Special Report

ALLOCATING THE COSTS OF ALLEVIATING SUBSONIC JET AIRCRAFT NOISE

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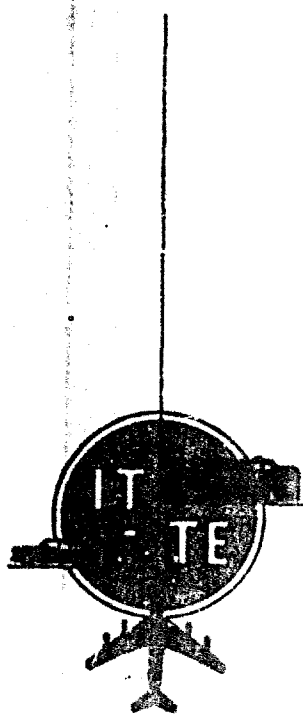

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SUMMARY

Bases of the Noise Problem

The problem of aircraft noise around airports contains two principal elements: (1) quiet jet aircraft are and will remain (barring major progress in airframe and engine technology) prohibitively inefficient in terms of payload and revenue-generating capacity; (2) jet airports are and will remain (barring changes in land-use and transportation planning) centers of economic activity, including dense residential development.

Conflicts in public policy also appear to have contributed to the noise problem. On the one hand, it is in the public interest to keep noise at as low a level as possible; on the other hand, aircraft become technically less efficient and more costly as they are made quieter. Public policy encourages both a quiet society and the development of more efficient air transportation.

Finally, under U. S. transportation policy, airlines are private enterprises, free to make their own business decisions within economic and safety constraints. Since the air carriers do not pay the costs of aircraft noise, they tend to ignore these costs in making business decisions.

Responsibility for Airport Noise

The responsibility for owning, developing, and operating airports has historically rested with local governments in the United States. Largely for this reason, the U. S. Supreme Court, in Griggs v. Allegheny County, decided that the noise from aircraft operating to and from airports was a responsibility of the local airport owner.

Similarly, from economic theory, it may be argued that local government, as the public airport entrepreneur, has the obligation to purchase the property rights required to make the cost of noise internal to the airport operation. This cost should then be charged to the users of the airport and direct users of air transportation just as are other airport costs.

We find little justification for the government paying a portion of the noise costs from general tax funds because of any secondary or indirect benefits. The only directly relevant secondary benefits of aircraft noise are those accruing to secondary producers and consumers in the form of gains in national income or profits. If secondary benefits of this type exist, the primary beneficiaries should be able to shift a portion of the noise costs to secondary beneficiaries. There appears to be no need for governmental intervention in the market to make these reallocations. The primary purpose of governmental intervention into the noise problem should be to see to it that those persons are compensated who initially experience a disproportionate share of the noise costs because they live around airports.

Capabilities of Local Governments for Dealing with Airport Noise

Although local units of government which own and operate airports appear to have adequate administrative authority to deal with the noise problem, they are too restricted in their powers of financing, planning, and zoning to deal with it effectively.

Both of the traditional forms of airport financing — general-obligation and revenue bonds — have disadvantages for financing the acquisition of property rights and the payment of compensation.

Comprehensive planning is possible in many metropolitan areas and can help alleviate the noise problem around airports; but zoning is, almost without exception, a prerogative of local governmental jurisdictions, so the development of compatible zoning around airports is difficult, if not impossible. Moreover, for either planning or zoning to provide some effective solution to the noise problem, there must be restrictions on the amount of noise emission from aircraft, just as there are restrictions on smoke and noise emissions from factories.

A Policy of Federal Assistance

There are three directions of policy available to the Federal government: it can do nothing, do everything, or provide a program of assistance to strengthen local government with the power it needs to cope with airport noise.

Since the U. S. Supreme Court has said that the noise problem is essentially the obligation of

local governments, the Federal government could do nothing, leaving the problem with local governments and the courts. Conversely, it appears probable that the Federal government could take such actions as would upset the Griggs decision, placing full responsibility on the United States. The Federal goverment could then use its powers to attempt to find and implement solutions. Because planning and zoning decisions are so important in dealing with the noise problem, and because the Federal government has relatively limited power in this area, however, a completely Federal solution does not appear desirable.

It is possible, nonetheless, for the Federal government to strengthen the ability of local governments to deal with the noise problem. The different programs which the Federal government might adopt to this end have different implications for cost allocation.

Regulation: Regulation of the amount of noise emitted from an aircraft is clearly required if local communities are to establish compatible controls over land-use. The costs of regulation, largely appearing in the form of less technically efficient aircraft, will fall initially on the direct users of air transportation and on airline profits. Also, some of these costs may be shifted backward to suppliers, including aircraft manufacturers.

Research Assistance: There appear to be four areas of research which require some governmental activity. Each area has its own implications for cost allocation: (1) the costs of technical research should be allocated largely to the air-transportation industry; (2) the costs of planning research, which has multiple objectives, should largely be allocated to the general public; (3) the costs of socio-political research (which should be expanded) should be charged to the general public, at least in the initial stages; and (4) the costs of a systems analysis of the entire noise problem and its alternative solutions should be allocated to the air-transportation industry.

Financial Assistance: It appears desirable for the Federal government to provide three forms of financial assistance, as required, to help alleviate the noise problem:

1. Loan guarantees to the air-transportation industry to finance the modification of aircraft where needed and (on account of technical advances) possible.

2. Interest-bearing Federal loans directly to local governments for additional capital to finance the acquisition of property rights and compensation payments.

3. Grants-in-aid to local governments for additional incentive when needed to stimulate property acquisitions. The level of these grants is indeterminate, but might reasonably equal the level of the current Federal-aid airport program. The carrying costs of the land acquired with the grants should be charged to the airport users, so there is no subsidy to air transportation; and the grant should be repaid if the property is released for public use.

I. INTRODUCTION

In his Transportation Message of March, 1966, the President of the United States called for a "concerted effort to alleviate the problems of aircraft noise."[1] In the same month the Office of Science and Technology, Executive Office of the President, released a report of an ad hoc panel of specialists in the problems of jet-aircraft noise near airports.[2] That report noted, in part, that any effective program for dealing with the jet-aircraft noise problem would involve costs, and that there is need to resolve how those costs will be allocated.[3] This paper explores the applicable economic facts and relationships and the public policy issues which affect the allocation of the costs of subsonic aircraft noise alleviation. Although the primary approach of the paper is an economic one, it will be necessary to consider as well some of the technical, legal, social, and political problems implicit in the formulation of a public policy.

We begin with some general considerations in order to put the problem in perspective.

Some Physical and Economic Aspects of Aircraft Noise

Sound may be defined as a physical and mechanical disturbance which is detectable by the human ear.[4] The phenomenon of sound includes a source, or mechanical disturbance; a path, usually air; and a receptor, typically the human ear. The physical disturbance causes waves of relatively compressed and rarified air to travel outward from the source. If these waves are intercepted by a human ear they have significance as a sound; if the waves are so strong as to damage an object which intercepts them, as in shattering a Dresden vase, they may have a significance even if they are not heard. Thus sound is essentially a physical phenomenon, the meaning or value of which depends upon its characteristics, the circumstances and manner in which it is perceived, and the interpretations given to that perception. Some sounds may be interpreted and designated as noise, which is simply unwanted sound.

The intensity of sound is measured in units called decibels (or dB), which express the ratio of any given sound intensity to a standard reference intensity. Because of the wide range in sound intensities, the ratio is expressed as a logarithmic quantity. In the discussion of airport noise, the most frequently used measure of noise intensity is the Perceived Noise Decibel, or PNdB. The PNdB measure takes account of the difference in perceived loudness of a sound intensity as the frequency varies. Higher-frequency sounds seem louder than lower-frequency sounds of the same intensity or dB level. Adjustment of sound-level measurement for frequency is of particular importance in the appraisal of aircraft noise, since the frequencies of that noise vary considerably among aircraft, particularly as between jet and piston engines, and more recently as between turbojet and turbofan engines.

Typical noise levels: The noise levels on the ground near landing and departing jet aircraft are high. The Port of New York Authority (PNYA) requires airlines to so operate their aircraft that takeoff noise will not exceed 112 PNdB in the communities surrounding John F. Kennedy International Airport. This noise level was established by the PNYA as being no greater than that produced by 75% of the piston engine aircraft operating from the airport before the transition to jets. Similarly, the British Ministry of Aviation has established maximum levels of 110 PNdB for daytime and 100 PNdB for nighttime operations.[5]

To provide a frame of reference for appraising the level of the airport noise, some comparative perceived noise levels are shown in Table 1.

