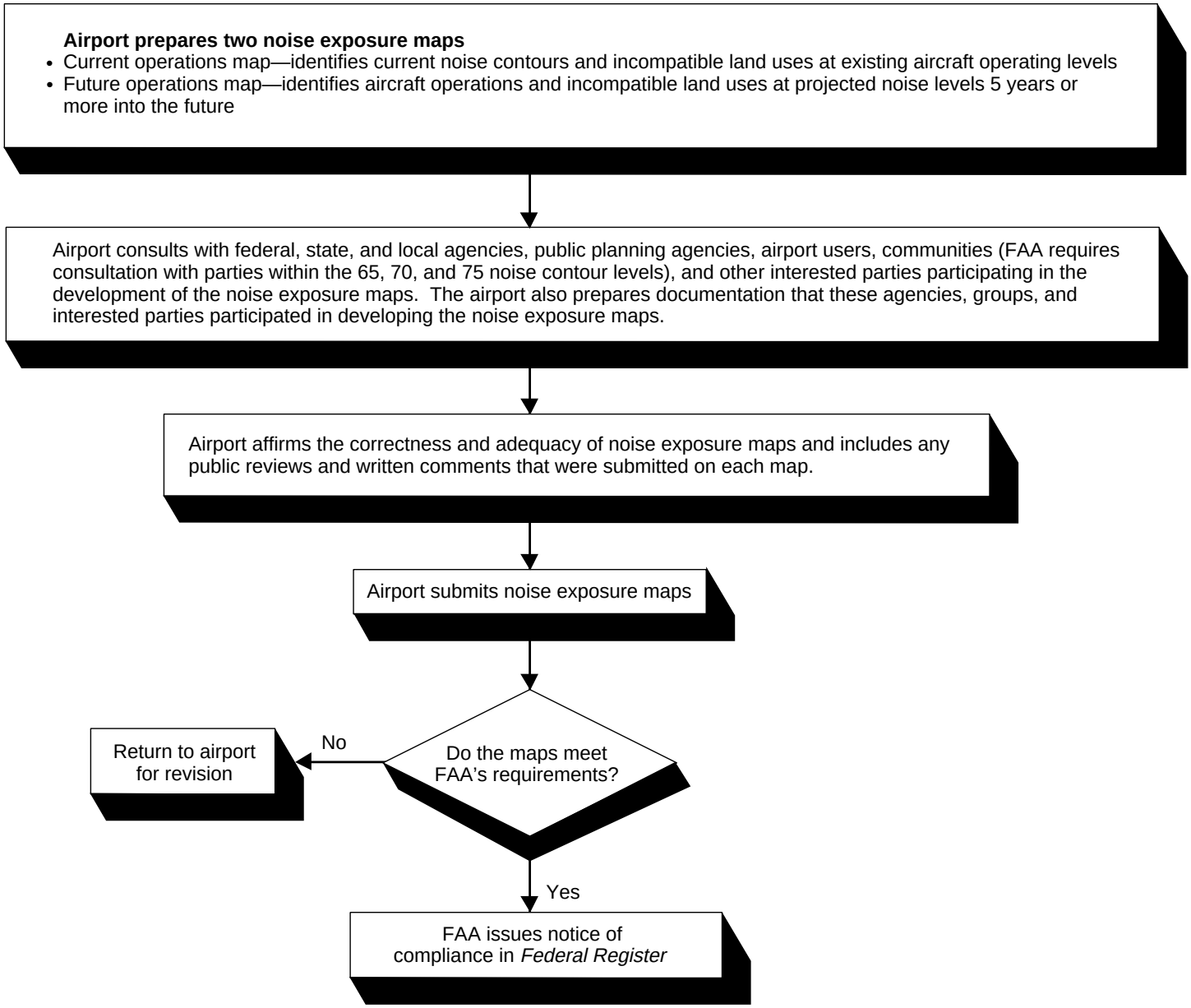
With regard to the fourth concern, the Association incorrectly concluded that the airport model included only two aircraft. As appendix V of the report explains, the model was designed to provide a reasonable facsimile of an airport for use in comparing and illustrating the various noise measurement methods. Six aircraft were selected from FAA's list of certificated aircraft to represent categories of aircraft operations. Aircraft selection was not intended to include only those aircraft currently in production because that would have eliminated stage 2 aircraft from the model.

With regard to the final concern, we revised the draft report to acknowledge that reducing aircraft noise may result in higher aircraft emissions.

Process for Participating in the Part 150 Noise Compatibility Program

The first step in preparing a noise compatibility program is to develop noise exposure maps that identify incompatible land uses. The airport must provide a map that shows the present noise exposure levels and a second map that shows projected noise exposure levels based on anticipated airport operations 5 or more years into the future. Once the Federal Aviation Administration (FAA) accepts the maps as complying with regulatory and technical requirements, it publishes a notice of compliance in the *Federal Register*. If the airport makes any operational changes that would increase the noise level by 1.5 decibels or more in areas with incompatible land uses, the airport must submit a revised noise exposure map. Figure 8 illustrates the preparation, review, and acceptance process for noise exposure maps.

Figure 8: Part 150 Noise Exposure Map Preparation and Acceptance Process



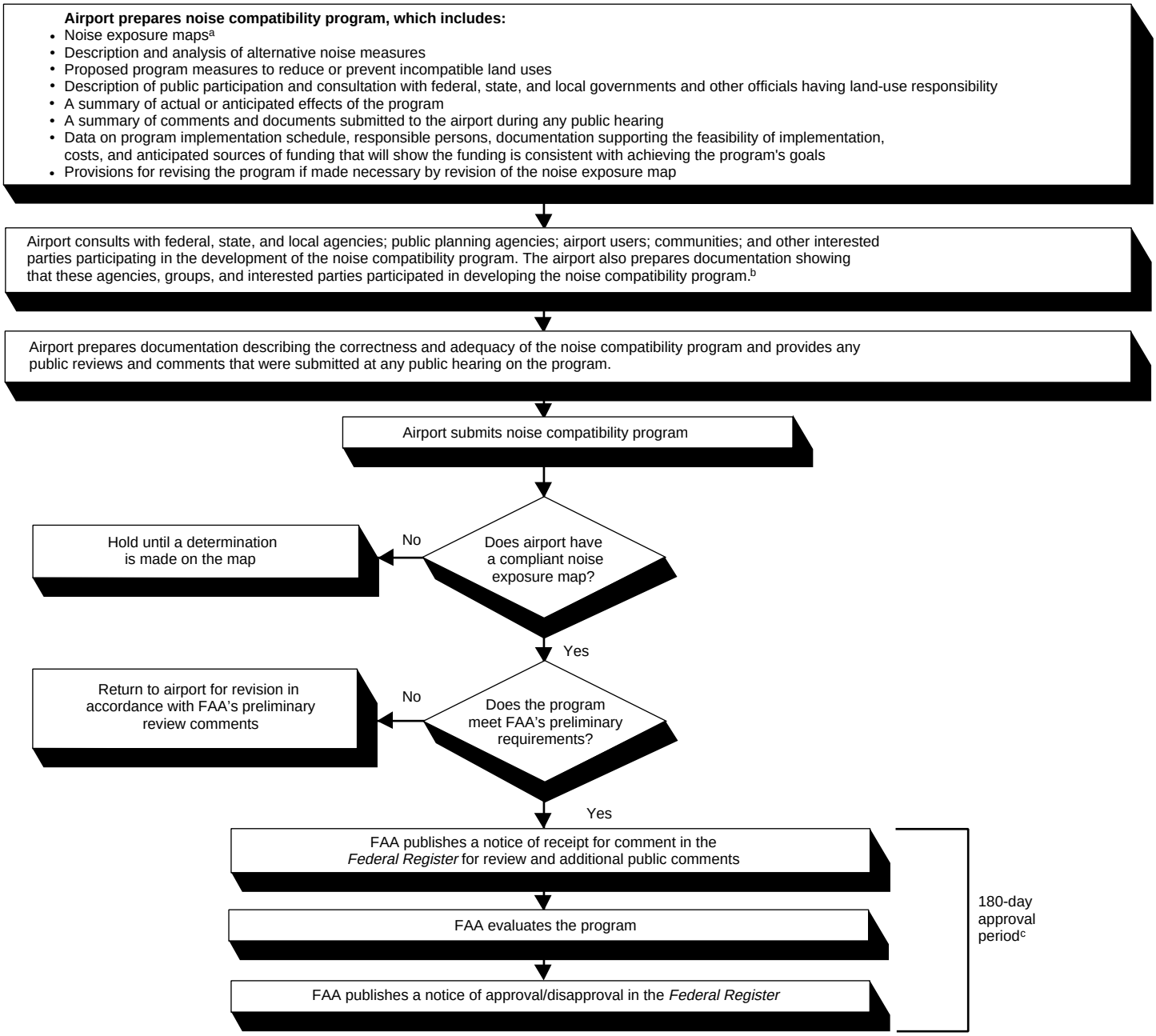
Note: Noise exposure maps identify airport runways; flight tracks; noise contours for at least 65, 70, and 75 decibels; airport boundaries; incompatible land uses; any optional aircraft noise monitoring sites; and location of noise sensitive public buildings such as schools, churches, and hospitals.

