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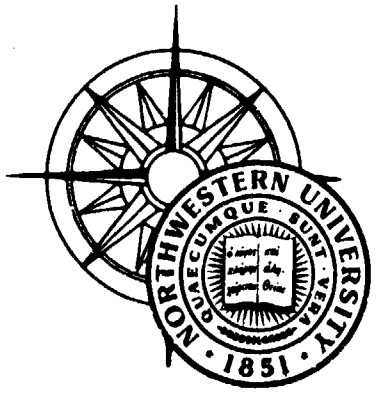

The Transportation Center
Northwestern University

FACTORS AFFECTING THE RETIREMENT OF COMMERCIAL TRANSPORT JET AIRCRAFT

by

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FOREWARD

This is the third and final report on the Factors Affecting the Retirement of Commercial Jet Transport Aircraft. It includes the contents of the first two reports as well as bringing the material up to date (as of August 1979). During the last 10 years the decisions involving whether or not to retire aircraft have become more complex as new elements for consideration arose. Management found it necessary to consider: (1) the effect of aircraft age, (2) the impact of government noise regulations and legislation, (3) the cost and availability of fuel, (4) the ability to finance replacement aircraft, (5) the impact of inflation on the ability of technology to provide more cost-efficient aircraft, and (6) the impact of deregulation.

The first progress report treated aging, the problem of financing in the 1970-1975 period, the conflict between the government and the airlines over the desirability of a retroactive application of a noise limitation rule to the majority of the transport fleet, and deregulation (only a proposal at that time).

The second report highlighted industry efforts (ultimately unsuccessful) to secure special financing legislation whose effect would be to accelerate the retirement of a major portion of the jet transport fleet in order to comply with a newly promulgated noise compliance rule.

As a result of the failure to secure assisting financial legislation, airlines endeavored to secure through legislation a modification or elimination of the administratively determined compliance rule. This final report, in addition to chronicling the progress of this effort up to August 1979, treats the impact of fuel cost and availability; examines the problem of obtaining cost-effective technology to induce retirements; and reviews the "new look" in financing capability made possible by earnings and restructured balance sheets from 1976 through 1978.

Evanston, Ill.
August 1979

F.A.S.

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Frank A. Spencer
Evanston, Illinois
August 1979

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FACTORS AFFECTING THE RETIREMENT OF TRANSPORT JET AIRCRAFT

by
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ABSTRACT

In the last ten years the changing social-economic-technological picture, as well as a shift in our national priorities, has introduced new elements complicating the calculus of aircraft retirement decisions. Because of the belief (historically correct) in a compound growth rate of traffic and economics of size, the primary attention of aircraft designers has been on developing large capacity (250-500 passenger) wide-body aircraft, such as the 747, DC-10, and L-1011, which fortunately meet our national objectives of fuel efficiency and lower noise emissions.

More recently, in the smaller 200 passenger category, designers have met the challenge though not without great difficulty, of producing quiet fuel-efficient aircraft (767, 757) to replace the early 707 and DC-8 series. However, for various reasons, there has not been comparable progress in developing such a replacement for the smaller sized 727/737/DC-9 which constitute about 75% of the airline fleet and which either do not meet, or barely meet, the earliest noise standards which are themselves being progressively tightened. Because of the technical difficulties and cost involved for private industry to develop a fuel-efficient, quiet, replacement for the 2- and 3-engine, 100-160 seat category, it is suggested that NASA channel additional research toward meeting our energy and environmental goals for this size aircraft.

EXECUTIVE SUMMARY

Prejet Era The thousands of aircraft built in World War II and, in particular, their use in carrying passengers and cargo, focused public attention on air transportation. Large sums of federal money were fed into the aircraft manufacturing industry thus providing financial support to develop more efficient technology for commercial air transport. This development, combined with pent-up demand, increases in disposable income and leisure time, led to high growth rates in air travel which quickly absorbed the products of the new technology. Airlines were able to dispose of their existing aircraft as fast as they acquired new larger craft. Such disposal was above the book value and provided substantial funds for new equipment.

Jet Era The jet age was born in 1958 with the introduction of the Turbojet Boeing 707 and Douglas DC-8. Quickly there followed a period of high growth rates induced by fares made possible by the lower operating costs of these new technology aircraft. As a result, the industry was enveloped with optimism. Accentuating this optimism was the fact that the new jets soon began to stretch in size as more powerful engines were developed. There seemed to be every reason to expect a repetition of the prejet cycle of retirement and replacement long before useful life expired. On this basis, a series of wide-bodied airplanes were designed. The first such craft was the jumbo 747. With a capacity of 375 to 500 seats, it represented a quantum jump in seats offered, as compared with existing jets with normal seating of from 100 to 160. The second series of wide-bodies, the DC-10 and L-1011, were delivered with 225 to 250 seats in normal configuration. Unanticipated escalation of all categories of costs, a business recession, and the Arab oil embargo, contributed to a dramatic decrease in the rate of travel growth, a swing from profit to loss for many in the airline industry, and the failure of orders of new equipment to materialize.

NEW FACTORS AFFECTING RETIREMENT

In the past the factors affecting the retirement of aircraft have been very similar to those affecting the replacement of machines in industry generally. They include: (1) the need to replace because machines are worn out by use or age; (2) the ability to finance replacement; and (3) the availability of a correctly sized substitute which has lower operating costs, including the costs of ownership, than the existing machine. However, in the current airline equipment retirement situation, four entirely new factors have emerged which have added further uncertainty for the decision makers, not only in the airlines but in the airframe and engine manufacturing companies as well. These factors are:

(1) "Deregulation" or "Regulatory Reform"
(2) Aircraft noise regulations and the financing of compliance
(3) Availability and price of jet fuel
(4) Inflation to the degree that costs may offset technological efficiencies

1. Deregulation as a Retirement Factor: With regard to "deregulation" or "regulatory reform" this study concluded that complete deregulation was not a real threat. Therefore, the initial position taken by the industry that "chaos is around the corner" was not valid. After considerable rhetoric arguing that the U.S. had the best air transport system so a change in the regulatory system is not warranted, industry leaders embraced the concept of regulatory reform. Since the study began, the Air Line Deregulation Act of 1978 was enacted. Thus far the majority of industry supports or expresses low key reservations about deregulation.

In any event, the uncertainty of whether there would be regulatory change has vanished.

2. Noise Regulation as a Retirement Factor: The second new factor is the noise controversy. In 1974 the Federal Aviation Administration (FAA) proposed an amendment to the Federal Air Regulations (FAR) requiring all existing jet aircraft to meet new stricter noise emission standards which over 80% of the jet fleets did not then meet. A segment of the population living near airports have asserted a loss in property values, a deterioration in the quality of life, and adverse effects on the education of their children - all due to jet noise. Buttressed by favorable court decisions, airport neighbors have pressed for more stringent federal rules. Late in 1976 the FAA adopted an amendment to the operating rules (Part 91-136) providing an eight-year period for a phased-in compliance with a near term cost estimate of between one and five billion dollars. Compliance would accelerate the retirement of certain models of jets.

The opponents of the rule argue that installation of retrofit kits of sound absorbent material (SAM) does not make a perceptible difference in noise emissions of the current non-FAR 36 planes with the JT8D engine. They also argue that while application of SAM to the 707 and DC-8 series with JT3D powerplants would provide significant relief on approach, modification is not warranted because: (a) the greater problem is on takeoff where there is little benefit; (b) because the planes are not only old and approaching the end of their design life but are also extremely fuel inefficient. Therefore, these latter craft are almost, if not already, economically obsolete. Finally, it is clear that the expenditures of large sums on retrofit will decrease funds available for purchasing new aircraft which themselves will reduce noise to a greater degree, and will also use less of a scarce resource - petroleum. Prior to November 18, 1976, the evidence is that the FAA had no intention of promulgating new noise rules without a legislative plan to assist in the financing. The November 18th Aviation Noise Abatement Policy contained no such policy and, therefore, was a change in position.

Just before leaving office, President Ford again reversed administration policy and proposed financing legislation. In 1977 and 1978 there were a series of bills purportedly aimed at replacement. The emphasis, however, actually varied between retrofit, replacing the engines, and replacing the airplane. In December 1977, after considerable political maneuvering, H.R. 8729, a bill satisfactory to the airlines, was reported favorably by the House Committee on Public Works and Transportation. This bill provided substantial financial assistance to airlines for retiring noisy aircraft in favor of new technology aircraft. In 1978, objections by the House Ways and Means Committee, concern over precedent such legislation would establish, rising airline profits, and a rash of

airline aircraft orders, led to failure of Congress to enact financing legislation by the time of adjournment.

The reasons for the defeat of the financing legislation in 1978 made clear to the ATA the political impossibility of success of a similar bill in 1979. To return retirement decisions to the old basis of economics required removal of the environmental constraints. Thus the ATA set for its 1979 goal the removal of 2- and 3-engine transports from the compliance rule and the extension of the time limits on 4-engined aircraft through some mechanism such as a "new technology incentive provision." The Senate bill gave lip service to the possibility of financial assistance under CAB auspices, but was not taken seriously.

The industry was a little too successful in "gutting" the House bill with the result that several airlines broke industry ranks and testified that both the Senate and House bill (1) were so weak that state and local governments and airport operators would initiate curfews and other constraining rules which would be more expensive in the long run than compliance, and (2) that the bills discriminated against those carriers which had at considerable expense programmed themselves for compliance. As of August 1979 no legislation had been enacted.

3. Availability and Price of Jet Fuel: The third new factor relating to the replacement of current jets is availability and price of jet fuel. Short run availability became an issue at the time of the oil embargo and present energy forecasts indicate increasing shortages at desired prices for the future. The availability problem diminished but then re-emerged in the spring of 1979. Additionally, domestic prices of jet fuel have more than quadrupled from about 11¢ per gallon to over 50¢ with further escalation likely. International fuel costs are still higher. The rising fuel prices have done much to render certain aircraft models economically obsolete. While new or derivative technology aircraft are significantly more fuel-efficient than the narrow-bodies, a difficulty arises in optimizing fuel costs unless a stable price is known. NASA and industry studies indicate that aircraft designs are different for 10¢, 30¢ and 60¢ fuel. Designers have been successful in reducing specific fuel consumption from early jets by about one third.

4. Inflation as a Factor in Retirement: The fourth factor affecting the retirement of aircraft is inflation. In the 1960's, a stable price level, increasing profitability of new more efficient aircraft, and cash flow from depreciation, enabled carriers to finance equipment purchases. Currently year-to-year price increases for the same equipment are running 8 to 9%. Finally, units of technological progress are becoming so increasingly expensive that, when ownership costs are included, the return on investment (ROI) is

likely to be less than the corporate "hurdle rate."

REVIEW OF CONVENTIONAL RETIREMENT FACTORS

Age As a Factor: Age was examined in the context of chronological age, age in hours of service, age in cycles (landing or pressurization) with the conclusion that none of these are elements in todays retirement problem.

End of Book Life: The investigation revealed that there has been considerable variance in rates of depreciation charges. The variance is due primarily to "financial management" policies and hence has no necessary direct relationship to actual retirement policies on aircraft.

Financial Capability: The financial capabilities of airlines in general, and more particularly of the airlines who historically have been leaders in the re-equipment cycle, were, in the 1970-1975 period, such as to pose extremely serious problems in raising funds for launching a new technology or derivative airplane. As a result of high debt/equity ratios and poor earnings records, long term financing by insurance companies had become an unlikely event. In 1976 there were a limited number of what may be described as interim aircraft equipment purchases financed by commercial banks, manufacturers, and other lenders under imaginative contractual arrangements. With new technology or derivative aircraft estimated to cost from $25 to $40 million each in the 200 seat category, and with the quantities needed for individual airlines, lending institutions could not justify financing for some needy airlines.

The year 1977 showed a resurgence of profitability. Balance sheets evidenced considerable "corrections". At least one carrier, though not a candidate for launching new large scale equipment purchases, obtained long term unsecured financing from insurance companies. It should be noted that a significant portion of the earnings and balance sheet correction came from accounting adjustments which could not be counted on to continue.

A still greater growth in airline profitability occurred in 1978. Banks were now happy to lend money for aircraft acquisitions. As the early jets came closer to economic obsolescence because of rising fuel costs, and as carriers began to feel that their long run interests were congruent with retiring noisy, fuel-inefficient aircraft, orders began to flow for new technology aircraft. As if to demonstrate that the financial difficulties of 1974-1976 were passed, some carriers, in announcing new orders, proudly proclaimed that the purchases could be financed "internally".

By July 1979, while the economists were agreeing that the U.S. was either in or approaching a recession, the downturn had not yet significantly affected airline earnings. However, despite substantial improvement in balance sheet items, the leverage situation of a number of carriers made them highly sensitive to adverse economic conditions. Nevertheless, obtaining financing for replacement aircraft is not currently a factor in the retirement equation.

Conclusion: Rapid technological progress, much of which was initiated through federally assisted research in World War II, resulted in quantum jumps in productivity as a result of the ability of engineers to compound the benefits of speed and size. Because of the lowered operating costs which were reflected in the rate structure, the airlines experienced high growth rates and adequate profits sufficient to finance aircraft replacements with larger more efficient aircraft. A recession, inflation, fuel price and availability, uncertainty over environmental standards and high reliability of and low maintenance on jets combined to slow the replacement process.

Because it is much easier to engineer reduced operating costs into ever larger airplanes and because such engineering in the past has been congruent with a projection of previous growth trends, insufficient attention has been given to developing a quiet, fuel-efficient, new technology plane in the capacity range of the 727, 737, DC-9 series. Engineers indicate that design problems in handling the center engine preclude the economic re-engining of the current 727 of which over 1500 have been built. Solutions are not readily apparent for the twin engine 737. The DC-9-80 series is a derivative and not new technology. With Boeing heavily committed to launching two new airplanes, with Douglas busy stretching the DC-10 and marketing its DC-9-Super 80, and with Lockheed not having the resources to gamble on a "clean sheet" aircraft there exists a gap in the 100-160 seat configuration.

Although substantial efforts are being made to reduce the noise emissions of the 2- and 3-engined narrow bodies, such efforts, except for the re-engined DC-9 Super 80, even if successful, will not likely be associated with the needed reduction in fuel consumption so necessary to compete with the economics of the high bypass ratio aircraft. Therefore, given our national priorities, it is appropriate to channel additional research to support the development of a freshly designed "clean sheet" aircraft which would integrate the latest technology airframe of 727/737/DC-9 replacement size with a high bypass type powerplant specifically tailored in thrust, fuel economy and noise emissions for the specific airframe.

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FACTORS AFFECTING THE RETIREMENT OF TRANSPORT JET AIRCRAFT

A.

INTRODUCTION

A.1 RESEARCH TASK

In June, 1975, representatives of airlines, aircraft manufacturers, the investment community, the government, and academia met in Washington under the sponsorship of NASA for an Air Transportation Demand and Systems Analysis Workshop. Various participants pointed out that because historically there had been a relationship between the demand for air travel and the type of equipment and service offered, there was a need to know more about retirement plans for current aircraft. Both the engine manufacturers and the aircraft manufacturers suggested an investigation into what elements went into the retirement decisions of management. The airline representatives themselves expressed interest in further studies of the length of life of existing jets and the possibilities and costs of extending this life. Both the airlines and the manufacturers were concerned about new factors entering the replacement equation, such as (a) noise regulations, (b) fuel prices and fuel availability and (c) inflation. Finally, the lending institutions who had a large stake in financing previous

airline equipment as well as financing the large aircraft manufacturers and their suppliers were interested in what type of commitments would be sought by their customers. At that time, when a number of major airlines were in serious financial difficulties, figures in the area, depending on the time span considered, of from 20 to 60 billion dollars were mentioned as the capital requirements.

As an outgrowth of the concerns and questions raised, the current study was sponsored by NASA to investigate the technological and economic factors affecting the retirement dates of commercial jet aircraft. As time went on it became necessary to add to the area of investigation the effect of legislation and environmental forces.

A.2 RESEARCH PROCEDURE AND FOCUS

Early research satisfied us that because of varying dynamic forces a meaningful mechanistic model is not possible. As the text will reveal, there is no reason to retire current jets in the next several years because of chronological age, hours of service, or the number of landing cycles or pressurization cycles. Therefore, retirement decisions are economic, or even political depending upon various perceptions of future demand and costs flavored by voluntarily or involuntarily induced ideas as to timing of replacements for environmental reasons. These decisions are the results of interaction between the engineering departments

of the airlines and manufacturers as well as between fleet planners and high echelon corporate officials who deal not only with market factors, airplane economics, and financing, but also with regulatory authorities.

Therefore, the research procedure decided upon required field trips to the headquarters of the three major aircraft manufacturers, the two primary engine manufacturers, most of the major trunk airlines, the FAA, DOT, ATA, CAB and lending officials of insurance companies, commercial banks, and investment bankers. Additionally, investment analysts and members of the staff of the Subcommittees on Aviation of the House and Senate were consulted.

To provide an underpinning for the study as well as to develop the broad dimensions of the problem, a complete inventory of the free world commercial jet fleet, focused on various parameters of age, was developed covering 1958 thru 1975. (Appendixes A and B). This large data base includes categorization by airline, equipment type, age in years, age in hours, cycles of high time aircraft, as well as whether the aircraft were purchased new or used.

Generally speaking, the interviews with the aircraft manufacturers encompassed several visits of more than one day each. Interviews with airlines personnel ranged from several hours to several days. A sample list of questions and issues discussed is included in Appendix C. A partial list of the companies and agencies visited and persons consulted is also listed in Appendix D.

A.3 REPORT STRUCTURE

The report is structured to present first a brief historical background of the technology and economics of aircraft replacement and retirement in the prejet era to determine whether useful insights can be obtained applicable to the jet era. As the text demonstrates there are very significant differences between the two periods with several entirely new factors currently present. These new factors are identified and explored. Secondly, the report proceeds with an investigation of current technological and operational economic perspectives. Decisions are made by humans not by computers and hence it is the interpretation of technological and economic data against certain past experiences, prejudices and attitudes that result in ultimate equipment decisions. Therefore, in the body of the report there is an attempt to flavor the pure technical and economic factors with the qualifications put upon them by the corporate decision makers.

The final main section of the report deals with financing. To be sure, this is an economic element. However, because of the adverse financial results for many of the carriers in the early 1970s the financial perspectives emerged as a focal point in our investigations. Therefore, a separate section is necessary for its treatment.

B.

THE SETTING: THE AIRLINES AND AEROSPACE THEN AND NOW

B.1 THE PREJET ERA, 1934-1958

A brief survey of the prejet era was made seeking clues which would be helpful as to factors affecting current retirements. In 1934, commission type regulation of the airlines began under the ICC. Thus, this period is the first in which public records are available. At that time there were 56 different aircraft models built by 21 different manufacturers. By today's standards, capital costs were amazingly low. Some models cost from $30,000 to $50,000 with the first DC-2 being considered expensive at $73,000. Carriers depreciated aircraft to zero in one to three years. Some used depreciation based upon hours using a life of from 1,500 to 6,000 hours. By 1938, a 5-year depreciation was considered standard for the DC-3. As time went on, service life on the DC-3 which between 1936 and 1941 sold for from $90,000 to $100,000 was computed for depreciation purposes at 7 years. [1/] Airlines were indeed an infant industry struggling with subsidies to stay afloat.

The post World War II period of prejet operation from 1946 to 1958 was one of rapid growth. Traffic growth made larger size more practical, and the larger size was accompanied by lower oper-

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1/ Spencer, F.A. Air Mail Payment and the Government, Washington, D.C., 1941, The Brookings Institution. Chapter IX.

ating costs which, in turn, as result of decreased fares, developed further growth. Among the reasons for this rapid growth were an increase in the gross national product (GNP), an increase in disposable income, an increase in leisure time, an increase in the frequency of airline service and a declining fare level. Not to be overlooked was the development of the pressurized, 4-engined long-range faster transport which combined increased comfort with more efficient use of leisure time.

From 1946 on there were incremental technological advances involving, with one or two well known exceptions, superior economics which served as an incentive for carriers to replace portions of their fleets. A further contributing factor was the price of used aircraft during this period. An examination of capital costs of new aircraft versus used aircraft prices is found in Gellman's study. 2/ While certain prices did fluctuate widely, in general it was a period in which significant amounts of capital could be secured from the sale of used aircraft to help defray the cost of new. Although there was an escalation of prices for new aircraft, it was not the dramatic price jump relationship which exists in the 1975-1979 period. Table 1 lists several examples of the cost as new and the selling price as used aircraft.

2/ The replacement of various commercial piston aircraft with new (and sometimes the same) types and the reasons therefore are treated more extensively in Gellman, A.J. Effect of Regulation on Aircraft Choice, Cambridge, Mass. 1968, Massachusetts Institute of Technology Ph.D. thesis.

The economic environment in which the carriers and manufacturers find themselves today is quite different from that of the 1946-1958 prejet era. However, Table 1, when integrated with the history of carrier actions with regard to developing markets under the regulatory regime of the Civil Aeronautics Act of 1938 and its successor the Federal Aviation Act of 1958, sheds some light on

TABLE 1

SOME PREJET NEW AND USED PRICES

Model No.	Year Purchased	Price	Year of Sale	Selling Price
L-049	1946	$ 800,000	1956	$ 900,000
L-749			1953	800,000
DC-4		400,000	1951	355,000
			1952	700,000
			1956	700,000
DC-6B	1951	1,000,000	1954	1,400,000
DC-6	1946-53	600,000	1953	1,600,000
		800,000		
DC-7	1953-55	1,700,000	1957	2,100,000
			1962	100,000
DC-7B	1953-55	1,900,000	1962	100,000
DC-7C	1956	2,200,000	1962	350,000
L-1649	1957	2,300,000	1962	150,000
CV-240	1948	225,000	1950	337,000
			1952	540,000
CV-440	1956	650,000	1958	650,000
B-377	1949	1,500,000	1960	Scrap

factors affecting the retirement of aircraft. First, the table indicates that in periods of substantial traffic growth airplanes with "good economics" not only hold their value but may increase in value. DC-4's which cost $400,000 were sold several years later

for $800,000. DC-6's also were successful in the used market. In the chaotic scramble for new airplanes to accommodate traffic growing at a compound rate, there were cases in which carriers with delivery positions on the production line sold aircraft at a profit to others before ever taking delivery.

The precipitous decline in the price of the DC-7 is explained as follows. While earlier series of planes each had lower operating costs than their predecessors and, therefore, were more profitable, the DC-7 series was the result of individual carriers attempting to beat the competition in coast-to-coast nonstop operation. It was, or should have been, quite clear to the purchasers that the seat-mile costs of the DC-7 would be higher than on existing aircraft. However, it was reasoned that since the competitor did not have the speed or nonstop capability of the DC-7, a carrier with a DC-7 would develop a monopoly and be able to maintain a sufficiently higher load factor to be profitable while awaiting the arrival of the new jets. In other words, the DC-7 was an interim airplane. The theory worked in practice for awhile but eventually others purchased the DC-7 or a substitute plane and the uneconomic aspect of the DC-7 operation became a reality. As a result, the used price declined.

One point the DC-7 did demonstrate clearly was that the public, aided by advertising from airline marketing departments, can be led to believe for a time that a new type of plane is the desirable one on which to ride. Gellman reported several cases in which a carrier

Table 2
Free World Active Jet Aircraft Fleet
Total Production By Year of Original Delivery
U.S. Manufacturers 1958-Year End 1975

	Boeing				Douglas			Convair	Lockheed	
Year	707 & 720	727	737	747	DC-8	DC-9	DC-10	880 & 990	L-1011	Total
1958	8									8
1959	77				21					98
1960	91				89			15		195
1961	80				44			27		151
1962	68				22			30		120
1963	34	6			19			19		78
1964	38	95			20			9		162
1965	62	111			31	5		2		211
1966	102	135			32	69				318
1967	118	155	4		41	158				476
1968	111	160	107		102	202				682
1969	59	115	112	4	85	122				497
1970	19	54	36	92	33	49				283
1971	10	33	30	69	13	46	13			214
1972	6	41	22	30	4	32	52			187
1973	11	92	23	30	-	29	57		56	298
1974	21	91	55	22	-	48	47		41	325
1975	9	91	51	21	-	42	45		25	284
Total	904	1,179	440	288	556	802	214	102	122	4,587
*1976	2	61	41	29	0	47	19	0	16	215
*1977	5	67	25	20	0	22	15	0	11	165
Total	911	1,307	506	317	589	894	247	102	149	4,967
Active in Airline Service(1975)	724	1,130	407	243	463	687	211	17	118	4,000

Source: "Ross, Commercial Jet Replacement Process", MST Thesis. Transportation Center, Northwestern Univ.

*Update from manufacturers

receiving a new route could have instituted service with the more efficient DC-6B, but chose to wait and publicize the newer faster (and noisier) DC-7. Using this technique, Continental was successful in developing market dominance on the Denver-Los Angeles route, Braniff on the Los Angeles-Dallas route, and American on the New York-Los Angeles route.

Gellman, after examining used aircraft sales for most of the prejet period, concluded that airlines sold their aircraft 7 to 10 years after purchase and generally at or above book value.

B.2 THE JET ERA, 1958-to date

(a) Narrow-Bodies: Introduction of the long range narrow-bodied jets, namely, the 707 and DC-8 series, began with 8 deliveries in 1958. In 1959, the figure rose to 98. With the addition of the Convair line in 1960, deliveries rose to 195. Table 2 provides a complete listing for the free world of deliveries by years and by type from 1958 to 1975 of all domestically produced jet aircraft. The number of those still in commercial service at the end of 1975 are listed on the following page.

It is to the factors affecting the retirement of these aircraft that this study is addressed. Appendix A contains a breakdown by carrier (trunks, regional/local service and supplemental/cargo) for the United States. The breakdown includes the number in service, the first year operated, whether any in the fleet were purchased new, the age of the oldest planes of the type, the high-

Number of Jet Transports in Service Dec. 1975

Boeing	
707 & 720	724
727	1,130
737	407
*747	243
Douglas	
DC-8	463
DC-9	687
*DC-10	211
Convair	
880 & 990	17
Lockheed	
*L-1011	118

*Wide-Bodies

est hour plane and the highest cycle (Landing) plane. Table 2 indicates that of the 4,000 in service in 1975, 3,428 were narrow-bodies.

The early 1958-1959 707's and DC-8's "flyaway" [3/] cost was in the neighborhood of $4.8 million each. By 1969, the craft had been "stretched" and the new models were priced as high as $10.2 million for the largest versions. Deliveries of the 727-100 series began in 1969 "flyaway" at $5.8 million. By 1976, the price for the newer 727-200 was $11 million and by 1979 had reached $12

[3/] "Flyaway" means airframe, furnishings, avionics and engines.

million. The early Boeing 737 series entered the books at about $3,400,000 in 1969. A 1976 new purchase was reported as $6 million, and in 1979, $8 million to $9 million.

(b) Wide-Bodies: The same type of price escalation has occurred on the wide-bodies. The early 747-100 series were sold for $21.9 million each with the freighters running about $5 million more. By 1976, prices had risen to about $35 million for the regular 747 with a recent announcement of a 747 combination passenger/cargo aircraft for 1977 delivery at $45 million. A 1978 delivery purchase has been reported as $54 million. Combining the DC-10 and the L-1011 together, we find 1972 and 1973 introductory prices of around $17 million. Since that time, prices have moved to the $22 million area for the lower priced models and to over $30 million for the higher. The first order for the new long range version L-1011-500 was reported as $37 million each.

The above figures, focusing as they do with a general model and not with specific series of each model, are misleading to the extent they mask the increase in the number of seats and changes in range and missions of the specific series. The above figure, however, may be generalized by referring to the U.S. Department of Commerce, National Income and Wealth Division, Bureau of Economic Analysis table of the relative increases in new aircraft prices on the basis of the "GNP Deflator" which shows index numbers indicating a 22% rise between 1956-1967, a 12-year period, followed by a 20% rise in the next 5 years to 1972. Escalation has proceeded at a

faster pace since that time and, according to the Department of Commerce, rose another 41% in the next 3 years to 1975. Our talks with potential customers indicate their expectations are for a future increase of 8% to 9% compounded annually.

To summarize, the jet era began at a time of surging demand and adequate profits. Further, it was initiated by planes requiring unit capital expenses of about $4.5 million for the 707 and DC-8. The first Fanjet 707-300 series began in 1962 at $6 million. Price escalation increased the price to $10 million in 1972 and to $15 million in 1976. These aircraft are now no longer produced for domestic use because of high fuel consumption and their failure to meet federal government's noise regulations for current production aircraft. In the middle nineteen sixties the intermediate range 727 initially sold at $4.5 million and, after being stretched in length in the 200 series, have now escalated in price to about $11.5 million each. The shorter range 737 and DC-9 deliveries began in 1968 with a price tag of $3.4 million and by 1976 had about doubled in price. The larger DC-10, L-1011 and 747 have, in a shorter time, experienced similar increases to the point where commitments made in 1976 will result in capital outlays of $25-35 million for each of the smaller wide-bodies, to $45 to $55 million for the jumbo 747 combination passenger/cargo version.

In a period of no or small growth, or in a period of some excess capacity and particularly in a period of unsatisfactory capital formation, this substantial increase in the "lumpiness" of

capital has a dampening effect on retirement of current jets. In a period of excess capacity, additional units can be supplied by aircraft carried on the books at low or zero value instead of expending $12 million to $40 million per unit. Unless the carriers see a replacement aircraft with significant economies (including ownership costs), or which can be used as a product differentiation marketing factor, the incentive for retirement is limited. Government mandated noise regulations, as will be seen in another section, can significantly affect management's equipment plans.

C.

CURRENT POLICY CONCERNS

In the past, aircraft retirements have been the result of finding a "better mouse trap". In economic terms this means a plane with passenger appeal which is correctly sized for the mission and has superior operating economics. Of course, where borrowing is necessary, capital had to be available at a satisfactory price. In recent years five new factors affecting the investment decision, even if the other conditions were satisfactory, have arisen. They are: (1) deregulation or regulatory reform, (2) government policies on aircraft noise control, (3) the existence or non-existence, as well as the tilt, of special legislative financial assistance or incentives for retirement, (4) fuel cost and availability and (5) inflation. In this section our primary emphasis is on (1) and (2). In subsequent sections we treat the remaining items.

C.1 DEREGULATION OR REGULATORY REFORM

During several years a segment of the academic community has argued that because of the economic characteristics of airlines the type of regulation provided by the Civil Aeronautic Act of 1938 as amended by the Federal Aviation Act of 1958 has resulted in the protection of inefficient carriers, competition in service, and higher than necessary fares to the detriment of the public. The story has

been detailed extensively in the literature in recent years.[4/]

On October 8, 1975, President Ford announced a legislative reform program encompassed by a bill known as the Federal Aviation Act of 1975. This bill if enacted would have been a major policy change in regulating the airlines. The Act, among other things, would make pricing more flexible, provide for a much freer system of entry and exit, relax rules on mergers and consolidations, and remove constraints from Supplemental carriers. The announcement of this proposed legislation triggered an avalanche of hearings,[5/]

4/ Richard E. Caves, Air Transport And Its Regulators: An Industry Study, Harvard University Press, Cambridge, 1962.
Richard E. Caves and Marc J. Roberts, eds., Regulating The Product: Quality and Variety. Ballinger Publishing, Cambridge, 1975. See Chap. 2 Lawrence J. White, "Quality, Competition and Regulation: Evidence from the Airline Industry;" Chap. 8, S.L. Carroll, "The Market for Commercial Airliners;" Chap. 12, R.E. Caves and L.A. Pazner, "Value of Options, Value of Time and the Local Airline Subsidy."

George W. Douglas and James C. Miller III, Economic Regulation of Domestic Air Transport: Theory and Policy, The Brookings Institution, Washington, D.C., 1974.

George C. Eads, The Local Service Airline Experiment, The Brookings Institution, Washington, D.C., 1972.

Almarin Phillips, ed., Promoting Competition in Regulated Markets, The Brookings Institution, Washington, D.C., 1975. See Chap. 2, George C. Eads, "Competition in the Domestic Trunk Airline Industry: Too Much or Too Little?"

William A. Jordan, Airline Regulation in America: Effects and Imperfections, Johns Hopkins Press, Baltimore, 1970.