TABLE 1 — TYPICAL PERCEIVED NOISE LEVELS[6]

PNdB	Source of Noise
115 - 120	Large Civil Jet Transport — Takeoff Power — 1,000 ft
105 - 110	Large Civil Piston Engine Transport — Takeoff Power — 1,000 ft
100	Diesel Truck — 60 mph — 50 ft
85	Passenger Car — 60 mph — 50 ft
75	Inside Busy Supermarket Near Checkout Counter
55 - 65	Average Ambient Daytime — Residential Area
45 - 55	Average Ambient Nighttime — Residential Area

Aircraft Noise as a Cost: Aircraft noise can be characterized in economics as a "technological externality." This means a value that appears in either production or utility functions rather than in shifts in relative prices, and that falls on economic activities other than those which produce the cost.[7]

In general, aircraft noise affects utility rather than production functions. Indeed, there seems to be no unequivocal evidence that noise reduces work output or adversely affects the productive behavior of individuals. To the contrary, noise may actually improve the level of performance of some types of jobs.[8] So aircraft noise is not a component of the typical production function, except at some relatively high level of intensity where it causes physical damage.[9]

Aircraft noise constitutes a cost because it reduces the utilities, or values of the services, which individuals receive from properties exposed to the noise. The reduction in value of the services causes a reduction in capital values, other things equal. Interestingly, some evidence suggests that it is not always the noise, per se, which causes problems, but the fear of falling aircraft which is engendered by the noise. Whatever its psychological roots, aircraft noise constitutes a cost largely because it reduces the ability of persons to enjoy the services of property, thus reducing capital values.

Positive and Negative Effects of Airports: We have noted that aircraft noise around airports can be characterized economically as a technological external cost. It is external in that it affects people outside the air-transportation industry; it is technological in that it affects either individual utility functions or, in some cases, production functions. But there are also external benefits generated by airports. These benefits are evidenced by the fact that property values tend to rise more rapidly near airports than elsewhere in the urban area. So noisy major airports impose external costs and also generate external benefits. Are these two opposing effects comparable, and should they be offset one against another to determine if an airport has imposed a net noise cost?

The view of the courts on these opposing factors is, as yet, unclear. According to one commentator, the courts have concerned themselves with theories of liability to the exclusion of question of the appropriate method for computing damages.[10] On the other hand, from an equity viewpoint, change in market value is clearly a relevant measure of the extent of damage if any, and it may be expected that the courts will use this measure,[11] at least in part.

From the strict viewpoint of economic efficiency, the positive and negative effects of airports on surrounding land values are different economic phenomena, and should not be offset one against the other. The distinction between the negative effects of aircraft noise near airports and the generally positive effect of the airport on surrounding land values is of that type which most economists would make between technological and pecuniary external economic effects. We have already noted that technological external effects, such as the noise of aircraft around airports, affect either the production or utility functions of persons who have no direct control over those effects. Pecuniary external effects arise from changes in relative prices. The building of an airport in a particular area of a metropolitan region gives that area a unique ability to satisfy the demand for land convenient to air transportation. As a result, the demand for land near the airport tends to rise, relative to the demand for other land in the region. Production and utility functions remain the same; only the relative prices of land change, and some people benefit relative to others. We do not require that those who have been hurt by the shift in relative prices be compensated. To put it another way, technological externalities interfere with the efficiency of the economic system, while pecuniary externalities do not (although they do change the distribution of its product). From the formal economic viewpoint, it would be argued that those persons who have been forced to bear the economic costs of aircraft noise around airports should be compensated without regard to the pecuniary shifts in land values, which the economist is technically unable to judge.

Although this distinction between technological and pecuniary externalities is analytically important, it seems unlikely that it will have much effect on settlements with affected property owners. The degree to which the distinction will become practically important will depend upon the method of calculating noise cost. If the courts continue to rely on changes in market value, the technological and pecuniary effects of the airport will commingle, and the net change in value may actually be positive rather than negative.

Singularity of Occurrence: When an aircraft-noise cost accrues to a piece of property, it is a unique event, not to be repeated unless the character of the noise changes materially. Compensation for noise costs should be paid to the person who owns the property at the time of the constitutional taking or damaging. There is no apparent justification in legal theory and none at

all in economic theory for paying compensation to subsequent owners of the property. Under the constitutional-taking theory, the cause of action belongs to the property owner at the time of the taking, and does not run with the land.[13] From economic theory it is clear that the noise cost will be capitalized as a relative reduction of the value of the property, which will be borne by the owner at the time the noise cost is imposed, and cannot be passed on to subsequent owners as long as they are presumed to be knowledgeable about the property they are buying.

Basis of the Airport-Noise Problem

To this point we have referred to the noise problem as that of "aircraft noise." Since subsonic jet aircraft create a noise problem only during landing and takeoff operations at airports, we shall take the liberty of using the term "airport noise" as shorthand for the noise created by subsonic aircraft near airports.

Noise Costs and Aircraft Economics: We have noted that the phenomenon of sound occurs when a mechanical disturbance is transmitted, usually through the air, and is heard by an individual. When the sound is unwanted, it is noise. One might well ask whether it is unnecessary for aircraft to make the offending mechanical disturbance and, if so, whether it is necessary for people to live or work where they can hear the noise.

Jet aircraft are noisy because it is costly to make them less noisy, and because it may be prohibitively costly to make them quiet. Jet-engine noise is generated from two sources; the exhaust jet and the compressor. In both cases there is a positive relationship between engine thrust, or power, and noise level. Improvements in the performance of engines tend to result in more noise. To some degree, this noise can be mitigated with noise suppressors at the exhaust jet and absorptive devices to attenuate noise developed by turbines or fans. These measures have been incorporated in present jet engines, but not without cost. For subsonic aircraft in operation today, noise-attenuation devices yielding as much as a 5-PNdB noise reduction will impose fairly little penalty in payload or range. But the penalties for suppression in the range of 10 to 15 PNdB equal or exceed current typical payload capabilities.[13] At the present stage of technology, significantly quieter aircraft could neither fly very far nor carry much payload.

Urban Development Around the Airport: The airport-noise problem arises not only from the fact that jet aircraft must be noisy, but also from the fact that large numbers of people choose to work or live near airports, where they can hear the noise. The reasons for this tendency toward high-density residential development around major urban airports are not entirely clear, but some of the factors may be cited.

Transportation Friction. Probably one of the most important reasons for persons living and working near airports is the "friction," or cost, of urban transportation systems. Employment on major airports numbers in the thousands[14] and these individuals will tend to live near their places of work.[15]

Over the past several years, large industrial, commercial, and office complexes have developed around airports, especially the larger ones. Undoubtedly at least one reason for these developments is the minimization of surface travel time between the office and air transportation. In all metropolitan areas, surface-transportation times between the airport and the urban core or other parts of the urban areas are large. Peak air-travel times correspond to peak surface-travel times, compounding the problem of airport access. There are no special airport-access facilities (except helicopters) which do not make use of common surface routes, nor do any data exist which even remotely suggest that an adequate system would be economically feasible. So the frequent business traveler may also be induced to locate his home and place of work near the airport.

Planning Criteria. Planners have often reinforced the tendency of business to locate near airports to take advantage of the noise compatibility of the two land uses. They have encouraged and planned industrial districts on and around airports, generally supporting and augmenting the tendencies of the free urban land markets. This airport-industrial district planning criterion tends to overlook the possibility that the industrial areas may absorb relatively little of the noise-affected land while attracting additional medium-to-high-density residential land development. The planning criterion may contribute to the noise problem rather than to its solution.

Problems of Public Policy

From one viewpoint it may be said that the airport-noise problem has arisen out of conflicts

among public and private goals and policies. On the one hand, it is clearly in the public interest to keep airport noise at as low a level as possible, and below some maximum level. On the other hand, it is in the public interest — although not necessarily the same segment of the public — to have the airlines adopt all improvements in airframes and engines which will provide more comfortable, faster, and more economical air transportation. Indeed, it is the legal obligation of both the Civil Aeronautics Board and the Federal Aviation Administration to promote the development of air transportation.[16]

Moreover, it is a central aspect of U. S. transportation policy that the airlines be privately owned, competitive, profit-making enterprises, free to make their own business decisions within a framework of safety constraints and economic regulation.[17] In making their decisions, airlines may be expected to be sensitive to community noise problems, but they must also be responsive to the needs of the public for faster, safer, and more economical air transportation, and to the obligations to their stockholders to earn the profits allowed them by regulation.

Any effective new public policy for allocating the cost of alleviating airport noise must take these conflicts into account. It must also be both remedial and preventative in its approach.

Remedial Policy: Airport-noise policy must provide compensation to those who have been economically hurt in the past and are continuing to be hurt by present actions. If noise costs around airports were stabilized at today's levels, the problem would be greatly simplified, but many persons would still be deserving of compensation. Recourse to legal action does not appear wholly satisfactory for a couple of reasons. The time required to recover damages is often long, and the costs of legal proceedings large. But, more importantly, it is not clear that the courts' criteria for computing damages are adequate. The test of change in market price may be inadequate here, and it may be desirable to provide the courts with some legislative direction as to the basis for computing constitutional taking or damages.

Preventative Policy: A goal of policy must be the elimination or mitigation of future costs of airport noise. Achieving this goal is difficult: it entails resolving some of the conflicts among existing policies.

Economically, the most desirable set of policies would be one which would leave the airlines the broadest possible choice in their purchase and use of aircraft. Ideally, any set of policies should seek to make the noise costs internal to the airlines, and to leave airline management free to make choices based on the full cost of their operations, including the noise costs. This approach could meet both equity and resource-allocation criteria, but might not meet growth criteria. In the face of a number of political, institutional, and technological constraints, it is likely that the final set of public policies will reflect a composite of interests and approaches.

II. RESPONSIBILITY FOR AIRPORT NOISE

Determination of who should pay the cost of alleviating airport noise depends largely on assignment of ultimate responsibility: who benefits from the noise? Those who benefit should pay. The benefit implied by the noise is the availability of transportation by aircraft with lower operating costs. If this benefit does not exceed the noise costs, then the aircraft are, in fact, economically inefficient.