Airports interested in developing a noise compatibility program may generally submit noise exposure maps for FAA's acceptance at the same time that they submit their overall noise compatibility program for FAA's approval.[1] The noise compatibility program is intended to show the measures the airport has taken, or proposes to take, to reduce incompatible land uses and to prevent the introduction of additional incompatible uses in the future. According to FAA, the noise compatibility program is the primary vehicle for guiding and coordinating all those whose combined efforts are essential to achieve the maximum degree of noise compatibility between the airport and its neighbors while taking into account the requirements of the national aviation system. Figure 9 illustrates the preparation, review, and approval process for noise compatibility programs. [2]

[1]According to an FAA official, 7 of the 9 FAA regions generally process noise exposure maps and noise compatibility programs together, while 2 generally require acceptance of the noise exposure maps before submission of the noise compatibility program.

[2]These are the processes that currently apply to this program. FAA is preparing revisions, however, to streamline the process and reduce the implementation costs. FAA officials plan to issue a Notice of Proposed Rulemaking by the end of the year 2000.

Figure 9: Part 150 Noise Compatibility Program Preparation and Approval Process



[a]An airport may submit its noise exposure maps along with the noise compatibility program.

[b]FAA's evaluation of all proposed measures includes whether they are reasonably consistent with the goals of reducing or preventing incompatible land uses and ensuring that they do not create an undue burden on interstate commerce, adversely affect aircraft safety or efficiency, or otherwise adversely affect any other powers and duties of the FAA administrator.

[c]Flight operational changes—including actual operations as well as measures related to flight procedures, such as navigational aids—are not subject to the 180-day approval requirement.

National Priority System for AIP-Eligible Projects

FAA ranks all projects eligible for the Airport Improvement Program (AIP) according to its national priority system in order to identify those of sufficient national interest to warrant federal funding. A priority ranking formula serves as an initial screening of all AIP-eligible projects. Under the formula, priority rating = (0.25 x purpose) x [(1 x airport size) + (1.4 x purpose) + (1 x component) + (1.2 x type)]. Each of the four elements in the formula—purpose, airport size, component, and type—has assigned point values consistent with FAA's goals and objectives. The point values assigned are listed in tables 7 through 10. FAA also considers other factors—such as benefit-cost analyses, risk assessment, regional priorities, state and metropolitan system plans, airport growth, and market forces—in determining a project's overall ranking.

Table 7: Point Values Assigned for Project Purpose in FAA's National Priority System

Points	Type of purpose
10	Safety/security
9	Statutory emphasis program
8	Environment (including Part 150), planning, reconstruction/rehabilitation
7	Capacity
6	Standards
4	Other—such as people movers, rail systems, access roads, parking lots, fuel farms, training systems.

Table 8: Point Values Assigned for Airport Size in FAA's National Priority System

Points	Size of airport
5	Large-and medium-hub airports, other commercial service and general aviation airports with 100 based aircraft or 50,000 operations
4	Small and nonhub airports, other commercial service and general aviation airports with 50 based aircraft or 20,000 operations
3	Other commercial service and general aviation airports with 20 based aircraft or 8,000 operations
2	Other commercial service and general aviation airports with less than 20 based aircraft or less than 8,000 operations

Table 9: Point Values Assigned for the Component Element in FAA's National Priority System

Points	Type of component
10	Runway
9	Helipad, seaplane
8	Equipment, taxiway
7	Homes—residential noise mitigation; land; other, such as fuel farms and airport drainage, public buildings—noise mitigation, planning
5	Apron
4	Transportation—people movers and rail/road access, new airport, vertiport
3	Building
1	Terminal
0	Bond retirement financing

Table 10: Point Values Assigned for Project Type in FAA's National Priority System

Points	Category of type
10	Noise projects in 75-decibel day-night sound level and above, construction, obstruction removal, aircraft rescue fire fighting vehicle
9	Runway friction, master planning, runway/taxiway signs, snow removal equipment
8	Improvement to existing infrastructure, lighting, runway safety area, sensors, state planning, safety zone, visual approach aid, weather reporting equipment
7	Noise projects in 70- to 74-decibel day-night sound level, access to airport, instrument approach aid, metropolitan planning, noise plan/suppression
6	De-icing facility, development-land, extension/expansion, environmental mitigation, security, airport service road
5	Acquire airport, miscellaneous
4	Noise projects in 65- to 69-decibel day-night sound level
3	People mover, rail
2	Fuel farm development, plan to construct a vertical take off and landing runway/vertiport
1	Automobile parking
0	Noise projects in day-night sound level below 65 decibels, administrative costs, bond retirement

Funding for Noise-Related Projects Through the Airport Improvement Program, Fiscal Years 1982 Through 1999

Table 11 provides the amount of AIP grants awarded for noise-related projects by type of project and by fiscal year, for fiscal years 1982 through 1999. As the table shows, the amount has varied from a low of $35.6 million in fiscal year 1982 to a high of $254.4 million in fiscal year 1993.