5/ U.S. Congress, Senate Subcommittee on Aviation, Regulatory Reform in Air Transportation, Hearings before Subcommittee on Aviation of Committee on Commerce. 94th Cong. 2nd Session, April, 1976, pp. 1314.

proposals, seminars and workshops throughout the country.[6/] Subsequently other proposals and bills were drafted such as the Kennedy bill, the CAB's Bureau of Operating Rights proposal, the CAB proposal, the Anderson-Snyder bill, and bills carrying Senator Cannon's and Rep. Levitas' names. After numerous hearings, accompanied by pressure by both the Ford and Carter administrations, legislation entitled the Airline Deregulation Act of 1978 was eventually adopted in October, 1978. However, in the interim, the financial condition of the airlines which some attributed to faulty regulatory legislation, plus complaints by the "have not" airlines, plus a heavy thrust by the Department of Transportation led to the conclusion that there would be substantial changes liberalizing the existing legislation. Even if such legislation were not to pass, public pressure plus new members of the Civil Aeronautics Board who had different philosophies indicated that, under the CAB, there would be a large measure of de facto regulatory change. Under CAB Chairman Alfred E. Kahn this did come to pass.

The initial reaction of the airlines and the financial community to the bills, particularly the original DOT bill, was negative to the point of predicting chaos and bankruptcy. Publicly the airlines and the financial community maintained that the prospect of

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6/ Regulatory Reform and the Federal Aviation Act of 1975, A workshop held at the Transportation Center, Northwestern University, Evanston, Ill., Feb. 29 and March 1, 1976. Sponsored by Northwestern University and the Program of University Research of the Department of Transportation.

any such legislation increased the risk of doing business so much that all thoughts of retiring aircraft for replacement equipment were put aside. Until the fear of "deregulation" or "regulatory reform" had disappeared the airlines claimed they could not consider replacing aircraft. However, if they did, the financial community would not loan the necessary funds. The strategy of the airlines that could afford to consider new equipment was to conserve their cash so as to outlast their weaker competitors. Then, when freer entry became effective, the survivors, as monopolists, could recoup their fortunes.

Our interviews with airline managements, aircraft and engine manufacturers, and the financial community began in June, 1976. Although at this time there had not been much change in management's public rhetoric, we discerned in private conversations a growing feeling that some change, though substantially different from the DOT bill, would not only be forthcoming but actually could be beneficial. By early 1978, the industry, with some striking exceptions, seemed ready for less restrictive legislation. The "horror" with which regulatory change was first approached had dissipated. No longer was the fear of regulatory change a significant factor impeding aircraft retirement. A growing surge of orders since passage of the Airline Deregulation Act is proof that fears of deregulation consequences has not caused airlines to defer plans for retiring their aircraft.

C.2 NOISE CONTROL AS FACTOR IN RETIREMENT DETERMINATION

This subsection deals with the environmental concerns of aircraft noise control and concludes that changes not only in the federal government's FAR 36 noise regulations, but also in airport and municipal regulations dealing with sound emissions have, depending on their focus, both a positive and negative effect in the minds of airline managements' making decisions on whether to retire old jet aircraft. Whereas promulgation of noise rules makes management focus attention on retirement, the uncertainty of government policy has tended to delay decision making for retirement. This is particularly true where financing is a problem. To put the situation in proper perspective a summary of the history and present state of the noise regulation is necessary.

(a) History of the problem and attempts to deal with it. The first jets introduced were the Boeing 707 and Douglas DC-8 powered by a very noisy JT3 and JT4 turbojet engines. Shortly thereafter, a somewhat quieter and much more fuel efficient engine, the JT3D low-bypass turbofan, was introduced. Some carriers immediately re-equipped their fleets with this power plant, and the JT3D shortly became standard on all new production aircraft. However, these planes were still objectionably noisy and the affected public pressed for relief at various levels of government. Pressure was also applied by private airport owners.

In 1966 President Johnson asked his Office of Science and Tech-

nology to develop a noise abatement and sonic boom program. The new DOT Act of 1966 established an Office of Noise Abatement but did not provide regulatory authority for noise control. Legislative authority to regulate noise was given to the FAA in 1968 by an ammendment to the Federal Aviation Act of 1958, in Section 611. The authority was not unlimited but was subject to (1) safety consideration, (2) the economics of reasonableness, (3) the requirements of being technically practical and (4) the requirement of being appropriate for the type of aircraft to which it would be applied.

1969 saw the FAA promulgate FAR 36 as the basic noise control regulation.[7/] Its immediate thrust was aimed not at the current fleet of jet aircraft, the cause of the complaints, but at future design aircraft. The new wide-bodied 747 (except for a few early ones), DC-10 and L-1011 jets were the first designs affected. The rule limited sound emissions measured at three points: (1) take off, (2) approach, and (3) side line. To describe the type of sound being regulated a unit known as EPNdB (Effective Perceived Noise in decibels) was employed. Whether this or some other unit should be used in certain situations has been the source of endless debate and much confusion. Various versions of bills introduced from 1977 to 1979 addressed this point. Additionally, heavier

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7/ Appendix E. Shortly thereafter ICAO Annex 16, essentially a similar requirement, became an international standard.

transport jet planes were permitted higher EPNdB limits than lighter ones. This also has been a source of controversy.

The preamble of FAR 36 in 1969 put the aviation industry on notice that the FAA in the future planned to regulate the noise levels of the then current 707, 727 and DC-8 jet fleet under its congressional mandate to provide present as well as future noise relief. Public pressure continued and Congress, in its 1972 Noise Control Act, amended Section 611 in an attempt to hasten FAA action by declaring it to be the policy of the United States "to promote an environment for all Americans free from noise that jeopardizes their health or welfare." Federal agencies were directed to carry out the programs within their control in such a manner as to further that declared policy of the United States "to the fullest extent consistent with their authority under Federal laws administered by them." The Environmental Protection Agency was authorized to propose noise regulations to the FAA.

In 1973 the building of 2- or 3-engined jet transport over 75,000 pounds in gross weight, regardless of when the design was certificated, was prohibited unless it met FAR 36 on and after December 31, 1973 (December 31, 1974, for 4-engined aircraft). However, no rule was established to require a "retrofit" of the existing fleet. From that point on there has been a continuous battle inside and outside the government between environmentalists and the air transport industry over both the need and desirability of "retrofit" versus gradual replacement and also how the costs

should be borne.

The record shows a long history of attempts by different groups to have the FAA cover already built jet aircraft, i.e., "retrofit." An extensive but not complete chronology of those efforts at the federal level follows:

Attempts at Covering the Already Built Planes, i.e. "Retrofit"

1. 11/4/70 Advanced notice of proposed rule making (ANPRM 70-44)
2. 1/3/73 ANPRM 73/3
3. 3/22/74 NPRM 74-14 mandating 100% compliance with FAR over 4-year period
4. 10/74 DOT 23 airport study
5. 12/74 Draft environmental impact statement
6. 1/75 NPRM 75-5 proposal by EPA
7. 7/75 FAA, before the Subcommittee on Aeronautics and Space Technology, endorsed retrofit of the commercial fleet
8. 8/12/75 FAA recommended to Secretary of DOT that he send retrofit plan to OMB and the White House.
9. 12/3/75 FAA, before House Committee on Public Works Aviation Subcommittee, endorsed retrofitting.
10. 1/76 FAA produced two new studies for retrofit:

    (1) Aircraft Noise Reduction Approaches to Mitigation

    (2) International Implications to Retrofit
11. 2/76 FAA again, before the same committee, endorsed retrofit.
12. 2/10/76 Secretary Coleman made commitment to decide retrofit question in 60 days.
13. 4/6/76 Secretary Coleman announced he could not meet the deadline - he needed time to analyze an ATA proposal.

14. 6/1/76 Secretary Coleman completed his "Airport Noise Policy Statement" and forwarded it to OMB. It was not made public.

15. 7/76 The Attorney General of the State of Illinois served nctice he would sue the FAA for violating the Noise Control Act of 1972 because FAA has failed to carry out its non-discretionary duty. It was now 7 years since FAA was given the authority (1968 Sec. 611) and 4 years since it was directed to act.

16. 9/4/76 Secretary Coleman was scheduled to present his "retrofit" policy to the Subcommittee on Aviation of the House Committee on Public Works. Secretary Coleman postponed meeting because he needed "a few more days."

17. 9/9/76 Secretary Coleman again was scheduled to present his noise policy to the House subcommittee. At the last minute, the Secretary reported he was unable to get clearance from OMB and the White House.

18. 9/21/76 Secretary Coleman was once again, a fourth time, scheduled to present the administration's plan on "retrofit-replacement." Hearing concelled.

19. 9/30/76 Secretary Coleman, a fifth time, asks "indulgence" over noise delay (Aviation Daily p. 167)

20. 10/18/76 "President Ford indicates early noise policy unlikely" Aviation Daily p. 250)

21. 10/21/76 "President Ford has instructed the FAA and DOT to extend the 1969 and 1973 noise standards 'to all domestic U.S. commercial aircraft ... to become effective January 1, 1977, and be phased in over the next eight years'." More hearings on financing were ordered to be held (Aviation Daily p. 290)

22. 10/22/76 Announcement was made that the States of Illinois, New York and Massachusetts jointly filed suit in U.S. District Coutrt, Washington, D.C., against Secretary Coleman, the Administrator of the Federal Aviation Administration John McLucas, and the Administrator to the Environmental Protection Agency, Russell E. Train, for failure to perform their non-discretionary duties of promulgating airport and aircraft noise regulations under Section 7 (b) of the Noise Control Act of 1972.

23. 11/18/76 Secretary Coleman announced that the FAA would shortly promulgate a noise control rule involving a phased

retro[illegible] program in steps over a maximum eight-year period. Hearing on methods of financing were confirmed for December 1. 8/

24. 12/1/76 A one-day hearing before Secretary Coleman was held in Washington, D.C., on the issues of financing aircraft noise reduction requirements.

25. 12/23/76 The FAA published in the Federal Register (Vol. 41 p. 56016) an amendment to Part 91 of the Code of Federal Regulations (14CFR91) which added subpart E requiring airplanes of over 75,000 pounds to meet the current Federal noise standards in accordance with a phased time schedule of not more than eight years beginning January 1, 1977, and ending January 1, 1985. Contrary to previous understandings, implementation was not tied to any financing legislation. (Appendix F)

To summarize: The FAA, under pressure for several years by environmentalists to require commercial jet aircraft manufactured before 1974 to be retired or comply with FAR 36 as promulgated in 1969, and under pressure from the airline industry to take no retroactive action, finally, in the last days of the Ford Administration, notwithstanding a public commitment to take no action unless it were tied to financing legislation, promulated a rule requiring retrofit, re-engining, or replacement to be effective in eight years but with a phase-in by steps. In the absence of a provision for financing, the airline felt betrayed.

How this breaking of faith came about in such a fashion that the responsible persons were not accountable is a fascinating

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8/ Aviation Noise Abatement Policy, Office of the Secretary, FAA, November 18, 1976. 61 pp.

story on the vagaries of politics at the time of an outgoing administration. 9/

Airline managements are in a difficult position in the noise controversy. On the one hand, they cannot be against lower noise levels for three reasons: (1) it is akin to being against motherhood, (2) quieter planes attract more passengers, and (3) the consequences of failing to reduce noise may result in curfews, or even outright bans locally on jet operations. In essence, the failure

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9/ Explanation of FAA Administrator John L. McLucas at AIAA Forum "The Future of Transportation" Washington, D.C., January 13, 1977:
The noise regulation was being handled by the Administrator of the FAA, Dr. John L. McLucas, while the companion financing proposal was being developed by the Secretary of Transportation, William T. Coleman, Jr. As is explained in more detail later, both the proposed noise rule and the financing proposal became hot political issues. Both were sent to the Office of Management and Budget in the Executive Office. After several meetings, some attended by President Ford, no agreement was reached. Finally, the President asked Messrs. McLucas and Coleman to the White House to determine the final policy. McLucas support a financing proposal involving a reduction in the ticket tax by 2% and a concommitant surcharge of 2% with such monies to be used only for retrofit, re-engining, or replacement.

President Ford did not make a decision in their presence but asked them to go back to their offices and he would advise them of his conclusion. Sometime later Dr. McLucas received a letter from Ford telling him to promulgate the noise rule. The President at the same time also wrote to Secretary Coleman telling him that the financing proposal was not approved. Thus each man received a different letter and each could say he did not break his word to the industry. In a few days all three participants were out of office and had no responsibility for the future.

to deal with noise satisfactorily from society's viewpoint may place serious constraints upon the industry. On the other hand, should the costs of retrofit or replacement exceed the ability of the industry to pay for them, either alone or with such assistance as society is willing to give through legislation, then the industry is also constrained. Thus, for those carriers which have significant numbers of non-complying jet aircraft (about 1,600 in number), whether to keep, retrofit, or retire and replace, in the absence of a known government policy, complicates and delays their equipment planning.

The current noise problem will not go away. The question is not whether special interest groups may be able to prevent federal legislation, but how can the differing interests of the population close to airports, the traveling public, the public at large, airlines and the manufacturers be accommodated in the manner best suited to society?

During the past several years countless hearings on noise rules have been held not only in Washington, D.C. but all over the United State.[10/] Even a summary would be too long to include

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10/ U.S. Congress, House Committee on Public Works and Transportation, Current and Proposed Federal Policy on the Abatement of Aircraft Noise, Hearings before the Subcommittee on Aviation of the House Committee on Public Works and Transportation. 94th Cong. 1st and 2nd sessions, 1975, 1976. 1493 pp. See also the same subcommittee hearings titled Airport and Aircraft Noise Reduction, Hearings before the Subcommittee on Aviation of the House Committee on Public Works and Transportation on H.R. 4539 and Related Bills 95th Cong., 1st session, 1977, 567 pp. _____ ___, Senate Committee on Commerce,

here. However, to understand the delays and some of the complexities of the problem which make for uncertainty in the minds of the decision maker a few points are in order.

(b) Impact of Legal Problems: Complaints about noise led to lawsuits. The Supreme Court in Griggs vs. Allegheny County, 369 US 84 (1962) established that airport operators are liable for noise damages resulting from operations to or from their airports. Thus it was not the makers of the noise that were liable. From this one would conclude that each airport operator could make his own rules. If so, the air carriers could find themselves in a thicket of unworkable and intolerable conflicting regulations. The Ford administration's view was that Section 611 of the Federal Aviation Act furnished a means of preventing such a conflict by providing the FAA with authority to preempt noise regulation of air carriers. However, until the FAA acted, the airport proprietors were free to make their own rules, subject to being nondiscriminatory and not being unduly burdening on interstate commerce. As long as the FAA did not make a regulation covering existing non-FAR 36 aircraft, the carriers through the Air Transport Association would be kept busy putting out fires around the country where aggressive local groups were pressuring airport authorities curfews and outright banning or progressive banning of operations

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10/ cont. Science and Transportation. Aircraft and Airport Noise Reduction, Hearings before the Subcommittee Aviation, 95th Cong. 2nd Session, 1978, 397 pp.

by noncomplying aircraft.

The pressures locally are far more than mere strong expressions of desires. As a result of legal proceedings, Los Angeles has been ordered to pay more than $1.7 million in damages because of noise. In addition, $24 million has been paid in negotiated settlements. What is more, the California courts have held that noise damages may be not only for loss in property values but for mental and emotional distress (Greater Westchester Homeowners Association, et al., vs. City of Los Angeles, et al.)[11/] Self-supporting airport authorities must fund the payments by increasing their landing fees and rentals from airlines. This will, of course, further increase fares and thus decrease the demand for air transportation. One attempt to minimize the problem has been to employ land use planning in which homes near the noise path are acquired and the land re-zoned for other uses. Because land acquisition is very expensive (Los Angeles has spent $160 million in 5 years) airport authorities push hard for a "retrofit" or "replacement" solution.

As indicated by items 15 and 22 shown on page 22, local pressures intensified and were aggregated first to individual state pressure and ultimately to the point where three powerful state governments (Illinois, New York and Massachusetts) banded

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11/ This 1975 lower court ruling was upheld by the California Court of Appeals for the Second Appellate District in C-931-989, February 28, 1979.

together to exert further pressure in the form of a suit.

Inasmuch as the federal government had the authority to impose noise regulations for existing non-FAR 36 aircraft, which constitute 75% to 80% of the fleet, and since it is somewhat unusual for bureaucracy to fail to exercise authority, particularly in the face of public pressures, one can ask why this delay which brought such uncertainty to managements' decision process? These are three primary answers:

(1) The time-consuming nature of the rule-making process and attendant bureaucratic infighting

(2) Time for solving legal and political considerations

(3) Industry opposition

(1) Rule-making Structure and Bureaucratic Infighting: Delays as a result of hearings are nothing new in Washington. However, in this case because of the manner in which Congress has structured the process by placing so many agencies and offices "in the loop," the art of delay through hearings has reached a new high. The bureaucratic maze is somewhat as follows.

Under its rulemaking authority, the FAA in 1970 issued Advanced Notice of Proposed Rule Making (ANPRM) 70-44. Several years later this was followed by NPRM, 74-14 which, of course, generated comments. In 1975 the EPA originated NPRM 75-5. The Office of Environmental Quality in the FAA works on these matters. However, the FAA is not an independent agency and must "consult" with the Secretary of Transportation. Some space in the congressional

hearings was devoted to "suggesting" that in fact "consultation" was a euphemism. It was pointed out that even the testimony of the FAA Administrator had to be approved by the Office of the Secretary of Transportation before he appeared before a congressional committee on the subject.

Lack of action by the FAA caused Congress to include in the Noise Control Act of 1972 further legislation affecting jet aircraft noise control. There was some debate favoring transferring noise control from the FAA to the Environmental Protection Agency (EPA). However, Congress provided the EPA with the authority to propose rule changes to which the FAA must respond affirmatively or with the reasons for its inaction. The purpose was to continue the FAA "in the loop" because of its expertise, but to use the EPA to keep the FAA's "nose to the grindstone." Under this legislation the EPA had, by the end of 1975, proposed 8 rules and were working on others.[12/] Subsequently, by 1977, the list had grown to 11. The EPA has its own staff independent of the FAA. The process in making an EPA proposal takes time. Suppose, for example, that the FAA is just about to promulgate a rule when it receives an EPA proposal. The FAA may quite properly hold up its rule to consider the new proposal. This procedure can trigger more hearings. The process can be endless.

12/ Hearings, Current and Proposed Federal Policy on the Abatement of Aircraft Noise. House Subcommittee and Aviation, December 3, 1975, p. 123.

Another participant in the bargaining over what type of noise abatement rules are appropriate is the Council of Wage and Price Stability (COWPS) in the Executive Office of the President. This agency came into being in August 1974 (Public Law 93-387). The act, as well as Executive Order 1182 of November 27, 1974, directs the Council to review the policies, programs and activities of the departments and agencies to determine the extent to which these programs and activities are contributing to inflation. COWPS has been at odds with the FAA and EPA on various points. After analysis of the EPA's proposal to FAA, COWPS faulted the EPA for not providing an Environmental Impact Statement as required, and sided with the airlines that the rule was (1) unnecessary from a health and welfare standpoint, (2) that the rule only accelerated benefits which would come about anyway, (3) that the rule failed on a cost benefit analysis, and (4) that the rule was inflationary.

Thousands of pages of testimony, technical reports and position papers have reached the public view as a result of activities of the EPA and FAA. When the FAA proposal leaves the FAA and begins its course through the Secretary of Transportation's office, the OMB, and perhaps the State Department and other agencies and departments, a curtain of secrecy descends. This is where the behind-the-scenes maneuvering in Washington can take place. Whether these subsequent "evaluations" are made only on the basis of the record, or constitute a whole new ball game in which the "tilt" goes to the participants with the most political skill is not clear.

In the present case an FAA proposal went to the Secretary of Transportation. His office also has legal, technical and economic staffs to work on the problem. Inputs from industry did not favor the FAA plan. It was reported in the press that the Secretary adopted in general the approach of the Air Transport Association and sent it on to the White House where the OMB became involved. The size, if any, of the specialized noise staff on noise control in OMB is not available. Instead of a prompt decision the matter was hidden for months. What reports that did come from the "usually reliable sources" were that Secretary Coleman's proposal for an Administration position did not "fly" with the "White House OMB staff." On various occasions, notwithstanding reported meetings with President Ford, Mr. Coleman, as noted above, was forced to delay his testimony.

Of course rules proposed by agencies such as the FAA or FHWA for transport operating equipment do not normally find their investigations replicated at other levels of government, so the question is why in this case? The answer lies in the fact that the industry has successfully argued that it would be unfair if not unconstitutional to adopt a rule which the industry in its 1976 financial situation could not afford. Support for the logic is found in Section 611 of the amended FAA Act which includes the statement that the regulation must be economically reasonable. Accordingly, in the absence of available private financing, some governmental legislated assistance would be needed. The FAA then

adopted the position that it would not promulgate a regulation until appropriate legislation was passed.[13/] However, since legislation could have an adverse effect on the revenues of the government by diverting taxes from the Airport and Airway trust fund to private carrier accounts, the OMB and the White House became involved.

2. Legal and Political Consideration: First is the problem of federal preemption. In order to have one set of rules to live by, the aerospace and airline operators have pressed for federal preemption of noise control. However, wholesale transfer to the federal government might also mean transfer to it of the burden of combatting countless lawsuits and, therefore, subject it to enormous liability. The government has been reluctant to subject itself to this liability.

What rights should be left to the local governments? In July, 1975, there was proposed in the Federal Register for comment a National Airport Policy with four options: (1) All control would reside with the local authorities, (2) the local proprietor would establish a policy which had to be reviewed and approved by the FAA, (3) a proposal that the local operator be constrained by the

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13/ Current and Proposed Federal Policy on the Abatement of Aircraft Noise, op. cit. Testimony of Frederick A. Meister, Associate Administrator, FAA, p. 69; also, testimony of Dr. John McLucas, Administrator, Federal Aviation Administration, pp. 1154 and 1159.

FAA under a coordinated federal plan, and (4) the option of proceeding on a case-by-case basis.

Secondly, time is required to assess a correct balance of the rights of various segments of citizens. On the one hand, the environmentalists testified to the decreasing quality of life near the airport coupled with a decrease in property values, mental and emotional distress, physical damage to property, and adverse effect on the educational system in schools located near airports. Other interests downgraded this testimony and pointed out the catastrophic adverse effect on local business and employment, on regional business and, in fact, on the entire country if the environmentalists were to be satisfied.

Finally, when it came to outright government provision for aid in retrofit or replacement, a provision which the industry and ostensibly the Secretary of Transportation favored, there were several in the industry who secretly, and perhaps not so secretly, were exerting pressure where they thought it would do the most good to keep the proposal bottled up. Delta, with strong finances and an aggressive fleet modernization program of its own, strongly felt that it had a lower cost exposure than did its competition to a noise regulation, whatever it might be, because of its past sound management practices. Delta therefore reasoned that it was not right for it and the public to be taxed to cover faulty management of others. Northwest was in the same position. Both carriers stood to be in an enviable competitive position should a rule be

adopted without financial aid to the weaker carriers. At this time, some analysts felt it was not inconceivable that less well-suited carriers, such as Eastern and TWA, could be driven to the wall.

More detailed financial analysis is contained in section G. Suffice to say while insurance companies, commercial banks and investment bankers applaud successful management, nevertheless, they have immense investments in the entire airline and aerospace industry. Obviously, the pressures from this group are for retirement of non-FAR aircraft from their client airlines and replacement with aircraft from their client manufacturers. The financial community favors such legislation as is necessary, short of nationalization, to make this possible.

3. Industry Opposition: The various advanced notices of proposed rule making resulted in a March, 1974, proposal which would require jets weighing over 75,000 pounds to meet the FAR 36 on a progressive basis, with 50% compliance by July 1, 1976, and 100% by July 1, 1978. The final rule made public November 17, 1976 changed the four-year timetable applicable to all aircraft to six years for the wide bodies and 727/737/DC-9/BAC-111 and to eight years for the old first generation jets such as the 707/720/DC-8 and 990.

Industry opposition was, except for the well-financed carriers, identical with the points made to the investigators privately by individual carrier managements, an indication of a deep conviction

on their part. Briefly, the arguments were:

1. The ATA, while encouraging more stringent rules on new aircraft, aruged that the technology currently available for noise control via retrofit resulted in minimal noise relief. The extent of relief possible was vigorously disrupted.

2. The cost of accomplishing retrofit with sound-absorbent material (SAM), given its limited effectiveness, produced an inadequate benefit/cost ratio.

3. Retrofit by refanning the engines was not a viable approach because it was five times higher in cost.

4. The cost of replacing the engines with those of newer technology on the noisy aircraft was such a high multiple of straight retrofit using Sound Absorbent Materials (SAM) that such an option was clearly eliminated.

5. Those companies with the greatest number of old non-FAR 36 airplanes could not afford retrofit.

6. Replacement of the old less fuel-efficient and noisy airplanes by newer technology, quieter, more fuel-efficient planes, while very desirable, was not a viable alternative because no such planes of appropriate size and economics were currently available from aircraft and engine manufacturers.

7. The retrofit rule would, at great expense, only move up in time, noise relief which would take place anyway.

8. Current noise levels were not a health hazard but only an annoyance.

9. Acting favorably on retrofit would be inflationary.

The advisability of carefully evaluating these arguments contributed to the delays.

(c) Noise Proposal of November 1976 - Impact: A few facts can place in perspective the retrofit-replacement controversy as it existed at the time of the policy statement of November 14, 1976.

In the free world there were at the end of 1975 approximately 4,200 jet aircraft in commercial airline service (Table 2, p. 8) of which 2,050 were in the United States. The ATA calculated that its member airlines operated domestically about 1,601 aircraft which did not meet the FAR 36 standard and only 389, or 20% which did comply. The breakdown by aircraft type follows:

TABLE 3

NUMBER OF COMPLYING AND NON-COMPLYING
ATA MEMBER AIRLINE AIRCRAFT

	Number of Non-FAR 36 Aircraft	Number of FAR 36 Aircraft
707	268	0
720	18	0
DC-8	161	0
DC-9	330	7
727	620	136
737	122	2
747	51	44
BAC-111	31	0
DC-10	0	122
L-1011	0	76
Total	1061	387

Source: ATA, Table dated Feburary 12, 1976 furnished House Subcommittee on Aviation, 1976, p. 797.

Various estimates have been given for the cost of retrofit per aircraft with the following figures being representative in-

cluding installation. The total ATA Fleet Cost was claculated at $1 billion.

TABLE 4

COST OF RETROFIT PER AIRCRAFT
1980 DOLLARS

707	$ 2,160,000
720	2,160,000
DC-8 21/31	516,432
DC-8 62/63	1,678,404
DC-8 50/61	2,323,000
DC-9	273,000
727	195,000
737	432,000
747	483,000

Source: Same as Table 3.

The impact of the rule affects each carrier differently, depending on the age and composition and degree of modernization of its fleet. The number of non-FAR aircraft for selected carriers are shown on Table 5.

TABLE 5

NUMBER OF NONCOMPLYING AIRCRAFT OF
SELECTED CARRIERS, 1976

	AAL	UAL	TWA	PAA
707	88		100	51
DC-8		101		
DC-9			19	
727	99	150	35	13
737		59		
747	11		11	0
	198	310	165	64

Source: ATA

Proponents of retrofit pointed out that at the end of 1975 82% of the jet fleet did not meet FAR 36 and, unless something were done, by 1990 there still would be 48% of the aircraft not complying.

These carriers in the Table 5 are the same airlines which in the past had initiated the re-equipment cycle with new, more efficient aircraft, and indeed, the launching of a new generation of more efficient craft depends upon orders for a quantity of aircraft which only these carriers are of a size to purchase. Their perception in 1976-1977, aside from their financing problem was that if retrofit were required, in many cases, it would be more advisable to retire their 707's and DC-8's by replacing them with a known aircraft, such as the 727-200, even though such craft might not be the optimum size for their operation, and even though a new technology or derivative airplane was under development. The carriers also expressed the fear that if legislation were passed favoring retrofitting, the result would be an unwise use of their available funds which would constrain them from taking advantage of a newly developed aircraft when it became available. Such a situation could have adverse effects on the aerospace industry and hence on the economy as a whole.

The total cost of retrofit alone was first presented as $536 million in 1974 dollars. In February, 1976, the ATA presented cost estimates of $1 billion for retrofitting the U.S. fleet. The figures did not include $87 million expended by NASA in efforts

to assist in developing SAM modifications and re-fan engines. Secretary Coleman's mid-November 1976 press release indicated an expected cost of $5 to $8 billion for a combination of retrofit and replacement.

Extent of Relief from Retrofit: A major source of controversy between the industry and those favoring retrofit involved and still involves, a dispute as to whether retrofitting non-FAR airplanes with SAM affords meaningful relief. The proponents (FAA, EPA, and various community interest groups) pointed to testimony by a number of psychoacousticians whose thrust was that the EPNdB reduction afforded by SAM was measurable and significant.[14/] Defining meaningful noise reduction as 6 EPNdB, the psychoacousticians found reductions in noise of such magnitudes as 11 on takeoff and 15 on approach for the JT3D 707's and 2 to 4 on takeoff and 8 on approach for the JT8D engined smaller airplanes. Some 727's had lower values. The 707 and DC-8 constituted only 15% of operations.

On the other hand, the opponents of retrofit (airlines and manufacturers), while submitting reasonably similar estimates for the 707's, found lesser figures for other aircraft. They also vigorously pressed three other points to widen the difference of

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[14/] Ibid., Testimony of Paul N. Borsky, Columbia School of Public Health; Dr. Karl Kryter, Stanford Research Institute, and Kenneth Eldred, Vice President of Bolt Beranek and Newman, Cambridge, Mass., pp. 1057-1150.

opinions: First, retrofit was most effective on apporach for the 707 type but of little use on takeoff; and takeoff was the configuration making the most noise. Secondly, in general, the JT8D (727/737/DC-9) retrofitted planes benefitted only by 7.9 EPNdB on approach and 2.2 on takeoff. Third, the opponents disputed the meaningfulness of a threshhold of 6 EPNdB. Using data from actual "flyover" experiences in the field plus an audio-visual presentation of tape recorded "flyovers," an attempt was made to demonstrate to the Congressmen that the human ear did not register the sounds in the same way as did the instruments. 15/ The argument was that a person hearing a retrofitted 727 cannot tell the difference between it and a non-retrofitted craft. With 85% of aircraft operations employing this power plant, the whole SAM program was said to lack justification.