The question of who is responsible for airport noise can be approached from a number of viewpoints. In this section, we propose to proceed from the broadest viewpoint of general considerations to the narrower conceptions found in legal and economic theory.

Pervasive Importance of Air Transportation

In the very broadest sense, the entire nation or possibly the entire world shares a responsibility for the airport-noise problem. The growing importance of air transportation for intercity passenger travel is indicated in Table 2. In the decade 1955-1964 domestic air carriers' share increased from 31.0 to 53.1 percent of all intercity passenger traffic by common carrier and from 3.0 to 4.9 percent of total intercity passenger traffic, including automobile traffic. Although the automobile is the major mode of intercity passenger travel, air travel is the predominant common-carrier mode, with the largest and expanding portion of that market at the present time.

In the decade 1955-1964, passenger miles by scheduled air carriers increased some 117.2%, domestic ton-miles of air mail increased 113.8%, and air cargo increased 239.6%. Ton-miles of air cargo exceeded one billion in 1962. Over the same period, domestic air passenger traffic increased 105.9%, and air cargo 121.9%.

TABLE 2 — COMPARATIVE INTERCITY AND AIR TRAFFIC STATISTICS[18]

	1955	1960	1964	% Change 1955–1964
Intercity Passenger Traffic by Mode, Passenger Miles (000,000)				
Common Carrier	62,100	64,000	78,400	
Private Automobile	585,800	680,600	763,000	
Total	647,900	744,600	841,400	
Scheduled Air Carrier	19,200	29,200	41,700	117.2
Air vs. Other Intercity Passenger Traffic				
Percent Air to Total	3.0	3.9	4.9	
Percent Air to Common Carrier	31.0	45.7	53.1	
Domestic Enplaned Traffic				
Passengers (000)	37,226.4	50,584.1	76,657.1	105.9
Cargo (tons)	389,307.9	510,492.5	863,811.1	121.9
Domestic Ton Miles				
Air Mail (000)	88,751	135,923	189,782	113.8
Cargo	375,210	723,670	1,287,863	239.6

There is little question but what air transportation significantly affects the well-being of the vast majority of the population in the United States, whether or not they have ever flown. So, in effect, the demand for a modern air transportation system is a pervasive national demand.

National Interest and Federal Responsibility

The fact that there exists a pervasive national interest in air transportation in general and in the noise problem in particular does not necessarily lead to the conclusion that the responsibility for airport noise is a Federal one.

Legal Rights and Obligations: The Federal government has, by statute, the obligation to promote and regulate air transportation. It has chosen to regulate within some relatively broad criteria, with the exception of detailed regulation in the interest of safety. Prior to 1938, the Federal government was prohibited from owning and operating airports. By Sec. 302(c) of the Civil Aeronautics Act of 1938, the administrator of the Civil Aeronautics Authority was directed by Congress to investigate and report to the Congress with respect to the degree and manner in which Federal participation in airport development was required or desirable. The results of that report, delayed by World War II, was the Federal Airport Act of 1946,[19] which provided for a loosely prescribed and annually updated National Airport Plan and a program of grants-in-aid intended to induce cities and counties to implement the Plan. Aside from the general prescriptions of the National Airport Plan and grants-in-aid and extensive technical information on airport planning and design provided by the Federal government, the location, planning, operation, and ownership of airports has been left to local governments. It is largely for this reason that the U. S. Supreme Court decided in Griggs v. Allegheny County that the principal responsibility for airport noise was that of the local airport sponsor.[20]

The Question of General Benefit: The fact that the Federal government does not, under

present statute and case law, have a primary legal obligation for airport noise does not wholly answer the question of possible Federal responsibility. It is also relevant to ask whether there are any "general" or "secondary" benefits which are not reflected in the benefits to direct users of air transportation, and for which others should be required to pay.

Aircraft noise costs, like all other costs of air transportation, are incurred primarily for the benefit of the direct users of air transportation. The value of that transportation is revealed by the willingness of persons to pay for it. To argue that some of the costs of air transportation should be paid out of the governmental (Federal, state, or local) treasury is to argue one or both of two propositions: first, that air transportation causes gains in national income that are not reflected in the willingness of persons to pay for air-transport service; second, that air transportation serves public objectives in ways that are not reflected in any increase in national income (redistribution of income and wealth is possibly the most important instance of this second proposition).[21]

There is little justification for an income transfer from the general public to the air traveler, for the average income of the air traveler is substantially above the national average. Multipurpose programs of which noise alleviation is only one element (such as a program involving urban renewal, airport-noise alleviation, and development surface transport systems) may justly use general tax funds, since the income transfers would in this case go primarily to lower-income residents of the airport area rather than air travelers, and the program would have broader objectives than noise alleviation. But aside from these multipurpose projects, there appears little justification for achieving income and wealth redistributions through projects to alleviate aircraft noise.

The other category of secondary benefits encompasses gains in national income accruing to people other than the direct users of air transportation. The crucial questions here are whether any such secondary national-income gains exist and, if so, whether the free market leaves them untouched?

Some secondary benefits of the national-income variety probably exist. The user of air transportation buys inputs from and sells outputs to others. These others may be able to sell at higher prices, buy at lower prices, or enjoy physical economies of scale because air transportation exists, even though they themselves never use it. So there may exist some national-income gains, or profits, which accrue to people other than the direct users of air transportation, but which are clearly traceable to that transportation.

In general, if secondary national-income gains exist, the primary beneficiaries would be able to extract them if they could act as complete monopolists. In fact, most of the primary producers are probably not complete monopolists, but neither do they function in an environment of perfect competition. There is, then, no reason to believe that the initial impact of additional costs of air transportation, occasioned by the internalization of noise costs, will rest only on the primary users. To the extent there are national-income gains (that is, higher profits) at levels 2, 3, ..., n, the primary beneficiaries of air transportation will be able to extract at least a portion of them. If there are no such abnormal profits to be extracted, there are no secondary benefits.

The Federal Government Should Require Compensation: Noise resulting from the operation of jet aircraft makes some persons worse off; it decreases the welfare of those living near the flight path. But the creation of noise makes some persons better off. We have already noted that jet aircraft operate at less cost when their noise output is not restricted. For those operating and using the aircraft, the noise implies an advantage, lower-cost air transportation. So, given the present technology of aircraft turbine engines, the noise means that some individuals are better off and some are worse off. By the test of economic welfare, the noise is economically desirable if the gainers (those using the aircraft) can compensate the losers (those adversely affected by the noise) and still have some gain left over. Noise is economically acceptable — that is, it is economically efficient — if the gains resulting from it are at least as great as the losses it imposes. But in addition, the gainers must actually compensate the losers. The mere fact that the gainers could overcompensate the losers is not an adequate criterion, for it overlooks the changes in income distribution. If those who gain are, say, generally in the higher income brackets and those who lose generally in lower ones, the mere fact that the gainers have gained slightly more dollars than the losers have lost does not entail an increase in community welfare, unless one assumes that both groups have the same marginal utility of income, so that the gain of satisfaction by the wealthy group is (even slightly) greater than the loss of satisfaction of the poorer group.[22]

There is, then, a clear social requirement that those affected by aircraft noise be compensated by the primary users of air transportation. If the costs are not paid by airport sponsors in recognition of their public responsibility, and charged in turn to the air carriers and ultimately to the primary users of air transportation, then the Federal government should establish a corrective policy.

Other Aspects: The impact of airport noise on the political, social, and moral aspects of national life is possibly even harder to assess than is the economic impact. If airport noise causes urban blight, it generates social as well as economic problems. Many of the possible solutions to the noise problem are political in nature, since they involve the resolution of conflicting public and private interests. Nonetheless, at this time airport noise does not seem to have any extensive political or sociological implications. Kryter has surveyed the available empirical data about the implications of noise on public health and has concluded that:

> "Except that some of the extremely intense noises of the factory, office, home and street may damage the ear of man, there is little evidence of any damage to psychological health by such noise, although feelings of annoyance are expressed by some of the people exposed."[23]

In extensive hearings, Congress found no evidence of physical damage or physical injury to persons caused by noise.[24]

Obligations of the Airport Sponsor

Economic theory and legal decisions place the initial responsibility for airport noise with the airport sponsor, as long as the Federal government does not specifically preempt the obligation.

Griggs Decision: In the case of Griggs v. County of Allegheny, the United States Supreme Court faced the question of whether Allegheny County had taken an easement over Griggs' property for which compensation was required by the Fourteenth Amendment. The material question was who was de facto responsible for the development of the airport.

The majority opinion argued that the County, "which was the promoter, owner and lessor of the airport, was in these circumstances the one who took the air easement in the constitutional sense."[25] The responsibility was that of Allegheny County, for there was "no difference between its responsibility for the air easements necessary for operation of the airports and its responsibility for the land on which the runways were built."[26] The Court concluded that the County had to acquire some private property to provide the airport, and that, in failing to also provide an airspace easement over the Griggs property, it had failed to acquire enough property.

The Supreme Court decision in the Griggs case, and the controversy between the majority and minority opinions, reduces to the question of whether the Federal government or local government is, in fact, the airport "entrepreneur."