Table 11: Noise-related Projects Funded Through the Airport Improvement Program, Fiscal Years 1982 Through 1999, by Project Type

Dollar in thousands

Project type and fiscal year	Amount	Percent
1982		
Land for noise control	$32,392	91.1
Landscaping	0	0
Lighting	0	0
Miscellaneous	0	0
Navigational aids	0	0
Noise barrier	194	0.5
Planning	637	1.8
Noise-suppressing equipment	0	0
Relocation assistance	1,193	3.4
Runway development	1,146	3.2
Soundproofing	0	0
State grant	0	0
Taxiway development	0	0
Fiscal year total	**$35,563**	**100**
1983		
Land for noise control	$51,478	80.3
Landscaping	0	0
Lighting	270	0.4
Miscellaneous	1,142	1.8
Navigational aids	0	0
Noise barrier	0	0
Planning	1,476	2.3
Noise-suppressing equipment	0	0
Relocation assistance	6,017	9.4
Runway development	0	0
Soundproofing	3,759	5.9

Continued

Dollar in thousands

Project type and fiscal year	Amount	Percent
State grant	0	0
Taxiway development	0	0
Fiscal year total	**$64,142**	**100**
1984		
Land for noise control	$49,210	67.1
Landscaping	0	0
Lighting	187	0.3
Miscellaneous	673	0.9
Navigational aids	0	0
Noise barrier	632	0.9
Planning	2,938	4.0
Noise-suppressing equipment	0	0
Relocation assistance	5,357	7.3
Runway development	6,624	9.0
Soundproofing	6,120	8.3
State grant	0	0
Taxiway development	1,588	2.2
Fiscal year total	**$73,330**	**100**
1985		
Land for noise control	$57,754	67.8
Landscaping	0	0
Lighting	45	0.1
Miscellaneous	661	0.8
Navigational aids	20	0.0[a]
Noise barrier	511	0.6
Planning	5,099	6.0
Noise-suppressing equipment	0	0
Relocation assistance	6,007	7.1
Runway development	3,848	4.5
Soundproofing	8,860	10.4
State grant	0	0
Taxiway development	2,316	2.7
Fiscal year total	**$85,121**	**100**
1986		
Land for noise control	$59,351	59.6
Landscaping	196	0.2

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Dollar in thousands

Project type and fiscal year	Amount	Percent
Lighting	0	0
Miscellaneous	768	0.8
Navigational aids	0	0
Noise barrier	625	0.6
Planning	4,196	4.2
Noise-suppressing equipment	115	0.1
Relocation assistance	4,535	4.6
Runway development	2,435	2.4
Soundproofing	23,124	23.2
State grant	0	0
Taxiway development	4,154	4.2
Fiscal year total	**$99,499**	**100**
1987		
Land for noise control	$48,385	65.4
Landscaping	0	0
Lighting	0	0
Miscellaneous	2,324	3.1
Navigational aids	0	0
Noise barrier	210	0.3
Planning	3,050	4.1
Noise-suppressing equipment	0	0
Relocation assistance	7,190	9.7
Runway development	156	0.2
Soundproofing	12,688	17.1
State grant	0	0
Taxiway development	0	0
Fiscal year total	**$74,003**	**100**
1988		
Land for noise control	$76,743	50.0
Landscaping	0	0
Lighting	24	0.0[a]
Miscellaneous	2,662	1.7
Navigational aids	0	0
Noise barrier	0	0
Planning	4,383	2.9
Noise-suppressing equipment	0	0

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Dollar in thousands

Project type and fiscal year	Amount	Percent
Relocation assistance	13,162	8.6
Runway development	6,030	3.9
Soundproofing	47,487	30.9
State grant	0	0
Taxiway development	3,147	2.0
Fiscal year total	**$153,638**	**100**
1989		
Land for noise control	$82,511	59.0
Landscaping	0	0
Lighting	2,171	1.6
Miscellaneous	306	0.2
Navigational aids	50	0.0[a]
Noise barrier	4,171	3.0
Planning	2,540	1.8
Noise-suppressing equipment	0	0
Relocation assistance	4,796	3.4
Runway development	3,230	2.3
Soundproofing	35,910	25.7
State grant	0	0
Taxiway development	4,152	3.0
Fiscal year total	**$139,838**	**100**
1990		
Land for noise control	$96,022	62.2
Landscaping	0	0
Lighting	371	0.2
Miscellaneous	345	0.2
Navigational aids	0	0
Noise barrier	0	0
Planning	1,636	1.1
Noise-suppressing equipment	26	0.0[a]
Relocation assistance	11,398	7.4
Runway development	7,582	4.9
Soundproofing	27,546	17.8
State grant	2,800	1.8
Taxiway development	6,621	4.3
Fiscal year total	**$154,348**	**100**

Continued from Previous Page

Dollar in thousands

Project type and fiscal year	Amount	Percent
1991		
Land for noise control	$113,891	56.0
Landscaping	0	0
Lighting	336	0.2
Miscellaneous	3,542	1.7
Navigational aids	0	0
Noise barrier	115	0.1
Planning	2,854	1.4
Noise-suppressing equipment	0	0
Relocation assistance	13,263	6.5
Runway development	5,408	2.7
Soundproofing	54,955	27.0
State grant	3,000	1.5
Taxiway development	5,968	2.9
Fiscal year total	**$203,330**	**100**
1992		
Land for noise control	$104,530	52.4
Landscaping	0	0
Lighting	1,299	0.7
Miscellaneous	0	0
Navigational aids	0	0
Noise barrier	234	0.1
Planning	2,738	1.4
Noise-suppressing equipment	980	0.5
Relocation assistance	19,119	9.6
Runway development	66	0.0[a]
Soundproofing	65,884	33.0
State grant	1,912	1.0
Taxiway development	2,808	1.4
Fiscal year total	**$199,569**	**100**
1993		
Land for noise control	$141,092	5.55
Landscaping	0	0
Lighting	0	0
Miscellaneous	3,762	1.5
Navigational aids	0	0

Continued from Previous Page

Dollar in thousands

Project type and fiscal year	Amount	Percent
Noise barrier	2,877	1.1
Planning	3,293	1.3
Noise-suppressing equipment	250	0.1
Relocation assistance	27,609	10.9
Runway development	33	0.0[a]
Soundproofing	73,716	29.0
State grant	1,800	0.7
Taxiway development	0	0
Fiscal year total	$254,432	100
1994		
Land for noise control	$118,270	51.6
Landscaping	0	0
Lighting	0	0
Miscellaneous	1,590	0.7
Navigational aids	0	0
Noise barrier	0	0
Planning	4,367	1.9
Noise-suppressing equipment	740	0.3
Relocation assistance	16,922	7.4
Runway development	13,011	5.7
Soundproofing	72,557	31.7
State grant	1,698	0.7
Taxiway development	0	0
Fiscal year total	$229,154	100
1995		
Land for noise control	$81,304	49.3
Landscaping	640	0.4
Lighting	40	0.0[a]
Miscellaneous	3	0.0[a]
Navigational aids	0	0
Noise barrier	0	0
Planning	1,659	1.0
Noise-suppressing equipment	1,000	0.6
Relocation assistance	9,178	5.6
Runway development	0	0
Soundproofing	69,972	42.4

Continued from Previous Page

Dollar in thousands

Project type and fiscal year	Amount	Percent
State grant	1,113	0.7
Taxiway development	0	0
Fiscal year total	**$164,909**	**100**
1996		
Land for noise control	$90,256	47.6
Landscaping	528	0.3
Lighting	0	0
Miscellaneous	15,774	8.3
Navigational aids	0	0
Noise barrier	1,126	0.6
Planning	661	0.3
Noise-suppressing equipment	167	0.1
Relocation assistance	11,737	6.2
Runway development	3,250	1.7
Soundproofing	63,081	33.3
State grant	3,000	1.6
Taxiway development	0	0
Fiscal year total	**$189,580**	**100**
1997		
Land for noise control	$60,513	34.7
Landscaping	0	0
Lighting	1,356	0.8
Miscellaneous	9,408	5.4
Navigational aids	0	0
Noise barrier	602	0.3
Planning	1,668	1.0
Noise-suppressing equipment	2,796	1.6
Relocation assistance	9,639	5.5
Runway development	7,463	4.3
Soundproofing	80,753	46.4
State grant	0	0
Taxiway development	0	0
Fiscal year total	**$174,199**	**100**
1998		
Land for noise control	$79,355	37.5
Landscaping	0	0