Charts 1, 2, and 3 on the following pages, depict graphically the extent to which selected jet aircraft deviate above or below the FAR 36 standard for the three measuring points. Standing out above the FAR 36 line for takeoff and approach are the early Boeing 707's and DC-8's as well as the very early Boeing 747's. Well below the line for takeoff and approach are the wide-bodied DC-10's, Lockheed L-1011's and newer Boeing 747's. For some reason the 727-100 series is not shown. If it were, it would be only one

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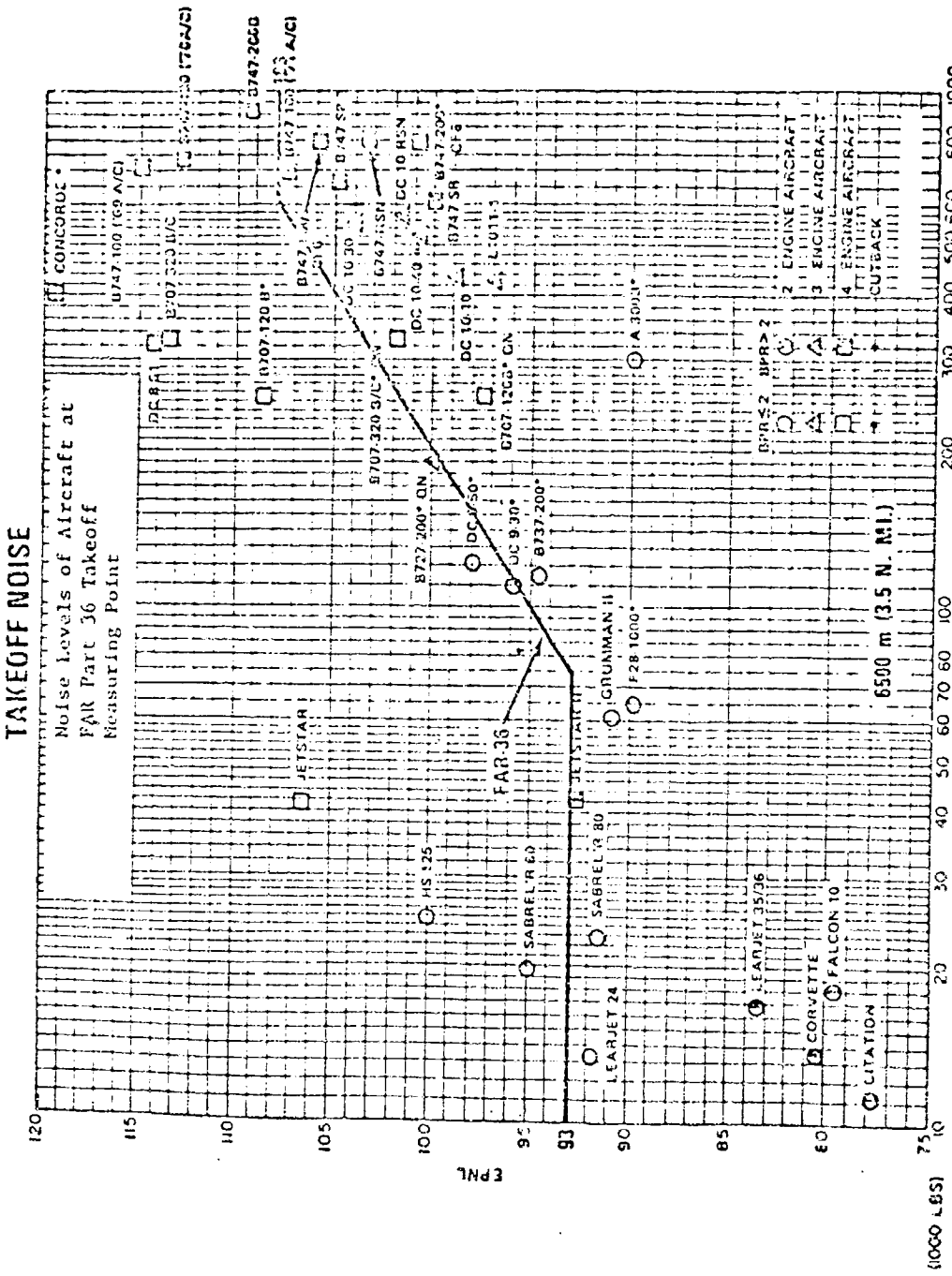
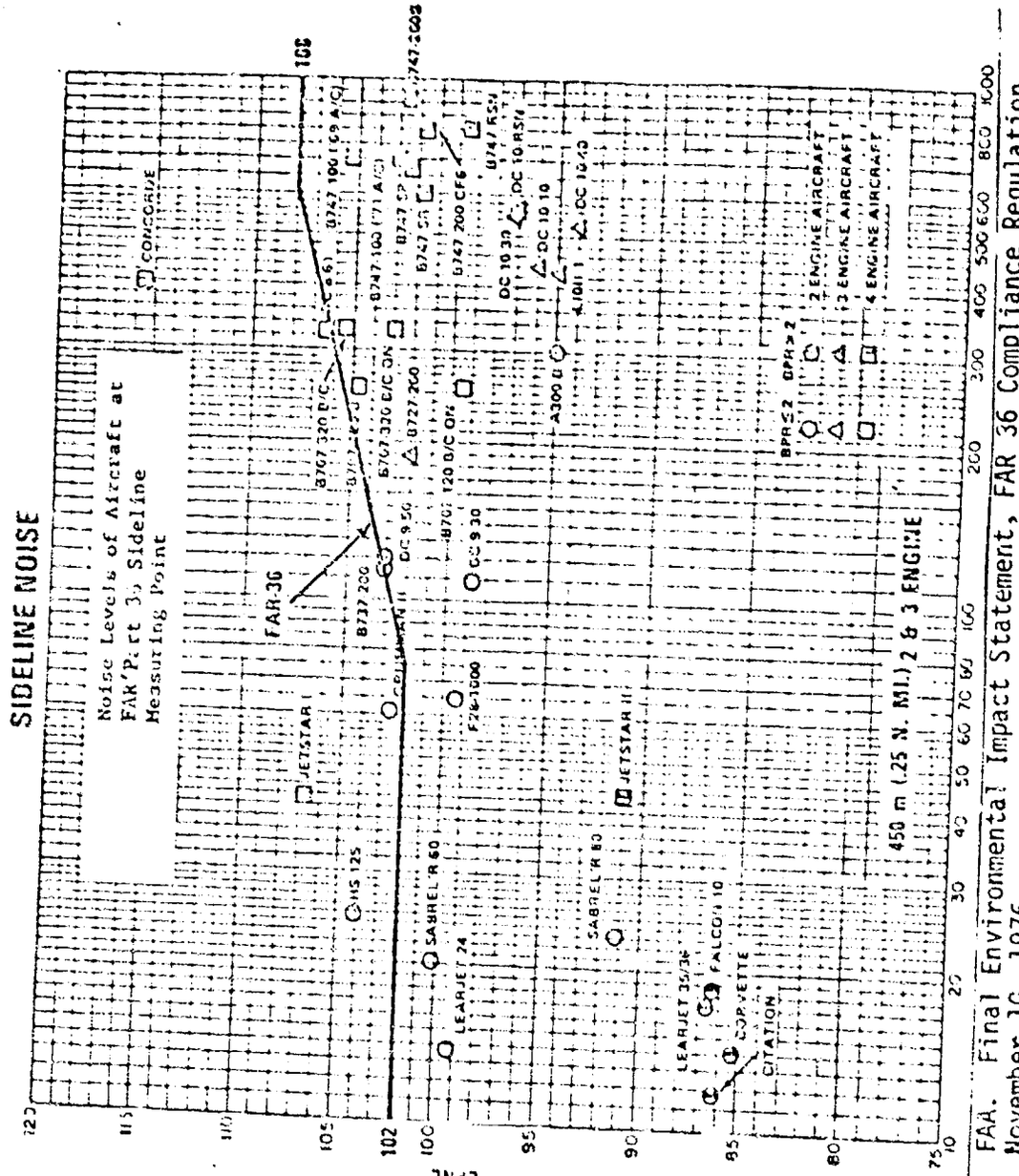
15/ Ibid., January 22, 1976 testimony of A.L. McPike, McDonnell Douglas Corp., pp. 311-412.

Chart 1



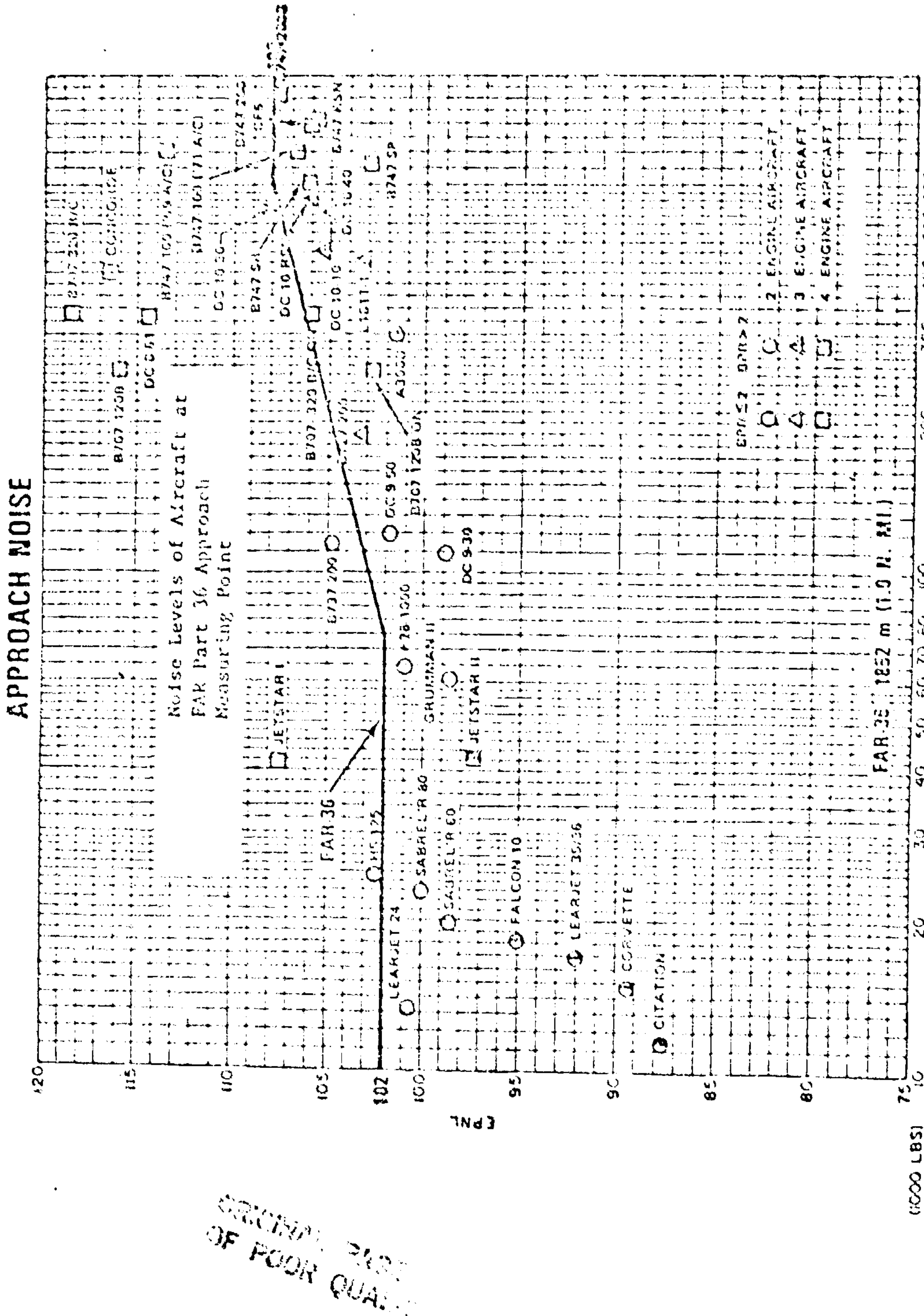
Source: FAA. Final Environmental Impact Statement, FAR 36 Compliance Regulation, November 10, 1976

Chart 2



Source: FAA. Final Environmental Impact Statement, FAR 36 Compliance Regulation, November 10, 1976

Chart 3



Source: FAA. Final Environmental Impact Statement, FAR 36 Compliance Regulation, November 10, 1976

EPNdB higher than Part FAR 36 for approach and 6.5 EPNdB high on takeoff.

Additional comparisons as shown by the FAA under FAR 36 certification conditions are found in Table 6 on page 45.

Summary: During the past several years, thousands of pages of testimony have been taken; designs for retrofit have been formulated; NASA has spent $87,000,000 in re-engine and re-fan research; the EPA has presented a number of proposals and the FAA up to the end of 1976 indicated that no noise rule would be promulgated unless satisfactory financing was tied in. Experts can be found to say that the SAM program is meaningful and others that it is not. While certain airlines, because of their strong financial position, equipment and competitive posture, would not be upset with a retrofit required without financing, the same can be said during 1975-1977 about the large carriers who normally might be expected to initiate a new equipment cycle. The uncertainties of ultimate government complicated their equipment plans. If the financing of retrofit were to be the only assistance provided, it is quite likely that purchase of new equipment would be put off. Also, if financing legislation were drawn so as to make re-engining more advantagious than replacement, purchase of new planes would be held back. On the other hand, if the financing of noise abatement were to be tilted toward replacement, one would expect retirement of the current narrow-bodies as fast as production of new equipment would

TABLE 6

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
FINAL ENVIRONMENTAL IMPACT STATEMENT

NOISE LEVELS UNDER FAR 36 CERTIFICATION CONDITIONS (EPNdB)

Aircraft	Condition	FAR 36 Limit	Unmodified	Fully Modified
707-320B	Takeoff	103.7	113.0	102.2
	Approach	106.3	116.8	104.0
	Sideline	106.3	102.1	99.0
DC-8-61	Takeoff	103.5	114.0	103.5
	Approach	106.2	115.0	106.0
	Sideline	106.2	103.0	99.0
727-200	Takeoff	99.0	101.2	97.5
	Approach	104.4	108.2	102.6
	Sideline	104.4	100.4	99.9
737-300	Takeoff	95.8	92.0	92.0
	Approach	103.1	109.0	102.2
	Sideline	103.1	103.0	103.0
DC-9	Takeoff	96.	96.	95.0
	Approach	103.2	107.0	99.1
	Sideline	103.2	102.0	101.0
747-100	Takeoff	108.0	115.0	107.0
	Approach	108.0	113.5	107.0
	Sideline	108.0	101.9	99.0

Source: DOT Environmental Impact Statement in Response to NPRM 74-14 and 75-5, Statement of Nov. 11, 1976.

allow. The situation would be more certain than it is if satisfactory replacement airplanes were "on the shelf" waiting to be purchased. However, as will be seen in the technology and economic sections, emphasis on the economcis of size has resulted in technological advances in aircraft capable of using powerful high bypass engines have not been matched by equivalent developments in narrow bodied aircraft in the 100-150 passenger category. In any event, until carriers and manufacturers have a clear notion of the cost alternatives under a final determination of noise legislation, intelligent decisions cannot be made. Thus, it can be said for carriers with financial constraints the FAR 36 controversy up to 1978, was a significant factor affecting the retirement of current jet aircraft. We now first turn to the efforts of the industry to obtain financing assistance during their financially troubled times. We then will turn to their efforts in better times to obtain through legislation a modification of the FAA compliance rule.

D.

FINANCING AND COMPLIANCE LEGISLATION: EFFECTS ON THE RETIREMENT OF JET AIRCRAFT

The preceding section dealt primarily with the controversy over the desirability of retroactive application of the 1969 noise rule to aircraft not previously covered. The point was made that the uncertainty which the controversy engendered served to delay retirement decisions. On December 23, 1976, announcement of the implementation of a retroactive rule for 2-, 3-, and 4-engined jet transports weighing over 75,000 pounds removed the uncertainty of whether there would be a rule and the details of its application. However, absence of the promised companion financing bill coupled with the departure from office of those promulgating the rule created further confusion for a few months. This subsection traces the changing attitudes and policies of the airlines and the ATA from consternation and defiance to acceptance, though less than unanimously, of the rule in concert with a determined push to obtain special legislative interim financing arrangements. We begin with the rule and its time span.

D.1 AMENDMENT 91-136 SUBPART E

Amendment 91-136 to the operating regulations (see Appendix F) extended FAR 36 to cover earlier produced aircraft in accordance

with the following time scale:

Compliance Date	Percent of Compliance Required	
	2 & 3 engines 727/737/DC-9 JT8D Engines	4 engines 707/DC-8/880/990 JT3D Engines
January 1, 1981	50%	25%
January 1, 1983	100%	50%
January 1, 1985		100%

According to the Policy Statement, in establishing these dates the Administration took into account the length of time needed to develop, certificate, produce, and install retrofit kits for those airplanes for which the operators would decide that retrofit was the best course of action. Since the 747s, 727s, 737s, and DC-9s were newer and closer to meeting FAR 36, these would be the prime candidates for retrofit, other things being equal. The time needed from the production decision to first kit delivery for the 707 and DC-8 was said to be 2 1/3 and 3 years respectively. Therefore, these aircraft were given a longer period to comply. A more potent reason was the belief that certain models of the 707 and DC-8 were old, noisy, and inefficient so that replacement would be the best course of action. The passage of time from go-ahead for a newly designed aircraft to introduction could easily be four years. Since no designs satisfactory to the airlines had been completed, and since financing currently would be a difficult problem, time was needed.

D.1.1 Initial Reaction to Part 91 Amendment 136

Prior to President Ford's October 21, 1976 acceptance of the proposal of the FAA Administrator and Secretary of Transportation, which later became 91-136, the industry was reasonably well resigned to some new noise rule coupled with special means of financing legislation. Additionally, there was cautious optimism that the rule would not affect the 2- and 3-engine jet aircraft. The promulgation of a retrofit rule which included these very planes, and, in addition, failed to be accompanied by financing assistance, left the industry stunned and with the feeling of betrayal. The ATA had built its favorable reception of new noise rules for the 707 and DC-8 on the quid pro quo of financial help.

Interviews with industry decision makers in early 1977 indicated that the industry would not accept the rule and would fight in the new administration to have it set aside. The airlines would simply take advantage of time and not order retrofit kits, thus presenting the government with the dilemma of either grounding those planes beginning in 1981 or of cancelling the noise rule. The latter would cause the environmentalists to rise up en masse and unleash a barrage of state and local uncoordinated constraining rules. If this scenario had held, there would have been little or no retirement of jet aircraft.

However, on reassessing the situation a different course of action was decided upon. ATA and the individual Federal Affairs

representatives of the airlines and aircraft and engine manufacturers had developed rather effective representation with various Senators and Representatives in which they made the most of the point that new airplanes meant jobs at a time when unemployment was a national problem. They also stressed that new aircraft would be quieter and hence socially more acceptable. Accordingly, legislation aimed at encouraging new aircraft would be a means to getting the environmentalists off the legislators' backs. Finally, the industry pointed out that new aircraft would be much more fuel-efficient. Therefore, the ATA decided to press for new bills in Congress providing for the type of financial assistance which had been proposed by the industry in 1976 and had only been abandoned when President Ford sent his separate letters to McLucas and Coleman.

D.2 COMPONENTS OF A SALEABLE BILL TO ASSIST RETIREMENT OF AIRCRAFT

One of the primary reasons why the noise financing proposals did not "fly" when they reached the upper echelon in the Ford Administration was the fear that they would be viewed as special interest bills for airlines, aircraft and engine manufacturers and banks, and would set a precedent for other businesses to seek similar special treatment. Accordingly, a bill which could be labelled "the aerospace and airline relief plan" would have little chance of success. On the other hand, hearings had clearly shown that the noise problem developed haphazardly because of the failure of the

federal government, the manufacturers, the airport proprietors, the state and local governments and planning agencies, the air carriers, and residents at or near airport to take appropriate actions.

The 1976 Aviation Noise Abatement Policy document marshalled the facts and pointed out that it would take coordinated action by all parties to reduce the impact of noise. Control of aircraft noise at the source - a matter for the manufacturer and the airlines - was just one, albeit a very important, element of the problem. As long as airport proprietors failed to acquire enough surrounding land, as long as cities zoned in such a fashion that homes could be built adjacent to the airport, or under a takeoff or approach path, and as long as the federal government failed to consider adequately the noise implications of operational or air traffic control procedures, the noise problem would not be solved. Thus the policy statement formed a solid basis for developing a series of bills known as the Airport and Aircraft Noise Reduction Act.

At the time of the decision by President Ford, on October 21, 1976, to order a retroactive application of FAR 36 (just 3 days after he had indicated an "early noise policy" was unlikely) his advisors had convinced him for political reasons not to include financing legislation. The White House position was that the passage of the Airline Deregulation Act would be sufficient. However, immediately after the election while under strong pressure from the ATA, Ford authorized a one-day hearing for December 1 to determine whether any additional financing arrangements were necessary. Secretary of

Transportation Coleman himself presided over this hearing. Shortly thereafter once again Secretary Coleman recommended legislation embodying financing assistance. Subsequently, a few days before leaving office, President Ford drafted a message to Congress proposing legislation which would have provided for the establishment by the CAB of an environmental surcharge on passenger and freight tariffs to be offset by an equal reduction in the air passenger and freight tariff tax. Grants to airlines from existing balances in the Airport and Airway Trust Fund would assist in financing modification of aircraft specified by the Secretary of Transportation. Time prevented hearings from being conducted so the bill was dropped. The basic concepts were to surface in a series of bills beginning in March 1977.

To summarize, as a new administration took office at the beginning of 1977 the airlines were faced with a "fait accompli", i.e., a rule requiring that 75% of their fleet be retired or modified without financial aid from Congress. The policy statement of November and the hearings in December provided the underpinning for the components of a majority of the bills which followed. After much maneuvering and compromise, as the next subsection will spell out more clearly, in December 1977 the House Committee on Public Works and Transportation completed work on H.R. 8729. Title III of the bill was directed toward financing of retrofit, re-engine, or replacement. Unfortunately, analysis of this bill alone will not demonstrate the extent to which legislation can affect the pos-

ture of airlines toward the retirement problem. The balance of this section will give an indication of the extent to which public policy can counteract the normal economic process of decision making so as to in fact influence technology. Not only the timing of financing aid and the "tilt" of legislation toward retrofit, re-engine, or replacement, but also special tax credits have an important effect on airline and aircraft and engine manufacturer decisions. This is particularly true in the case of airlines with weak financial statements. It is, therefore, necessary to review the major bills with particular emphasis on the incentives they provided.

D.3 EMPHASIS ON RETROFIT - H.R. 4539

The new administration, through Secretary of Transportation Brock Adams on the TV program "Face the Nation" in February, emphasized the desirability of replacement over retrofit for the primary reason that between the year 2000 and 2010 the U.S. would run out of petroleum. New technology fuel efficient aircraft were needed. He did not define how the replacement would be financed. On March 7, 1977, Rep. Glenn Anderson (D-Cal.) introduced the first of several comprehensive noise abatement bills. Each of the major bills bore the title "Airport and Airport Noise Reduction Act" and contained three to four titles dealing with (1) airport planning and determining one official noise descriptor, (2) additional funding for ADAP for air carrier and general aviation airports, and (3) financing the retrofit, replacement of engines or replacement

of noisy commercial jet transports weighing over 75,000 pounds.

While not in the original H.R. 4539 or in the final version of H.R. 8729, several versions contained a Title IV which militated against preemption by the federal government where state and local governments were concerned. Since this study is focused on retirement, it will not be appropriate to deal in detail with all the titles of the various bills. However, since the various title III proposals were a significant part of solving the airlines' aircraft retirement problem, it is advisable to treat these proposals in some detail and give an overview of the contents of the other titles.

D.3.1 Title I. Comprehensive Land Use Planning

First, in order to eliminate the confusion and lack of comparability of the various noise measurements, the Secretary of Transportation was given the authority and duty to establish a single system of noise measurement. Secondly, there was a mandatory requirement for airport operators to submit (a) a noise contour map showing non-compatible land uses, and (b) a noise compatibility program to control noise. The financing of the above would come from a $2.00 head tax which an operator could levy and from grants made by the Secretary of Transportation. To ensure prompt action, it was provided that if the plan was not disapproved by the Secretary in 180 days, it became effective.

The purpose of the Title was to force the airport operators and local and state planners to make effective contributions to

the reduction of noise. Zoning and purchasing land around airports could move residential owners and schools far enough away from the noise to reduce demands on the manufacturers and airline operators for further relief. The effect of a successful application of the title would lessen the pressure to retire current jet aircraft and minimize demands for more stringent noise limits. By the time the committee agreed upon a bill the mandatory feature and the head tax fell by the wayside.

D.3.2 Title II. Funding For Air Carrier And General Aviation Airports

An additional amount of $260 million for the fiscal year 1979 and $310 million for fiscal 1980 was provided for the Air Carrier and General Aviation Airports. These amounts were carried forward in subsequent versions and in the final committee print on H.R. 8729. Initially, Transportation Secretary Adams opposed these additions because the last increase was less than a year earlier. There appeared to be no further objection until a memorandum from the General Counsel of the Treasury on September 27, 1977, opposed the addition "as long as the costs of operating the Federal airway system and most of the maintenance costs thereof are funded from the general fund of the Treasury."

D.3.3 Title III. Financial Aid For Bringing Large Jets Into Compliance With Noise Rule

As a base point from which to determine the number of spe-

cific aircraft for which operators were entitled financial aid, the bill provided for an inventory to be made of those aircraft which did not as of January 1, 1977, comply with FAR 36 as amended by 91-136. The logic was that on this date the government changed the rules of the game initiating a requirement that airlines spend money which they would not otherwise have had to do. It would also prevent a carrier after that date from purchasing a noisy aircraft just for the purpose of obtaining government aid in its replacement.

Because the source of funding was to be a surcharge on tickets, the inclusion of private business aircraft would have resulted in a cross-subsidy to the owners of such aircraft. The bill, therefore, was limited to planes used for the carriage of persons or property for hire. Military planes were, therefore, exempt. This section was carried forward in all subsequent bills.

Funding Source: Surcharges on tariffs: A major problem in legislating financial aid for a particular industry is how to avoid the charge that the general population is being taxed to favor special interest groups, in this case the airlines and air travellers. The ATA thought it found the answer when in the previous year it had suggested that since the balance in the Airport and Airway Trust Fund had consistently been increasing to the point where it had reached $3 billion, the taxes going into it were excessive. It was reasoned that for a temporary period, 10

years in the case of H.R. 4539, a portion of the taxes could be reduced and an equivalent surcharge be put upon the airline customer with the resulting revenues placed into a fund for the sole purpose of financing aircraft noise abatement. Thus, the user would be paying for abating the noise.

While this concept was adopted by Messrs. McLucas and Coleman in the spring and fall of 1976, it did not at that time "fly" with the Office of Management and Budget and other top Ford advisors. As a matter of record, it did not "fly" with Ford until after the election at which time he transmitted a bill with such a provision. The primary argument against such a plan was that it would further unbalance the budget because the percentage now going into the Trust Fund would end up going to the airlines. Although the Trust Fund itself had a balance, the overall government budget would be further unbalanced.

H.R. 4539 provided that each operator with a non-complying aircraft would assess a 2% surcharge on the before-tax tariff (passenger or property). This surcharge would be placed into a special account for the purpose of retrofit, replacing engines, or replacing aircraft. The offsetting 2% decrease in the 8% passenger tax was not covered in the bill because it was in the province of the Ways and Means Committee.

It was estimated during the hearings that the 2% tax would yield approximately $4 billion over the 10-year period prescribed in the bill (Table 7).

TABLE 7

ATA BASIC DATA ON NOISE REDUCTION PROGRAM

Carrier	Total jet fleet Jan. 1, 1977	Nonpart 36 2-3 engine jets Jan. 1, 1977	Nonpart 36 B-747'3 Jan. 1, 1977	Nonpart 36 standard 4-engine jets Jan. 1, 1977	Cost to retrofit 2-3 engine jets[1] (millions)	Surcharge collections/ entitlements[2] (millions)
AA	235	99	8	85	$37.9	$567.8
BN	86	53	1	11	20.4	163.7
CO	56	32			12.3	160.2
DL	179	80	3	13	24.4	460.2
EA	228	168			57.7	535.4
NA	53	38			14.6	89.4
NW	113	55	17	8	21.1	212.9
PA	114	13		64	5.0	151.5
TW	233	90	10	100	32.8	428.4
UA	364	209	12	100	84.6	651.3
WA	74	29		23	12.8	168.7
FT	19			16		26.4
AL	80	72			23.4	120.6
FL	21	20			9.1	51.2
NC	27	19			5.5	48.3
OZ	28	27			7.8	41.2
PI	20	20			9.1	40.2
RW	37	34			9.9	52.1
SO	28	28			8.2	34.1
TI	22	21			6.0	30.1
HA	8	2			.5	18.1
TS	8	8			3.7	13.1
WC	7	4			1.8	14.3
AS	10	10			3.8	19.1
Total	2,050	1,131	51	420	412.4	4,089.3

1/ Based upon number of nonpart 36 2- and 3-engine jets as of Jan. 1, 1977; times the estimated cost of SAM retrofit of each type in 1981 dollars.

Based upon ATA proposed domestic and international surcharges over a 10-year period beginning Jan. 1, 1977, as follows: Domestic Fares 2%; Domestic Waybills 2%; International Departures $2. Traffic has been estimated to increase at a 5% annual rate. Current fare levels have been assumed for the entire 10-year period.

Source: House Subcommittee on Aviation, Hearings on H.R. 4539 p. 111.

Formula for Payment from Fund: For the purpose of analyzing the factors affecting the retirement of jet aircraft, the section dealing with the entitlement formula for allocating funds from the special surcharge accounts is of key importance. Some seemingly minor word or percentage changes can significantly alter the retirement plans of operators. This is particularly true of carriers in a weak financial position. As this and subsequent versions of the bill were presented and amended, it was fascinating to observe the ebb and flow of changes as different interests obtained the ear of the legislators and as the legislators bargained within their group for a consensus.

The legislation provided that within 30 days after the publishing of the inventory of non-compliant aircraft, the "owners" (later changed to "operators") would advise the Secretary which of three methods they would employ to bring their aircraft into compliance by the dealines dates. Each method entailed a different cost to the carrier. The formula provided reimbursement from the special surcharge funds as follows:

Retrofit:	75% of the cost of retrofit
Replacement of engines	150% of the cost of retrofit
Replacement of aircraft	250% of cost of retrofit

As has been mentioned, there had been a great deal of controversy over whether there should be any rule at all for retrofitting the two- and three-engined airplanes on the ground that any modification would be barely, if at all, discernible. There was almost complete agreement that the 4-engine 707s and DC-8s

should be replaced in view of their age and fuel inefficiency. Thus, presumably the formula was designed to encourage retirement of these aircraft and their replacement by newer technology airplanes with high-bypass engines. At first glance the percentages suggest this to be the case. However, "plugging in" a few realistic numbers shows that the incentive was to retrofit rather than to retire. The "ball park" figures in Table 8 are illustrative.

TABLE 8

APPLICATION OF THE 75%, 150% AND 250% FORMULA OF H.R. 4539

707 --- DC-8 (1980 DOLLARS)

	Est. Cost Per Aircraft	Entitlement Formula	Balance to be Raised	% of Cost From Fund
Retrofit	$2,160,000	$1,620,000	$540,000	75%
Replace engines	8,000,000	2,430,000	5,570,000	30%
Replace aircraft	23,000,000	4,050,000	18,900,000	17.6%
Replace aircraft	33,000,000	4,050,000	28,960,000	12.3%

It is evident that 250% of retrofit cost for replacement provides less than 20% of replacement cost for medium sized aircraft. Should the replacement be with the larger wide-bodied DC-10 or L-1011 types or newer technology types in the price range of $30-35 million, the figure would fall to around 12%. Table 5 (p. 37)

shows United and TWA each had about 100 such planes and American 88. Simple multiplication shows the enormous capital cost of replacement.

It is clear that the formula merely ensured that carriers in weak financial condition would be forced to retrofit and retain their old fleet whereas carriers with independent means, such as Delta and Northwest, to name two, would buy new more efficient aircraft and obtain a competitive advantage. The ATA calculated that the total cost of retrofit for its member airlines was approximately $1 billion as is shown in Table 9. Assuming the formula was so strongly "tilted" toward SAM retrofit that retrofit was the option used, the ten year collections would bring in $4 billion but retrofit would cost $750 million ($1 billion X 75%), leaving unspent $3.25 billion. The sum would be actually less because those few carriers without financial constraints would replace aircraft and use the funds, up to their entitlement, to reduce their cost of their ongoing re-equipment program. There was no capacity limit in the bill; it was to come later. The position, therefore, of the carriers and the aircraft manufacturers was that the bill would result in slowing down the retirement process, impede the introduction of new more efficient and quieter aircraft, and fail to respond to the unemployment problem.

D.3.4 Other Criticisms Of H.R. 4539

Unfairness to Pan American: The varying financial position

TABLE 9

ESTIMATED RETROFIT COST ATA AIRLINE MEMBER FLEET
(Based on U.S. Aircraft Only Being Retrofitted)

Aircraft	Current ATA Fleet Non-Part 36/Part 36 1975	1980 ATA Fleet Non-Part 36/Part 36	Cost Per Ship Set (1980 $) includes Spares (20%) & Labor (6%)	Fleet Capital Cost (1980 $)
DC-9 (all models)	330/7	300/60	$ 273,297	$ 81,989,100
B-737	122/2	121/9	431,520	52,213,920
BAC-111	31/0	27/0	350,000	9,450,000
B-727 100/200	620/136	600/245	195,441	117,264,600
B-707-B100-300	268/0	206/0	2,160,000	444,960,000
B-720-B	18/0	15/0	2,160,000	32,400,000
DC-8 21/31	31/0	23/0	516,432	11,877,936
DC-8 50/61	99/0	74/0	2,323,944	171,971,856
DC-8 62/63	31/0	28/0	1,678,404	46,995,312
B-747 (all models)	51/44	48/75	482,744	23,171,712
Totals	1601/189	1442/389		$992,294,436 1/

ATA Airline Member Fleet Annual Operating Cost Penalties

Added Fuel Cost - FAA forecasts 4,000 barrels a day or 1,424,000 barrels per year 60,808,000 gallons per year at 1980 cost of	$24.140,776
Added Maintenance Cost - B-707 only per year (1980)	3,037,410
Added Annual Operating Cost (1980)	27,178,186

1/ "Down-time cost is not included nor is cost of interest - interest would add 10%.