Economic Responsibility — The Public Entrepreneur: It has been argued in detail elsewhere that local governments in the United States are responsible for airport development.[27] The conclusion has distinct economic implications for the assignment of responsibility for noise. As economic undertakings of government, airports constitute an instance of public production of economic services which are made available to the general public as individuals. Airport services, as distinguished, for example, from national defense, could be privately produced; in some cases, private production has been successfully undertaken. But in the vast majority of cases, airport services are publicly produced in the United States.

The concept of public enterprise implies that production is being undertaken for the benefit of the public as a whole and not for some small group of enterprise owners. If, then, local government owns and operates an airport for the benefit of the entire community, it cannot logically disregard the fact that the airport imposes disproportionate costs on one segment of that community — on those who must endure high levels of airport noise. If jet aircraft must generate relatively high noise levels in order to operate efficiently as apparently they must, then the airport operator is under obligation to see that the burden of the noise cost is not arbitrarily inflicted on one group for the benefit of another.

It should be remembered, however, that in order for the air-transport system to be economically efficient, it is necessary not only that airport operators undertake various measures to "internalize" the noise of jet aircraft, but also that the costs of those measures be charged to the airport users creating the noise. The history of airport development in the United States, legal theory stemming from the Griggs case, and economic theory all indicate only that the local air-

port operator has the responsibility of providing a reasonably quiet airport environment, not that that environment need be provided free of charge to the airport users.

III. CAPABILITIES OF LOCAL GOVERNMENT FOR DEALING WITH AIRPORT NOISE

The fact that local governments have the legal and economic responsibility to deal with the airport-noise problem does not imply that they also have all of the powers necessary to accomplish this task. In this section, we consider the powers of local airport owners as entrepreneurs and some of the limitations of those powers.

Authority and Power Delegated from the State

Early aviation legislation, as we have seen, prohibited the Federal government from engaging in airport development. This fact, together with a virtually unbroken line of legal decisions establishing the authority of municipalities to own, finance, and operate airports,[28] provided the primary historical impetus for the municipal ownership, development, and operation of local airports. The powers delegated by states to local government to provide airports are administrative and financial.

Airport Administration: In general, airports are administered either as a department of general local government — that is, a city, town, or county — or under special district or authority legislation. A 1962 survey showed that cities or counties owned 86.7% of the publicly owned airports of record with the Federal Aviation Administration serving cities with populations of over 10,000 (with 84.0% of the surveyed airports responding). Of the city-owned airports, 23.1% were leased for operation. Many of the smaller airports are leased to private individuals or corporations, and some of the larger airports are leased to other public bodies. The most notable of this latter group are Newark and LaGuardia Airports, both leased to the Port of New York Authority. State governments owned and operated 3.9% and special authorities 9.4% of the airports.[29]

These census data substantially understate the use of independent public agencies or special authorities for the ownership and operation of airports. Numerous airports are owned by authorities or quasi-independent districts which the Bureau of the Census defines as "subordinate agencies and areas" and for which no comprehensive tabulations are available. But the special-district form of ownership is used more frequently for smaller airports. Of the 25 airports in the United States with the highest volumes of scheduled air-carrier operations in the year ending June 30, 1966, all but seven were operated by general governments (cities, counties, and the Federal government). Of the seven airports not operated by general governments, three were operated by the Port of New York Authority, three by other port authorities, and one by a special airport authority.

It is difficult to generalize on the question of whether airport administration under general government or under independent special districts has a better opportunity to cope with the airport-noise problem from an administrative viewpoint. The real requirement of airport administration in problem of noise alleviation is foresight in anticipating noise problems and resourcefulness in searching for solutions. A government of either form may have these characteristics.

Airport Finance: The finances of an airport may make a significant difference in the ability of the airport administration to cope with noise problems, and may affect the ability of airport operators to properly allocate the costs of the noise-alleviation measures it undertakes. Airport operators rely on both general-obligation and revenue financing. Each has disadvantages in providing financial solutions to the noise problem.

General-Obligation Financing. General-obligation financing is tax-supported debt, at least in the formal, legal sense, even when it is actually amortized from airport revenues and constitutes no cost to the taxpayer.

A major advantage of general-obligation debt is its relatively low interest rate. The interest cost reflects the tax pledge rather than the actual source of funds used for amortization, and tends to be lower than that of revenue bonds. The primary disadvantage of general-obligation debt is that it falls within constitutional or statutory debt limits, and thus diverts financing from other projects. If heavy expenditures are required for noise alleviation, it is virtually certain that they could not be economically made from general-obligation sources without having serious adverse effects on the community's ability to finance other facilities.

Most local governments operate under artificial budget restrictions on investment imposed by state constitutional debt limitations.[30] Under these limitations, governments should rank potential investments according to the ratio of discounted net benefits to initial capital cost. Investments should then be made beginning with the project with the highest ratio and proceeding to projects with successively lower ratios until the available budget is exhausted.

If such a budgetary procedure were applied to noise-alleviation projects, one of two events would occur:

1. If the noise-alleviation projects have relatively high benefit-cost ratios, they would absorb much of the budget, leaving unaccomplished many other projects with lower ratios (but still with ratios greater than unity), or

2. If the noise-alleviation projects have relatively low benefit-cost ratios they could fall outside the budget, leaving the noise problem untreated.

Additionally, a very real possibility exists that the courts could award substantial compensation to property owners adversely affected by airport noise without reference to the financial capacity of the city or county held responsible. If alternative provisions are not made, the city or county would have to pay these awards from general-obligation funds at the sacrifice of other important projects.

Since many metropolitan governments are operating within relatively severe budget constraints, they cannot justifiably be called upon to bear the additional burden of noise-alleviation costs if alternatives are available.

Revenue Financing. Revenue financing of projects to alleviate airport noise has one major advantage and several disadvantages. The advantage is that this type of financing falls outside the usual debt limitations, since it is supported wholly (in most instances) from the earned net income of the airport. Thus, the problems of budget limitation are not encountered. The disadvantages of revenue financing are the following:

1. Revenue financing tends to be more "expensive," in terms of the rate of interest, than general-obligation financing. Both the airport sponsor and the user hesitate to use high-cost revenue financing if alternatives with lower interest costs are available.

2. To be marketable, revenue bonds require substantial "coverage," an excess of annual net revenues over average annual requirements for debt service.

3. Revenue-bond indentures tend to place relatively severe restrictions on the management of the airport and, particularly, on future financing.

In addition to these general disadvantages of revenue financing, there are two special disadvantages for the purchase of property rights for noise alleviation.

1. In most instances, revenue bonds are payable only from the net revenues of the airport. Using revenue financing thus precludes the use of any general-tax funds reflecting whatever general-community benefits might exist.

2. The acquisition of nondepreciating, and usually appreciating, assets or property rights with revenue bonds raises some difficult problems of crediting the residual or reversionary value of the asset. The use of revenue financing to acquire land or other nondepreciating property rights obliges the airport users to pay all (or at least a substantial proportion depending on the availability of nonuser revenues) of the original cost of the property, plus carrying charges over the amortization period, but does not give them title to the property: the airport sponsor will normally hold it. The users should be called upon to pay only the relevant carrying costs on land, and only while it is devoted to airport purposes; users should not also be called upon to pay its original cost of acquisition, unless they thereby obtain title to the reversion at the end of the lease period. As long as the airport sponsor holds rights to the reversion, the airport users should only pay a fair lease value for that porperty over the period in which they use it.

The acquisition of real property for noise-alleviation purposes, whether financed with revenue bonds or with general-obligation bonds amortized solely from airport net revenues, will result in the purchase of substantial acreage by air-transport users or airlines for the ultimate benefit of municipalities. Although the use of either revenue or general-obligation bonds can lead to this result, revenue financing virtually assures it.

We conclude that, although administrative powers under either general or special governments probably have roughly equal administrative capabilities for dealing with airport noise, the

financing of the costs of local noise-alleviation programs with either of the forms of debt traditionally granted airport operators by state constitutions and statutes raises substantial problems. Both forms of debt imply cost allocations which are unacceptable. When general-obligation debt is used, the implied costs include not only the debt-amortization expense, which may be allocated between airport users and others, but also the opportunity costs of alternative projects foregone. These latter costs necessarily fall on the local community. Revenue bonds are undesirable because they would result in the users of air transportation paying for substantial valuable and appreciating land belonging to local communities.

Since most special-district and special-authority governments are confined to revenue financing (although some have taxing and general-obligation bonding power), this governmental form is probably financially less able to cope with the noise problem than is general government.

Land-Use and Zoning Problems

The adjustment of land-use and zoning around airports is clearly but one way of dealing with the airport noise problem. It is, however, about the only way in which local government can respond to the noise problem in a positive manner. Alleviating jet aircraft noise through zoning may be costless in some instances; in others it may imply definite cost allocations. In this section we consider some of the problems and possibilities of dealing with aircraft noise through land-use and zoning controls.

Land-Use Decisions: The importance of decisions concerning land-use around airports cannot be overestimated. Jet-aircraft noise becomes a problem only when it disturbs persons. To the degree that the number of persons disturbed can be kept small — either by creating low-density land-use around the airport or by imposing physical or distance barriers between the noise source and individuals — the noise nuisance can be mitigated. The planning and zoning of land use works on each of these variables.