Continued from Previous Page

Dollar in thousands

Project type and fiscal year	Amount	Percent
Lighting	0	0
Miscellaneous	97,069	45.9
Navigational aids	0	0
Noise barrier	0	0
Planning	3,352	1.6
Noise-suppressing equipment	538	0.3
Relocation assistance	2,000	0.9
Runway development	350	0.2
Soundproofing	26,189	12.4
State grant	2,855	1.3
Taxiway development	0	0
Fiscal year total	**$211,707**	**100**
1999		
Land for noise control	$80,519	33.4
Landscaping	0	0
Lighting	0	0
Miscellaneous	140,340	58.2
Navigational aids	0	0
Noise barrier	10,411	4.3
Planning	2,902	1.2
Noise-suppressing equipment	906	0.4
Relocation assistance	5,700	2.4
Runway development	0	0
Soundproofing	420	0.2
State grant	0	0
Taxiway development	0	0
Fiscal year total	**$241,199**	**100**
Totals—fiscal years 1982 through 1999		
Land for noise control	$1,423,579	51.8
Landscaping	1,364	0.0[a]
Lighting	6,100	0.2
Miscellaneous	280,368	10.2
Navigational aids	70	0.0[a]
Noise barrier	21,708	0.8
Planning	49,451	1.8
Noise-suppressing equipment	7,516	0.3

Continued from Previous Page

Dollar in thousands

Project type and fiscal year	Amount	Percent
Relocation assistance	174,821	6.4
Runway development	60,633	2.2
Soundproofing	673,020	24.5
State grant	18,178	0.7
Taxiway development	30,753	1.1
Grand total	**$2,747,561**	**100**

Continued from Previous Page

[a]The percentage is less than 0.1 percent.

Funding for Noise-Related Projects Through the Passenger Facility Charge Program, Fiscal Years 1992 Through 1999

Table 12 provides the amount of passenger facility charges approved for collection for noise-related projects by project type and by fiscal year, for fiscal years 1992 through 1999. As the table shows, the amount approved for collection for noise-related projects ranges from a low of $12.8 million in fiscal year 1995 to a high of $555.0 million in fiscal year 1998.

Table 12: Noise-related Projects Funded Through the Passenger Facility Charge Program, Fiscal Years 1992 Through 1999, by Project Type

Dollars in thousands

Project type and fiscal year	Amount	Percent
1992		
Land acquisition	$142,472	56.8
Miscellaneous	192	0.1
Monitoring	502	0.2
Multiphase	37,306	14.9
Planning	732	0.3
Soundproofing	69,686	27.8
Fiscal year total	**$250,890**	**100**
1993		
Land acquisition	$44,064	33.9
Miscellaneous	612	0.5
Monitoring	3,125	2.4
Multiphase	2,744	2.1
Planning	16	0.0[a]
Soundproofing	79,360	61.1
Fiscal year total	**$129,921**	**100**
1994		
Land acquisition	$39,726	21.2
Miscellaneous	0	0
Monitoring	465	0.2
Multiphase	112,082	59.8
Planning	523	0.3
Soundproofing	34,609	18.5
Fiscal year total	**$187,405**	**100**
1995		
Land acquisition	$6,779	53.1

Continued

Dollars in thousands

Project type and fiscal year	Amount	Percent
Miscellaneous	0	0
Monitoring	974	7.6
Multiphase	0	0
Planning	1,447	11.3
Soundproofing	3,558	27.9
Fiscal year total	**$12,758**	**100**
1996		
Land acquisition	$61,880	17.5
Miscellaneous	6,207	1.8
Monitoring	761	0.2
Multiphase	99,681	28.2
Planning	4,097	1.2
Soundproofing	181,091	51.2
Fiscal year total	**$353,717**	**100**
1997		
Land acquisition	$72,300	69.4
Miscellaneous	600	0.6
Monitoring	1,002	1.0
Multiphase	0	0
Planning	862	0.8
Soundproofing	29,415	28.2
Fiscal year total	**$104,178**	**100**
1998		
Land acquisition	$10,977	2.0
Miscellaneous	0	0
Monitoring	0	0
Multiphase	503,500	90.7
Planning	539	0.1
Soundproofing	39,964	7.2
Fiscal year total	**$554,980**	**100**
1999		
Land acquisition	$69	0.2
Miscellaneous	0	0
Monitoring	0	0
Multiphase	0	0
Planning	10	0.0[a]

Continued from Previous Page

Dollars in thousands

Project type and fiscal year	Amount	Percent
Soundproofing	42,986	99.8
Fiscal year total	**$43,065**	**100**
Totals—fiscal years 1992 through 1999		
Land acquisition	$378,267	23.1
Miscellaneous	7,611	0.5
Monitoring	6,829	0.4
Multiphase	755,313	46.1
Planning	8,224	0.5
Soundproofing	480,669	29.4
Grand total	**$1,636,913**	**100**

Continued from Previous Page

Note: The fiscal year data are based on the year that the airport received FAA approval to collect passenger facility charges for those kinds of projects.

[a]The percentage is less than 0.1 percent.

Airport Model for Noise Measurement Method Comparisons

We developed an airport model to illustrate and compare the various methods discussed in the report when applied to a specific airport profile. FAA used our airport model as the input data to calculate noise levels under the various measurement methods using its Integrated Noise Model, a computerized program created to apply most of the noise measurement methods described in this report. Measurement scenarios were designed to (1) illustrate the kinds of noise measurements provided by the different methods under the same airport operations scenario, (2) show the effect on noise contours when flight schedules are shifted between different times of the day, and (3) show the effect on noise contours when the total number of aircraft operations increases from about 26 operations, in increments, to a total of about 1,586 operations to reflect an airport's growth in activity from very few operations to a level that reflects the activity of a large commercial service airport.[1]

The Airport Model

To design our airport model, we selected the single runway pattern of Manassas Regional Airport in Manassas, Virginia. The number of aircraft operations for a single day and the distribution of aircraft operations among the different types of operations—air carrier (commercial service aircraft with more than 60 seats), air taxi/commuter (commercial service aircraft with 60 seats or less), and general aviation (all other aircraft)—was based on the operations levels at the airport that was at the 90th percentile in each of the National Plan of Integrated Airport Systems airport categories. The 90th percentile was chosen to preclude extreme sizes but still reflect as closely as possible current operations levels. According to the operations levels of these airports, (1) the number of operations for a single day used in the simple comparison of three methods was 528 operations, distributed equally among each hour of a 24-hour period and (2) the distribution of aircraft operations in the model was 70-percent air carrier, 26-percent air taxi/commuter, and 4-percent general aviation.

We selected six aircraft from FAA's list of certificated aircraft to reflect the distribution of aircraft operations by type of operation—air carrier, air

[1]We examined noise measures when total aircraft takeoffs and landings equaled 26, 78, 234, 468, 702, 1,056, and 1,586 operations. The different levels of operations illustrate the impact of growth in operations at an airport, and airports of different sizes, when holding all other elements constant. If aircraft are replaced with quieter aircraft, the impact of the quieter aircraft on noise contours for an airport will depend on the extent to which aircraft are replaced, the extent to which operations increase, and when those operations occur during a 24-hour period.

taxi/commuter, and general aviation. For all aircraft weighing more than 75,000 pounds, stage 3 aircraft were chosen because after December 31, 1999, large aircraft that do not meet stage 3 requirements were not allowed to operate at U.S. airports. For aircraft weighing 75,000 pounds or less, both stage 2 and stage 3 aircraft were selected because both may operate at U.S. airports. The six aircraft are listed in table 13. FAA conducted the measurements using its Integrated Noise Model, Version 6.