Source: Hearings on H.R. 4539 House Sub-Committee on Aviation, Committee on Public Works and Transportation, 2/17/76, p. 797.

and the status of differing fleet mixes of the carriers made it impossible for the ATA to present a unified position to Congress. Pan American pointed out that it would suffer a competitive disadvantage with its foreign competitors because it would be obligated to raise its fares 2% but its foreign competitors would not. It recommended an additional $2 departure tax for all international carriers.

The Cross-Subsidy Issue: The bill provided that any excess money not used by a carrier would revert to the Airport and Airway Trust Fund. However, in the event a carrier needed more money than the surcharge would provide, the Secretary of Transportation could dip into the Trust Fund to supply the necessary amount.

This became known as the cross-subsidy clause. Delta and Northwest were particularly hostile to such a provision on the ground that they, through efficient management, had gone ahead and spent large sums in modernizing their fleets, so that it was unfair to require their passengers to subsidize their competitors. The ATA, to keep these carriers on the airline team, testified against the cross-subsidy subsection. On the other hand, Pan American strongly supported the provision as necessary to provide a "competitive balance of equipment." Using figures found in Table 7, p. 58, an Executive Vice President of Pan American pointed out that American would have $6.68 million, Braniff $14.8 million, and Delta $35.5 million to replace or modify each plane while

PA would have $2.36 million.[16/] The Secretary of Transportation also opposed the cross-subsidy provision and it was dropped from succeeding bills. Pan American's real objection - the fact that the $2 departure tax failed to provide sufficient funds to replace their noisy planes - was later met by increasing the charge to $10 for fares of over $100.

D.3.5 The Administration Position On H.R. 4539

On May 5, 1977, the last day of hearings on H.R. 4539, DOT Secretary Adams in testifying on the bill proposed changes which, if enacted, would have markedly affected managements' decisions on retrofit, re-engining or replacement. Two months earlier, on March 3, 1977, the FAA issued Amendment 36-7 to FAR Part 36 requiring significant noise reductions in newly designed aircraft.[17/] The effective date was Octover 1, 1977. This immediately raised the question why the financing should not be structured to encourage the replacement of aircraft by the quietest planes instead of by those merely meeting the old 1969 standard. Accordingly, the Administration proposal was as follows:

16/ Hearings on H.R. 4539, House Subcommittee on Aviation, April 21, 1977, p. 466. Testimony of W.W. Waltrip.

17/ Aircraft meeting the FAR 36-7 standard (subsequently modified by Amendment 8) are now known as Stage 3 aircraft. Earlier aircraft meeting the 1969 rule are known as Stage 2 aircraft and complying with neither are Stage 1.

35% of replacement cost providing the replacement airplane met the March 3 published standards.

100% of the cost of re-engining, not to exceed 35% of replacement cost for replacing the plane.

100% of the cost of retrofit for retrofit.

If we use the same format as for the H.R. 4539 calculation we have the following:

TABLE 10

APPLICATION OF ADMINISTRATION MAY 5 PROPOSAL

707 ---DC-8 (1980 DOLLARS)

	Est. Cost per Aircraft	Entitlement Formula	Balance to be Raised	% of Cost from Fund
Retrofit	$ 2,160,000	$ 2,160,000	0	100%
Replace engines	8,000,000	8,000,000	0	100%
Replace aircraft)	23,000,000	8,050,000	$14,980,000	35%
Replace aircraft)	33,000,000	11,550,000	21,450,000	35%

Assuming other factors of the bill remained the same, which they did not, the proposal missed the target. Although the amount available for retrofit was increased to 100%, the 100% available for replacing engines was a much larger figure and hence was a shift in emphasis toward replacing engines. A carrier with a large number of 4-engine aircraft (100 in the case of TWA) and a weak

balance sheet (TWA) out of economic necessity would be forced to choose replacing engines. On the other hand, another carrier with a strong balance sheet and a desire to have the competitive advantage of the newest technology aircraft, could opt for an $8 to $11 million discount on the purchase price of a replacement aircraft during the years of surcharge. Another way of putting it is to equate it with a 4-year rollback in inflation. While the hearings were replete with statements which drew no objection that replacement would result in quieter, more technically efficient planes, particularly in the area of fuel consumption, together with increased employment, and enhancement of U.S. technical superiority, and an aid to the balance of payments problem, the formula in most instances tilted a management's choice to replacing engines or retrofit rather than to replacing aircraft.

Voluntary vs. Mandatory Surcharge: One of Secretary Adams' proposals came as a shock to the industry. He proposed that a carrier could establish a surcharge or not, as it saw fit. Objections from the "have nots" in the industry immediately surfaced. They pointed out that since carriers competed with each other, a two-tier pricing system could not survive. If one well-financed carrier chose not to increase its fares, all the others would be forced to follow suit or lose business. Thus, the entire financing package would fall apart. Interestingly, the press reported [18/]

18/ Aviation Daily, May 11, 1977. p. 57.

that the surcharge financing concept, as originally proposed by Adams, was opposed by President Carter's staff and the Office of Management and Budget. President Carter, while accepting the surcharge concept ordered Adams to support only a voluntary surcharge.

D.3.6 Minority View Of Bill

The most frequent and articulate opponent of the bill (and of subsequent bills) on the subcommittee was Rep. Gene Snyder (R. Ky.) who, from time to time, introduced amendments which would have emasculated the bill. His H.R. 5706 attempted to protect aircraft operators from law suits for damages because of aircraft noise by providing that no person would have standing to bring a suit for compensation for damages from aircraft noise if he leased or purchased the property after the airport was established. His bill in effect repealed FAR 91-136 by providing that no aircraft manufactured before January 1, 1974, would have to comply with the FAA noise rule 91-136. Efforts to delete or minimize the application of 2- and 3-engine aircraft from the FAA rule ultimately were unsuccessful.

D.4 RETROFIT DE-EMPHASIZED - H.R. 8124

On the basis of testimony on H.R. 4539, Rep. Anderson on June 30, 1977, introduced a new bill, H.R. 8124, which changed the thrust of financing in significant ways. Briefly, they were as follows:

D.4.1 Relaxing Compliance Date For 2- And 3-Engine Airplanes

As a result of the considerable testimony that retrofitting the JT8D 727s, 737s, and DC-9s would result in little discernible change to the human ear, the compliance date for these aircraft was extended 7 years to 1990. Since there were 1,131 such aircraft on January 1, 1977, over 50% of the entire fleet and over 70% of the non-FAR fleet was involved.

D.4.2 Less Emphasis On Retrofit In The Payment Formula

(a) Retrofit: In the new bill, on the ground that retrofitting 4-engined, old, noisy, fuel-inefficient planes was a waste of resources, the percentage allowance was fixed at 50% as compared with the 75% in H.R. 4359 and the 100% in the Adams proposal. The percentage for the 2- and 3-engined planes constructed before January 1, 1974 was 90% unless advantage was taken of the 7-year extension. In that case the figure was 50%.

(b) Re-engine: Here the concept of relating entitlements for re-engining to a percent of the cost of retrofit, as was the case in the previous bill, was replaced by one of the percentage of cost of re-engining, with a ceiling limited to the relationship of the cost of replacement. It will be recalled that in March the FAA had issued stricter noise rules (Amendment 36-7) for new Stage 3 aircraft. The committee was anxious for modifications to use the best technology. Therefore, the provision was for 75% of re-engine costs, provided the aircraft then met Stage 3, but not

to exceed 35% of the cost of replacing the airplane. Here again, a penalty was attached for taking advantage of the seven year extension. If a carrier waited until after January 1, 1985, it would received only 25% of re-engining costs.

(c) Replacement: A similar tilt toward using the best technology quickly was used for the replacement percentages. Here also the concept of relating replacement to a percentage of retrofit was abandoned in favor of a relation to the cost of replacement. In general, the amount was 35% of the replacement cost of a Stage 3 aircraft and 20% for meeting the FAR January 1, 1977 standard.

For 2-engine airplanes and 727-200s constructed before January 1, 1974 and being replaced between 1985 and 1990, the figure was 10% of replacement cost to meet Amendment 7 and 0 to meet the earlier standard. One sample calculation gives the following results:

TABLE 11

APPLICATION OF H.R. 8124 FORMULA

707 ---DC-8 (1980 DOLLARS)

	Est. Cost per Aircraft	Entitlement Formula	Balance to be Raised	% of Cost from Fund
Retrofit	$ 2,160,000	$ 1,080,000	$ 1,080,000	50%
Replace engines	8,000,000	6,000,000	2,000,000	75%
Replace aircraft)	23,000,000	8,050,000	15,950,000	35%
Replace aircraft)	33,000,000	11,550,000	21,450,000	35%

The formula portion of the bill was one which the airlines could accept. Although retrofit allowances were reduced, no one, at least of the 4-engined operators, wanted to retrofit anyway. At this time, few airlines looked upon replacing engines as a reasonable alternative, unless they could not get financing for replacing the entire airplane. The replacement percentage of 35% was even 5% higher than the Vice President of American Airlines, Donald Lloyd-Jones, had suggested as an adequate figure.[19/] In essence, the cost to the company from its regular sources of income would be rolled back to about the 1975 costs. However, other sections of the new bill presented problems.

D.4.3 Surcharge Collections

The collections were to be 2% of domestic passenger fares, domestic and international freight waybills, plus a $3 international departure tax. The most important surcharge change was that instead of accruing for ten years, it would accrue mandatorily for the first five years and voluntarily for the next five. This was a compromise between the Carter proposal of 10-year voluntary and the ATA 10-year mandatory. As is detailed later, it also was a mechanism to keep Delta and Northwest in support of the bill. Since there was general agreement that the voluntary system would not work, airline managements drew the conclusion that the amount

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19/ Hearings on H.R. 4359, op cit., p. 507.

available for assistance was just cut in half.

D.4.4 Subsequent Sale Or Lease Of Re-engined Or Replacement Airplanes

In deciding whether to retire or re-engine a plane, airline managements were faced with restrictions on selling replacement planes for 15 years, unless they paid back the total surcharge. A 5-year limitation on selling re-engined planes was established, unless the surcharges were paid back.

D.4.5 The Buy American And Equal Capacity Replacement Clauses

A replacement airplane could not be bought with surcharge money unless over 50% of the airplane price was attributable to United States materials or labor. The reason for this was not clear inasmuch as Col. Borman, President of Eastern, which had the A300 under close investigation, testified that over 50% of the price of the A300 was attributable to U.S. construction.

Finally, since replacement airplanes were likely to have a larger capacity than the planes they replaced, some expressed the fear that a wealthy carrier could vastly increase its capacity by buying larger planes. Accordingly, this bill and all subsequent bills limited replacement to 107% of the non-compliant airplane seats and to 107% of non-compliant airplane cargo capacity.

D.4.6 Summary

As of July, 1977, with H.R. 8124 the airlines and aircraft

and engine manufacturers were encouraged that the 2- and 3-engine aircraft might escape retrofit and that considerable incentive had been given to retire the old 707 and DC-8 aircraft. On the other hand, they were concerned that governmentally imposed restrictions on the sale and lease of aircraft might force them to cancel replacement plans. The environmentalists were upset that the majority of the non-FAR airplanes which also made the most flights into noise impacted regions, were being exempted. The minority, through Rep. Snyder, considered the bill a "rip-off" for the benefit of airlines, bankers, and aircraft manufacturers.

D.5 A REDUCTION IN FINANCING BENEFITS - H.R. 8729 AUG. 3, 1977

The optimism which the airlines felt over financing assistance because of the provisions of H.R. 8124 soon evaporated when a new bill, H.R. 8729, was introduced by Rep. Anderson on August 3, 1977. As a result of pressures from environmentalists and the ranking minority member, the changes contained in H.R. 8729 adversely affected financing benefits in three significant ways.

D.5.1 Deletion Of The 7-Year Extension For 2 And 3-Engine Jets

Although the extension in H.R. 8124 was for 7 years, the net effect for all practical purposes was presumed to kill the retrofitting of the 2- and 3-engined aircraft. Since Table 7, (p. 58), indicates a cost of over $400 million for the SAM retro-

fit, this amount, if deleted, could have been applied to help pay for new aircraft and accelerate the retirement of old aircraft. However, the new bill reinstated the dates in 91-136, the 1976 FAA rule, thus requiring the expenditure of over $400 million for retrofit. Thus, a reassessment of retirement plans, assumed before H.R. 8124 was introduced, became a necessity. This change heightened the element of uncertainty in planning.

D.5.2 Changing Of The Base Date For Determining Eligibility For Surcharge Entitlements

Prior to H.R. 8729's introduction, the non-compliant airplanes eligible for financing assistance were those in service January 1, 1977. Under the new bill, the date was moved to July 1, 1977 - six months later. During the intervening 6 months, various airlines had made fleet changes toward compliance with the FAR 91-136. For example, American added 5 new complying aircraft and disposed of a non-complying 707. Delta had 16 changes in its fleet, acquiring nine 727-200s and disposing of 7 non-complying planes. The new date would remove them from application of the formula. Faced with this kind of a possibility, retirement of noisy aircraft would be delayed. The incentive would be to maintain the status quo until Congress decided upon a final bill. The very carriers doing the most to bring their fleets into line with the rule were being penalized.

D.5.3 Reducing The Entitlement Computation Base By The Accrued Depreciation

As noted, the previous formula embodied a figure of 35% of replacement cost if the replacement airplane met the March 3, rule, and 20% if it met the January 1 requirement. Minority members of the House Committee argued that the carriers already enjoyed financial offsets by reason of depreciation charges and such charges should be subtracted from the computation base. Accordingly, the new bill provided that the replacement cost against which the percentage would be applied:

> shall be the actual cost reduced by the aggregate amount allowable under the Internal Revenue Code of 1954 for depreciation or amortization with respect to the aircraft being replaced, for periods before the date of acquisition of the replacement aircraft. 20/

The results of applying this provision to two assumed replacement prices for early 707 and DC-8 aircraft, whose constructive purchase prices were about $7,100,000 and using a residual of $100,000, is shown on Table 12.

TABLE 12

APPLICATION OF DEPRECIATION DEDUCTION AUGUST 3, 1977 VERSION OF H.R. 8729

707 and DC-8 AIRCRAFT

Estimated Replacement Cost	Accrued Depreciation	Base for Formula	From Fund at 35%	Amount To Be Raised Privately	Reduction From H.R. 8124
$23,000,000	$7,000,000	$16,000,000	$5,600,000	$17,400,000	$2,450,000
33,000,000	7,000,000	26,000,000	9,100,000	23,900,000	2,450,000

20/ 95th Cong. 1st Sess., H.R. 8729 Title III, Sec. 303 (b) (3)

These figures show a reduction in financing assistance by $2.5 million per plane. Although there was a rationale behind the theory of the deduction, as a practical fact, its application not only reduced the funds available to below the desired goal but also penalized the carriers with aggressive fleet replacement plans in operation. Delta estimated the adverse effect to be $100 million.

Some carriers, such as Delta and Northwest, had depreciated planes for tax purposes as quickly as possible for cash flow purposes. For the early planes, the rate was 7 years on the double declining balance (DDB) method and, under current rules, on a 9-1/2 year DDB. At the other end of the scale were those using the CAB standard of 14 years for turbofans or 16 years for widebodies to enhance reported earnings under the new bill. Utilizing the double declining balance on a 7-year basis would entail 4 times the penalty for such a carrier, and at the end of 7 years the penalty would still be double that for those carriers using a maximum life. In private conversations, the carriers referred to this as "the big wipe-out."

D.5.4 Other Provisions

Slightly offsetting the effect of reintroducing compliance by 2- and 3-engine aircraft was a "safety valve" provision which permitted the Secretary of Transportation to waive the application of the regulations to such aircraft for such time as seemed

reasonable. No standards were established for the Secretary's guidance. The most likely potential use of the waiver involved certain 4-engined craft on which manufacturers might drag their feet on building retrofit kits. Conceivably in a certain economic situation with an amenable Secretary of Transportation, the whole retrofit program could be jeopardized.

Based upon complaint of Pan American that the surcharges were inadequate for international operations, two increases were provided. One, the 2% property surcharge was changed to 5%, and, two, the $3 U.S. Departure Tax was changed to $10 on fares of $100 or more, and $2 on fares of less than $100.

A significant benefit to the carriers was the elimination of the funds received from inclusion in gross income under the Internal Revenue code - a provision which was to draw continuous criticism from the Treasury and Representative Snyder.

Finally, the bill contained a Title IV which could be read to be in opposition to federal pre-emption. This was a direct blow to the ATA contention that for uniformity federal pre-emption was a must.

D.6 RESTORATION OF BENEFITS BY SUBCOMMITTEE AND FULL COMMITTEE

To recapitulate, after several years of hearings emphasizing the desirability of replacement over retrofit, the first draft of the Airport and Aircraft Noise Reduction Act, H.R. 4539, contained incentives for retrofit rather than replacement. Secretary Adams

proposed a marked shift away from retrofit as did the subsequent bill H.R. 8124. Within a month, H.R. 8124 was superseded by H.R. 8729 which again reversed course in providing benefits and introduced a provision said to be discriminatory against efficient self-sufficient carriers. As a result, the adversely affected parties marshalled their Washington forces to correct the inequities.

Earlier in this report we alluded to the initial lack of enthusiasm for any financing bill by financially strong carriers who had engaged in equipment modernization programs meeting FAA noise requirements. These carriers objected to helping the weaker lines, apparently preferring to see them "go down the tube." Secondly, they most strenuously objected to any cross-subsidy features in which their passengers would be taxed to preserve the existence of less efficient competitors. The ATA had a most difficult time in developing a position upon which all carriers could agree. It was only when the cross-subsidy was dropped and Delta and Northwest found that they too could enhance their on-going programs through using the surcharge funds that they became not only willing but aggressive parties in favor of financing legislation.

Given the strength and politics of those who considered the whole financing arrangement as special interest legislation, all that would be needed to defeat the bill would be for several airlines to turn against it using as a reason favoritism to selected inefficient carriers. Thus the price of support from such car-

riers as Delta and Northwest was satisfying their complaint that they were being discriminated against. Table 13 shows that Delta would have to return $48 million of its charges to the trust fund, Eastern $188 million, Northwest $67 million, National $20 million, and Continental $40 million. All the other trunks were eligible to use far more than their collections.

Secretary Adams was sympathetic to some of the carrier complaints and urged an increase in the percentages for replacement as partial compensation for the depreciation deduction. He also recommended a 100% coverage for retrofit. The depreciation deduction he found "counterproductive" and the 15-year restriction on selling replacement aircraft and the 5-year restriction for re-engined aircraft "unnecessarily restrictive." Additionally, he favored eliminating the "buy American" provision for fear of international retaliation. On the other hand, he again reiterated the Carter position that the whole surcharge plan should be voluntary. Finally, he indicated that the $10 international rate for Pan American was "excessive and inflationary."

A markup session for the subcommittee to amend the bill was held on September 20, 1977 but the proceedings were blocked by Rep. Snyder's use of a parliamentary technicality. His real complaint was that he had a commitment from the chairman of the full committee, Harold Johnson, that the bill would: (1) prevent the use of federal funds for replacing planes which would be retired before January 1, 1985 (the noise compliance date); (2) provide

TABLE 13

COMPARISON OF SURCHARGE COLLECTIONS AND ENTITLEMENTS
UNDER H.R. 8729 AND PROPOSED MODIFICATIONS
TO ALL ATA MEMBER CARRIERS
(Millions of Dollars)

AIRLINES	SURCHARGE COLLECTIONS 1/	ENTITLEMENTS UNDER HR 8729	ENTITLEMENTS UNDER PROPOSED MOD.
AA	315	524	630
BN	94	117	144
CO	59	17	21
DL	247	199	227
EA	335	147	206
NA	50	30	40
NW	127	60	104
PA	312	517	598
TW	258	622	724
UA	288	773	947
WA	84	115	130
AL	49	20	20
FL	21	8	8
NC	20	5	5
OZ	17	6	6
PI	16	8	8
RW	22	8	8
SO	15	7	7
TI	13	5	5
FT	55	90	90
AS	7	18	27
WC	6	2	2
HA	8	1	1
TS	5	3	3
TOTALS	2423	3302	3961

1/ Assuming 5 year domestic/10 year international surcharges, under HR 8729. Proposed modification have no substantial effect on collected amounts.

Source: ATA

that the funds would be proportionate to the useful remaining life of the replaced plane; and (3) explicitly prohibit banks or financial institutions from receiving any benefits under the bill. However, the markup did take place days later on September 23.

D.6.1 Subcommittee Amendments Of September 23 - Enhancing Replacement And Re-engining

The amendments can be summarized as follows:

6.1.1 The Formula. After the committee amendments,[20/] the financing formula was as follows:

Retrofit	90% for 2- and 3-engined planes 50% for 4-engined planes
Re-engine	75% of cost of re-engining not to exceed 40% of the cost of replacement.
Replacement	35% of replacement cost for March 3 standards 25% of replacement cost for January 1 standards Prior to applying the above percentages, the replacement cost would be reduced by the excess, if any, of depreciation over the amount treated as ordinary income in the disposition of the replaced aircraft.

The retrofit formula represented no change from the June and August bills. The re-engining figure of 40% involved a 5% increase from previous bills and actually provided a greater dollar benefit than the 35% for replacement. The difference was more than 5% of the cost of replacement average because in the case of replacement

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20/ H.R. 8729 showing amendment adopted by the Subcommittee on Aviation [Committee Print] September 27, 1977.

the depreciation deduction was taken from the replacement cost before applying the percentage. Since re-engining was 1/3 to 1/2 the cost of replacement, the balance to be raised would be much smaller.

6.1.2 Eligibility Date Moved To January 24, 1977, From July 1: Each airline has its own special problems and when a few have the same problem they can combine to seek a consensus. The prospect of success is enhanced if what they seek does not hurt another carrier and has a rational basis. An amendment moving the eligibility date back to January 24 (the true effective date of the December 23 order) benefitted the industry by $41,200,000 according to ATA calculations. As indicated in Table 14 below, the amounts varied widely among selected carriers.

TABLE 14

EFFECT OF DATE CHANGE ON SELECTED CARRIERS

American	$8,000,000
North Central	8,000,000
Pan Am	4,300,000
Flying Tiger	5,000,000
Western	5,000,000
Braniff	3,000,000
Continental	100,000
TWA	100,000
National	0
United	0

Source: ATA

If one assumes a $24,000,000 new technology replacement airplane requires 4 years from date of order to significant deliveries and that the manufacturer requires 30% down by date of delivery with payments to begin at once and be amortized evenly, the $8,000,000 made available by the date change could provide one year's progress payments on 4 aircraft which would involve the ultimate retirement of more than 4 aircraft. Thus, this date change was not insignificant.

6.1.3 The Depreciation Offset: Delta and Northwest strongly argued that the depreciation deduction was a blow against efficient operators using conservative financial practices such as DDB. The greater the depreciation, the bigger the deduction from their cost basis before applying the formula percentage figure for replacement money. Thus their incentive for retirement was decreased while the incentive for re-engining would be increased. Since the sale of a used aircraft over book value is an indication that depreciation is excessive and since the amount is treated as ordinary income and so taxed, they argued that the deduction for depreciation should be offset by the amount realized as ordinary income on a sale. Both Delta and Northwest have been very successful in disposing of old aircraft with little or no value on the books for prices close to or exceeding their original purchase price. In these cases applying the offset completely eliminates the deduction so that the carriers would be back to the benefits under the old H.R. 8124. (See Table 11, p. 69).

Not only was this type of offset important for retiring old relatively cheap (by current standards) planes but also for newer more expensive types. For example, suppose a carrier owning three non-complying 747s, each costing about $22 million, contracted to sell them for a total of $43 million after three years of ownership. Having used depreciation on the double declining balance method, $36 million in depreciation would have to be deducted under the first version of H.R. 8729. This would be $12 million per plane from a replacement figure using our standard $33 million assumed replacement cost. Thus the money available from the fund would be $7.35 million for each plane [($33 million-$12 million) X 35%]. Assuming the sale price of $14.3 million each, the deduction would now be $7.7 million so that the fund could supply financing assistance of $8.9 million. Thus the September amendment added $3.6 million financing assistance on this particular transaction.

6.1.4 Replacement Percentages: Since the 35% figure was retained for aircraft meeting the March 3 standards (Stage 3), while the 20% for the old standards of January 1 was increased to 25%, once again it appeared that a step backward was taken from increasing the incentive for replacement. As has been just pointed out, with a re-engine limit of 49% of replacement cost and only a 35% limit for replacing the entire aircraft the total dollars required for replacement were very much more than for re-engining.

C-2

Considering capital constraints this split would cause carriers to take a very close look at re-engining which would, of course, have an adverse effect upon retirement of aircraft.

6.1.5 Other Changes Made By The September Amendments:

Several other changes of interest to us were made.

1. Improving the domestic market for 2- and 3-engine non-complying used aircraft.

Some carriers cannot afford to purchase new aircraft and often there are no new aircraft of the correct size available. If carriers were to purchase a non-complying aircraft after January 1, 1977, they would be ineligible to use surcharge money to retrofit such an aircraft. The ATA proposed that these carriers have access to the same financing mechanism as the original operators. The ATA suggestion was adopted including a recommendation, the reason for which is not clear, that the replacement entitlement of the original operator should then be reduced by the amount of the retrofit entitlement. This reduction was criticised by the Secretary as an attempt to cure an inequity which did not exist. He also argued that the new provision placed an undeserved penalty on the selling carrier. 21/

2. Elimination of Title IV

Title IV had weakened the airlines' position with regard to

21/ October 19, 1977, letter from Secretary Adams to Chairman of Committee on Public Works and Transportation, House of Representatives, p. 2-3.

federal preemption. Its elimination was gratifying to the industry.

3. Reduction of the period within which a carrier could not sell its replacement airplane without losing a portion of surcharge funds used to purchase the aircraft.

The former figure of 15 years was reduced to 5 thus restoring to management some degree of flexibility in decision making and giving management an opportunity to change equipment with changing conditions.

4. "Buy America"

This provision was deleted, thus reducing problems with foreign manufacturers and foreign governments.

5. Guidelines for granting waivers of compliance

As previously noted, an early bill gave the Secretary very broad powers to grant waivers of compliance with no limiting guidelines. The new provision required a finding of "good cause" which was defined as: (1) a case where the supplier could not furnish in timely manner the necessary engine retrofit kets, replacement engines, or replacement aircraft; (2) any case where the operator could not obtain financing at reasonable rates; (3) any case where compliance would result in the inability to operate the aircraft so that service to the public would end; and (4) any other circumstances the Secretary deemed appropriate.

D.6.2 DOT Position: Further Increase In Entitlements Desirable

The final opportunity for those for and against financing

assistance to affect the legislation to go before the House came at the full committee markup October 20. The administration in general favored the airline view and made the following points and suggestions in a letter to Chairman Johnson.[22/]

6.2.1 Formula: Replacement Vs. Re-enginging: The change increasing the percentage for January 1 standards to 25% while at the same time keeping the replacement percentage at 35% and increasing the re-engine figure to 40% exacerbated the basic problem with the section which was its failure to provide sufficient incentive to purchase new quieter designs; it was to the distinct advantage of the carriers to buy older designs. The Secretary recommended that no funds be provided for replacing with aircraft meeting only the lower standards of January 1, 1977.

6.2.2 Cost Reduction For Depreciation: The Secretary argued that while the offset amendment modified the extreme penalty of the depreciation deduction, the result would still be to discourage replacement of older, noisy aircraft. The depreciation reduction provision, he said, should be deleted. Of course, such a deletion would have to contend with strong opposition from Rep. Gene Snyder for whose benefit the provision was inserted.

22/ Letter, Brock Adams to Chairman Harold T. Johnson, October 19, 1977.

6.2.3 International Concerns: Little attention had been paid to foreign carriers who under the bill would be required to levy the surcharge but could not use the revenues to purchase new aircraft or modify old ones. The inequity could be corrected by turning the money over to the foreign carriers. However, this would be a $1/2 billion transfer to foreign carriers without benefit to American carriers. The Secretary reiterated his September complaint that the $10 surcharge was excessive.

6.2.4 Excessive Powers Given To The Secretary: The most serious objection to the September 23 version was the broadness of the standards by which the Secretary would judge applications for exemptions. "They are so broad that airlines unwilling to comply with the regulations could by their own market decisions force a situation where the Secretary would have little choice but to grant exemptions." 23/

Finally, he pointed out that the requirement that the Secretary establish allowable costs of retrofitting, re-engining and replacement placed a heavy duty upon him with which he was not equipped to cope. He could have gone further and pointed out that the Secretary would be under great political pressure from the airlines and manufacturers to pick figures favorable to them with the consequent allegations of "deals."

23/ loc. cit.

D.6.3 H.R. 8729 Final Amendments October 20, 1977 Full Commitee

6.3.1 The Increase Of The Replacement Percentage To 40%:

As a result of various pressures the full committee approved an amendment increasing the replacement percentage to 40% which did two things, specifically, (1) eliminate the inequity of the September amendment under which a carrier could receive significantly more to re-engine at 40% of a replacement and no deduction for depreciation than for replacement; and (2) increase the actual dollar entitlement for replacement. Table 15 shows the collections and entitlements estimated by ATA for member airlines for both the 35% figure and 40%.

While entitlements of approximately $600 million for American and Pan American, $700 million for TWA and $900 million for UAL made satisfactory reading for the respective airline managements and their lenders, the availability of such funds through the surcharges was another matter. The original bill contained surcharge accruals for a 10 year period and was estimated to produce about $4 billion - the amount estimated by the ATA to be required in the final bill. However, the compromise of 5 years mandatory and another 5 voluntary cut ATA's estimate to $2.4 billion. An effort to restore the 10-year provision failed in the markup session as did a compromise effort of 7 years.

On an individual aircraft basis, assuming replacement costs of $23 million and $33 million, and assuming depreciation offset completely by depreciation recapture on sale, the 40% replacement

TABLE 15

ESTIMATED IMPACT OF MODIFIED
NOISE BILL
(MILLIONS OF DOLLARS)

Airline	Collections 1/	Entitlements 2/	Entitlements 4/
AA	315	547	607
BN	94	126	134
CO	59	19	19
DL	247	275	298
EA	335	176	176
NA	50	35	35
NW	127	135	142
PA	312	522	593
TW	258	634	712
UA	288	821	899
WA	84	115	130
FT	55	90	90
AL	49	20 3/	20 3/
FL	21	8	8
NC	20	5	5
OZ	17	6	6
PI	16	8	8
RW	22	8	8
SO	15	7	7
TI	13	5	5
AS	7	3	3
WC	6	2	2
HA	8	1	1
TS	5	3	3
Totals	2423	3571	3911

Notes: 1/ Assumes 5 year domestic / 10 year international surcharge collections.

2/ Provides entitlements of 25% for Part 36 and 35% for Part 36-7 aircraft; also provides for depreciation recapture.

3/ Assumes that carriers would exercise the retrofit option. Should they elect to replace non-complying aircraft, their entitlements would be greater.

4/ Provides entitlements of 25% for Part 36 and 40% for Part 36-7 aircraft, also provides for depreciation recapture.

Source: ATA

percentages develops a $9.2 million entitlement as compared with the previous $8.05 million for the $23 million replacement. And for the $33 million larger aircraft the resulting figure is $13.2 million or a $1.6 million increase. A recapitulation from the first bill to the one committed to the whole House on December 13, 1977, is shown on Table 16.

TABLE 16

SUMMARY FOR 707/DC-8 AIRCRAFT REPLACEMENT

ENTITLEMENTS

Bill or Proposal	Entitlements (in millions of dollars) $23 Million Aircraft	$33 Million Aircraft
H.R. 4359, March 7, 1977	$4.05	$ 4.05
Administration, May 5	8.05	11.55
H.R. 8124, June 30	8.05	11.55
H.R. 8729, August 3	5.60	9.10
H.R. 8729, September 23*	8.05	11.55
H.R. 8729, October 20	9.20	13.20

*Assuming old aircraft show maximum depreciation on the books.

Note: The figures for August 3, September 23, and December 13 are maximums. Should the depreciation and depreciation "recapture" be different than assumed, the entitlements would have to be adjusted accordingly.

Although within the ATA there was a problem of presenting a united front (at one time or another Delta, Northwest, Continental,

National, and even Eastern seemed ready to break ranks), the figures in the table which in March began with a $4.05 million maximum entitlement ended in October with $9.2 and $13 million. This would indicate that up to this point the ATA lobby was very successful. Of course, the ATA had a broad spectrum of supporters in its efforts. First, were the aircraft and engine manufacturers. However, because of differences among the customer airlines, the manufacturer's role was less visible. Manufacturers are very skittish about alienating customers. Obviously their interest was replacement by new design airplanes and their testimony did not understate the difficulties or disadvantages of retrofit and re-engining. Given the unemployment problem, labor unions were solidly on the side of financing assistance with emphasis on replacement. Understandably, the investment community strongly supported financial assistance in order to strengthen their customers, both the airlines and the manufacturers.