If airport environmental planning may be said to have a tradition it is that low-density recreational uses or open space should be provided within the areas of most intense noise and that these should be surrounded by industries. The logic underlying these recommendations rests on the premises that recreational and industrial land uses are (1) functionally or economically complementary with the airport and (2) relatively insensitive to high-level noise. But the recommendations tend to overlook the fact that these land uses (3) take up only a fraction of the noise-affected land and (4) strongly attract medium-to-high-density residential development.

It is plausible therefore, to hypothesize that the planning of major industrial districts near airports may tend to increase rather than alleviate the noise problem by attracting high-density residential development; and it is not unreasonable to hypothesize further that a broad-based program to use the noise-affected land — excepting that with the highest PNdB levels — for low-density housing may have more long-range potential for alleviating the noise problem than do programs based on current planning criteria. Low-density housing would include multiple-family as well as single-family dwellings, would be at least partially noise-insulated, and would be strategically placed with reference to distance from the noise source, natural or created terrain differentials, screen planting, and so forth. Extensive areas should be left open and in recreational use to maintain low gross population density.

Properly sited, low-density residential developments around airports are not a likely result of free-market forces in urban land. They could, however, be included in private and public urban-renewal and resettlement programs. These programs, while reducing the gross impact of airport noise on the population, could bring the advantages of low-density living to families resettling from urban slums without, in many cases, substantially increasing total noise levels to which they are exposed.[32] Direct data indicating average noise levels in slum areas subject to urban renewal is sparse. Nonetheless, from what general data is available, it appears that daytime noise levels in these areas might approach noise levels in the airport vicinage.[33]

The hypothesis that noise-affected areas might be redeveloped for low-density housing runs startlingly counter to the traditional planning criteria. Nonetheless, it does not seem that it can be categorically rejected without a careful test. Redeveloping some areas around an airport for industrial and commercial uses as a means of alleviating the noise problem appears of doubtful validity when used alone. The entire noise-affected area must be considered, rather than only the most critical areas adjacent to the airport, and appropriate combinations of land-uses planned.

One further planning criterion remains for brief consideration. Some planners have advocated air-surface transportation corridors, wherein freeways or other major transportation

routes would be channelized under aircraft arrival/departure paths.[34] This conception involves many of the same difficulties as the industrial-district proposals. A six-lane urban expressway planned to desirable standards would use less than three hundred feet out of a noise-affected corridor (with a PNdB level of 85 or greater) some three miles wide. Since urban expressways have relatively closely-spaced interchanges, the transportation corridor would attract medium-to-high-density residential development to much of the critical noise area, tending to increase rather than decrease the noise problem. It may well be that primary transportation routes within the noise-affected areas should run perpendicular to and not parallel with principal aircraft approach and departure paths.

Limitations of Planning and Zoning Laws: There are several factors which prevent planning and zoning from being the effective tools they might be for solving the airport-noise problem.

Multiple Jurisdictions. In view of the relatively large areas affected by airport noise and the rather small size of suburban communities in metropolitan areas, it is not surprising to find the noise problem cutting across numerous political boundaries and affecting many political jurisdictions. Although some region-wide planning is accomplished, no zoning is so broadly handled. The planning function may be delegated from a small community to a more comprehensive metropolitan or regional planning commission, but the tools of planning implementation, particularly the right to zone, are almost invariably retained at the local level of government.[35]

Limitations Inherent in the Concept of Zoning.[36] Zoning is an exercise of police power in the interest of general health, safety, morals, and welfare. In its legal history certain criteria have evolved and these must be met if zoning is to be a useful device for alleviating the airport-noise problem.

Any zoning law must be established on a criterion of public welfare. Clearly, the general public has an interest in air transportation, but it does not follow that a segment of the public can, for that reason, be denied the desired use of their property without compensation. The fact that noise costs fall in a discriminating manner on some segments of a community cannot be justified by the police power of zoning, even though the air-transportation system creating the noise operates in the public interest. The argument can be illustrated by analogy to other environmental pollutions.

Water-pollution regulations have the aim of preventing or lessening the polluting activity of an industry or group of industries. Alternatively, the aim might be to restrict the use of downstream land to activities compatible with polluted water. Similarly, air-pollution regulations might limit land around a factory emitting air pollutants to uses compatible with pollution. Such would be the effect of large-scale zoning regulations directed toward making land uses in the airport vicinage compatible with airport noise.

In actuality, zoning laws and regulations take the quite different approach of fixing limits for air and water pollution and requiring industry to function within them. If effective, this approach undoubtedly increases industrial production costs, leading to higher consumer prices or reduced profits or both. Most pollution-control regulations direct restrictions toward those offending, not those offended.[37]

To put the argument in a somewhat less extreme perspective, one might say that a zoning ordinance based on good planning will attempt to regulate both the potential offender and those who may be offended: pollution and the use of land effected by pollution should both be controlled. Until an effective limit is placed on noise around airports, it is difficult to see, from an economic viewpoint, how zoning ordinances controlling the use of land around airports can function in the public interest.

A second problem of traditional zoning criteria is that of "cumulative" and "noncumulative" zoning. The notion of cumulative zoning generally accepts the use of land for a purpose higher than that for which it has been zoned, such as residential development in an industrial zone. Apartments may be built next to a jet runway according to this notion. Noncumulative zoning rejects such land uses.

Noncumulative zoning has a substantial statutory and case history in the United States, but its status does not yet seem clear. Tondel shows that the existing cases on noncumulative zoning have largely been decided according to the extent to which the proposed, higher, nonconforming use already exists in the zone.[38] Where the use is substantial, the courts have not considered it constitutionally possible to keep the situation from worsening. Until the status of noncumulative zoning is firmly established, the effectiveness of land-use zoning in alleviating airport-noise problems will be hampered.

A third problem in using zoning for noise control is that this requires a defensible criterion of noise-affected land. Whether such a criterion exists today is unclear. Tondel suggests that the methods now used to measure airport noise and to anticipate community reaction to it are probably adequate for the most seriously affected areas, but not for marginal areas.[39]

Economic Limitations. If the airport-noise problem is to be alleviated in any significant degree by rezoning, without merely redistributing noise costs throughout the community, an economic demand must exist for land in uses compatible with the airport. That demand must exist not only in terms of the aggregate amounts of land in various uses, but also in terms of spatial structure and rates of development or absorption.

Say that considerable noise-affected land is rezoned for commercial and industrial uses. Then the supply of such land is being arbitrarily increased through governmental action, without any corresponding increase in demand. Local owners of such land will find the value of their property to have decreased owing to the artificial increase in supply. The result of rezoning may be to compensate those affected by the technological externalities of airport noise — but the compensation will have been accomplished, at least in part, by converting technological external costs to pecuniary ones and altering their distribution throughout the community.

In short, urban planning and land development as a method for alleviating airport noise costs will tend only to shift the incidence of those costs, unless planning is undertaken within the limitations of the aggregate and spatial demands in the locality for land of various uses.

Possibilities for Additional State Legislation

There exist some possibilities for additional state legislation which will increase the capabilities of communities — particularly multi-jurisdictional metropolitan areas — to deal with their airport noise problems. Unfortunately, many of these possibilities involve reforms of local government planning, zoning, and financial powers — reforms which have broad implications for much of the structure of local government and tend to be politically impracticable.

From the purist viewpoint, those concerned with airport noise should probably be encouraging general municipal reform. Any other measures are in the nature of second-best solutions: they may alleviate the noise problem but, like all partial or interim solutions, they only tend to delay more substantial reforms. On the other hand, I am not sanguine about the ability to achieve general and genuine reforms of local government. I will, therefore, only note what those general reforms might be, and proceed to consider some partial reforms.

Planning: Of the general reforms, the one most likely attainable is metropolitan-area planning. Although strictly limited in its power, metropolitan-area planning appears to hold some promise for alleviating the noise problem and for providing an acceptable distribution of costs.

State laws providing for mandatory planning in metropolitan areas and stipulating that that planning will constitute a criterion for local zoning[40] could, within the economic limits outlined previously, provide some alleviation of the noise problem. It seems likely, however, that in view of the implications of such legislation for all phases of community development, no such general reform can be expected in the foreseeable future.

A more limited, and probably more feasible, goal would involve airport-area zoning along the lines of the Chicago O'Hare experience.[41] State laws might define, or require the definition of, the area around the airport which is to be planned, and make that planning mandatory. The legislation should further provide that the planning shall constitute a major criterion for evaluating the reasonableness of local zoning. This approach clearly does not guarantee good planning, but it does not prevent it either. Where comprehensive metropolitan-area planning takes place, special airport-zoning legislation should be based upon it; where there is no comprehensive planning, airport-area planning and zoning would have to function in something of a vacuum, but would probably be no worse than no planning, and could be considerably better.

Financing: State governments could remove artificial debt limits and replace them, if necessary, with economically more realistic limiting criteria. But, like comprehensive planning and zoning, the economically most rational alternative carries a great many political problems and implications, and is probably impracticable. So, again, one is forced to look for second-best, special-purpose measures.

Direct Financial Aid. One alternative would be to provide direct financial aid, in the form of grants-in-aid or long-term loans. But in the historical context of airport financial development, it seems inappropriate to look to the states for this aid. State governments have not become extensively involved in the financial aspects of airport development.