Table 13: Aircraft Selected for Airport Operations

Operations category	Aircraft
Air carrier operations	**Boeing 747-200** 4 engine Stage 3 Maximum takeoff weight—833,000 pounds Grouping—over 240 seats
	MD-83 2 engine Stage 3 Maximum takeoff weight—149,500 pounds Grouping—60 to 170 seats
Air taxi/commuter	**CL-600** 2 engine Stage 3 Maximum takeoff weight—41,250 pounds Grouping—under 60 seats
	Falcon 20-F 2 engine Stage 2 Maximum takeoff weight—28,600 pounds Grouping—10 to 40 seats
General aviation	Gulfstream V[a] Stage 3 Maximum takeoff weight—89,000 pounds Grouping—over 75,000 pounds business jet
	Lockheed 1329-25 Jetstar[b] 4 engine stage 2 Maximum takeoff weight—44,500 pounds Grouping—under 75,000 pounds business jet

[a]This aircraft is not in FAA's Integrated Noise Model. A Gulfstream IV, stage 3, with maximum takeoff weight of 71,000 pounds was substituted as the closest representative of the criteria.

[b]This aircraft was not in FAA's Integrated Noise Model. A military C-140, with 4 engines, stage 2, and a maximum takeoff weight of 44,507 pounds was substituted. FAA officials said this was the same aircraft but in a military version.

Comparisons of the Maximum Sound Levels and Sound Exposure Levels for Four Aircraft

Figures 10 and 11 present the maximum sound level and the sound exposure level noise measures for four of the six aircraft included in our airport model. The measures for the remaining two aircraft are presented in chapter 4.

Figure 10: Maximum Sound Level and Sound Exposure Level for the CL 600 and FAL 20 Aircraft

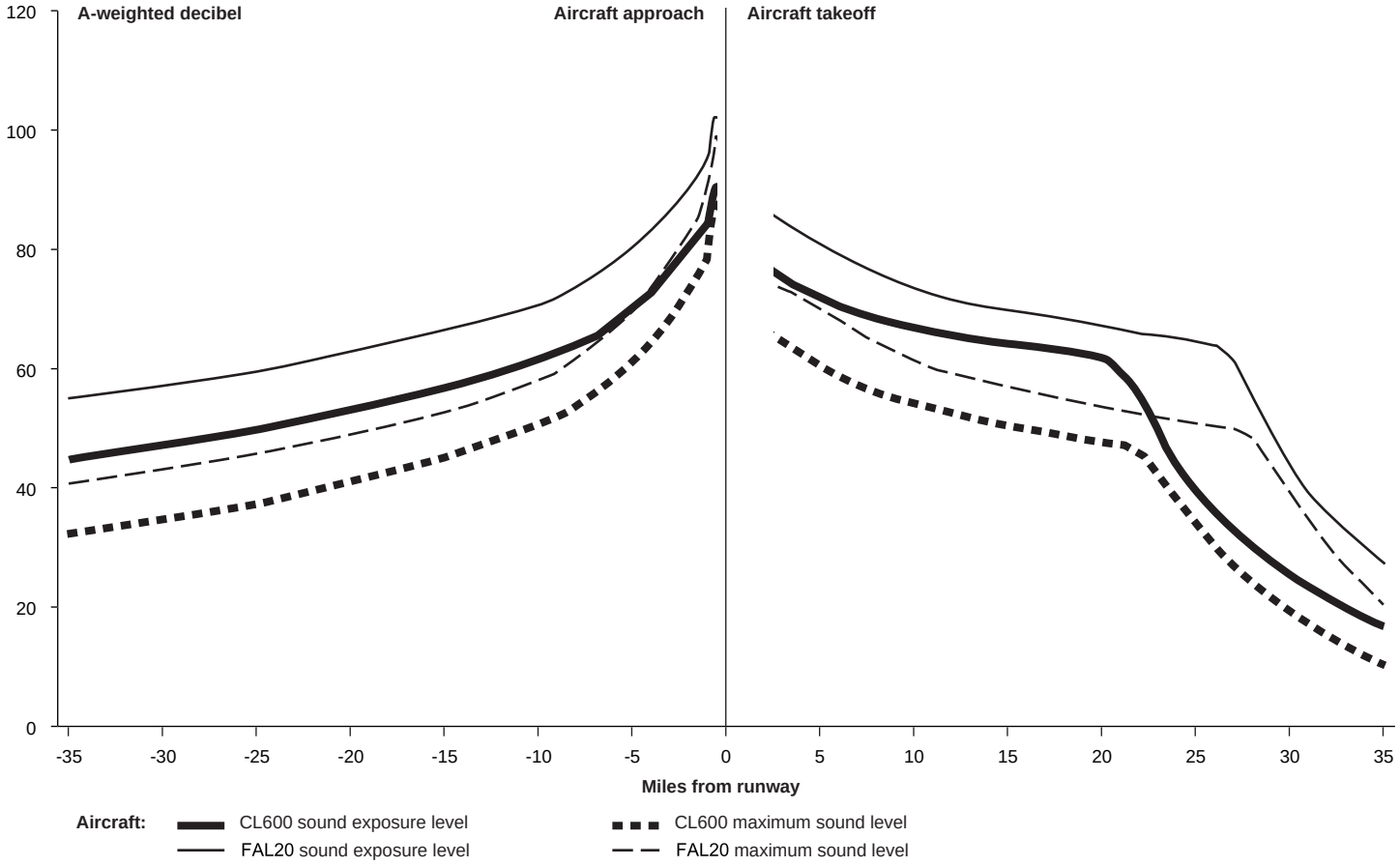
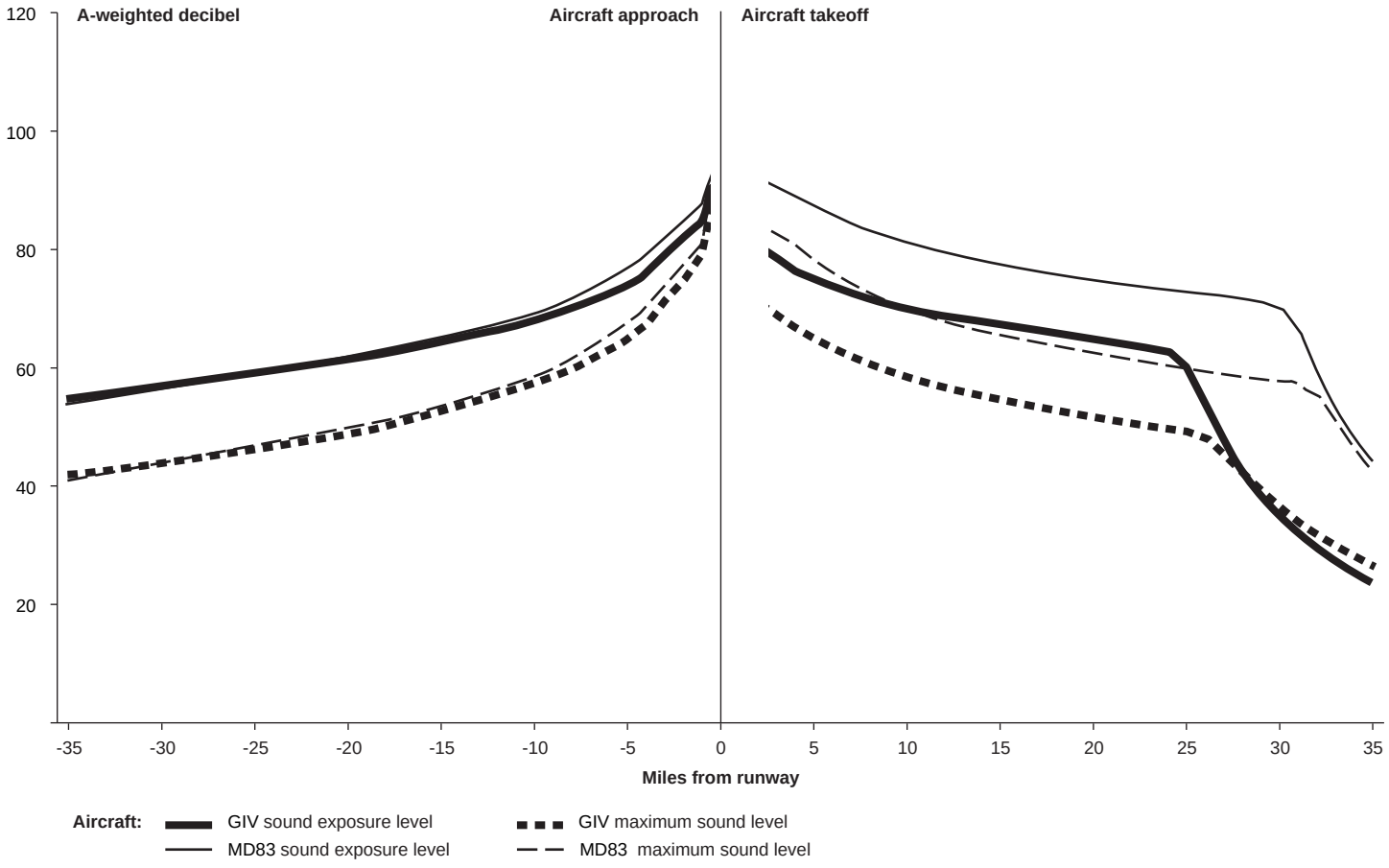