Additionally the bill was strongly supported by the environmentalists providing the 2- and 3-engine airplanes would not escape the timetable in the noise rule. Finally support came from many municipal authorities because of their hope for federal assistance with the noise problem.

6.3.2 Foreign Carriers Made Eligible For Surcharge Fund: Foreign air carriers have relatively the same number of jet aircraft as the U.S. carriers, i.e. 2000. Of these 2000 about 400

not meeting January 1, 1977 FAR 36 standards fly into the United States. Because of their longer range with the extra fuel loads required, these 400 tend to create higher noise levels. [23] Their retirement or modification would be looked upon with favor by the public and the aircraft manufacturers. In the debates much was said of the international problem of taking an action unilaterally. However, the committee recognized the inequity of making demands on and giving benefits to U.S. operators and not to foreign. It developed that in certain foreign countries there were already such things as a noise head tax and noise related landing charges which U.S. passengers paid.

The Committee passed an amendment which provided that the foreign carriers would be required to collect the surcharges applicable to international flights and could obtain a portion or all of the surcharges back as soon as its entire fleet operating in the United States met FAR part 36. To a certain extent this was discriminatory against domestic carriers. First, foreign carriers did not have a phased timetable as did U.S. carriers. Foreign carriers did not have to comply until 1985. Secondly, it was possible under the wording of the amendment for a foreign carrier to receive 100% of replacement, re-engine or retrofit cost. This is true because of the provision that when all the aircraft meet FAR 36 and are so certified as to the cost the Sec-

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[23] 95th Cong. 1st Session, House Report No. 95-836, Airport and Aircraft Noise Reduction Act, December 13, 1977, p. 12.

retary is required to return an amount equal to the certified expenses, but not to exceed the amount collected by the operator.

D.7 SUMMARY OF TITLE III AS ADOPTED BY FULL COMMITTEE

As adopted by the full committee on Public Works and Transportation of the House of Representatives on October 20 and reported December 13, 1977, Title III of the proposed Airport and Aircraft Noise Reduction Act, H.R. 8729 may be summarized as follows:

1. The Secretary of Transportation would publish the list of commercial jet aircraft weighing over 75,000 lbs. which were in for-hire service on January 24, 1977, and which did not meet the FAA noise regulations promulgated December 23, 1976, to be effective January 1, 1977.

2. Within 30 days the operator must advise the Secretary that he would comply with the rule and specify the means chosen: (1) retrofit, (2) replace engines, or (3) replace airplane.

3. To provide funds to support this program each domestic operator was required to impose a 2% surcharge on its before tax passenger and cargo tariffs. International cargo required a 5% surcharge. International passenger surcharge was $10 for fares of $100 or more, and $2 for lesser international fares.

4. In the case of U.S. carriers the funds were to be deposited into individual trust accounts to be withdrawn as needed under terms of a formula. In the case of foreign carriers the surcharges would go into one fund and utilized only upon certification that all the operator's aircraft operating into the U.S. complied with the rule. 1985 was the final limiting date.

5. Domestic surcharges are mandatory for the first five years and voluntary for the next five. International surcharges are mandatory for ten years.

6. Surcharges in the accounts would be withdrawn for the sole

purpose of noise abatement. The "Entitlements" for withdrawal were calculated by a formula intended to provide an incentive to replace non-compliant aircraft with compliant aircraft, preferably new technology aircraft meeting the stricter FAA (Stage 3) rule published March 3, 1977.

	Entitlement Formula
A. Retrofit:	2- and 3-engines: 90% of retrofit cost 4-engines: 50% of retrofit cost
B. Replacing engines:	75% of the cost of replacing engines but not to exceed 40% of the cost of a replacement plane meeting the March 3 rule
C. Replacing the Aircraft:	40% if cost of replacement if the aircraft meets the March 3 rule 25% if meeting the January 1 rule Before applying the above percentages, depreciation minus the ordinary income recovered on sale must be deducted. Non-complying aircraft could be sold with the buyer making the modification with his entitlement, and the seller losing an equivalent amount. Leasing of replacement aircraft was restricted to leasing to another air carrier for 5 years. If a replacement aircraft was sold within 5 years, a prorate of the used entitlement went to the Treasury. Replacement payments were limited to covering no more than 107% of seats of non-complying aircraft; 107% also was established for replacing dedicated cargo capacity.

7. Surcharges were not to be considered as gross income for Internal Revenue purposes.

8. No cross-subsidy. Excess surcharges above entitlements would go via the Treasury to the Airport and Airway Trust Fund.

9. The Secretary, through the FAA Administrator, could waive application of the regulations upon application by operator who showed "good faith" and there was "good cause" for failure to comply. The good cause was further defined as: (1) inability to obtain SAM kits, replacement engines, or replacement airplanes; (2) inability to obtain financing "at reasonable rates"; (3) inability to maintain scheduled service to the public; (4) "any other circumstances the Secretary deems appropriate."

D.7.1 Impact On The Federal Budget

Precise quantification of the effect of Title III on the Federal Budget is not possible. The revenue side, consisting primarily of aggregating passenger revenues of each carrier and projecting them forward for five years, is less complicated than estmating the cost side. The latter involves replacement assumptions versus re-engine versus retrofit decisions using some aircraft not yet designed and whose economic effects are under constant evaluation. The changing economic fortunes of the carriers which can be heavily influenced by route awards, by regulatory reform as well as by technological progress, widen the forcast bands of possibilities. With this caveat we present the estimates furnished to the legislators.

Assuming the 5-year mandatory period the Congressional Budget Office estimated that the surcharge "may result in excess revenue of approximately $100 million." [24/] Such a statistic was not overlooked by those pushing for the bill's passage. In view of the

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[24/] Ibid. p. 25.

fact that the FAA had estimated that the surcharges would produce $2.5 billion for U.S. Flag carriers, and that the ATA had estimated the entitlements to be about $4 billion, a word of explanation is in order. Simply stated, no carrier could withdraw more than its own surcharges no matter what the cost or entitlements were, whereas carriers whose surcharges exceeded their entitlements would have to refund the difference to the Treasury. Using the 1970-1976 financial results presented at the hearing, this meant that some of the neediest carriers would receive relatively less to meet their requirements than some more affluent carriers. The elimination of the cross-subsidy provision was the initial obvious cause of this situation.

However, a deeper explanation demonstrates the interaction of economic and political power. Considering the problem and the ultimate objective ATA had in keeping its members behind the bill, perhaps Anwar Sadat and Menachem Begin could consult the ATA on composing conflicts. Key sections of the bill were the result of successful maneuvering by Delta and Northwest whose support was absolutely essential. Profitable Northwest, led by President and Chairman Donald Nyrop, one of the last of the rugged individualists, was almost paranoid against permitting any money collected from its passengers being used to support equipment purchases by any of its competitors. The plight of other airlines, he openly stated, was due to incompetent management. Delta also felt that any use of its surcharges to weaken the competitive ad-

vantage it had carved out for itself was government intervention in private business of the worst sort. Northwest and Delta made it clear that they were in a position to "blow the bill out of the water" unless two primary demands were met.

The first demand was that no carrier's surcharges be used by any other carrier. The second demand was that regardless of how the rest of the carriers were affected these two carriers would have to be able to use all their surcharge money. They did not wish to refund anything to the Treasury. The original bill, it should be noted, called for a 10-year accrual and would have provided over $4 billion. In the breakdown of entitlements this would have provided Northwest and Delta with almost twice as much as they could use. Thus the 5-year figure not only was a compromise with the administration's position of voluntary surcharges for 10 years, but handily fit Northwest and Delta's requirements. In meeting these demands many other carriers had to sacrifice significant benefits. However, when faced wtih the choice of significant benefits, though inadequate, or no benefits, the other carriers, with the sword of Damocles hanging over their heads, felt they had no choice.

D.7.2 The Minority View

As had been suggested early in this section, the opponents to the bill were articulately represented by Rep. Gene Snyder of Kentucky who consistently objected not only to specific provisions but also to the philosophical basis of the legislation. His po-

sition is outlined in a minority report. 25/

In assessing the effect of Title III of the bill on the retirement of transport jet aircraft one must consider the possibilities of the successful progress of the bill through Congress and its ultimate approval by the President. The proponents of legislation often become overconvinced of the success of their project merely by rereading their own material. Therefore, it seems appropriate to highlight the objections of both those with a simple lack of enthusiasm and those who in less formal conversation use terms as "ripoff," "subsidy," or "wonderful gimmick." The contra opinions covered in the minority report may be summarized as follows.

Three signers of the report (Reps. Snyder, Ambro, and Goldwater) considered retrofitting a waste of money which should be spent on new technology aircraft, and at the final markup Rep. Snyder unsuccessfully again tried to repeal the FAA Amendment 91-136 of December 23, 1976, which would have voided the retrofit requirement. The minority report also commented that since FAR 91-136 did not have to be fully complied with until January 1, 1985, "There is no sane justification for giving owners or operators of aircraft financial assistance for replacing their equipment which will be totally depreciated and out of use prior to

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25/ Ibid, pp. 33-36.

January 1, 1985. [26] In regard to replacement, some of the minority felt that even the depreciation deduction was not enough to take away from replacement cost. It was argued that the percentage of life left in the old aircraft on January 1, 1985, if any, should be the percentage of cost of new replacement aircraft on which the 40% "subsidy" is computed. This would result in a de minimis amount.

Rep. Ambro commented that the replacement formula of 25% for the January 1 rule (Stage 2) and 40% for the March 3 rule (Stage 3) still did not provide enough incentive for new technology. However, his proposal was not to increase the 40% but to decrease the 25% to 20%. This was opposite to the concern expressed by some in Boeing who felt that the 40% to 25% spread was already too large to the detriment of some of their current technology aircraft sales potential. As an example, it was calculated that from their point of view a 10% spread was already a $1.3 million penalty on a 727 price.

Rep. Ambro also pointed out that the 5-year mandatory and 5-year voluntary surcharge was deficient for two reasons. First, a 10 year period as provided in the original bill was needed to collect the estimated needed sum of $4 billion. The 5-year mandatory period cut the amount collect in half. Secondly, the competitive pressures within the industry would ensure that the 5-year voluntary period would rever be utilized; thus the objective of

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[26] Ibid., p. 34.

the program would never be realized. We have already discussed the economic and political pressures which gave rise to this provision.

The minority report also expressed disappointment with the waiver provisions which seemed to contain broad economic loopholes for airlines not disposed to investing in noise control. It could well have added that whatever may be said on the merits of a series of limitation on the Secretary's power, the addition of the clause "Any other circumstances the Secretary deems appropriate" opened wide the door for possible abuses.

Between October and the end of 1977 there was no further House action and the Senate conducted no hearings.

D.7.3 1975-1977 Reviewed

The development of the jet transport in the 1950's and their introduction in significant numbers in the early 1960's represented a quantum jump in productivity for the industry. The coupling of larger size with an almost doubling of speed accompanied by more economical operation laid the basis for an increasing volume of flights. Unfortunately for society the first jets were exceedingly noisy. Although the introduction of the turbofan represented some improvement in the noise level, the sheer increase in number of operations more than compensated for the difference.

In 1969, bowing to public pressure, the FAA promulgated FAR Part 36 which provided that any newly designed certificated plane

must have a significantly lower level of noise emissions. Later in 1973 the rules were tightened to include any currently produced plane coming off the production line. This left 75% of the existing jet fleet uncovered by the regulations. In descending order of noise emissions were (1) the early pure jet 707s and DC-8s, (2) the turbofan 707 and DC-8s, and finally (3) the 2- and 3-engined turbofan jets such as the 727, 737, and DC-9 series. The wide-body high bypass 747, DC-10 and L-1011 met lower emission requirements.

Homeowners, school operators, and others located near airports continued their pressure for noise relief insisting that the noise rule be extended to cover the remaining 75% of jet transport aircraft. If previous history is to be used as a guide, often a dangerous assumption, many in the 707 and DC-8 fleets were on the point or beyond the time of their expected retirement from their first purchaser. Indeed they were approaching what had originally been assumed by many to be their design life.

However, during the 1970-1976 period the airlines were suffering reduced, and in some cases, negative earnings. Their position was that private financing to handle noise compliance expenses was just not available. Another section covers this changing financial perspective in detail.

As a result of extensive public hearings and many private discussions, in November, 1976, Secretary Coleman issued a policy statement indicating that the FAA would shortly publish a rule re-

quiring the earlier manufactured, non-complying, noisy planes to meet the 1969 rule over a period of time either by retrofitting, replacing engines, or retiring the aircraft. Such a rule was issued December 23, 1976. Although there was spread on the record a commitment by the FAA not to promulgate such a rule without a financing plan, the rule was so promulgated and initially the administration argued that the passage of a deregulation bill would improve the carriers' economic position sufficiently that financing would not be a problem. The airlines felt betrayed and immediately took their case to congress. At this time most airlines felt that deregulation would have serious negative financial effects.

The foregoing section depicted the ebb and flow of the battle between the airport neighbors and the airlines over the timing, method, and financing of the noise abatement. After first considering and rejecting the idea of refusing to take any steps toward compliance so as to face the government with a "fait accompli" and daring it to ground the aircraft, the ATA sought to support that part of broad noise control bills which would assist in the financing of either retrofit, replacing engines, or retiring the planes. Their strong preference was for retiring current planes and replacing them with quieter, more fuel-efficient airplanes. In this they were supported by the labor movement which saw more jobs, and by the aerospace industry which saw the need for keeping technology moving as well as the relative effect on the bottom line of their operations.

In tracing through the various versions of the bills H.R. 4539, 8124, and 8729 one develops a deeper understanding of the problem of uncertainty facing airline managements making equipment decisions. Those managements under severe financial constraints need to know the implications of their decisions. A decision made on the assumption that H.R. 4539 with its emphasis on retrofit would pass, would have been most unwise if H.R. 8124 with its elimination of the 2- and 3-engined aircraft from compliance were enacted. Similarly, at one stage H.R. 8729 had a higher percentage going to re-engining some than replacement, and replacement entitlements were reduced by depreciation charges. Accordingly, any carrier in extremely tight financial condition would have been forced to consider quite seriously re-engining some very old planes when retirement was the preferred course. Although H.R. 8729 as reported out by the full committee December 13, 1977, was quite satisfactory to the airlines, the fact that it had not been to the Ways and Means Committee, much less the Senate, indicated that it had a long way to go. Therefore, one must give much credence to the view voiced by many airline equipment decision makers in 1976 and 1977 that they were in a holding pattern until they knew the final outcome of the noise financing legislation.

However sincere these statements were, changing conditions cast a cloud over their continued validity for some carriers. The overcast of financial impossibility of the 1975-1976 period was replaced if not by broken clouds at least by rays of sunshine

in 1977. The change in direction of profitability wrought significant changes in the attitudes of certain carriers. Secondly, the overcapacity with which the industry was plagued began to disappear at an accelerated rate so that playing a waiting game might put some carriers at a competitive disadvantage with insufficient capacity. Finally, one situation which made it easier to say, "We won't move a muscle until a financing bill is passed," changed. This situation was the availability of a "better mousetrap" as a replacement airplane.

Over the past several years overcapacity and the absence of an economic new technology or derivative plane between the size of a wide-body and a 707 or DC-8 which also met the new more stringent noise standards was given as a further reason for not retiring the older planes. As traffic surged in 1977 some airlines became less certain that the DC-10, L-1011 and the A300 were too large. Further, intensive development by Boeing and McDonnell-Douglas of derivatives and new technology models had been slowly but surely sapping the non-availability argument of validity. Finally, the need for more aircraft due to growth, plus more interest on the part of lenders in providing funds, and the strong financial condition of several carriers whetted the appetite of a few carriers to participate in launching a new type aircraft, particularly if large savings in fuel consumption were involved.

Notwithstanding these latter developments, one can safely conclude that uncertainty concerning federal legislation over

financing assistance for retrofit, re-engining or replacement was the primary factor adversely affecting the retirement of jet transport aircraft in the 1975-1977 period.

D.8 1978 NOISE LEGISLATION

As 1978 opened, the industry was optimistic that financial assistance legislation for retiring older aircraft would be passed early in the session. There would then follow a flow of orders for newer, quieter and more fuel efficient aircraft and the older equipment would be sold to countries which had not yet perceived the noise problem. Because the bill before the House involved a change in the tax structure, it would have to go through the Ways and Means Committee before reaching the floor of the House and then the Senate. However, almost immediately the bill ran into unanticipated trouble. On January 16 the Airport Operator's International (AOCI), which had supported financing legislation in the past, expressed concern that the Anderson bill might bankrupt the Airport and Airways Trust Fund.

The next jolt occurred just a few days before the February 6 hearing before the Ways and Means Committee when, amid reports of better earnings by the carriers, TWA, which had consistently been pictured along with Eastern and Pan Am as the prime example of dire need, announced (1) vastly improved earnings, (2) that it was considering making acquisitions, (3) that it was reducing its ratio of debt to equity, and (4) that it would spend $3.8 billion on

aircraft by 1985. Additionally the Ways and Means Committee was not pleased at being largely bypassed by the House Public Works and Transportation Committee during the previous hearings on the bill. Notwithstanding the extensive support testimony by the ATA, the manufacturing industry, the airport operators, and the Department of Transportation through Secretary Brock Adams, heavy criticism developed along the following lines.[27/]

The Treasury Department objected that the financing would be "off budget" because there would be no tax on the surcharge revenues collected. Such a provision would open Pandora's box for other industries to come in and receive financial aid for government mandated programs. Additionally, the amounts paid would further unbalance the U.S. budget because they would come out of the Trust Fund which was a budgetary item. Contributing to the Committee's unhappiness was its running battle with the FAA which had, so the committee thought, been slighting safety expenditures and letting the Trust Fund build to unconscionable levels. The committee did not want safety needs to take a back seat to retrofit, re-engine or replacement. Finally, rocky going for the bill was indicated when such terms as "rip-off", subsidy", and "crazy gimmick" were used by members of the Ways and Means Committee. Shortly after completion of the hearings Representative Vanik noted

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27/ U.S. Congress, House Committee on Ways and Means, Airport and Airway Trust Fund and Airport and Aircraft Noise Reduction, 95th Congress 2nd Session, February 6, 1978, p. 112.

that Pan Am and American had just reported large profits. He then told the House that since 1976 American, Eastern, and Pan American had paid no income taxes and suggested that the airlines already enjoyed many tax benefits and were asking for more. His view, which he continued to maintain throughout the year, was that no financing legislation was in order. His motion before the committee to put off the financing issue for some months lost by only four votes.

At this time it became clear that the "off budget" method involving a non taxable surcharge of 2% was unacceptable. In its place came a substitute for Title III of the Anderson bill in the form of H.R. 11986 sponsored by Representative James Corman (D-California), called the Noisy Aircraft Revenue and Credit Act of 1978. Without going into detail on the various sections of the bill, essentially it solved the tax free problem in H.R. 8729 by imposing a 2% tax on airfares, reducing the present tax by 2% and depositing the tax in the Treasury. Carriers operating non-complying noisy aircraft would be able to obtain refunds or credits for the new taxes where such monies were spent to bring planes into compliance by retrofit, re-engining or replacement. These funds or credits would be treated as taxable income when received by the carriers. 28/ Even this bill which would have reduced payments from the October version was subject to acid criticism.

28/ House Report No. 95-1082, Committee on Ways and Means, April 24, 1978, p. 45.

Two committee members termed it the "Great Treasury Raid of 1978." Not helpful to the proponents of legislation were the announcements by Eastern of a $778 million order for the French Airbus with U.S. engines, and by Pan American of a $480 million order for the Lockheed L-1011-500 with Rolls-Royce engines. Additionally, an extensive article in Air Transport World (March) suggests that lending sources were optimistic that airlines would find the money needed for aircraft financing. Despite the aforementioned criticism of financial legislation, the Corman bill was approved by the Ways and Means Committee thus clearing the way for the House Rules Committee to act upon it before going to the full House.

D.8.2 The Senate Approach To Noise Financing Legislation: In the face of the difficulties encountered in the House and the position taken by ATA that the dealines for compliance could probably not be met, Senators Cannon and Pearson designed a different approach which was introduced (April 24) in S. 3064 entitled "Aircraft and Airport Noise Reduction Act of 1978". Titles I and II were similar to the House version. Title III involving incentives for retiring aircraft provided for a $20 billion loan guarantee under which loans would be made to carriers which entered into a contract before January 1, 1985, to purchase replacement planes meeting "Stage 3" noise levels as they were in effect May 1,

1978.[29] An extension of the compliance date of FAR 91-136 to 1990 would be accorded for replacing 2- and 3-engine planes. Finally, another provision permitted the Secretary of Transportation to waive compliance for a number of different reasons, including a final open end clause reading "any other circumstance the Secretary deems appropriate." [30]

At the hearings the Cannon bill quickly ran into difficulty. The Airport Operators Council International (AOCI) and environmental groups strongly opposed the compliance roll back for 2- and 3-engine aircraft. The airlines and manufacturers disliked the loan guarantee concept because, unlike the surcharge arrangement, there would be no "up front money." A further objection

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[29] Beginning at this time reference to noise limits have, by convention, been referred to in terms of "stages". On February 25, 1977 the FAA adopted stage definitions in Amendment 7 to FAR 36. Stage 1 are those airplanes not meeting stage 2. Stage 2 are those aircraft meeting the current Appendix C, i.e., the 1969 rule as refined. Stage 3 aircraft are those meeting still more stringent requirements and to apply to all aircraft for which an application for a certificate is made after May 1976. In the spring of 1979 the terms "Stage 4" and "Stage 5", although nowhere officially defined, have appeared. They refer to standards listed as 80 FAR 36 and 85 FAR 36 respectively as contained in the EPA proposal to the FAA published as NPRM 76-22, FR 47358 October 28, 1976. As proposed these standards would become effective 1 January 1980, and 1 January 1985.

[30] U.S. Congress, Hearings before the Subcommittee on Aviation of the Committee on Commerce, Science, and Transportation, on S. 747, S. 3064 and H.R. 8729, Aircraft and Airport Noise Reduction, 95th Congress 2nd Session, May 24, 25, and June 13, 14, and 17, 1978, p. 397.

was that the loan guarantees would increase the debt-to-equity ratio of the companies at the very time airlines were trying to reduce the ratio to merit consideration for equity financing. Additionally, the financial community was not happy to have the government take over its function. Finally, in a particularly effective 33 page presentation, CAB Chairman, Alfred Kahn, stated that Board studies indicated returns on investment were running so high that he could see no requirement for a noise bill. However, if Congress felt that some assistance was in order, he would prefer the House bill approach.

D.8.3 New Senate Bill S. 3279

Opposition to the loan guarantee approach resulted in Senator Cannon abandoning S. 3064 in favor of a new bill, S. 3279, which reduced the previous 10-year financing provision to a one-year mandatory charge with possible extensions by the CAB. The CAB wanted no part of the matter. The rest of Title III focused on two primary means of obtaining waivers from compliance with 91-136. Entitled "New Technology Aircraft Incentive", Section 303 mandated an unlimited waiver of 2- or 3-engine non-complying aircraft providing a binding contract for replacement by Stage 3 aircraft had been entered into by January 1, 1983. This was a tightening of the previous bill which had contained a 1985 date. But the failure to include a time limit on the waiver loosened the bill. Finally, Section 304 gave the Secretary the power to waive the requirements

of compliance of 2-, 3-, and 4-engined aircraft, subject only to a broadly defined "good cause" rule.

Less than a week later, with no further hearings, the bill was quickly approved 13-0 for transmittal to the Senate Finance Committee whose approval was necessary because of the ticket tax. Early in July the press indicated that final Congressional action on the noise bills would be late July or early August.[31/] However, political maneuvering and economic news placed this time table in jeopardy. Although the ATA had just warned of the airlines financial inability to order the minimum amount of equipment needed, United, on July 13, announced a $1.6 billion order for a new aircraft.

With Congressional adjournment only a few weeks away, and with a great deal of attention focused on the forthcoming vote on the Airline Deregulation Act of 1978, the ATA had its work cut out for it to move the less desirable Senate bill to the floor where perhaps a Senate-House Conference Committee could make it conform more closely to the Anderson bill. Bad news came in late September when Senator Cannon and Reps. Johnson and Anderson expressed concern that President Carter would veto the legislation if passed. It developed that the only way to get the bill out of the Senate Finance Committee was to drop the funding from the bill and retain the waiver provisions. In doing this on October 3, the Com-

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31/ Aviation Daily, July 10, 1978 p. 25.

mittee left untouched one benefit, i.e., a reduction in the ticket tax by 2 percentage points. The theory was that the carriers then would have the same two percent available for aircraft replacement as earmarked in the original bill. However, as the airlines saw it, the prosperous firms would reduce their fares by 2% and so the needy ones would have to do so to meet the competition. As a result, there would be no money for aircraft replacement. Thus, the airlines considered the Senate version was a total loss on the financing side, but a gain on the waiver matter. Although the bill still contained a provision authorizing the CAB to institute noise charges, given the CAB philosophy and its probable demise under deregulation, the provision was considered ineffective.

Since the possible effects of the Airline Deregulation Act would be more pervasive than the noise legislation, most of the remaining time prior to adjournment was spent by airline lobbyists in this area. As of October 12, with Congress striving to adjourn, the Senate bill had not been called up. However, at 2:00 AM, October 15, during the nonstop chaotic session beginning on the 14th the Cannon bill passed the Senate. Normally a conference committee would be appointed to compose the differences. In this case, with just hours left before adjournment and with a bill without financing but with waivers, house managers, seeing no way of finding a compromise between the extremes of the two bills, let the legislation die. A last minute parliamentary move by Rep. Anderson failed and Congress adjourned without a vote being

taken. The airlines were keenly disappointed that $3.4 billion assistance which the Anderson bill would have provided was lost.

D.8.4 Summary For 1978

The failure of noise financing legislation at the close of the 95th Congress did not have the catastrophic effect predicted when the legislation was initiated back in 1977. As earlier chapters have indicated, the legislation had its genesis when the federal government, at a time of economic recession during which airlines were having difficulty in digesting previous commitments for aircraft made during prosperous times, promulgated a rule which would require the carriers over a phasing period to modify or replace a large number of aircraft at substantial expense to effect a reduction in aircraft noise for environmental reasons.

Because the government ordered this retroactive application of the rule, the carriers reasoned that the government had an obligation to assist in financing compliance. At the very time hearings on proposed legislation commenced, the economic fortunes of the companies began to improve. However, the legislative process moved too slowly for success. By the end of 1977 profits had substantially improved. However, the carriers argued that profits were not yet sufficient and in 1978 might be lower. Their other thrust was that the expense of modifying the 2- and 3-engine planes was non-productive so that a waiver should be made for them. Behind the scenes the ATA had difficulty in keeping its act to-

gether. Delta and Northwest, with relatively modern fleets and plans for compliance, threatened to testify against the legislation if funds from their passengers were used to subsidize rival carriers.

Held up somewhat by intercommittee rivalries, noise legislation made slow progress during 1978. The longer the bills stayed in committee the less likely became their probability of passage. Economic fortunes of carriers improved faster than the most optimistic forcasters had predicted. Again the ATA had a difficult time maintaining a cohesive front. While the ATA was pleading the carriers' financial weakness case, various airlines, at most inopportune times, announced large capital commitments for new aircraft, high earnings, improved balance sheets, refinancing, and even the ability to pay for new aircraft primarily from internally generated funds. It was the combination of high earnings and the disinclination of Congress under these curcumstances to set a precedent which caused financing legislation to fail at the end of the 95th session.

As 1978 drew to a close, indications were clear that airline industry would press for some kind of legislation which would undoubtedly be opposed by environmentalists. Within two weeks of the failure of legislation in the 95th Congress, Senator Cannon announced plans to re-introduce a noise bill in 1979 without mandatory noise abatement charges. Since his previous bill contained broad waivers which would have invalidated a significant part of

FAA regulation Subpart E, 91-136, his announcement signalled to the environmentalists (primarily the airport operators and owners) that the ATA strategy would now be to change legislatively 91-136 where it had not been able to move the FAA administratively. Various organizations asked DOT to stand firm and enforce the regulation. Secretary Adams responded with letters saying that the failure of the 95th Congress to enact the aircraft noise bill "will not affect our determination to enforce the aircraft noise compliance regulation". Thus the stage was set for the 1979 legislative effort to which we now turn.

D.9 THE 1979 NOISE LEGISLATION AND AIRCRAFT RETIREMENT

The defeat of the two aircraft noise abatement financing bills in October 1978 and the simultaneous passage of the Airline Deregulation Act was followed by further increasing airline profitability. As a result, a law mandating financial assistance for retiring aircraft was no longer a political reality. However, little else had changed. On the one hand, ATA made its number one 1979 legislative priority the partial or complete elimination of the compliance program stipulated in FAR 91-136. On the rulemaking side, in March 1979, ATA petitioned the FAA to eliminate the January 1, 1981 compliance date (leaving the 1983 and 1985 dates alone) and substitute the submission of a compliance plan. On the congressional side, the ATA was pushing for legislation which would (1) permit the CAB to establish noise surcharges, (2) wipe

out the requirement to retrofit or replace 2- and 3-engined noncomplying aircraft, and (3) provide for extensions of compliance dates. Should the ATA be successful it could be argued that decisions on aircraft retirement would be made on the basis of the operating economics of the aircraft themselves, as they formerly had been, and not for legislated environmental reasons. 32/

On the other hand, public groups were preparing to push in the opposite direction. In California for example, pressures continued with the result that San Diego attempted to ban new carriers from entrance because of the noise problem. The California DOT was requesting that San Diego limit flights of noncomplying aircraft so as to meet strict environmental regulations. In Washington the Housing and Urban Development Department (HUD) was proposing a new, stricter noise descriptor, Ldn, and drafting legislation to include money under ADAP for noise monitoring equipment and the soundproofing of homes and public buildings near airports. Additionally, the FAA, to defuse the growing lawsuit problem, was suggesting to HUD that owners or rentors of property,

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32/ The idea that environmental and economic factors were mutually exclusive was, however, beginning to be questioned. Since high bypass engines brought significant fuel economies, as well as lower noise emissions, and since continued operation of noisy aircraft generated diseconomies in the form of curfews, lawsuits and other restrictions, some airlines began to feel that it was good economics to work toward compliance. Later, and not helping the ATA position, Continental, United, Delta, Northwestern and Eastern began to make public capital out of their compliance programs. Another large carrier, American quietly was ordering retrofit kits and planning compliance.

as a condition of receiving financial assistance, furnish statements acknowledging their awareness of the noise problem. The FAA was also proposing a scheduled closing of 9:30 p.m. for the Washington National Airport.

There was a Congressional proposal in the mill to establish a nationwide Airport Noise Curfew Commission. Further, the serious economic implications of unsatisfactory progress in resolving the noise problem was highlighted by the February 28, 1979 decision of the California Court of Appeals upholding the much talked about ruling awarding damages to homeowners for mental and emotional distress caused by noise from the Los Angeles International Airport, Greater Westchester Homeowners Association V. City of Los Angeles (No. C-931-989). Finally, one of the country's busiest airports, Atlanta, reported that noise levels were rising. The Administration position was that there were still 6 million people and 900,000 acres of land subject to noise levels above that which was considered by HUD to be normally acceptable and that lawsuits were still pending for millions of dollars with the potential liability for noise damages in billions of dollars.

Except for a muting of the argument of the impossibility of securing private financing, ATA's arguments were essentially the same as in the previous Congress. First, retrofit made no discernable difference for the planes equipped with JT8D engines and, in addition, carried a fuel penalty. Retrofit was, therefore, ineffective and a waste of money. Secondly, it was not possible to obtain delivery of the quieter Stage 3 aircraft in time to

meet the deadlines of 91-136. Third, Congress had delayed so long in enacting legislation that it was getting too late to order retrofit kits for the 707 and DC-8 series. According to the ATA and the aircraft manufacturing industry, relaxation of compliance dates would permit the industry to intensify its efforts at noise reduction on the existing fleets; whereas holding to the deadlines might cause the termination of important programs to reduce noise on future 727, 737, and DC-8 aircraft.

D.9.1 FAR Compliance, Initial 1979 Bills: S.413 (Cannon) and H.R. 2458 (Johnson/Harsha)

All the 1979 bills contained a Title I involving airport planning, a Title II involving funds for the construction of airports, a Title III involving FAR 36 compliance, and several other titles. Titles I and II were almost identical to the same titles in the 1977 and 1978 bills and will not be treated further.