Direct state financial aid to airports to alleviate the noise problem can basically achieve no more and probably less than direct Federal aid. Moreover, state goverments also operate under severe budget constraints. Unless one believes there to be an intrinsic advantage in providing financial aid at the state rather than national level, there appears to be little historical or logical justification for states becoming involved in programs of direct financial aid for noise alleviation. Moreover, since the noise problem persists across the entire national system of airports, consistent national policy rather than a multiplicity of state policies is probably desirable.

An Alternative Local Financial Technique. In the previous discussion of airport financing alternatives, consideration was limited to general-obligation and revenue bonds because these more traditional forms of public debt have been used most extensively in airport financing. But there exists a third method sometimes used in airport financing which appears to offer a partial financial solution to the acquisition of property rights for noise alleviation: the municipal lease-back.[42] The precise form of the technique would vary among states and its use would probably require special legislation in some states, but the general approach would be about the same.

In effect, a nonprofit public corporation is formed with the right to issue tax-exempt debt. The corporation may sell bonds and devote the proceeds to a recognized public purpose. The corporation could, for example, purchase noise-affected properties, hold them or redevelop them for a public purpose, pay compensation, and so forth. The lands could be leased to the airport sponsor or other public agencies with the lease payments being used to amortize the outstanding debt. The lease payments may come from any source, including tax receipts. Because the bonds of the corporation have no direct tax lien, they are not general-obligation bonds, and do not fall within constitutional debt limits. Neither are the bonds true revenue bonds, since the municipal lease payments derived from tax revenues may be pledged to the payment of the principal and interest. Finally, an election is not required to issue these bonds.

In cases where local government lacks adequate debt capacity to deal with the airport-noise problem and where general fiscal reform is improbable or impossible, the technique of the nonprofit corporate lease-back may be feasible and desirable.

IV. THE LOGIC OF ALTERNATIVE FEDERAL POLICIES

Since the responsibility for airport noise has not been placed with the United States by the courts, it is conceivable that the Federal government could adopt a policy of doing nothing. The problem of noise alleviation would then be left totally to the airport operators, air carriers, and airframe and engine manufacturers.

On the other hand, the Federal government possesses extensive technical and economic regulatory powers over air transportation. Indeed, it holds virtually exclusive regulatory rights over all phases of air transportation, with the exception of airport development and operation. These powers could be extended with the implementation of regulations controlling aircraft operating procedures and airport development in the interest of noise alleviation. If such steps were taken, they would probably upset the Griggs decision and place complete responsibility for airport noise on the United States. The Federal government would then be forced to adopt a complete set of policies for the alleviation of noise.

Finally, there is a middle ground in which the Federal government would provide assistance to the other segments of air-transportation industry — manufacturers, air carriers, and airport operators — to encourage and assist a systematic attack on the noise problem. In this section, we consider the logic of these alternatives.

The "Do Nothing" Policy

It is, at least initially, possible for the Federal government to do virtually nothing to alleviate airport noise. The basis for a do-nothing policy is clear. Local communities have elected to own, develop, and operate airports. Their right to do so has been fully established by law. Congress has aided them in their endeavor principally by providing municipalities with Federal grants-in-aid through the Federal Airport Act of 1946. The noise problem arises largely from the siting of airports and the failure or inability of communities to maintain compatible land uses around them. On the other hand, the emergence of the noise problem has not emerged in such a way as to allow communities to undertake adequate planning and protective measures. Even where communities have attempted to acquire enough land area around airports to mitigate

the noise problem, the noise levels have increased so as to cancel the value of the initial planning. Under these circumstances, local airport operators have little ultimate recourse but to purchase increasing amounts of property and charge the costs to the airport users. The economics of such a policy would undoubtedly cause the air carriers to ultimately establish noise criteria for their aircraft, but the process would be slow.

In Griggs v. County of Allegheny, the United States Supreme Court considered the distribution of legal authority and power for the development of airports, and has concluded that the responsibility for noise rests with the local airport operator. It might be possible for the Federal government to do nothing, leaving the solution of the problem to the local airport owner and the air carriers. Such a policy would overlook the possibility that only the Federal government has enough power and authority to deal with the airport-noise problem comprehensively.

The "Do Everything" Policy

If the Federal government is the only source of comprehensive authority for dealing with problems of air transportation, should it not adopt a policy of doing everything necessary to achieve a reasonable solution of the airport-noise problem? Many of the other segments of the air-transport industry might favor such a policy.

Basis for a "Do Everything" Policy: The Federal government has virtually complete regulatory powers in all segments of aviation except airport ownership, development, and operation. In some instances it has chosen not to utilize these powers extensively. Under the Federal Aviation Act of 1958, the Federal Aviation Administration may regulate, by certification and otherwise, aircraft, airmen, air-navigation facilities, and airports. The Administration has chosen not to certificate airports, but probably has the power to do so in the interest of safety.[43] The FAA is currently drafting legislation which would allow it to certificate aircraft for noise.

Shortcomings of a "Do Everything" Policy: Certainly one policy alternative of the Federal government for dealing with airport noise is to do everything. Such a set of policies would, of course, have to be legislative and not administrative, but it is possible, even if not probable, that the Congress could take the necessary action. Moreover, a "do everything" policy would not require Federal payment for all noise-alleviation programs. The Federal government could recover the costs of all of its programs through user charges. But such a policy would have a number of shortcomings.

Planning and zoning can probably accomplish much to alleviate airport noise. The Federal government has very limited authority or power in this area. It can, through grants-in-aid, encourage comprehensive planning, and can even affect the implementation of that planning to a degree through its programs for urban renewal, highways, airports, community facilities, and the like. To date, the effects have been indirect, partial, and may in many instances be uncoordinated and conflicting. Better coordination is possible through the Demonstration Cities and Metropolitan Development Act of 1966.[44]

Lacking planning and zoning power, any Federal program involving the purchase of property rights around airports and the payment of court-awarded compensation claims could result in some most uneconomic solutions of the noise problem. With the Federal government paying for property acquisitions, local governments would have little incentive to plan compatible land-use and enforce zoning based on it. Although the local government might not totally overlook the airport-noise problem in determining land uses around airports, a major incentive to opt for compatibility would be missing. If the Federal government paid for the property acquisitions and compensations from its own budget without recovering these costs from the air carriers, it would have a strong incentive to achieve noise-alleviation in a manner which would not fall on the Federal budget — through regulation, for example. It is probable that the costs of noise regulation would, under this set of policies, exceed the costs of some mix of regulation and property acquisition.

Recovering Federal costs from the air carriers could lead to an optimum mix of regulation and property acquisition, but not an optimum mix of these with land-use control. Local governments should potentially stand to bear part of the costs of noise alleviation as a financial incentive for achieving compatible land use and zoning.

Instead of calling on the Federal government to pay all costs of property acquisition, policy should require local government to purchase property rights and charge airport users with the costs relevant to them. If the division of costs between local government and airport users is disputed, the division may be made using existing mechanisms for resolving such disputes (as discussed below).

In general, a "do everything" policy is superior to a "do nothing" policy and inferior to a policy of Federal assistance.

A Policy of Federal Assistance

Although Federal "do-nothing" and "do-everything" policies both appear unwarranted, a Federal assistance program is needed, for several reasons:

1. Local government may lack the finances required to meet the problem.

2. Local government may be prevented by budget constraints from using finances available to meet the problem.

3. Research on noise control and alleviation will benefit the entire air-transportation industry (including airport operators, air carriers, and airframe and engine manufacturers). Thus research is a public good, by which each element of the industry may benefit without reducing the benefit available to others. Consequently, no element is induced to undertake, or register its true preference for, research.

4. Airlines may lack the finances to modify aircraft to meet noise criteria without sacrificing other equipment improvements.

5. Since air transportation and the noise problem are nationwide, the Federal government is in the best position to evolve a comprehensive, consistent program for noise alleviation, a program encompassing all potential trade-offs and minimizing cost.

6. At least a portion of the noise problem can be dealt with by the certification of aircraft for noise; only the Federal government has this authority.

A systematic approach to the problem of noise alleviation suggests three general areas in which Federal assistance may be warranted.

Regulation. Regulations should limit the noise to be permitted at various points on the ground along aircraft approach and departure paths.

Research Assistance. A systematic solution to the noise problem is hampered by inadequate quantitative data and criteria in a number of areas.

Direct Financial Assistance. Present and potential financial constraints warrant a Federal policy to make financial assistance available in cases where appropriate action would be hampered without it. Assistance should be available to communities, for redeveloping noise-affected land and financing compensation payments, and air carriers, for financing major aircraft modifications.

These potential areas for Federal assistance would comprise many programs of research and direct action. There are alternative programs implying various cost allocations. We next consider some of the more evident of these.

V. IMPLICATIONS OF ALTERNATIVE PROGRAMS FOR COST ALLOCATION

The allocation of the costs of programs for alleviating aircraft noise will depend largely upon the specific nature of those programs.

Cost Allocation for Alternative Programs

Regulation: The Federal Aviation Administration currently proposes a bill to amend the Federal Aviation Act of 1958 by adding a new subsection empowering the administrator "to prescribe and amend standards for the measurement of aircraft noise and... to prescribe and amend reasonable rules and regulations governing the design, construction, performance, and operation of aircraft and aircraft engines as will provide for the abatement of aircraft noise." Concurrently, the Federal Aviation Administration has prepared and circulated for industry comment a draft of "Proposed FAA maximum allowable noise levels to be required for certification of future aircraft." In general, these or similar regulations may be expected to reduce the performance of efficiency of future aircraft and/or increase development costs. Regulations are, nonetheless, an essential element in any effective noise-alleviation program. The costs of complying with such regulations are largely internal to air transportation; they

will fall on user fares and tariffs, profits of airlines or aircraft manufacturers; or suppliers' prices. The distribution of costs among these alternatives is not at all clear.