Figure 11: Maximum Sound Level and Sound Exposure Level for the Gulfstream IV and MD 83 Aircraft



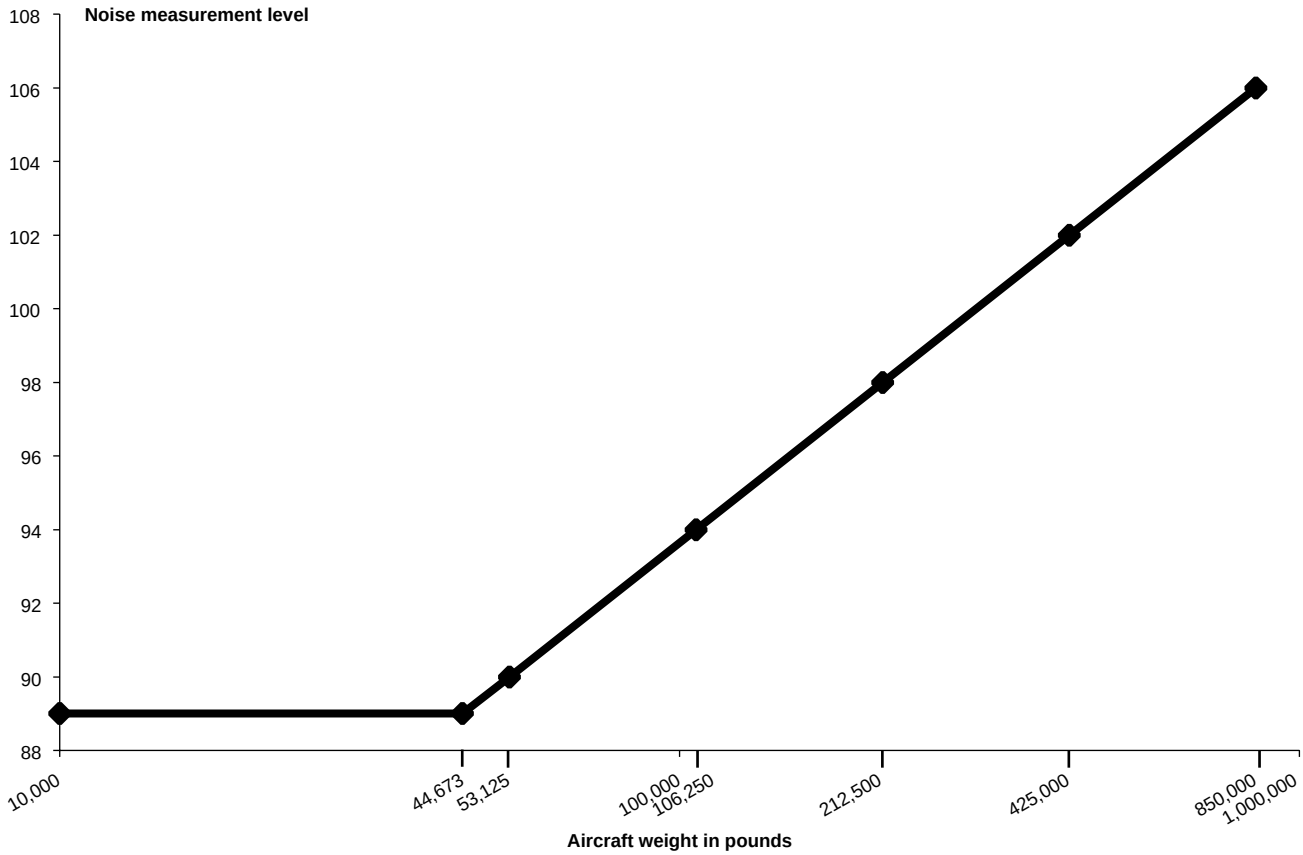
Stage 3 Aircraft Noise Standards

Figures 12 through 15 show the stage 3 noise standards and the increases in noise allowed as aircraft weight increases.[1] As figures 12 and 13 illustrate, the noise standards for takeoff operations also vary on the basis of the number of engines. Figure 13 also illustrates how a stage 2 aircraft weighing less than 75,000 pounds could generate less noise than a heavier aircraft that meets the more stringent stage 3 standards. A lighter aircraft at point "X" in the figure is a stage 2 aircraft because it produces noise at a level above the stage 3 standard for aircraft of that weight, while a heavier aircraft at point "Z" in the figure is a stage 3 aircraft because it produces noise below the stage 3 standard for an aircraft of that weight. In that case, the stage 2 lighter aircraft is producing lower noise levels than the heavier aircraft that meets the more stringent stage 3 standards. By contrast, it is also possible for some types of smaller aircraft to generate more noise than some types of larger aircraft. For example, a 1991 FAA study noted that an aircraft weighing 230,000 pounds had a quieter takeoff than 11 types of smaller aircraft weighing less than 6,500 pounds.[2]

[1]Aircraft must be tested in accordance with the conditions established in appendix A of 14 C.F.R. part 36. The appendix sets the test requirements for such things as weather conditions, test procedures, and noise measurement systems to be used. Appendix B describes how to translate those measurements into a measure of the "effective perceived noise level," which accounts for the presence of different tones in sound. The noise standards are established in appendix C, and they are defined in terms of the effective perceived noise level.