Recognizing the previous difficulty when a House move in advance and independent of the Senate resulted in two vastly different bills, Congressional leaders this time made an attempt to initiate quite similar legislation. Senator Cannon led off with a bill which required each airline to supply a compliance plan. However, the compliance dates contained in 91-136 could be moved by permissive or mandatory types of waivers. First, the Secretary could waive the date for an unspecified period of time for any noncomplying aircraft if there was "good cause" and "good faith". Additionally, an open-end clause permitted a waiver for

"any other circumstances the Secretary deems appropriate."

The second waiver was a mandatory waiver of the date for a noncomplying aircraft if the operator had a binding contract by January 1, 1983 to purchase a Stage 3 aircraft to replace a 2- or 3-engine aircraft, or by January 1, 1985 to replace a 4-engine aircraft. In subsequent bills this paragraph took the name of "new technology incentive provision".

Harking back to the Ford proposal of several years previous the Cannon bill authorized the CAB to impose a noise abatement charge of 2% of the ticket price to be used only for noise abatement purposes. This permissive charge, the vestigal remains of previous mandatory charges, given the temper and scheduled demise of the CAB, was not considered likely to be implemented. The House bill was identical except that there was no CAB financing mechanism.

D.9.2 Opposition To Cannon And Johnson Waiver Legislation

The waiver provision quickly proved unacceptable to many groups. First, the Administration, through the Secretary of Tranportation and the EPA, argued that waivers would erode the expectations of the public; that because the Secretary already had the power to grant waivers no additional legislation was necessary; and that the reason for the delay for new technology was spurious (the manufactuers would be glad to take orders for the 757, 767, A310, of Lockheed Super 80, all of which would meet Stage 3).

The EPA indicated that if waivers were to be granted, they should be limited to Stage 4 and Stage 5 aircraft as proposed by the EPA in 1976 and applicable to designs after January 1, 1980 for Stage 4 and January 1, 1985 for Stage 5.

By April further opposition surfaced in the form of eleven public interest, environmental and consumer groups banding together to defeat the Cannon bill. By March, Senator Cannon had whisked his bill through his committee on a 15-0 vote without public hearings on the grounds that the subject had been fully explored in the 95th Congress. As a result of the opposition to such wide inroads being made in compliance by the Cannon and Johnson bills, two new House bills were introduced narrowing the relaxation authorized in S. 413. H.R. 5347 introduced on April 9, by Rep. Norman Mineta (D-Cal.) did not contain a "good cause" or "good faith" waiver. Nor did the new technology waiver apply to 4-engine airplanes. To warrant a new technology waiver for 2- and 3-engine non-complying aircraft a binding contract had to be signed by January 1, 1981 and involved Stage 3 replacement. The date represented a two year shrinkage from the 1983 date in the previous bills.

Two days later, Rep. Glenn Anderson (D-Cal), stating that his purpose was to encourage the purchase of Stage 3 aircraft introduced H.R. 3596 which, if passed, would have been more restrictive than the Mineta Proposal. Title III of his bill provided no waivers after 1985, except that 2-engined aircraft could con-

tinue to fly indefinitely if limited to small community service. A second significant feature was the prohibition of the construction of Stage 2 aircraft after January 1, 1983.

D.9.3 Emergence Of Re-Engining As A Viable Alternative To Retirement

During the preceding two years the standard litany had been that retrofit, while not expensive relative to re-engining or replacement, was ineffective and a waste of resources; that re-engining was about 4 times as expensive and it would not make sense to spend $11,000,000 per plane on old airplanes; that replacement was the preferred way to go but that there were no suitable Stage 3 new technology aircraft currently available for purchase, even if financing were no problem. The development of the 767 and 757, plus the DC-9 Super 80, somewhat diminished the argument that no new stage 3 aircraft below the size of the 747, DC-10 and Lockheed L-1011 were available.

During 1978 a substantial progress had been made in reducing the price of re-engining and the time of certification of new technology stage 3 aircraft closer. Pouring over their books, airlines flying the 60 series of the Douglas DC-8 discovered that the operating costs after re-engining, would be in line with the wide-bodies. As the capital cost of new equipment escalated and with a still greater escalation of fuel prices, the economics of re-engining some of the 60 series, particularly the 61, instead

of retiring them, began to look better and better. Finally, at about the time of the House hearings in April, United, Delta, and Flying Tiger announced decisions to re-engine a number of the DC-8 series 60 with CFM56 engines, at a cost of $8 to $9 million per aircraft. By the time of delivery a new replacement plane would cost as much as $40 million. Since the re-engined configuration not only met Stage 3 but also involved a significant reduction in specific fuel consumption, the total result was considered a bargain. Thus, aircraft which only a year earlier had been programmed for retirement for economic and environmental reasons, would, except for a technicality in the wording of 91-136, be continued in active service.

As 91-136 was written, noncomplying Stage 1 or Stage 2 aircraft could be replaced only by aircraft shown to meet Stage 3 before the issuance of the original airworthiness certificate, which of course a re-engined plane could not do. At the time of House hearing the FAA announced a proposed change in the definition of "replacement airplane" to include a re-engining which would meet Stage 3, [33/] thereby making it possible for a re-engined aircraft to comply with the noise rule.

D.9.4 Senate Passage Of Cannon Bill With Broader Waivers

It has previously been noted that the Cannon bill, nicknamed

[33/] 44 Federal Register 24778, April 26, 1979.

the "industry bill" by the opposition, enjoyed a quick trip through the Committee without hearings before being approved 15-0. On May 1, it was likewise speedily approved in the Senate by a 78-5 vote with a further broadening of escape clauses. An amendment by Senator Stevens (R-Alaska) provided that aircraft which exceeded FAR 36 by no more than 5 decibels would be deemed in compliance. The rationale was to take into account the argument that an individual rarely can tell the difference in noise when the differential is less than 5 decibels. Senator Javits (D-NY), long under pressure from his New York constituents, failed in an attempt to have all the waiver provisions eliminated.

The Stevens amendment was looked on with approval by a majority of airlines and with disapproval by the environmentalists and a few airlines. Those who put a low value on the ability of environmental groups at the state and local level to place meaningful constraints on the operation of aircraft should the compliance rule be substantially relaxed saw: (1) the savings involved in not having to retrofit their aircraft, (2) the savings in being able to avoid the mandatory retirement from their fleets of noncomplying planes, and (3) the avoidance of high capital expenditures for new replacement aircraft.

As expected, environmentalists complained that the Stevens Amendment was an obvious step backward in the government's policy to control noise. As will be seen, the amendment was too much of a pill for Delta, a long time believer in noise abatement as a

requisite for the continued prospering of air transportation. Delta, who with Northwest, had been a thorn in the ATA side in the previous Congress, came out formally against any waiver of the noise compliance dates.

9.4.1 Impact of Stevens Amendment upon Retirement of Noncomplying Aircraft: There were conflicting views on the impact of the Stevens amendment. Many felt it would prolong the use of the 727, 737, and DC-9 fleets thus enhancing their value on the used aircraft market when it came time to replace them with Stage 3 aircraft which, according to the ATA, would not be available before the 1990s. The manufacturers argued that the amendment would buy them time to continue working on noise attenuation on DC-9, 727 aircraft to bring these airplanes in line with Stage 3 standards. However, a contrary opinion is just as logical. Boeing, because the design costs are largely written off, has a substantial incentive to keep the 727 line producing for as long as possible. A number of groups in Boeing find their jobs dependent on keeping the 727 and 737 competitively and environmentally up to date. Since the company has reported it is close to making both aircraft meet Stage 3, it could well be that holding to the FAR limits and deadlines would serve to accelerate the pressure on the company to make the breakthrough which would enable the Stage 3 problem to be solved.

One last point, the assumption that the amendment would raise the used aircraft value because the aircraft would be "legal" in

the United Stages may be invalid. First, the United States represent, less than one-half of the world market so that a broader view must be taken. Second, there is increasing disinclination, both in the United States and abroad, [34/] on the part of airport neighbors and other state and local levels of government to accept for themselves the rules laid down by the national authorities. For confirmation one need only observe the increasing activities of state departments of transportation, local and other authorities in the area of curfews, operating procedures, noise monitoring and so on. The desire for relief from noise is a world wide phenomena so that it may well be that for noise (as well as for fuel economy reasons), the demand for such aircraft on the use' market may slacken substantially.

8.9.5 Progress Before The House Public Works And Transportation Committee Of H.R. 3596 (Anderson)

Since no Senate Hearings were held it was not until the House hearings of late April, 1979, convened that the three parties (Administration, industry, and public interest groups) had the opportunity to present their views on 1979 legislative proposals. Here the main interest was the Anderson approach which involved the elements of (1) limiting waivers to 1985, except for

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34/ See a forthcoming NASA report by this investigator involving foreign noise regulations which shows that local authorities can constrain noisy aircraft operations against the desires of the national government.

twin engine flights in small community operation, and (2) the termination of production on January 1, 1983 of any aircraft which could not meet stage 3.

The manufacturers, wishing to keep all their options open, strongly opposed the cut off of Stage 2 production for three reasons. Fist, elimination of Stage 2 production would only change noise by 0.5dB by 1985. This was not surprising since very few Stage 2 aircraft would be replaced by Stage 3 in the period. No forecast was made for the change by 1990 or 1995. Secondly, it was argued that discontinuation of Stage 2 would force carriers to turn to non-optimum larger size 757s.[35/] Third, it was emphasized that the termination of Stage 2 production would end vital on-going noise reduction research for the 727 and 737. No one

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35/ In view of the tremendous success of the 737 and 727 indicating a market for this size airplane, it is curious that in later testimony before the Florio committee to which this legislation was sequentially referred, a Boeing representative stated that not even the first discussions have been held on a new technology replacement for the 727 and 737. Of course Boeing has its hands full in launching the 757 and the 767 in addition to operating its other product lines. Nevertheless the 757 started out with a promotion extolling its close derivation from the 727 with a great degree of commonality of parts. However, this has been replaced with promotions emphasizing more new technology and commonality with the 767. Presently there appears to be a void in the 100-150 passenger aircraft category embodying significant improvements in fuel efficiency and noise attenuation.

asked the question why, if research was reasonably close to bringing these planes to compliance with Stage 3, a date several years hence would not accelerate research which would bring closer the noise relief sought.

The Administration and public interest groups maintained their positions in the hearings against waivers. Additionally they argued that because some Stage 3 aircraft were now in production, cutting off production of Stage 2 aircraft was good for the environment and economically wise because of the significantly lower fuel consumption of the newer airplanes. However, after the hearings there continued to be strong lobbying by ATA and by the manufacturers. As a result, the Anderson bill H.R. 3596 was replaced by a less restrictive Johnson bill H.R. 3942. It was amended to be even less restrictive.

D.9.6 House Public Works And Transportation Committee Approves Heavily Amended Bill H.R. 3942

In the committee the industry view carried the day. As a consequence, the new H.R. 3942 was further liberalized. As finally approved in committee, Title III contained four main changes. First, the original provision for a January 1, 1983 cut off date for the end of production of Stage 2 aircraft was watered down by a "study and report" provision. The amended bill provided: (1) that the Secretary of Transportation study whether there should be a date and then make a report in one year; (2) that if a date was proposed, Congress would have six months to look at it; and

(3) if a date was actually promulgated, action would be delayed for another 60 days during which time either House could exercise a veto.

Secondly, a provision, later described by the FAA Deputy Administrator as "the biggest sleeper in the bill", prohibited the FAA from tightening the noise rules for 10 years. This would eliminate the retrofit requirement. A third change was the extension of the "small community exemption" to permit the waiving of the rules for 3-engine planes an addition to the original 2-engine exemption. This third change would require a mountain of bookkeeping as the application was limited to an aircraft (1) if 60% of its operations were at airports which emplaned less than 1 percent of total emplaned passengers of all certificated carriers in the United States and (2) at least 30% of its operations at airports which emplaned less than 1/4th of 1 percent. Finally, the fourth addition was a statutory waiver for 2-engine planes used within Hawaii. [36/]

Approval on May 11 of this heavily amended but less restrictive measure by the House Committee on Public Works and Transportation displeased not only the environmentalists but also long time sponsors of noise legislation. Representatives Anderson, Nineta, and Levitas voted against the bill in committee and sub-

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36/ The Hawaiian change is anomalous because in a forthcoming study involving noise regulations in the Pacific Ocean, Hawaiian authorities reported virtually no noise troubles with 3- and 4-engine large aircraft but problems with 2-engined planes.

mitted dissenting views. Representative Rosenthal called the bill a "total disaster" The press reported that Representative Anderson's dissent so annoyed his colleagues that he lost all control over the noise legislation and would not be a floor manager or a conferee. 37/ Criticism of both the Senate and the House bills accelerated both inside and outside of Congress to the point that the Administration testified that each bill was unacceptable and should not be passed. Of the two evils the House version was the lesser.

D.9.7 The House Interstate And Foreign Commerce Committee Enters The Noise Legislation Arena

Those interested in holding the line or tightening the rule on noise abatement did not accept their defeat before the House Public Works and Transportation Committee passively. Rep. James Florio (D-N.J.), Chairman of the Interstate and Foreign Commerce subcommittee of transportation and commerce, who also was representative from a district subject to noise complaints around the Philadelphia airport and a legislator whose committee's jurisdiction included EPA matters, asked for a sequential referral of S. 3942 to his committee on the grounds that it had jurisdiction over some of the matters contained in the bill. His complaint was that "we are retreating dramatically in aviation noise abate-

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37/ Aviation Daily, May 21, 1979, p. 33.

ment" and "the hand of the industry is visible in the legislation." As a counter measure, Chairman Johnson of the House Public Works and Transportation Committee asked for referral to his committee of the Reauthorization of the Noise Control Act bill, a matter previously under Rep. Florio's committee. Subsequent developments confirmed that there was emerging a jurisdictional battle over who had control of aviation legislation.

The Florio Hearings

The manufacturing industry, after first declining to testify, presented its views essentially unchanged from previous appearances. Boeing supported waivers and indicated that it appeared highly unlikely that Stage 3 replacements for 727s, DC-9s and 737s would be available to meet the 1985 deadline, and that re-engining altered drag, weight and balance and sometimes required an unwanted "stretch" on the aircraft. Such testimony implied a very limited role for re-engining. Douglas dwelled on the absence of meaningful benefits for retrofit and, therefore, urged that legislation encourage Stage 3 as a long term solution. Douglas made news by indicating that it not only had one narrow body medium-range derivative plane, the DC-8 Super 80, which could meet Stage 3, but had been offering in Europe, without success, a smaller DC-8 Super 80SF with a capacity of slightly over 100 seats.

The Administration through the EPA, and FAA testified against both the Senate and House bills indicating that the new technology

waiver in the Senate bill was a disincentive for compliance or retiring aircraft; that Stage 3 was not new technology but was today's technology (DC-10, 747, DC-9 Super 80, A310, L-1011); that a "good cuase" waiver tied with new technology waivers would merely give an airline excuses not to move; that the 2- and 3-engine waivers for small community usage would require an impossible amount of record keeping; and that the Stevens amendment in the Senate, the "study and report" amendment to the Stage 2 cut off, and the 10 year restriction on imposing stricter noise standards, in essence froze the EPA and FAA out of regulatory action. Finally, the EPA witness noted that both bills penalized the "good" carriers who had accepted Part 91-136 and were well on their way to full compliance.

The Breaking of the ATA Ranks on Modifying or Eliminating 91-136

In previous sections dealing with the 1977-1978 legislative effort, references have been made to the difficulties ATA experienced in keeping Delta and Northwest in the fold. Both carriers have understandable pride in their equipment programming and both, with an eye on the noise problem, have consciously acquired quiet equipment. Any government action which smacks of government aid to make their rivals more competitive is frowned upon.

Delta, viewing both the House and Senate bills as legislation which could backfire on complying carriers and the whole industry, broke ranks by volunteering to testify against the waiving of the

requirements of 91-136. At the Florio hearing on June 27, Delta's Senior VP and General Counsel made the following points:

1. After exhaustive testimony 91-136 was promulgated listing specific dates as much as eight years in advance after which all aircraft would have to comply with Stage 2 limits.

2. The FAA has continually stated that it intends to enforce the regulation.

3. Airport and local authorities in the United States, as a means of holding down the expansion of more constraining rules, have relied upon the implementation of the rule in their dealing with complaining aircraft neighbors.

4. Delta itself assumed that the rule would not be changed and developed an expensive concrete noise abatement plan which would achieve full compliance via retrofit, re-engining and via purchase of new Stage 3 equipment by the stipulated deadline dates.

5. Delta and others have moved ahead in good faith and spent the necessary funds to comply. It would be unfair to give special treatment to the laggards.

6. A relaxing of the deadlines, or giving permanent waivers, will result in a feeling by the public and the airport operators of being betrayed. As a result, there will be a proliferation of uncoordinated curfews and other constraining regulations which will hurt the complying airlines as well as those who have not. In fact, air transportation in general would be harmed by the actions of a few.

Nor was Delta the only carrier to speak out against the legislation. Northwest testified along the general lines of Delta and emphasized its strong re-equipment program involving retrofitting and phasing out of noisy aircraft. Northwest argued that both bills contained inequities giving preferred treatment to foot draggers. Somewhat more surprising was the testimony of Eastern which, until Col. Frank Borman came aboard as President, had been

considered to be incapable of handling a noise reduction program without government assistance. Although disagreeing with the benefit of retrofitting 2- and 3-engine airplanes, Eastern did relate the significant strides it had made toward compliance and indicated that it might miss the compliance date for one plane only and that by a matter of several months. Eastern was confident that under the existing rules it would receive the necessary waiver by the FAA. No other airline testified but reference was made that Continental had initiated a compliance program in April, that United had been proceeding for several years on the assumption that the rules would not be relaxed. American's commitment to phasing out its noisy aircraft had been publicized.

D.9.8 H.R. 3942 As Amended By Commerce Subcommittee On Transportation And Commerce Of The House

The Florio committee determined that the proposed legislation was seriously flawed in the direction of excessive waivers and escape clauses. Therefore amendments, the thrust of which were toward tightening provision which the Public Works and Transportation had just loosened, were added. Since Florio's committee clearly had jurisdiction over EPA in the past, the most supportable mechanism for tightening was, according to Florio, to "Include the Environmental Protection Agency back into the process of defining noise standards and to ensure that the (Commerce) Committee's jurisdiction is preserved as an element of deliberation on avia-

tion noise (issues)." 38/ If adopted, the Florio amendments would enhance the authority of the EPA and Commerce Committee. The emasculation of their bill displeased the rival House Public Works Committee so much that it proposed a cut of $4 million in the Noise Control Act Reauthorization Bill, a bill belonging in the past of the Commerce Committee. 39/

To tighten the 2- or 3-engine waiver for aircraft operating out of small community airports, an amendment made the waiver contingent upon a finding by the Secretary, after consulting with the EPA, that there would not be an adverse effect on people's health or the environment. However, since the Secretary is a political appointee, politics might skew the result and there could be long delays in the process. Because of jurisdictional problems, there was nothing much Florio could do with the date for cutting off the manufacture of Stage 2 aircraft other than to feed the EPA into the loop by requiring an EPA report to Congress which would make a comparison of DOT's recommended date and all "alternatives". The final change in Title III modified the 10-year restriction on more stringent noise regulations for airplanes having a certificate by permitting the Secretary to determine after notice and the opportunity for hearing that health and environmental benefits of compliance outweighed the costs to the operator. Changes in other

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38/ Noise Regulation Reporter, No. 135, July 16, 1979, p. A-19.

39/ Ibid.

titles enhanced EPA power, allowed noise exposure maps to be used in court under certain conditions, required people buying property near an airport to be furnished noise data, and required the FAA to submit all future noise emission regulations to the House Commerce Committee and Senate Environment and Public Works Committee.

On July 10 the FAA and eleven airlines were sued by Neighbors Opposed to Irritating Sound Emissions (N.O.I.S.E.) for failing to reduce noise at Washington National Airport. Damages of $10,000 per homeowner were asked. Various states and foreign countries were busy contemplating further noise rules. HUD adopted a final regulation which made Ldn the noise descriptor and established zones for acceptable, unacceptable, and formally unacceptable noise exposure. ICAO, over objections of many countries engaged in establishing earlier cut off dates for aircraft not meeting the foreign equivalent of Stage 2, established January 1, 1988 as a date for compliance with the international standard, Annex 16, Chapter 2.

D.10 SUMMARY OF LEGISLATIVE EFFORTS TO IMPLEMENT OR MODIFY THE COMPLIANCE RULE AND ITS EFFECT ON AIRCRAFT RETIREMENT

After several years of growing pressure by airport citizen groups requesting retroactive application of FAR 36 to aircraft previously not covered by the regulation, the FAA, on December 23, 1976, promulgated rule FAR 91-136 which provided for compliance by such aircraft via a three phase program with interim dates of

January 1, 1981, January 1, 1983 and full compliance by January 1, 1985. Although responsible public officials during the long hearings on the regulation had assured the airlines that because of the depressed state of the industry no rule would be passed without accompanying financial assistance legislation, no such legislation was even proposed with the issuance of the regulation.

It was possible to comply with the rule by three different methods at quite different levels of cost and benefit. Retrofitting and modification to the engine and adding sound absorbent material (SAM) would cost the least, but would result in the smallest decrease in noise. The industry contended and the environmentalists denied, particularly with regard to 2- and 3-engine airplanes, that the improvement through retrofit would not be discernable to the average person. Compliance could also be accomplished by replacing the engine with a new, quiet, more fuel-efficient engine at a cost of at least four times that of retrofit. Finally, replacing the airplane, the third means of compliance, would involve retiring the aircraft and replacing it with a new one costing at ten to fifteen times the cost of retrofit but having additional benefits in the form of new technology and efficiency in fuel and noise emissions. Since both retrofit and re-engining involved the continued use of 15 to 20 year old aircraft where previously retirements had often been between 7 and 10 years, a consensus emerged that if financing could be arranged replacement was the desired course of action.

In 1977 and 1978 a series of bills addressing the broad area of noise abatement including, in addition to aircraft financing, standardizing the measurement of noise, land use planning for noise abatement purposes, liability for noise damages, and other matters were introduced. Land use planning, if implemented, would in the long run have a pronounced effect on slowing the retirement dates of aircraft. Zoning and purchase of land for buffer zones would prevent people from moving to the noise. Notwithstanding the general agreement that financial assistance legislation should provide incentives for replacement, the first bill actually contained an incentive for retrofitting. A revised version, purportedly aimed at replacement, favored re-engining. Finally, in the fall of 1977, a revision favoring replacement was satisfactory to the airlines and passed the House Committee on Public Works and Transportation. By the time the bill reached the Ways and Means Committee, to which it was referred because of the tax changes required, increasing airline profits caused Congressmen to raise the question as to the need for the legislation. Additionally, fear of setting a precedent for other industries to follow also became a Congressional concern.

During 1978 the Senate took up the legislation in a less sympathetic atmosphere and there was introduced the concept of extending the compliance time contingent upon ordering aircraft meeting the more stringent Stage 3 standards. In October, the Senate dropped the key provision providing for airline funding

and in the closing hectic session of the Congress the differences between the Senate and House bills were so great that there was insufficient time to work out a compromise. The legislation, including Titles I and II failed. As 1978 drew to a close it became increasingly evident that the profitability of the airlines was such that legislation embodying financial assistance was a political impossibility.

In 1979 a new attempt at legislation was mounted by the ATA. However, because of the political impossibility of financing legislation, the focus of the industry was now on obtaining either a complete elimination of FAR 91-136 or a substantial relaxation of the deadline dates, or an elimination of the rule's application to 2- and 3-engined aircraft. As of June 1979 the industry was so successful in its efforts that the Administration and environmentalists urged, even at the expense of losing Titles I and II, that no bill be passed. As this is being written (July 1979), after some parliamentary footwork, the House Interstate and Foreign Committee has submitted amendments involving modest tightening of the House bill.

The introduction into legislation of a proposal to terminate production of aircraft which can only meet Stage 2 rules, coupled with holding fast to the compliance dates, could have a profound effect upon aircraft retirement. Given the pressures from the public for noise abatement and the increasing economic penalties imposed by the costs of fuel for low bypass engines, carriers

will be less inclined to compete with fuel inefficient aircraft regardless of government noise requirements. The situation would be even clearer but for the absence of "off the shelf" similarly sized replacements for narrow bodied 737, 727 and DC-9 using JT8D engines. Presently the alternative seems to be new technology or derivative planes larger and much more expensive than those currently in use. At present, there appears to be no new correctly sized, fuel-efficient engine with low noise characteristics, which can either be re-engined into existing 727, 737, or DC-9 aircraft, or installed in newly designed planes of that size. [40/] Attention has been centered on large highpowered high bypass engines because the larger 707s and DC-8s needed replacement first, and because economics favor the development of the large engines. As FAR 36 and 91-56 now stand, there is no pressure to comply by purchasing a Stage 3 aircraft with their attendant higher capital cost because all that is necessary is to meet Stage 2. At present, in the U.S. pressure for the purchase of Stage 3 comes from two sources: (1) from the fear that environmentalists will cause airport owners and operators to enact rules constraining the operation of aircraft based on their noise emissions and; (2) from the rapidly

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40/ The closest is the derivative DC-9 Super 80 which has not caught on in large numbers, probably partly because of a price differential in the face of no existing requirement mandating for replacement or growth anything more than a Stage 2 aircraft.

rising price of jet fuel whose effects can be significantly mitigated by the use of new aircraft designed to minimize fuel consumption and other costs.

E.

AGING AS A FACTOR IN JET AIRCRAFT RETIREMENT

The conclusion reached in this section is that for current jet aircraft "age" per se, whether it be measured by the passage of time, the number of hours the aircraft is in service, the number of "cycles" (either pressurization, or landing) is not a factor in the forseeable future leading to their retirement. The reasons for this conclusion follow.

AGING

E.1 AGE IN YEARS

The conventional view is that machines wear out with use. Provision for this is made by depreciating the machine over its useful life. We have seen that in the prejet era aircraft were retired after seven to ten years of service - a period which did not coincide their depreciation periods. It was anticipated that the more costly jets would have a longer service life than the preceding technology and thus spread the capital costs over more units of service. When, about ten years later, more efficient wide-bodied aircraft were designed, the annual traffic growth was approximately 15%. With this demand it appeared that the cycle of seven to ten years would repeat itself, at least, for trunk

carriers. However, the slowing of traffic growth accompanied by financial adversity which was intensified by the rapid increase in fuel prices adversely affected the need for more capacity and inhibited the purchase of new, more efficient, replacement aircraft if such were available.

As the advisability or necessity of keeping current fleets operating grew, attention turned to examining the question of to what length and at what cost could aircraft lives be extended. Table 17 shows the Fleet Age Distribution of U.S. Trunk lines. In 1976, from the standpoint of chronological age alone, 75 commercial jets exceeded 16 years of age and 487 were over ten years old. Since most of those are still in service, three more years can be added for updating purposes.

Engineering investigations and experience by the operators reveal that aside from some corrosion around the windows and in the floors and underbody of the aircraft, the passage of time alone does not cause significant deterioration of the aircraft. Maintenance "fixes" have been able to correct for corrosion. Appendix A indicates that the current jet fleet was introduced into service in 1958, about 21 years ago. Since 21 years have elapsed without significant degradation, time itself is not a concern within the period of this study.

TABLE 17

SYSTEM TRUNK AIRLINE
SCHEDULED FLEET AGE DISTRIBUTION
(1976)

Years in Service	Number of Aircraft
18	3
17	27
16	48
15	--
14	17
13	67
12	87
11	91
10	147
9	160
8	304
7	152
6	90
5	65
4	88
3	110
2	75
1	65

Source: Robert R. Ross, Commercial Jet Replacement Process, Master of Science in Transportation Thesis, Transportation Center, Northwestern University, 1976.

E.2 AGE IN HOURS AND CYCLES

In the prejet era, a convention arose to discuss airplane life in terms of hours flown. Until the introduction of the four-engine pressurized craft, the stage length of flights by the limited number of aircraft types were not widely different. Even in

the prejet era, before the days of "on condition" maintenance, much importance was attached to "hours", generally meaning accumulation of "off to on" times.

The advent of the jet, with its transcontinental and transoceanic range and the further sophistication of design concepts, brought with it the idea that the limiting factor of physical use of the aircraft would be better expressed by "cycles." This may be defined as takeoff and the subsequent landing.

E.2.1 Boeing Narrow Bodied Equipment

Boeing designed the early 707s for 20,000 cycles which, given their estimates of the longer stage length of the aircraft translated into an "hours" figure of about 50,000. It also translated into a service life of about 17 years. At about 30,000 hours, a significant unanticipated "rework" program was performed including "reskinning" certain wing panels. This brought the estimated service life up beyond the original 50,000 hours to 60,000 hours.

Three situations combined to make this rework desirable. First, the immediate public acceptance of the first jets led to their use on much shorter segments than the designers had anticipated and hence accelerated the time at which the cycle limit would be reached. Second, the market success coupled with the increased reliability of the jets enabled the operators to increase utilization. This also accelerated the accumulation of cycles.

Finally, Boeing which had previously been accustomed to the low utilization and relatively infrequent landing of military equipment and without the years of experience with a commercial fleet such as the DC-3, DC-4, and DC-6 of Douglas, designed the 707 to operate at somewhat higher stress levels than did Douglas. One result was a lighter airplane and an attendant presumed slight fuel economy and increased payload. In the 707 series the consensus is that the amount spent in increased maintenance just about balances the economy of the lighter weight.

In 1975 a number of 707s were exceeding 57,000 hours and were facing another but less substantial rework at reaching 60,000 hours. Some airlines undertook this maintenance expense and then projected the useful life to 82,000 hours. Employing normal annual utilization figures results in a total physical life expectancy of 28 years. Boeing engineers indicate, and this is not disputed by the operators of 707 aircraft, that when 82,000 hours are reached, it will be readily possible and not too expensive in relation to replacement costs to undertake further work which would extend the life to 100,000 hours or beyond. Table 18 displays a frequency distribution of flight hours for various series of 707 aircraft as of June 1975. By January 1, 1979, "high time" aircraft are over 70,000 hours.

Current Boeing 707 aircraft are powered by P&W JT3D engines. Earlier non-fan craft used the JT3C and JT4. Unlike the airframe, which in general terms stays intact but for repairs and modifica-

TABLE 18

BOEING 707/720, 727, 737, 747 FLEET STATUS
IN-FLIGHT HOURS AS OF JUNE 1975

	Number of Aircraft			
Hours	707 & 720	727	737	747
60,000+				
55-60	6			
50-55	24			
45-50	56			
40-45	99			
35-40	142	7		
30-35	132	66		
25-30	159	207		
20-25	102	228	12	25
15-20	22	240	109	95
10-15	8	103	154	67
5-10	11	138	45	39
0-5	34	165	116	38

Source: Ross (1976) See Table 14.

tion, an aircraft engine not only is moved from plane to plane but over time undergoes almost a complete replacement of component parts. In fact it is often said that the only part of an engine which remains after a few years is the nameplate displaying the serial number. Accordingly, as with the airframe, age per se of an engine has no necessary relationship to the retirement of the aircraft. The efficiency aspect will be treated elsewhere.

The next series of Boeing aircraft considered is the 727 series. Starting the design about 10 years after the design of

the 707, Boeing took into consideration its experience on the 707; it lowered some of the stresses on the wing and fuselage and designed the plane assuming a much shorter average length flight. Early 727 fuselages had a cold bond process which was unsatisfactory from a corrosion point of view and hot bonding replaced it. Thus the goal or design was set at 60,000 cycles. Subsequent experience indicates that the average stage length for the 727 is approximately one hour. Accordingly the design life on this basis is 60,000 hours. In 1975, the high time aircraft had over 37,000 hours, and more than 200 planes were over 25,000 hours. It will not be until 1980 that 727s will reach 54,000 hours. Since the 727 was designed on the experience of the 707, and since no structural problems have developed thus far, the conclusion is reached that it will be possible to push the service life another sizeable increment.

The Boeing 737 needs little treatment here. It was specifically designed for the higher cycles of the short haul and was also a structural advance over the preceding 707. With a chronological age of less than 9 years, a high time of about 20,000 hours and cycles of about 20,000 hours and cycles of about 32,000, age in any one of these parameters is not a concern to the operators of the 737.