Aircraft developmental costs incurred to meet FAA certification requirements may, at least initially, be added to the cost of the aircraft and shifted forward to the air carriers. In addition to these developmental costs, there will be somewhat higher operating costs than would exist in the absence of regulation, as the aircraft will have somewhat less efficient performance characteristics. These costs can be partially shifted forward to the user of air transportation through higher fares and tariffs. But since the demand for air transport has some elasticity, some decrease may be expected in the amount of air transport sold, and hence in air-carrier profits. If a significant portion of noise costs initially fall on air-carrier profits, the costs may, in part, be shifted backward to the manufacturer or to other air-carrier cost elements. Those costs which cannot be shifted away from profits will tend to diminish the future ability of the carriers to finance new aircraft, having an impact on aircraft manufacturing.

Short of developing a rigorous model of the air-transportation industry, about all than be said about the allocation of the noise costs implicit in certification regulations is that the primary effects will most certainly fall on the air carriers and their users, with some impact on aircraft manufacturing (through reduced demand for, and reduced ability to finance, new aircraft) and possibly on other suppliers of the air carriers.

Research Assistance: There appear to be four areas of research which the Federal government should undertake or sponsor, each with a slightly different implication for cost allocation.

Technical Research. Substantial technical research on the generation and measurement of aircraft noise is in progress in several groups, including the Federal Aviation Administration, the National Aeronautics and Space Administration, the U. S. Air Force, and the engine and airframe manufacturers.[45] Internal research by aircraft manufacturers has already led to significant improvements in the noise levels and characteristics of some aircraft under certain operating conditions. Continuing research is obviously required. Much of this research is of the nature of a social good since it is available to all, so it should be Federally financed. But even though it is desirable for the Federal government to take the lead in initiating, coordinating, and financing noise research, considerations of economic equity and efficiency require allocation of the costs of the research, with the exception of multipurpose programs, to the air-transportation industry.

Planning Research. Earlier in this paper we considered the importance of planning and zoning in the solution of airport-noise problems. That emphasis, in itself, is now commonplace. But before airport planning can be initiated, or assistance given, it is essential to be clear about the goals and criteria of that planning. Presumably, planning should minimize the exposure of persons to airport noise over some planning horizon that is reasonable, given the multiplicity of other planning goals -- say, twenty to thirty years.

Research to establish realistic airport planning criteria for noise alleviation is, like technological research, a social good. Once determined, the criteria become available for each community to use without reducing any other community's use. Local public agencies will, then, tend to wait while someone else expends funds to develop the criteria. It appears appropriate for the Federal government to take the lead in this research effort.

For planning research, as for technological research, cost allocation involves the question of multiple beneficiaries. Much of the planning research undertaken or sponsored by the Federal government will be the responsibility of the Department of Housing and Urban Development. To the degree that such research contains a discrete increment concerned with noise of air transportation, the research costs should be charged to the air-transportation industry. Conversely, the air-transportation industry should not be expected to bear a major portion of the costs of studies which may yield the industry benefits, but are primarily directed to some other purpose.

Socio-Political Research: There exists a distinct need for additional research on the relationship of the political and social environment of communities to individual and community responses to airport noise.[46]

More generally, it is well established that the responses of individuals to events depend to a large degree upon the environment in which the events are perceived and the relationship between events and other elements of the environment. Virtually nothing is known about these relationships as they affect the perception of airport noise as a cost, and the early research must be largely exploratory. The potential value of the initial research to the air-transportation industry is largely indeterminate. Preliminary research efforts, at least, should be financed and

paid for by the Federal government, since the research has potential value well beyond the requirements of the airport-noise problem.

Systems Analysis. A fourth type of research required by the airport-noise problem is a system analysis of the alternative programs to determine the proper — least costly or most profitable — mix of programs.[47] The analysis will clearly yield primary benefits to the air-transport industry, and should be paid for by the industry even though it may be initially financed and coordinated by the Federal government.

Financial Assistance. Public policy must be concerned not only with techniques which will permit solutions to airport-noise problems and research to find solutions to those problems, but also with mechanisms which will help induce solutions. One such set of mechanisms is the provision of Federal financial assistance.

The Problem of Budget Constraints. We have already dealt at some length with the obstacle to solution of the airport-noise problem which is created by budget constraints on the finances of local governments. Where local governments must operate within these constraints, the funds necessary for the alleviation of the noise problem either may not be available or cannot be made available without corresponding reductions in other essential local investments.

The Federal government does not face these same artificial constraints. This is not to argue that the Federal government has unlimited economic resources available to it without constitutional and political constraint or even that the Federal government can and does undertake every available public investment with a positive present value. On the other hand, the Federal budget is constrained primarily by economic and political factors rather than by constitutional and statutory limits.

In the private sector of the economy, a budget-constraint problem would arise if research were to yield an aircraft-modification program too large for airlines to finance while retaining sufficient capital resources to finance new equipment.

Types of Financial Assistance. The Federal government can consider essentially two types of assistance programs — loans and grants-in-aid.

Loan Programs. Loan programs are generally preferable to grants-in-aid on the earlier argument that the primary financial responsiblity of the Federal government for the airport-noise problem is to assure that the costs of noise are paid by those who enjoy the direct benefits of air transportation. To be sure, these Federal loans could be repaid from local tax sources, but they would at least avoid the channeling of Federal tax funds into a program for paying noise costs.

Loan programs fall roughly into two groups: direct loans and loan guarantees. In the total loan program of the Federal government, guaranteed and insured loans have exceeded direct loans for the last two decades. The total amount of Federal loans has increased steadily since 1945, with the amount of guaranteed and insured loans increasing most rapidly. In fiscal year 1965, of a total of some $125 billion in total Federal loans outstanding, direct loans constituted only some 28 percent, with guaranteed and insured loans composing the balance.[48]

If capital funds are required by the air carriers, they might best be provided through a program similar to, or extending, the present loan-guarantee program operated by the Civil Aeronautics Board for the local-service carriers. But whether the funds are provided through direct loans or loan guarantees, they should have a repayment requirement.

In situations where localities require capital funds, a direct-loan program seems more appropriate. There are several criteria which these loans should meet.

1. Amortization of the debt should not be directly tied to user charges, as would be the case with the typical revenue bond, since the user of air transportation should not be required to purchase the reversionary value of the property for the community in question.

2. The debt should not be of such a nature that it falls within state constitutional debt limits.

3. The debt should be such that it can be incurred by a decision of the local legislative body without a popular election.

4. The term of the debt should be flexible enough to match the requirements of individual communities.

The purpose of this Federal loan program would be to make additional finances available to local governments for the specific purpose of implementing local solutions to airport-noise

problems. Since it would not be the intent of the Federal government to subsidize local communities through such a program, interest rates charged should approximate those which the community would have to pay for general-obligation debt. The cost of using the property rights so acquired should be charged directly to the airport users by the airport operator. That cost should consist of an appropriate rate of return on the original cost (purchase price) of the property devoted to airport purposes. The original cost of the property, equal to or approximated by the principal value of the debt, should be paid by the community from nonuser funds, since the property is a nondepreciating asset of the community. The term structure of the debt, and the possibilities of borrowing to refinance the debt, should be liberal, so that repayment of the principal does not place a burden on the financial resources of the community.

Partial property rights acquired, such as easements, should be depreciated, since they will ultimately be obsolete when the airport site is abandoned. In this instance, depreciation, as well as a rate of return, should be charged to the airport users.

Grants-in-Aid. From the viewpoint of the airport operator, the air carrier, and the user of air transportation, a major grant-in-aid program might be the best solution to the airport-noise problem. Grants-in-aid to local communities for the purchase of noise-affected properties, the purchase of partial property rights, and the payment of compensation where required could relieve the air-transportation industry and its users of a potentially significant cost burden. By extending this reasoning, one could argue that the Federal government should pay the entire cost of air transportation, so that everyone could travel free of direct charge.

Grants-in-aid are a well-established element of governmental finance in the United States, and have, since passage of the Federal Airport Act of 1946, been used to varying degrees in the financing of municipally owned airports. Grants may normally be justified on one or more of three bases:

1. As a Subsidy. The formal purpose of a subsidy is to effect a lowering of the average cost curves of firms in an industry which is generally operating under conditions of increasing returns to scale. The subsidy acts as a wedge between the long-run average costs of the industry and the price it must charge to its customers, thus allowing the industry to expand to a lower level of average costs than would be possible without initial subsidy. Presumably, after the industry has expanded, the subsidy should be removed. The subsidy argument for grants-in-aid is not relevant to the airport-noise problem, and cannot be used as a basis for justifying Federal grants.

2. As a Payment for Services. Some activities may provide identifiable benefits to the general public for which the public should pay. Payment may take the form of a grants-in-aid. We find no evidence of such benefits in this case.

3. As an Inducement. Grants-in-aid are often used as inducements to local governments to act in ways considered desirable from a national viewpoint. Grants in the Federal-aid airport program are clearly inducements.[49] Two reasons may be cited as justifications for offering grants-in-aid as inducements.