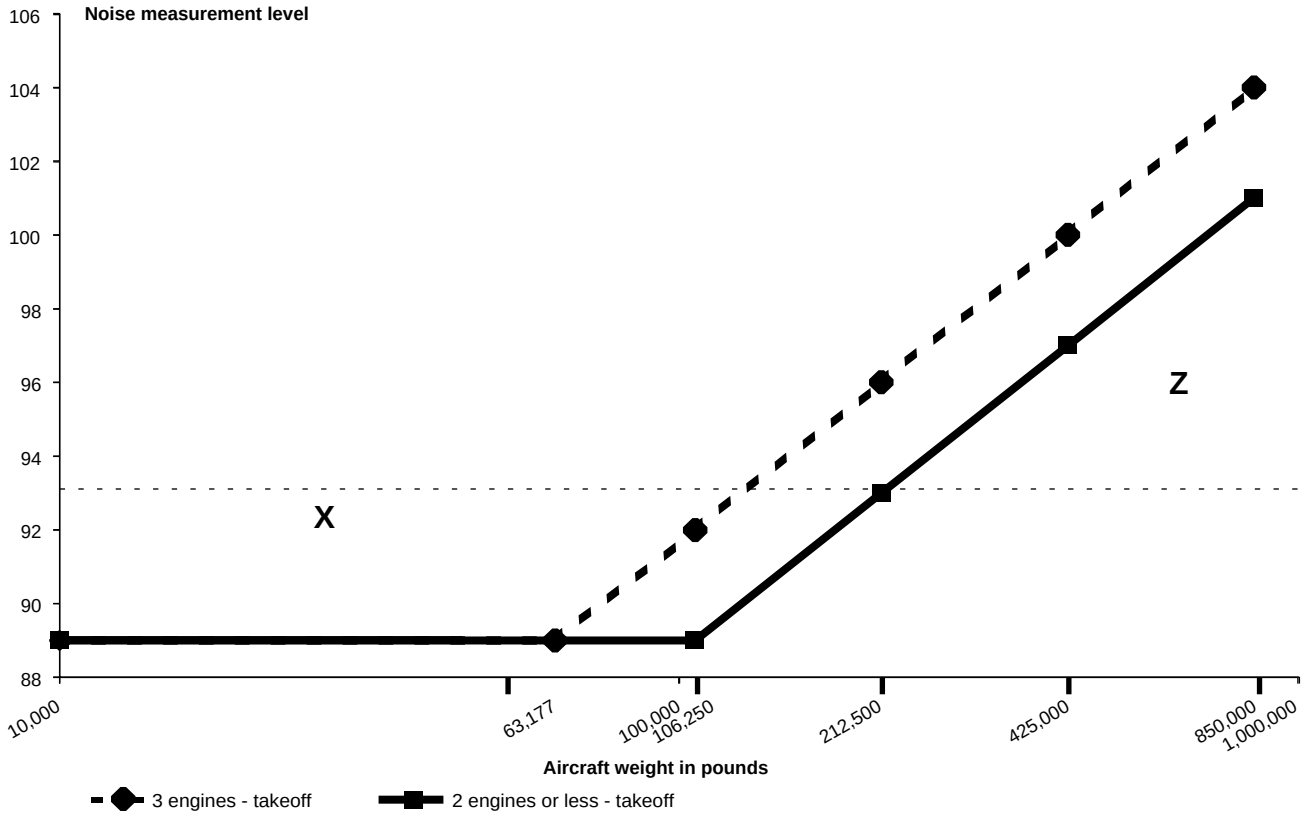
[2]*Study of the Application of Notice and Analysis Requirements to Operating Noise/Access Restrictions on Subsonic Jets Under 75,000 Pounds* (FAA Study Pursuant to Section 9305 of the Airport Noise and Capacity Act of 1990; 1991.)

Figure 12: Noise Standards for Stage 3 Aircraft With Four or More Engines—Takeoff



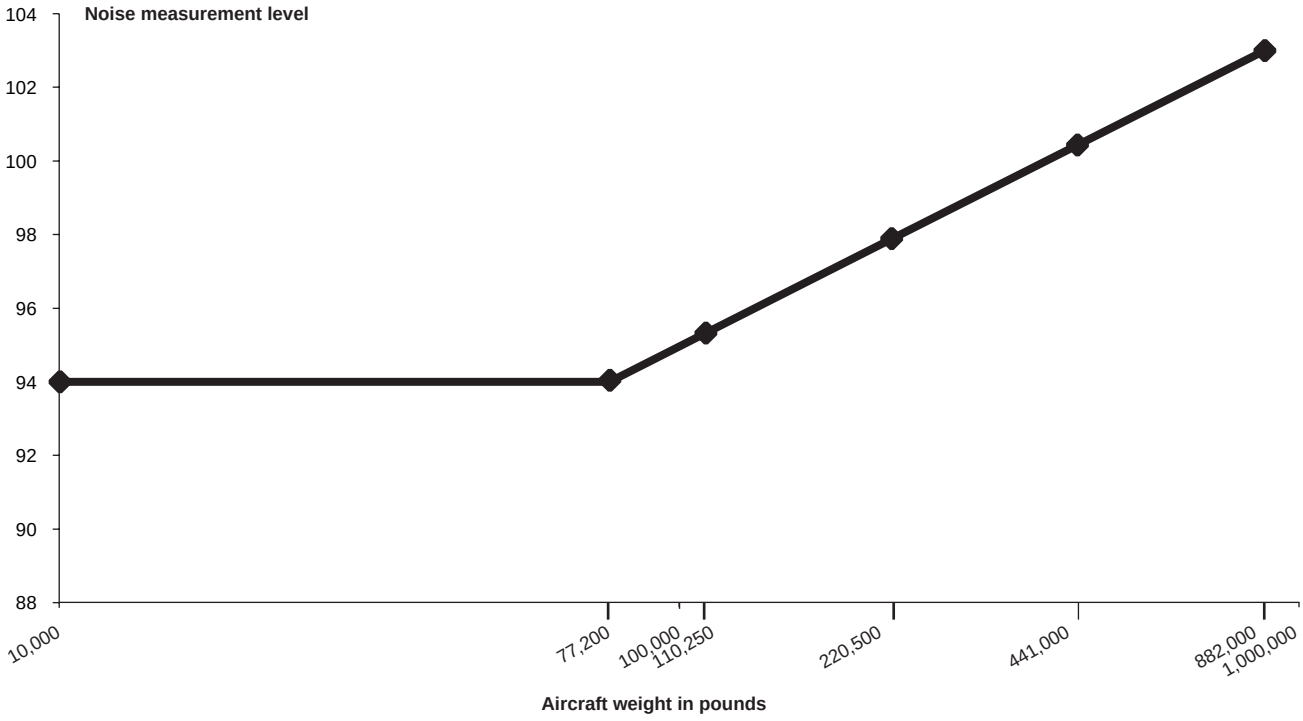
Note: The noise measurement level is defined in terms of the "effective perceived noise level," which takes into account variations in the tone of noise. The weight scale in the figure is a logarithmic scale.