In summary, for the current Boeing fleet, which number 2791 aircraft out of a total world commercial jet fleet of 4587, retirement of these planes will not come about because of their age

in years, or because they have reached the end of their life because of hours in the air or cycles.

E.2.2 McDonnell Douglas Narrow-Bodied Equipment

The next largest fleet is that of McDonnell Douglas whose commercial jet aircraft numbered 1240 in 1975. As was the case with Boeing, the DC-8 series aircraft were designed for a service life equivalent to 50,000 hours (McDonnell Douglas Company report J6903, "Structural Durability of DC-8 Jet Aircraft," June, 1975). At 8 hours a day, this is a design service life of 17 years. Table 19 shows the total flight hours of certain Douglas series.

TABLE 19

DC-8-20, -30, -40, -50 Series
FLEET STATUS IN-FLIGHT HOURS AS OF JUNE 1975

Total Flight Hours (000)	Number of Aircraft
15-20	8
20-25	7
25-30	22
30-35	37
35-40	45
40-45	62
45-50	55
50-55	12
55-60	5

Source: Ross (1976) See Table 14.

The early Douglas planes are now about 21 years of age, are now exceeding 70,000 hours of use and, because of the stage lengths, have fewer cycles than hours. On the basis of current structural studies Douglas is now predicting a mean service life of 82,000 hours which translates into a 28-year service life. As aircraft in the data base mature, it is felt by the manufacturer and operators that the service life can be further extended. For example, if examination at 60,000 hours reveals that 40 cracks have developed the projected life will be 100,000 hours or 34 years. If, on the other hand, approximately 30 cracks have developed the projected mean service life will be 110,000 hours or 38 years. As previously indicated the Douglas aircraft is somewhat heavier structurally than Boeing and historically has had less maintenance.

The Douglas DC-9 short-haul plane entered service in 1965 and 1966. No structural fatigue has been found and with an age of less than ten years, with hours less than 30,000 and cycles less than 40,000, the physical life of the series projects beyond anything of concern in this study.

In summary, for the current Douglas fleet retirement will not come about because of age on years, hours of service, or number of cycles performed.

E.2.3 Wide-Bodied Aircraft: Boeing 747, Douglas DC-10, Lockheed L-1011

The wide-bodied aircraft - namely, the 747, DC-10 and L-1011 - were designed after taking careful account of the experience

with the DC-8, the 707 and Convair series and much interaction between manufacturers and the airlines. As a result, the airframes contain incremental refinements of existing technology and should have an even longer service life than the narrow-bodied jets. This expectancy is confirmed by the longer depreciation periods the carriers have set up initially for the wide-bodied as compared with their previous aircraft.

E.3 DEPRECIATION, BOOK VALUE, USED AIRCRAFT PRICES

Depreciation is often defined as "the loss, not restored by current maintenance, which is due to all the factors causing the ultimate retirement of property. These factors embrace wear and tear, decay, inadequacy, and obsolescence" [Lindheimer v. Illinois Bell Telephone Co. 29 US 151, 167 (1934)]. In the air transport industry obsolescence is difficult to predict in advance. In the prejet era we noted that, despite the development of more efficient piston aircraft, obsolescence from a financial point of view was masked by a strong demand to fill an undercapacity situation. As a consequence, aircraft generally sold above book and provided funds for the purchase of jets.

In the jet era there has been a wide gap between the time one airline may start to retire a piece of equipment and that of another line. Table 20 indicates that BAC-111s began to leave American and Braniff in 5 and 7 years respectively; Eastern's 720s began at 7 years and Continental's at 14. Such departures

may mean the purchase was early proved a mistake because of over-capacity, wrong mission, or failure to receive a contemplated route award.

TABLE 20

JET AIRCRAFT RETIRED FROM TRUNK SERVICE

Aircraft Type	Carriers	Years in Service
BAC-11	AA, BN	5,7
CV-990	AA	6
Caravelle	UA	8
DC-8-61/63	EA,NA	6,8
707-100/300	CO,BN,PA	8,9,13
DC-8-NF	PA,EA,NA,DL	8,13,13,16
DC-9-10	CO	9
CV-880	DL,TW	13,15
720	EA,AA,BN,PA,NW,UA,CO	7,9,9,9,10,12,14

Source: Ross (1976)

Table 21 shows that aircraft retired from one carrier stay in service with others much longer. For example, on Western Airlines the Boeing 720 is still flying after 15 years of service. TWA and American still have the early 707s, which were once turbojets before conversion to turbofans, pushing 18 and 19 years of age.

If the Domestic Trunks plus Pan American were to replace aircraft as their book life expired, Boeing has calculated from public data that an average of 170 planes a year would be replaced over the epriod 1978-1986 as shown in Chart 4.

TABLE 21

JET CRAFT REMAINING IN TRUNK SERVICE

Aircraft Types	Carriers	Years in Service
707-100/300	AA,TW,PA,NW,WA	18,17,14,14,9
DC-8-NF/50	UA	17
720	WA	15
727-100	EA,UA,AA,TW,NA,NW,BN,PA	14,14,13,13,12,12,11,11
DC-9-10	EA,TW	11,11,
DC-8-61/62/63	BN,DL,UA	10,10,10
DC-9-30	EA,DL	10,10
727-200	AA,CO,NA,NW,TW,UA,WA,BN DL	9,9,9,9,9,9,8,6, 5
737	UA,WA	9,9
747	PA,AA,BN,NW,TW,UA	8,7,7,7,7,7
DC-10	AA,NA,UA,CO,TW,WA	6,6,6,5,5,5
L-1011	EA,TW,DL	5,5,4

Source: Ross (1976)

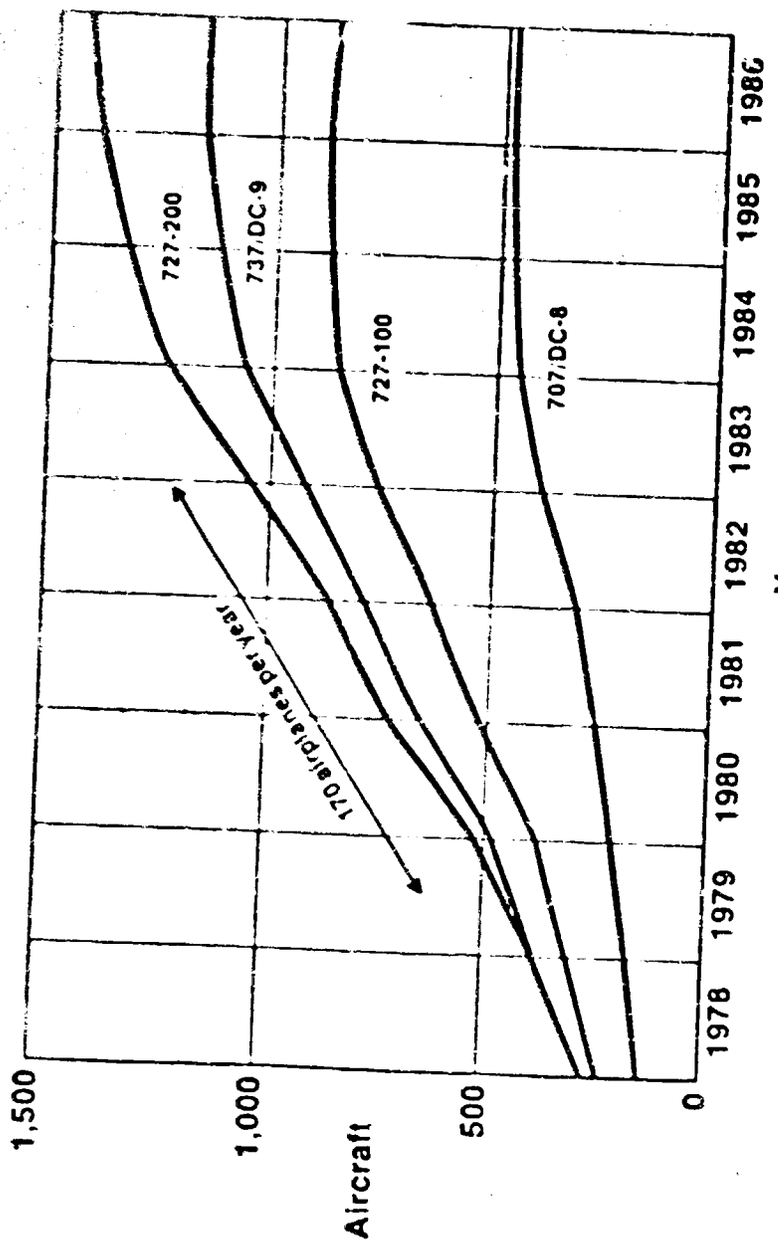
The average age of the fleet (Chart 5, p. 154) is shown to be 9.6 years for the total fleet, 10.2 for the low bypass fan, and 19.1 years for the non-fans. Different airlines have significant differences in the rates at which their fleets are aging. Chart 6, p. 155, illustrates trends. The largest airlines, the very ones that launched the jet era (PAA,AAL,UAL,TWA), have fleets that are above the trunk average age. While initially other lines followed the same aging pattern, beginning in 1972 several carriers (Continental, Delta, Northwest being very visible examples) began replacing their fleets with newer aircraft, thus lowering their average age dramatically. This action comes into focus

Chart 4

CHART 4

End of Book Life

Domestic Trunks and Pan American Standard Body Equipment



Individual airline practice

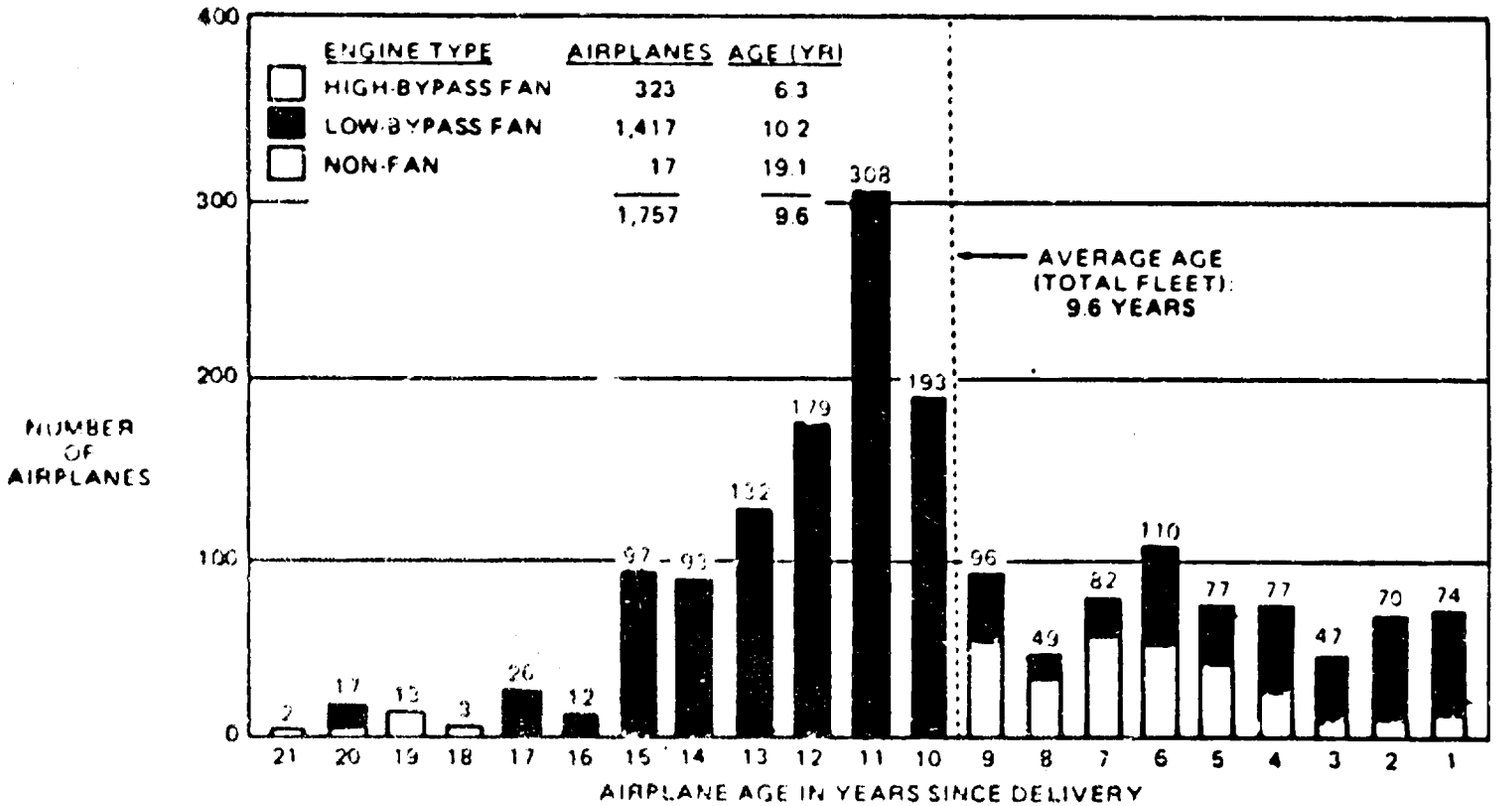
Source: Boeing Commercial Airplane Company, June 1976

Chart 5

Jet Fleet Age Distribution

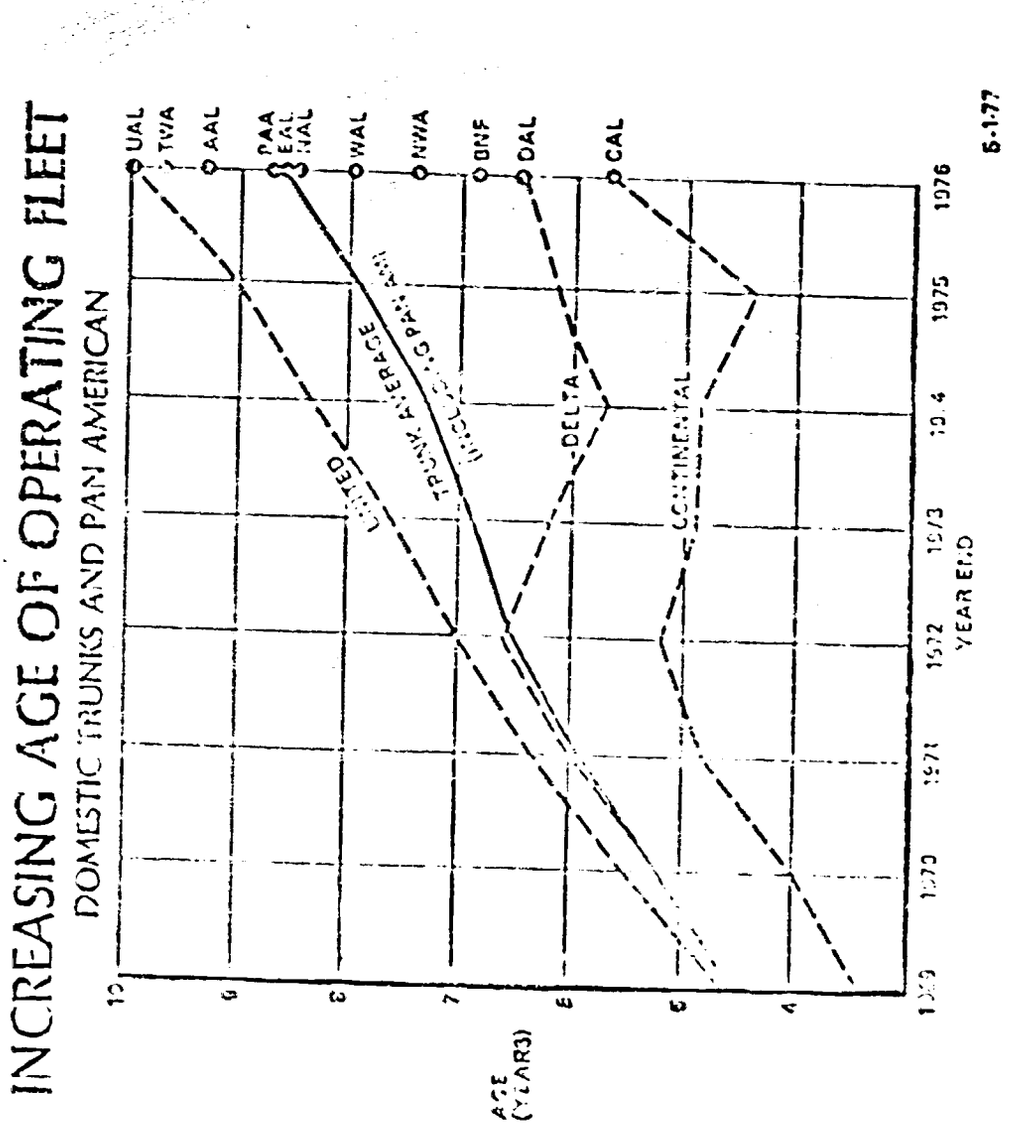
U.S. TRUNKS PLUS PAN AM

Jet Airplanes in Service December 31, 1978 (Estimate)



Source: Boeing Commercial Airplane Company

Chart 6



Source: Boeing Commercial Airplane Company

later during the discussion on the impact of noise regulations on replacement of aircraft and on the policy problems of how to assist needy carriers with old fleets without discriminating against carriers who feel that by good management they made the replacement at their own expense.

For regulatory purposes, the CAB has established depreciation periods of:

10 years ----------Turbojets

14 years ----------Turbofans

16 years ----------Wide-bodies

For business accounting, the carriers initially used the same or shorter depreciation periods. For example, Delta depreciated all aircraft over 10 years with a 10% residual while Northwest wrote off its narrow-bodies over 10 years with a 15% residual. On its wide-bodies Northwest employed 15 years with 10% residual. Subsequently when it became evident that the useful life of the narrow-bodies would exceed the book life, some airlines adjusted the depreciation periods to longer lives. The CAB itself in a recent economic study, has adjusted depreciation by auding 3 years to its normal regulatory figures tabulated above. This investigation revealed that on an industry wide basis, airlines are depreciating their equipment for accounting purposes over a longer period than the CAB regulatory rules. However, carriers with strong finances such as Delta and Northwest did not readjust their depreciation practices. The changes in depreciation rates on the

part of the carriers are a function of their desire to show earnings or minimize losses as well as to take advantage of investment credit laws. Accordingly, the changes are financial in character. Depreciation rates established for equipment are not a driving factor in determining retirement policies.

The extent to which these management depreciation decisions representing actual experience during the years 1970-1975 is reflected in a study made by AVMARK Inc. 41/ Table 22 taken from that study indicates that 841 U.S. air carrier planes were sold for $1.5 billion - a figure $232 million more than book value. In the case of Northwest, its book profit was 47%. The profit may not mean that Northwest was a shrewder bargainer but that it had a higher rate of depreciation on its fleet.

To the extent that used aircraft prices impinge on the decisions to retire aircraft, a market must exist or the decision must be made on the basis of scrap value. And to the extent that the past gives some basis for assessing the future, a review of where retired aircraft have been going is desirable. The AVMARK study, Table 23, indicates that in the 1970-1975 period, 70 jets have "trickled down" to the U.S. Local Service Airlines involving a sum of $175,000,000. However, more significantly, 37 planes went to the Middle East Region for about $180,000,000. Finally,

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41/ Transport Aircraft Values 1970-1984, AVMARK, Inc. Miami, Florida, 1976.

TABLE 22

SUMMARY OF USED AIRCRAFT SALES BY U.S. CERTIFICATED AIR CARRIERS - 1970-1975

Airline	Number Sold	Gross Sales Price	Book Profit (loss)	Percent Profit
American	66	$ 213,245,000	$ 21,663,000	10.2%
Braniff	36	79,942,000	3,916,000	4.7
Continental	39	142,693,000	(722,000)	(0.5)
Delta	68	106,574,000	22,578,000	21.2
Eastern	87	262,913,000	16,197,000	6.2
National	12	19,171,000	3,048,000	15.9
Northwest	51	166,264,000	78,639,000	47.3
Pan American	57	102,442,000	18,021,000	17.6
TWA	25	62,930,000	(5,015,000)	(8.0)
United	57	53,856,000	10,159,000	18.9
Western	27	32,112,000	9,786,000	30.5
Total Trunks	525	$1,242,181,000	$178,313,000	14.4%
Allegheny	43	$ 21,186,000	$ 1,913,000	9.4%
Frontier	18	24,134,000	1,769,000	7.3
Hughes Airwest	26	11,933,000	4,096,000	34.3
North Central	3	1,822,000	(8,000)	(0.4)
Ozark	3	5,654,000	1,977,000	35.0
Piedmont	6	1,597,000	135,000	8.5
Southern	14	10,062,000	1,973,000	19.7
Texas International	3	5,293,000	(67,000)	(1.3)
Total Regional	116	$ 57,547,000	$ 11,788,000	20.6%
Alaska	20	$ 6,022,000	$ 104,000	1.7%
Aloha	2	140,000	13,000	9.3
Hawaiian	2	7,586,000	1,800,000	23.7
Kodiak	10	446,000	188,000	42.2
Reeve	3	141,000	119,000	84.4
Wien	2	150,000	52,000	34.7
Total Territorial	39	$ 14,485,000	$ 2,276,000	15.7%
Airlift	22	$ 24,771,000	(3,052,000)	(12.3%)
Flying Tigers	13	43,591,000	6,195,000	19.0
Seaboard World	6	36,287,000	6,586,000	18.1
Total All-Cargo	41	$ 104,599,000	$ 9,730,000	10.3%
Capitol	23	$ 19,430,000	$ 6,892,000	35.3%
Johnson (Evergreen)	30	773,000	366,000	46.9
McCulloch	10	3,410,000	720,000	21.3
Modern	8	3,288,000	(3,038,000)	(93.5)
Overseas National	12	28,187,000	5,954,000	21.1
Saturn	20	11,248,000	526,000	4.5
Trans International	5	22,217,000	2,430,000	10.9
World	12	57,013,000	14,057,000	24.6
Total Supplementals	120	$ 146,963,000	$ 29,932,000	20.3%
TOTAL INDUSTRY	841	$1,565,767,000	$231,948,000	14.9%

Source: AVMARK, Inc., Miami, Florida

TABLE 23

USED AIRCRAFT - WHERE THEY WENT
U.S. Carrier Industry
1970 - 1975

Purchased By	Number Aircraft	Total Transaction Value (000)	Average Transaction (000)	Percent Total Value	Percent Total Number
Far East, Asia & African Area	57	$221,566	$3,887	13.1%	6.6%
Middle East Region	37	179,838	4,860	10.6	4.2
U.S. Local Service Airlines	70	173,337	2,476	10.2	8.2
Canada and Caribbean	57	144,100	2,528	8.5	6.6
Latin America	59	137,542	2,331	8.1	6.8
U.S. Manufacturers	54	136,299	2,524	8.0	6.2
European Cargo & Charter Airlines	73	131,723	1,804	7.8	8.4
U.S. Trunk Airlines	18	129,785	2,210	7.6	2.1
European Scheduled Airlines	28	97,702	3,489	5.8	3.2
Brokers in USA	117	69,861	597	4.1	13.5
U.S. Supplemental Air Carriers	52	66,115	1,271	3.9	6.0
U.S. All-Cargo Carriers	3	40,045	13,348	2.4	.3
Financial Institutions and Leasing Companies	43	45,770	1,064	2.6	4.8
European Brokers	25	30,887	1,235	1.8	2.9
U.S. Territorial Airlines	21	28,194	1,128	1.7	2.4
Aircraft Sold and Repossessed	15	17,801	1,187	1.1	1.7
Sales to Third Level Carriers, Flying Clubs, Corporations, Individuals and Others	137	43,790	320	2.6	15.9
Total Transactions	865	$1,694,345	$1,959	100.0%	100.0%

The foregoing data is from air carrier reports to the U.S. Civil Aeronautics Board and shows the purchasers listed by the airlines. In certain cases, especially those involving brokers and financial institutions, the aircraft were subsequently transferred to third parties. Further, data does not necessarily accurately reflect the extent of actual owners of the aircraft.

Source: AVMARK, Inc., Miami, Florida

57 aircraft were sold to the Far East, Asia and African Area for $223,000,000. AVMARK projected an increase in the price of used aircraft even in the face of a substantial potential increase in offerings of U.S. carriers desiring or being forced to retire their noisy high cost fleets.

E.4 CONCLUSIONS ON AGING OF THE CURRENT JET FLEET

E.4.1 Narrow-Bodied

The current jet era began in 1958 with the advent of the coast-to-coast Boeing 707 turbojet. Following quickly were the Douglas DC-8 and Convair 880 turbojets. The normal powerplant was the P&W JT-3 and JT-4. In 1961 a quieter more efficient engine, the JT-3D turbofan, was developed and powered all subsequent production aircraft. Some airlines re-equipped their existing aircraft with the new turbofans. In 1964 and 1965, the shorter range, smaller 727 and DC-9 were introduced powered by a new P&W JT8D turbofan. Unless sold to other carriers, these aircraft and their powerplants have been in use by the purchasing carriers continuously. Some of the older 707 and DC-8 series are reaching 21 years of age, far beyond the original depreciation periods set by the original purchasers, and approaching the design life span of the aircraft using hours as a standard.

Careful engineering analysis and structural re-testing by the manufacturers and users have developed the fact that with some

additional maintenance, the life span can further safely be extended by additional significant increments up to 82,000 and then 100,000 hours. This would bring the life span up to 30 or 40 years. With respect to depreciation, it is largely a management decision which is not necessarily based on the expected useful life of the aircraft. Therefore, neither chronological age per se nor book life of the aircraft can be said to be a factor in the retirement of current jet aircraft.

E.4.2 Wide-Bodied

The wide-bodied jumbo 747 aircraft was introduced in 1970 followed by the DC-10 and L-1011 in 1972. The manufacturers claim and the purchasers agree, that additional quality has been built into these airframes by taking advantage of the lessons learned from their previous models. Thus, age will be of no concern for some time to come. These aircraft are powered by a new generation of high bypass engines. Airline users are not yet ready to pinpoint the life span of wide-bodies, but do agree that it will be many years before age will be a retirement factor.

F.

ECONOMICS AND TECHNOLOGY AS FACTORS IN RETIREMENT

F.1 PREJET PRODUCTIVITY

Up to the time of the oil embargo in 1973 aircraft retirements were primarily the result of cost effecitve improvements in technology which tended to make aircraft economically obsolete before wearing out. However, in a few cases less economic additions to fleets (e.g., DC-7,377) tended to force retirement of some more efficient aircraft from a route or company. [42/] Technological improvements causing retirements have been of two kinds: (1) modest improvements which have had a gradual effect, and (2) quantum jump improvements whose effects were more dramatic. In the early 1930s aircraft manufacturers, through interlocking stock ownership, legally could and did control air carriers as means of assuring an outlet for their products. However, when because of its corporate relationship with United, Boeing rebuffed TWA's effort to buy the 160 mph Boeing 247D, TWA went to Douglas and developed

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42/ For a more detailed delineation of the history of factors affecting aircraft selection see: F.A. Spencer, "Aircraft Selection", AIAA Paper No. 78-1531, given at the Los Angeles AIAA Conference on Air Transportation, August 21-24, 1978. Also F.A. Spencer, ed., The Next Commercial Jet Transport, Papers at the Air Transportation International Forum, The Transportation Center, Northwestern University, Evanston, Illinois, 1977.

a more efficient plane, the DC-2. After legislation in 1934, manufacturers could no longer own stock in airlines. In 1936 American and Douglas developed the larger DC-3 and a model called the DST (Douglas Sleeper Transport) which carried more people longer distances with increased comfort at lower operating costs per seat-mile. The DC-3 was the immediate cause of the early retirement of the 247D as well as that of the slower Curtiss Condors which American had been using as sleepers. The DC-3 became the standard of the domestic industry.

Because of World War II restricted production the Boeing 307 Stratoliner and the Douglas DC-4, both unpressurized aircraft, had little long run effect on retirements. However, immediately after that conflict there occured the first of two quantum jumps in aircraft productivity, each to be accompanied by decreases in operating costs which ultimately rendered the DC-3 obsolete on medium to long-haul segments.

The DC-6 and Lockheed Constellation compounded a doubling of size with a doubling of speed for a quadrupling of productivity. Pressurization added comfort, and the longer range deleted the need for intermediate fuel stops in long-haul operations. The development of these craft resulted in a restructuring of the air transport map as carriers sought to take advantage of new marketing opportunities. Given the economies of these craft and managements' desires to extend their spheres of influence, some of the larger carriers decided to shift emphasis to longer haul routes for which

the DC-3 was not suited. Accordingly, the DC-3s began to be "retired" from the larger airlines but found a home in lower tier services of local service airlines. A development of twin-engined pressurized planes (the Convair and Martin series) put pressure on the local service carriers to retire the DC-3s. This first post-war quantum jump in productivity was made possible by the development of more powerful engines, the pressurized cabin, and improved aerodynamics. Since this technological development was accompanied by lower operating costs, the DC-3 became technologically and economically obsolete.

The continued development of ever more economical planes had exceptions which resulted in a foreshortened life for such aircraft. The Boeing 377 Stratocruiser introduced by Pan American in 1949 was a specialty plane for overwater operations. Its high operating costs were partly the result of the failure of the engines to produce the power anticipated. Nevertheless, United felt it was forced to select the plane, regardless of economics, to protect its Hawaiian market. Another attempt at a long-range plane, the Lockheed L-1649, resulted in a higher operating cost than its predecessor.

Finally, the DC-7 developed from one company's market desire to have the jump on competitors in coast-to-coast nonstop operations before the arrival of jets. Featuring additional speed as well as range, the DC-7 also had appeal for overocean operations. The inability of the aircraft to be able to fly westbound coast-

to-coast in less than 8 hours as required by FAA regulations brought about a labor dispute which was resolved by the company adding another crew member on over eight hour flights - a cost increasing solution. Engine maintenance was high and reliability was less than on the predecessor DC-6 and DC-6B. The foregoing events, coupled with the introduction of the superior jets, hastened the retirement of the DC-7 and the L-1649 at the very low prices shown in Section B, Table 1, page 6.

At the very time the post-war multi-engined, pressurized, piston aircraft were being incrementally improved via the "stretch" process made possible by increased engine power, and were enjoying tremendous passenger acceptance, the seeds for their retirement were being sown by the development of a second post-war quantum jump in productivity. Happily, somewhat unexpectedly, the development of the four-engined turbojets was associated with a one third decrease in operating costs. Lockheed, believing that turbojet development would take much longer than it did and would be confined to long-haul operations, chose to develop the turboprop L-188, which, although more economical than piston aircraft, lacked speed. Rapid cost-effective technological development of the pure jet resulted in a limited production run for the L-188 and its premature retirement from many of the routes for which it was designed.

F.2 JET PRODUCTIVITY

The new Boeing, Convair, and Douglas four-engined jets provided compounding a doubling of size with a doubling of speed to this second post-war quadrupling of productivity. Additionally, the jets provided amenities which increased their attractiveness in comparison with the slower piston and turboprop aircraft - namely a significant decrease in cabin noise and an even greater decrease in vibration. Notwithstanding these advantages, the early turbojets were exterally extremely noisy, underpowered for existing airports, and of less than desired range for many over-ocean operations. The development of the JT3D fanjet provided increased thrust, reduced fuel consumption and less external noise. Public acceptance of the jet was immediate, and the 4-engine piston aircraft began their retirement from long-haul operations as fast as jets could be delivered. While many assumed that the jets would be confined to long-haul operations, this proved not to be so. The new jet technology was then applied to developing short-to-medium range planes (727/737/DC-9) with similar success. Operating costs proved to be about one third less than predecessor planes so that the fares could be kept at attractive levels.

The high rate of traffic growth, averaging 19% annually in some periods, and the fact that there have been economies of scale as aircraft have grown led to the development of high capacity (225-500 seats) wide-bodied 747/DC-10/L-1011 with low seat-mile

costs. The 747 was built for low-cost mass transportation and cargo on the assumption that, at least on transoceanic operations, supersonic travel would attract all business travel and much of the well-to-do vacation travel. A feature of the wide-bodies was their adoption of the new technology high bypass engines which combined a significant improvement in fuel efficiency with a required reduction in noise emissions to meet FAR 36 for newly designed aircraft.