First is the so-called "merit wants" case: The merit-wants argument holds that certain kinds of goods and services should be included in the public budget, not because the private market will not supply them, but because the private market supplies the wrong amount — wrong in the judgment of some individual or group other than the individual consumer.[50] Few persons, irrespective of their political persuasion, would deny the desirability of at least some governmental intervention of the type described, but the question "How much?" elicits substantial debate.

The application to the noise problem is clear. Persons adversely affected by airport noise have recourse to the free market, supported by judicial proceedings. If they cannot persuade the local airport operator to purchase their property or at least an easement, they have recourse to judicial proceedings on grounds of constitutional taking or damaging. These resources are not adequate to solve the noise problem: many who have been economically injured may not have adequate recourse to judicial proceedings, since the bases for action are limited; even where there is recourse, the proceedings are slow and costly; and, finally, the market is not structured to take proper account of the future. So the free market does not provide for the purchase of enough property early enough. Here, then, is one justification for governmental intervention of an inducement nature.

But there is a second reason. The question of market adequacy concerns not only whether the free market provides an adequate total amount of goods and services, but also whether their

timing is proper. Even if we assume that all persons affected by noise will ultimately be compensated, there are two relevant time elements:

1. In areas of appreciating land values, it may be cheaper to acquire the property early rather than wait until an acquisition is forced. This will be true as long as the present value of some probable future acquisition, discounted at the appropriate rate of return, is greater than its current price.

2. In many instances, individuals incur noise costs which will not be compensated by the free market for several years. The loss for which they are compensated has a rate of earning which they will be denied in most cases unless a court makes an award of the amount of damage or taking plus imputed interest compounded and accrued from the time of taking to date.

Throughout this study, we have found no formal economic reason for arguing that the Federal government has any specific obligation to pay a portion of airport-noise costs. Insofar as direct financial aid is required, the Federal government could discharge its obligation by making available loans which meet the criteria discussed above. But the question remains as to whether the obligation of the Federal government is only to see that solutions to the noise problem are feasible or also to cause solutions to occur. If one takes the former viewpoint, direct financial aid in the form of loans fully discharges the Federal obligation. If one takes the latter viewpoint, then the loan program may be inadequate unless supplemented by grants-in-aid.

If loans are to be supplemented with grants-in-aid, two questions must be answered — the size grant required to induce action (20% grant-in-aid, or 50%, or 90%?), and the degree of distortion of equity and resource allocation which might result from such a program.

The answer to the latter question depends upon the terms of the grant. Since the grant is to be made not as a subsidy to air transportation, but only as an inducement to local government to resolve the airport-noise problem, the "full cost" of the property acquired with the grant should be charged to the airport users. The "full cost," it will be recalled, is represented by a rate of return on the original cost of the property, and does not include that original cost. The airport users should, then, pay a carrying charge on the full value of all property acquired for noise-alleviation purposes, irrespective of the method of financing the acquisition.

As long as the airport users pay (1) a carrying charge on the original value of all property acquired for purposes of noise alleviation and (2) depreciation on any depreciable property rights, distortions in the allocation of resources should be minimized. One can, however, anticipate some redistributions of wealth and income which have equity implications. If grants to municipalities for the purchase of full property rights are not recovered (and they should not, of course, be recovered from the airport users), the Federal government will have, in effect, purchased private property and bestowed it on local governments. After this property is no longer required for noise-alleviation purposes, it will be available for either an alternative public use by the community which owns it or sale for private use, with the proceeds of the sale accruing to the local community. This kind of redistribution is, of course, not unique, it occurs every time a government provides a good or service below cost. Virtually every economic act of government bestows differential benefit on the general public. So, from a practical viewpoint, the problem does not appear particularly bothersome.

Nonetheless it seems reasonable to place restrictions on the grants, providing that, if the property acquired is subsequently sold, leased, or otherwise developed for other than a public use, the value of the grant is to be repaid to the Federal government.

Having considered the question of distortions in allocation and equity from a grant-in-aid program, we are prepared to consider how large the grant should be. Since the grant, as described, would not subsidize the users of air transportation, but only induce local action on the noise problem, it should be large enough to provide an effective inducement. The Federal-aid airport program appears to have worked effectively as an inducement using grants-in-aid of approximately 50% on eligible items. As there is some administrative merit in consistency, the grant program might be established at the same level. It should, however, be separately funded and not linked with the earlier program, except where common administrative rules appear appropriate. We emphasize again the fundamental difference between the grant-in-aid program suggested for noise alleviation and the Federal-aid airport program: grants under the latter constitute not only an inducement but also a subsidy or a payment for services rendered to the Federal government. The grants proposed for noise alleviation are inducements only, and contain little or no element of subsidy for air transportation.

Cost Recovery Through User Charges

To this point, we have assumed that any costs of noise alleviation incurred by airport operators could be recovered through increased user charges. This assumption requires further exploration. The ability of airport sponsors to recover the costs of noise-alleviation programs through higher or separate user charges is dependent upon two factors: (1) the legal characteristics of airline-airport leases and (2) airline-airport bargaining relationships. These two factors will, in the final analysis, determine the allocation of the costs of local noise-alleviation programs between the air carriers and the local communities. They will, moreover, constitute a major influence on the willingness of airport operators to undertake noise-alleviation programs which involve additional airport costs.

Airline-Airport Leases: virtually without exception, airlines use airports and pay fees and rentals for services on the basis of lease agreements. In detail, there are significant differences in the terms and conditions of these leases as among airports and even, in some cases, as among individual lessees on a single airport. Nonetheless, certain common patterns are distinguishable: within broad limits, there exists a good deal of similarity among leases. Among the many provisions of airline-airport (hereafter, "airline") leases, only three are of particular significance: (1) term of the lease, (2) provision for determining rates and charges, and (3) provision for adjusting differences which cannot be settled by bargaining.

The term of alirline leases varies substantially, ranging from month-to-month in a few cases to twenty or more years in others. The term of the lease is not of particular significance to the present problem, except as it relates to the possibility of adjusting rates and charges. Most of the major airline leases which have been executed in recent years are long-term, often extending for fifteen to twenty years or more. In addition, most of these leases have provisions for renegotiating rates and charges on a periodic basis. There is usually no artificial or arbitrary limitation on the level to which rates can be adjusted (although some leases contain percentage limitations and others incorporate formulas for calculating rates), since the rates are subject to negotiation between the parties. That negotiation generally takes the form of bilateral bargaining between the airlines serving the airport, on the one hand, and airport management, on the other. Relative bargaining power in large part determines the level to which airport rates and charges can be adjusted in any renegotiation period. The term of the lease constitutes a problem primarily when there have been no provisions made for the readjustment of charges during a long lease term. Where leases have been entered into for long terms, the courts have ruled that they cannot be unilaterally broken by a municipality, even though the charges established under them may not be compensatory.[51]

Many of the airport leases executed over the past few years contain a compulsory arbitration provision. This obliges the parties, if they cannot agree on new rates and charges, to appoint a board of arbitrators to make a determination. In fact, arbitration has not been an important factor in the settling of airline-airport disputes on rates and charges, although the threat of arbitration may have had an effect in certain instances. But the provision exists in many airline leases, and could become important.

It appears likely that most airports could legally adjust rates and charges to encompass additional noise-alleviation costs. The point is of sufficient significance that it would be desirable to obtain extensive current data. Virtually all airport operators are members of the Airport Operators Council International. It would be desirable for that organization to survey its membership with an inquiry to determine: (1) the term or terms of outstanding airline leases for the use of the airfield and terminal building, (2) whether the leases have provisions for the periodic adjustment of rates and charges prior to the termination of the lease, and the length of the period, (3) whether there are any limitations on that readjustment, and (4) whether there are provisions for arbitration, either by a board of arbitrators or by a court, if no agreement can be reached on new rates and charges.

Bargaining Relationships: If there are no general contractual restrictions of the ability of airport management to add the cost of noise-alleviation programs to user charges, the question of whether such additions will be made reduces to a problem of relative bargaining power.

Bargaining between airport management and airlines concerning user charges often involves a relatively complex and shifting set of relationships, strategies, and coalitions. Although the airlines serving an airport will normally bargain as a single entity, that coalition is not always stable. The airlines must bargain among themselves to determine a "single" position — not always a simple problem, since not all carriers enjoy equal gain or loss from the bargain. So

the airlines' bargaining position is itself often the result of difficult and complex bargaining. The airline coalition is sometimes broken and a new coalition formed between some of the airlines and airport management. Issues irrelevant to the issue under discussion may also affect bargaining power, particularly when that issue affects one of the major carriers at the airport.

It is one of the stranger aspects of the airline-airport bargaining relationship that airport operators typically believe themselves to be in the weaker position. In fact, they are largely in a monopolistic position. The smaller airports, at which the airlines are currently losing money, and which they serve only because the Civil Aeronautics Board requires that service, are probably in no position to financially exploit that monopolistic position. But these smaller airports are generally not the ones with the noise problems. As airline traffic increases, and with it the noise problems, these airports will become increasingly valuable to the airlines, and the airport management's bargaining position will improve. At the larger airports where the airlines are currently earning profits, airport management is now in a position to elicit higher user fees.

In general, there seems to be little foundation for the view that airport management, either for legal or bargaining reasons, cannot increase user charges to meet the future costs of local noise-alleviation programs.

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