Figure 13: Noise Standards for Stage 3 Aircraft With Three or Fewer Engines—Takeoff



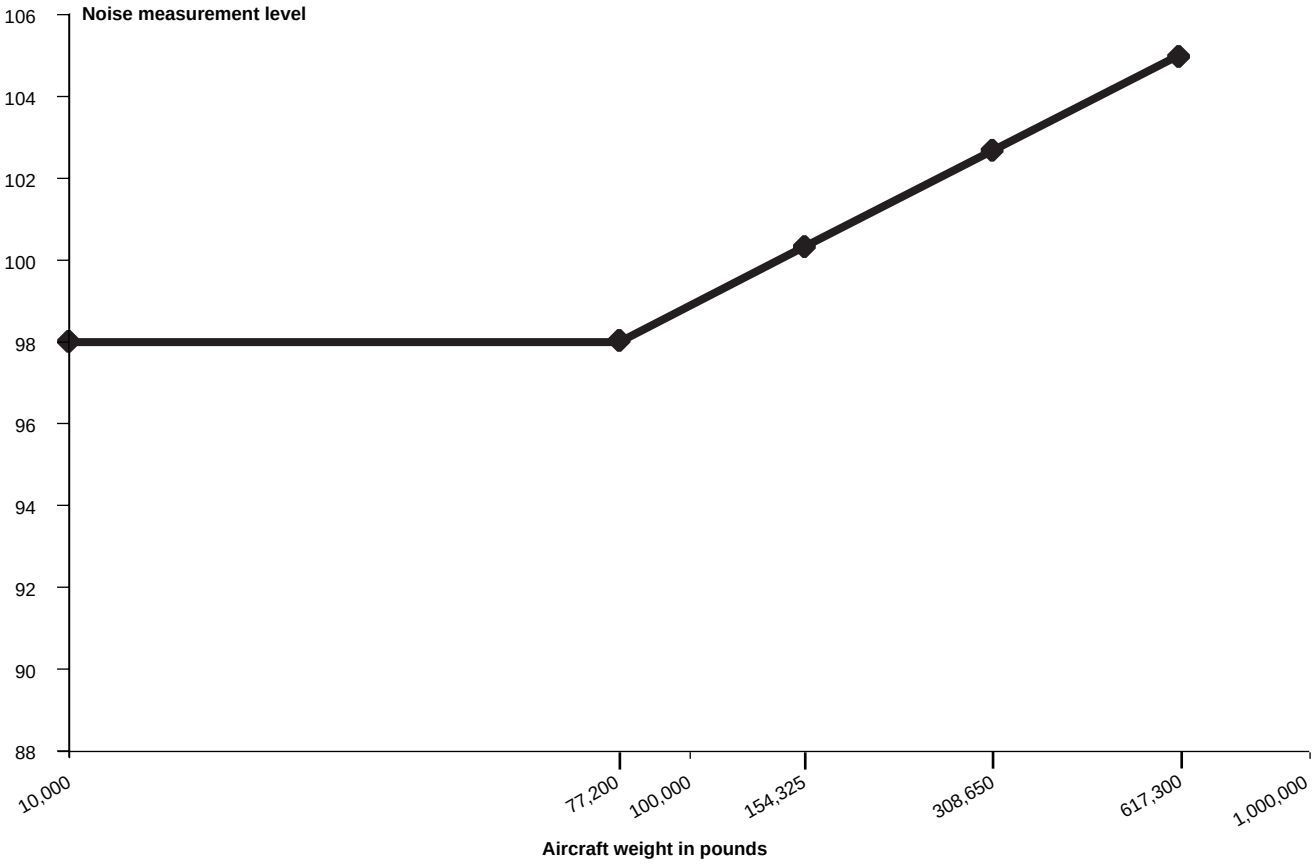
Note: The noise measurement level is defined in terms of the “effective perceived noise level,” which takes into account variations in the tone of noise. The weight scale in the figure is a logarithmic scale.

Figure 14: Noise Standards for Stage 3 Aircraft Regardless of the Number of Engines—Sideline



Note: The noise measurement level is defined in terms of the "effective perceived noise level," which takes into account variations in the tone of noise. The weight scale in the figure is a logarithmic scale.

Figure 15: Noise Standards for Stage 3 Aircraft Regardless of the Number of Engines—Approach



Note: The noise measurement level is defined in terms of the "effective perceived noise level," which takes into account variations in the tone of noise. The weight scale in the figure is a logarithmic scale.

FAA's Compatible Land Use Guidance

Table 14 describes FAA's land use compatibility guidance. In the table, "Yes" means that the land use and related structures are compatible land uses. "No" means that the land use and related structures are not compatible and should be prohibited. The numbers 25, 30, or 35 mean that the land use and related structures are generally compatible, but measures to achieve a reduction of 25, 30, or 35 decibels must be incorporated into the design and construction of the structures. Noise-level reductions refer to the reduction in noise levels (outdoor to indoor) to be achieved by incorporating noise attenuation into the design and construction of the structure.

Table 14: Compatible Land Use Table Based on FAA's Yearly Day-Night Sound Level Measurements

	Yearly day-night average sound level in decibels					
Land use	**Below 65**	**65-70**	**70-75**	**75-80**	**80-85**	**Over 85**
Residential						
Residential, other than mobile homes and transient lodgings	Yes	No[a]	No[a]	No	No	No
Mobile home parks	Yes	No	No	No	No	No
Transient lodgings	Yes	No[a]	No[a]	No[a]	No	No
Public use						
Schools	Yes	No[a]	No[a]	No	No	No
Hospitals	Yes	25	30	No	No	No
Churches, auditoriums, and concert halls	Yes	25	30	No	No	No
Government services	Yes	Yes	25	30	No	No
Transportation	Yes	Yes	Yes[b]	Yes[c]	Yes[d]	Yes[d]
Parking	Yes	Yes	Yes[b]	Yes[c]	Yes[d]	No
Commercial use						
Offices, business and professional	Yes	Yes	25	30	No	No
Wholesale and retail-building materials, hardware and farm equipment	Yes	Yes	Yes[b]	Yes[c]	Yes[d]	No
Retail trade—general	Yes	Yes	25	30	No	No
Utilities	Yes	Yes	Yes[b]	Yes[c]	Yes[d]	No
Communication	Yes	Yes	25	30	No	No
Manufacturing and production						
Manufacturing, general	Yes	Yes	Yes[b]	Yes[c]	Yes[d]	No
Photographic and optical	Yes	Yes	25	30	No	No
Agriculture (except livestock) and forestry	Yes	Yes[e]	Yes[f]	Yes[g]	Yes[g]	Yes[g]
Livestock farming and breeding	Yes	Yes[e]	Yes[f]	No	No	No
Mining and fishing, resource production and extraction	Yes	Yes	Yes	Yes	Yes	Yes
Recreational						
Outdoor sports arenas and spectator sports	Yes	Yes[h]	Yes[h]	No	No	No
Outdoor music shells, amphitheaters	Yes	No	No	No	No	No
Nature exhibits and zoos	Yes	Yes	No	No	No	No
Amusements, parks, resorts, and camps	Yes	Yes	Yes	No	No	No
Golf courses, riding stables and water recreation	Yes	Yes	25	30	No	No

[a]Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor reductions of at least 25 decibels should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a reduction of 20 decibels; thus, reduction requirements are often stated as 5, 10, or 15 decibels over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of these criteria will not eliminate outdoor noise problems.

[b]Measures to achieve reductions of 25 decibels must be incorporated into the design and construction of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

[c]Measures to achieve reductions of 30 decibels must be incorporated into the design and construction of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

[d]Measures to achieve reductions of 35 decibels must be incorporated into the design and construction of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

[e]Residential buildings require reductions of 25 decibels.

[f]Residential buildings require reductions of 30 decibels.

[g]Residential buildings not permitted.

[h]Land use compatible, provided special sound reinforcement systems are installed.

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