It was assumed that the 747 would lead to the retirement of the 707 and DC-8 series. However, introduction of the 747 came at a time of recession and a relative downturn of traffic. Thus in some cases it was the new technology 747 aircraft which was "retired" by sale or parked in the desert and not the aircraft originally marked for retirement. When growth still failed to materialize, even the smaller widebodies, the DC-10 and Lockheed L-1011, were too large to take over the routes of the smaller craft. It became clear that low seat-mile costs provided profits only if a high proportion of the seats were used by revenue passengers. Attempts to cure lack of profitability by reducing frequencies in order to increase load factors often failed because passengers deserted the carrier for an airline providing frequency of service with smaller capacity narrow bodies. As operating costs rose, and as pressure on the government increased to develop and enforce tighter noise rules, airframe and powerplant engineers sought to design a quiet, low operating cost, craft in the 200

passenger capacity bracket - a capacity well below the 250 capacity widebody but well above the 100 to 150 passenger capacity of the first generation jets.

With replacement of the 707 and DC-8 for economic and environmental reasons as an objective, aircraft manufacturers flooded the most likely clients (American, United and Delta) with a stream of new aircraft designs. The outcome was launching of the Boeing 767 and 757 series which combine (to the extent that carriers are willing to accept them) the latest technical advances. In spite of the high cost of technology, the craft have superior economics and two very necessary attributes. First is the low noise emission level which enable them to meet Stage 3 limits. Second is a fuel consumption saving in excess of 35% per seat-mile over the earliest jets. This now brings us to one of the most important factors in aircraft retirement, namely, fuel efficiency.

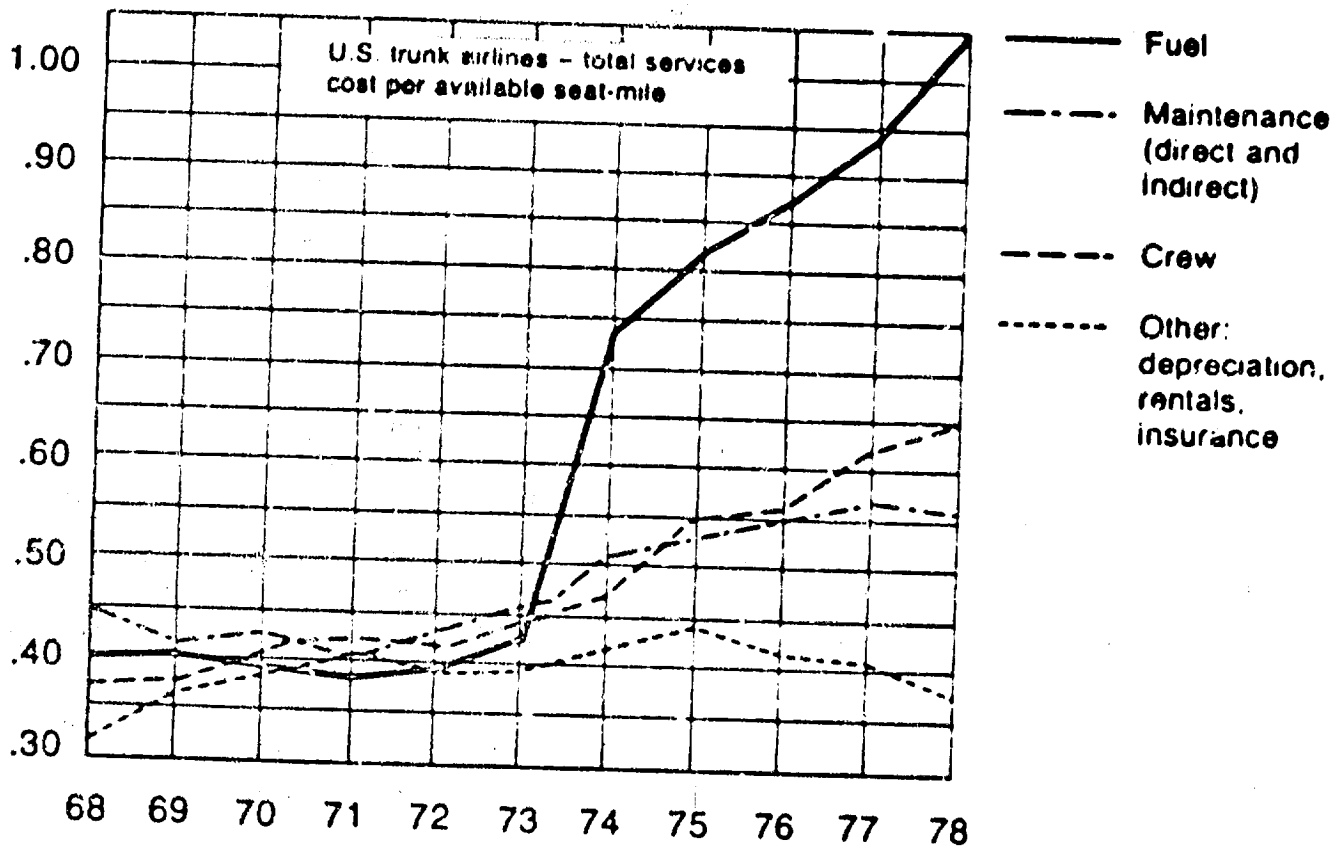
F.3 FUEL EFFICIENCY AS A FACTOR IN AIRCRAFT RETIREMENT

Prior to the 1973 oil embargo the price of fuel was not a factor in the design or purchase of transport aircraft. For years the price of fuel had been low -- only 12% of total operating costs and 20% of cash operating costs. Fuel prices were predicted to go still lower. Before the embargo the price of jet fuel was 13.5¢ per gallon. Chart 7 graphically depicts the increasing importance to an airline of fuel costs. By May 1979 the cost to domestic U.S. carriers was 50¢ a gallon; international carriers

CHART 7

Influence of Fuel Price

Direct Operating Cost Elements



Source: CAB form 41 schedule P5

V1930R1

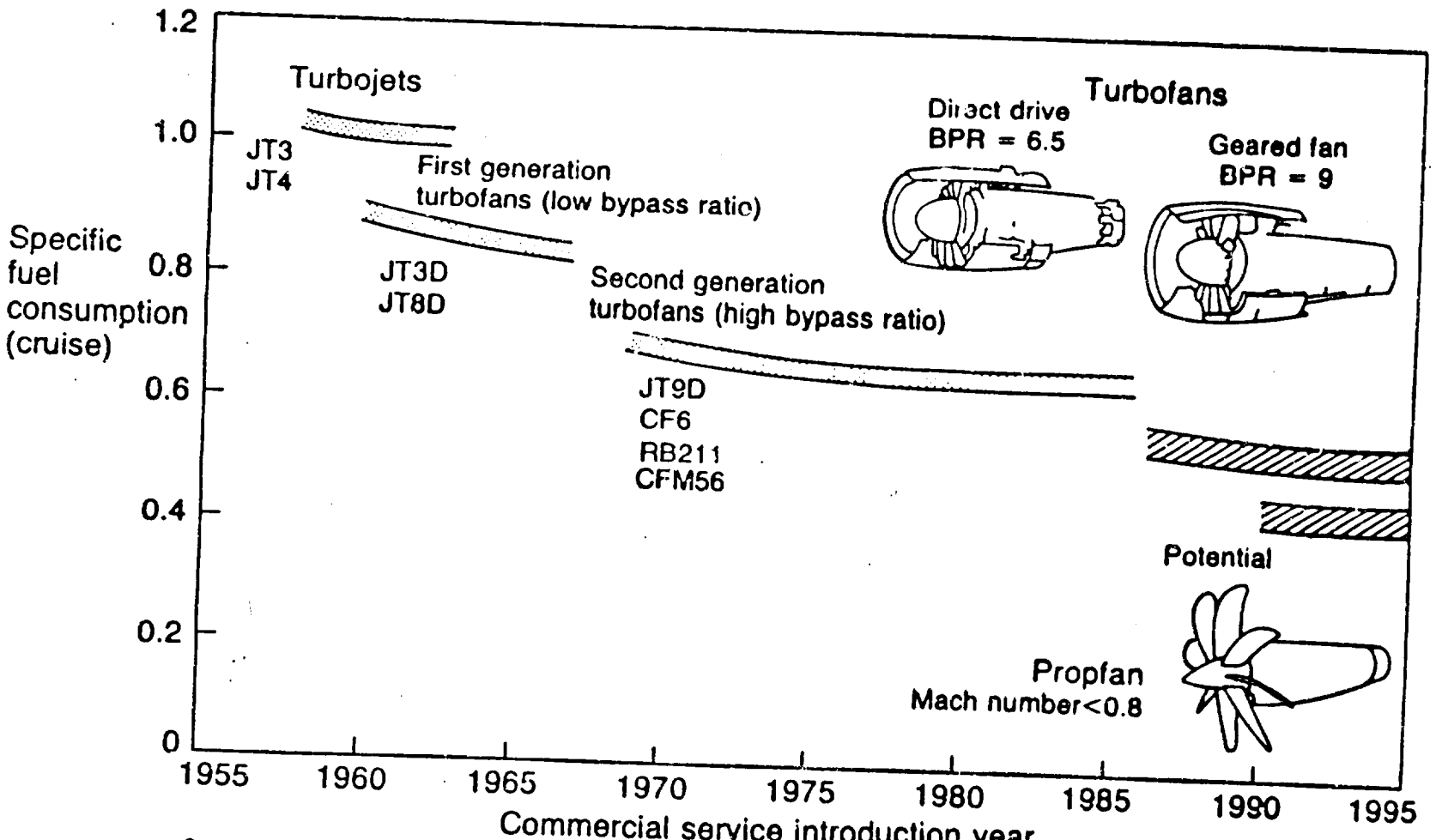
paid still more. Further increases are predicted. The result has been that fuel now amounts to about 50% of cash direct operating expenses and is moving toward 25% of total operating costs. The dramatic rise in fuel cost plus the increasing cost of technological improvements, has shifted the focus in the design objectives of carriers and manufacturers. Economics rather than technology for technology's sake is now king. Although there had been progressive fuel consumption improvements as engines progressed from straight jets to first generation turbofan (low bypass ratio) to the second generation turbofan (high bypass ratio), as shown in Chart 8, still more efficiency was sought through applications of the supercritical type wing, the use of light composite materials, and a redesign of the wing for an optimum speed for a planned fuel price. A tabulation of changes in fuel efficiency per seat as calculated by a major carrier in mid 1978 displays a difference of 50% between the early non-fan and the new Boeing 767.

Seats	Airplane	% Increase in Fuel Efficiency
129	DC-8 (non-fan)	-17%
129	DC-8-50	Base airplane
96	727-100	1.5%
132	727-200	20%
256	DC-10-10	31%
197	767	38%

It was not old age, lack of passenger comfort, unsatisfactory engine or airframe reliability which caused airlines to retire their non-fan DC-8s, but the escalating price of fuel which made them economically obsolete. Escalating fuel prices have been the cause

CHART 8

Fuel Consumption Improvements



V3015 Source:Boeing Airplane Co.

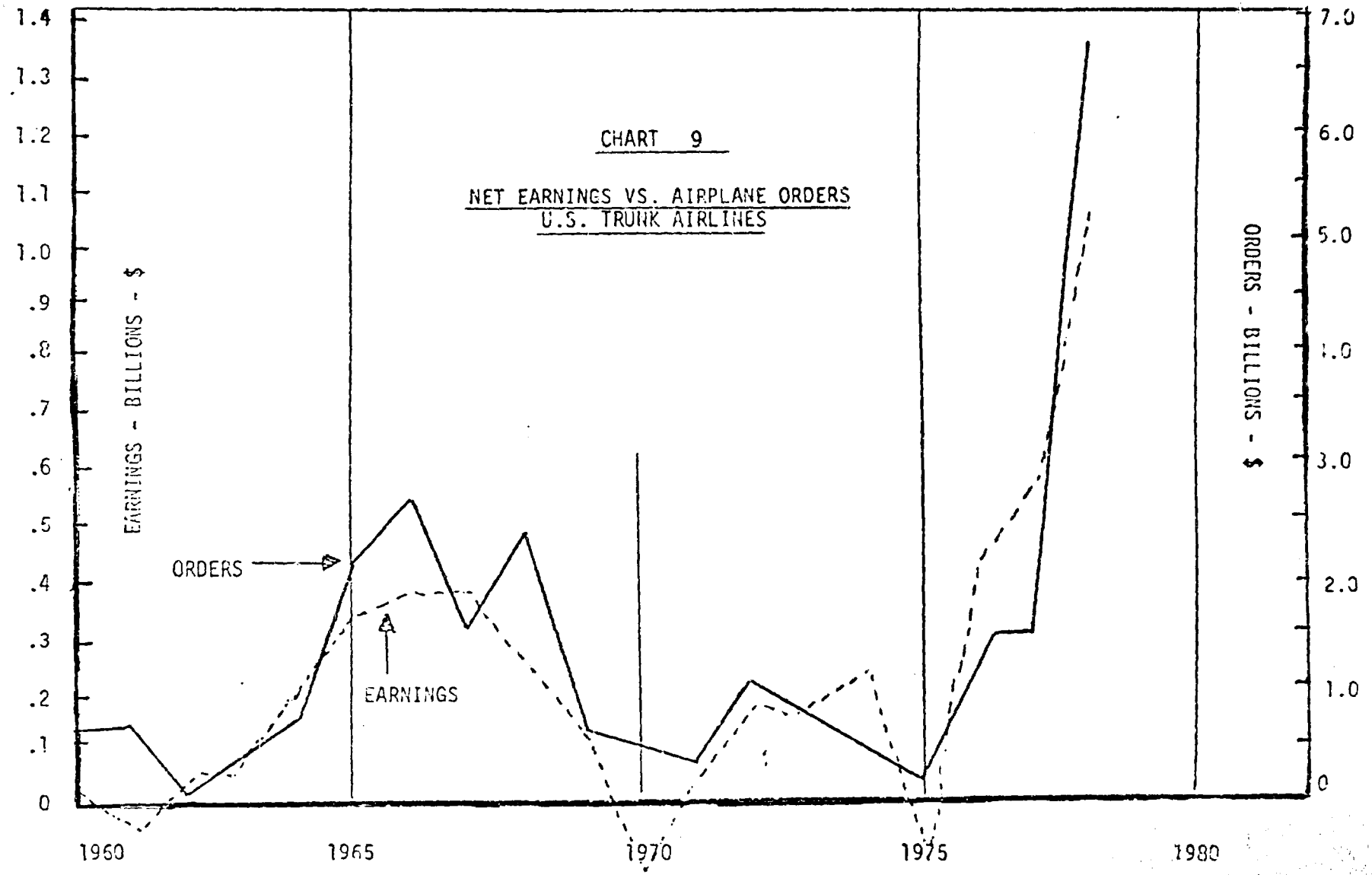
of the sale of the early 707-100 series and are now pushing the 727-100 series to retirement.

In 1978 many analysts considered the long-haul, high-capacity DC-8-60 series to be economically obsolete because of fuel costs. However, further increases in fuel prices and the escalation of prices of new aircraft have made re-engining the craft with the more fuel-efficient CFM 56 engines so attractive that they are programmed for reengining with an estimated additional 10 years of airline life.

F.4 ECONOMIC CLIMATE AS A FACTOR IN RETIREMENT

Another important factor in the retirement picture is the economic health of the country, the aviation industry, and of the individual carriers involved. Unless it is perceived that a carrier's earnings will support the purchase and use of new aircraft no matter how much better they are than existing craft, neither the board of directors nor the banks will look favorably on new purchases. Orders do not necessarily follow immediately upon technological advances.

There is a saying in the manufacturing industry that "orders follow earnings." This observation is aptly demonstrated in Chart 9, Net Earnings VS Airplane Orders, U.S. Trunk Airlines. Given the 1960-1970 history, as shown on the chart, one could expect that when the hearings on bringing all aircraft into compliance



Source: The Boeing Company

with FAR 36 were conducted in 1975-6, the airlines could, with some justification, claim they were in no position to modify or retire noncomplying aircraft. The chart also shows that the rapid turnaround in airline finances, caused by their highly leveraged position, was accompanied by such a flow of orders that Congress questioned, and then decided against, financial assistance. The changing financial fortunes of the airlines can have a powerful, if not determinative, effect on corporate equipment decisions whether they be for retirement or acquisition for growth. We now turn to a more detailed exposition of the financial perspective relative to retirement of aircraft.

G.

REPLACEMENT DECISIONS: A FINANCIAL PERSPECTIVE

We examine financial aspects of the aircraft retirement decision in this section. Since industry demand is generally perceived as rising, the retirement decision is in fact a decision to replace. We begin our discussion by introducing the economic logic of replacement decision. Perhaps, the single key element in that decision process is defining the discount rate which will equate the sum of future cash flow benefits with the current cost of obtaining new planes. The discount rate is taken to be the marginal cost of additional capital funds. As this marginal cost is determined by investors, based on their perception of return-risk characteristics of the firm, we focus our attention next on the economic performance of airlines in the 1966-75 period.

There are several qualifications to be made before we begin. First, our approach to airline industry financial problems is a descriptive one. That is, while we focus almost exclusively on quantitative aspects of performance, our emphasis is on the "proximate" determinants of the record. We do not examine industry financing in terms of explicit behavioral models simply because of a lack of funding, rather than a disdain for such work. Second, our financial analysis focuses on the "Big Eleven" trunk carriers: American, Braniff, Continental, Delta, Eastern, National, Northwest,

Pan am, Trans World, United and Western. These firms own the bulk of the domestic jet fleet, and operate nearly all of the aging, noisy, and fuel-inefficient craft.

It is important that we distinguish the sources data used in this section. With few exceptions, these data are derived from the COMPUSTAT tapes supplied monthly to the financial community by Standard and Poor's. 43/ As such, the data shown in our calculations are based exclusively on the annual audited statements of air carriers. Use of the COMPUSTAT series requires some additional clarification. We note that all balance sheet information employed here are measured in "book" rather than "market" terms. The data employed for all carriers are those of the consolidated form, reflecting the performance and structure of airline as well as other subsidiaries. (Our choice here is a deliberate one since it is the consolidated reports which are of concern to the financial institutions.) Finally, we note that our data are based on fiscal years. For all but two carriers, the 1975 fiscal year coincides with the calendar year. 44/

43/ C.E. Ferguson, Jr. and W.G. Glimpse (1976). COMPUSTAT Analysis System: Users' Guide, Investors Management Sciences, Inc.

44/ Exceptions and final month of fiscal year are: Delta, June, and National, June.

G.1 THE CALCULUS OF REPLACEMENT DECISIONS

The ultimate purchase decision for new aircraft is a financial one. True, the technological characteristics of the new craft and the craft to be replaced are integral to this decision. However, the outcome of this process will depend on several other variables which are unrelated to the new aircraft (e.g., the firm's capital structure and level of interest rates prevailing in the economy). Our task in this section is to summarize the decision and to describe the requisite calculations for these rules.

The distinguishing characteristic of capital equipment is that it provides services over a lengthy period. Managers must thus concern themselves with a multiperiod profitability calculation. For each future period up to its retirement date the equipment is presumed to generate cashflows ("profits" plus depreciation) which can be well estimated as of the current date. Replacement decisions require that we examine two distinct series of future cash flows: (i) those specific to the existing equipment, and (ii) those implicit in use of new equipment. That is, replacement implies that new equipment will displace current equipment in some given service activity. The differential cash flows resulting from replacement must be sufficient to justify purchase.

The cash flows resulting from continuing use of existing equipment are not difficult to project, since the service in which these craft are used is well understood, as are the craft's operating characteristics. Indeed, the only real difficulty here is

in anticipating inflation in the unit prices of associated inputs (e.g., fuel and wage rates). The future cash flows specific to new equipment are often more difficult to project accurately. This is typically the case where a new type of aircraft is under consideration, since its operating characteristics are often not established and the plan may well provide a different type of service (thereby altering demand).

Should an airline consider replacement of existing craft with new ones, the extended cash benefits will be of four types:

i) revenue gains through improved availabiltiy or altered service characteristics

ii) operating cost reductions produced by lower weight, reduced fuel consumption, etc.

iii) increased cash flows as the result of larger depreciation allowances; and

iv) decreased tax levels associated with the higher levels of depreciation or with any legislated special tax treatment.

In the context of the current debate some important qualitative views of these benefits can be made. We note first that the revenue gains from new aircraft will be slight indeed since new craft will not per se generate increased numbers of passengers. True, where higher capacity planes are substituted for DC-9s and 727-100s there will be passenger gains in certain limited capacity markets. However such markets are few in number - and additions to this market classification are not developing rapidly. Our analysis indicates that compared with current wide-bodies only limited operating cost reductions would be associated with a new-

design aircraft. Reductions in operating costs will be largely in the form of fuel savings - these the result of improved engine efficiency and lowered gross takeoff weights. The weight reductions now in view appear largely due to limited use of composite materials.

The "tax benefits" of new aircraft are immediate and are supportive of replacement. That is, the financial community focuses on the cash flow - net income plus depreciation - implication of an investment decision. The value of depreciation allowances, however, is conditioned on positive values of taxable income. To the extent that pre-tax earnings are minimal, the tax savings associated with increased depreciation are slight. The latter situation, of course, has been typical of U.S. trunk carriers in the 1970s.

Replacement implies that the older aircraft in fact leaves the fleet, thus generating immediate cash benefits. In a world of stable prices the sale price of the old plane will closely approximate its book value. As such the sale of older aircraft will not affect the firm's tax liabilities. However, the extreme inflation rates of the past decade have produced an understatement in aircraft book values. Thus aircraft which are current replacement candidates have market values well in excess of book - and their sale will produce taxable income. Consider the following: the Boeing B-737-200 which was purchased for $4.4 million in 1970 had a 1977 market value of $3.5 million. Employing a ten-

year service life, sum-of-the-year's-digits depreciation scheme, and a $1 million salvage value the 1977 book value of this plane is but $1.6 million. Thus the sale of a six year-old aircraft could produce a tax liability as high as $912,000 [45/] In 1978 and 1979 the used value escalated.

The replacement decision involves comparing the purchase price of the new aircraft (less the proceeds from sale of the old craft, net of tax liabilities incurred in that transaction) with the stream of future benefits obtained from operating the new plane in place of the older one. Since these future cash flows are obtained over time, they must be discounted to allow for earnings foregone by the firm as a result of the new aircraft purchase. The appropriate interest rate for such discounting would be the rate attached to a risk-free asset (e.g., short-term treasury bills) if the future returns were a certainty.

Considerable uncertainty is associated with the cash flows produced by a fleet of new aircraft. This stems from lack of information on technical performance, changing regulatory attitudes, competitive forces, etc. Accordingly, the case can be made for using a discount rate (in excess of the "risk-free rate") which reflects the risk characteristics of the new craft. By most conventional measures of trunkline risk, this sector is one of the

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45/ These data are taken from AVAMRK, Inc., Transport Aircraft Values, 1970-1984. Miami, 1976.

more risky in the U.S. economy. It follows that the discount rates used to analyze new aircraft purchases will be high relative to those used by other firms in capital budgeting.

The final step in the replacement calculus is to ask if the discounted future benefits from purchase exceed the net cost of the new equipment. If this result obtains, the aircraft will be purchased because this investment will increase stockholders' earnings and thus raise the market value of the firm's equity shares. Should the net purchase price exceed the discounted value of the future cash flows associated with purchase, then the aircraft would not be purchased. And this because the returns from the investment would fail to match the stockholders' earnings expectations, thereby producing a decline in the value of the stock.

The key features, then, in the replacement decision are the following:

i) uncertainty associated with cashflows from new aircraft;

ii) tax implications coincident with retirement of older planes and depreciation of new ones; and

iii) derivation of discount rates applicable to the future cash flows which adequately reflect the risk structure of the firm and industry.

The following paragraphs of this section review the current performance of the trunkline industry. This performance gives key indications as to the nature of uncertainty, tax considerations, and risk structure. From these findings, we go on to examine

qualitatively the prospects for fleet replacement under alternative economic and regulatory scenarios.

G.2 LEVERAGE AND RISK STRUCTURE

The cost of obtaining funds - as well as the potential barrier to any funding - is tied to the capital structure of a form. That is the relative size of debt and lease obligations in all corporate capital funds (leverage) influences the rate which must be paid to produce new capital funds. This is especially the case when "fixed obligations" (debt service and lease payments) bulk large relative to cash flow.

Table 24 examines the leverage position of the trunk carriers in the period 1971-1975. Part A of this table shows the ratio of long-term debt to all long-term (or "permanent capital") funds; that is the proportion of long-term funds obtained from creditors. While the tax deductibility of interest payments makes debt an attractive form of fund raising to the shareholders, when debt becomes too high the possibility of default - which places at risk the assets held by shareholders - discourages high debt proportions. In this context the data of Part A are interesting. While no trend emerges for the carriers, it seems clear that long-term debt has remained a fairly stable proportion of all capital.

In recent years firms have engaged in a good deal of "off the balance sheet" financing - i.e., leasing of capital equipment. That this has been particularly true of trunk air carriers is seen

Table 24

SELECTED FINANCIAL RATIOS: 1971-1975

U.S. Domestic Trunks Plus Pan Am

Item	Firm	1971	1972	1973	1974	1975
A. Long Term Debt/Long Term Debt plus Equity	AAL	.572	.573	.579	.531	.528
	BNF	.652	.658	.655	.618	.608
	CAL	.744	.696	.709	.717	.746
	DAL	.550	.517	.493	.564	.580
	EAL	.654	.620	.716	.696	.701
	NAL	.594	.667	.658	.579	.600
	NWA	.446	.410	.438	.387	.397
	PAA	.708	.717	.708	.739	.760
	TWA	.732	.724	.730	.739	.760
	UAL	.672	.674	.653	.630	.644
	WAL	.680	.626	.590	.554	.550
B. Long Term Debt plus Lease Payments/L.T. Debt plus Equity plus Lease Payments	AAL	.768	.778	.796	.788	.800
	BNF	.855	.842	.832	.829	.825
	CAL	.804	.769	.788	.784	.810
	DAL	.619	.593	.599	.629	.640
	EAL	.859	.817	.863	.866	.879
	NAL	.700	.730	.732	.690	.696
	NWA	.497	.463	.499	.462	.470
	PAA	.802	.811	.812	.844	.863
	TWA	.870	.861	.876	.875	.901
	UAL	.806	.814	.786	.769	.780
	WAL	.795	.773	.765	.760	.777
C. Times Interest Earned*	AAL	4.0	4.6	2.8	6.2	4.3
	BNF	4.2	5.0	4.6	4.1	4.2
	CAL	3.9	4.2	2.9	2.4	1.9
	DAL	8.4	12.7	13.9	10.2	6.4
	EAL	3.2	4.2	1.6	2.6	1.9
	NAL	2.6	6.0	5.7	6.3	4.4
	NWA	7.8	12.8	10.7	9.9	9.2
	PAA	1.9	2.4	2.5	.8	2.3
	TWA	3.8	6.5	6.2	2.6	1.4
	UAL	3.8	4.7	5.9	7.8	4.0
	WAL	4.9	6.3	8.0	8.2	5.5

* Includes book depreciation.

TABLE 24 (continued)

Item	Firm	1971	1972	1973	1974	1975
D. Coverage**	AAL	1.6	1.6	1.0	1.9	1.1
	BNF	1.9	2.1	2.2	2.1	1.9
	CAL	2.7	2.7	2.0	1.9	1.4
	DAL	4.6	5.0	4.5	4.2	3.0
	EAL	1.4	1.8	.8	1.4	1.0
	NAL	1.6	3.7	3.5	3.8	2.5
	NWA	3.2	3.9	4.3	4.7	3.8
	PAA	1.2	1.5	1.6	.5	1.4
	TWA	1.7	2.3	2.2	1.3	.7
	UAL	1.8	2.2	3.0	3.7	1.9
	WAL	2.9	3.4	4.0	3.9	2.1
E. Return on Equity	AAL	.005	.010	-.089	.36	-.038
	BNF	.106	.158	.176	.169	.122
	CAL	.070	.064	.001	.052	-.066
	DAL	.106	.133	.181	.204	.102
	EAL	.017	.061	-.167	.022	-.190
	NAL	-.032	.140	.126	.163	.058
	NWA	.045	.036	.097	.110	.070
	PAA	-.103	-.070	-.047	-.267	-.180
	TWA	.004	.128	.120	-.070	-.315
	UAL	-.013	.034	.079	.130	-.008
	WAL	.068	.116	.179	.182	.037
F. Return on Assets	AAL	.025	.023	-.015	.034	-.002
	BNF	.074	.089	.102	.123	.087
	CAL	.058	.060	.037	.074	.026
	DAL	.078	.104	.145	.159	.083
	EAL	.044	.052	-.009	.056	.003
	NAL	.002	.086	.090	.133	.054
	NWA	.026	.027	.065	.107	.053
	PAA	-.001	.003	.014	-.050	-.001
	TWA	.029	.051	.055	.020	-.020
	UAL	.024	.040	.068	.109	.021
	WAL	.058	.081	.121	.134	.032

** Includes book depreciation. Coverage is ratio of earnings before interest and taxes to interest plus one-third of rentals.

in Part B of Table 24. Here we adjust the long-term debt-to-permanent-capital ratio by adding lease obligations to both numerator and denominator. The resultant ratio more fairly reflects the firm's fixed obligations and the relative position of the stockholder. A different picture of leverage now emerges. To wit, trunk carriers are extremely leveraged. And in the case of six carriers this leverage has increased with time. These ratios are very high relative to other firms in the U.S. economy.

Parts C and D of Table 24 focus on the ability of trunk carriers to meet fixed obligations. These are the so-called coverage ratios. The first of these stresses interest coverage, the second provides for coverages of both interest and capital rentals (leases). In both cases the diversity of averages is of interest. The financial strength of both Delta and Northwest is the most striking finding: the tenuous - and deteriorating - situation for American, Continental, Eastern, Pan Am and TWA, the most perlexing.

Extreme leverage and poor coverage performance require explanation. One must ask how, in the face of poor coverage, the trunk carriers have developed such a high debt structure. The answer to this question lies in the economic history of the industry. The period bounded by 1946 and 1955 was one of strong traffic growth. Financing of early postwar equipment was made possible by retained wartime earnings and current internal funds (cash flow). With the advent of commercial jet aircraft, capital needs grew very rapidly. During the 1956-61 period, some 40% of

all funds were obtained through the sale of long-term debt. The specific debt instrument employed most often was the debenture; life insurance companies were the purchasers.

The first 4-engine jet aircraft provided a substantial shift on both the nature and quantity of air passenger service. During the 1961-66 period, capital spending continued at a high level as twin- and tri-jets were substituted for prop and turbo-prop equipment. Carriers turned to the substantial cash flows (especially profits) generated by these jet craft and their predecessors to finance this accumulation. Dividend payout remained low (consistent with the pattern of growth industries), declining slightly as a relative use of funds. The developments of the early sixties, then, caused little concern on the part of the senior lenders as carrier leverage declined and profitability appeared growing.

The 1966-71 period gave rise to substantial spending on flight and ground equipment. This, of course, involved the refinement of twin- and tri-jet configurations and the introduction of wide-body aircraft. During the period, funds came from a multiplicity of sources: convertible debt issues, bank borrowing, and (late in the period) leasing. Unfortunately, the heavy commitments of this period coincided with a rapid deterioration in the profitability of the carriers. 43/ This declining profitability

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43/ While this decline is partly the result of excess capacity associated with the high level of purchases, it is not our task here to explain the determinants of profitability. Rather we seek only to describe the implications of shifting profitability for industry financing.

made the financial commitments of the late sixties look unattractive almost immediately. While insurance companies' unsecured position worsened, these lenders took hope in the promise of improved financial performance. This improvement was ascribed to two factors: a seemingly sympathetic regulatory agency and projected demand growth which would alleviate excess capacity. Neither of these materialized.

1971-75 witnessed both demand instability and a call for regulatory reform. Slow and fluctuating demand for air passenger service - coupled with severe input cost escalation - produced a worsening economic record for nearly all carriers. In several cases, the results were nearly disastrous (Eastern, Pan American and TWA). High interest rates brought those carriers which had relied on bank financing into continuing difficulties with these lenders, and worsened relations with long term lenders. Indeed the declining fortunes of the carriers served to cut off insurance sources since these lenders porfolio decisions are narrowly circumscribed by regulators who focus largely on coverage performance. That the rising call for "regulatory reform" (especially easing of entry restrictions) caused concern among these lenders, as well as aircraft lessors, is hardly surprising. While the demand for funds was limited during the period, the supply was more constrained. True, financing was arranged; but at rates which were increasingly tied to forces in capital markets and at maturities which were ever shorter. Not surprisingly, depreciation and increases in short-

term liabilities provided about two-thirds of all funds, 1971-75.

In sum, the 1966-75 decade was one of changing fortunes for the trunk carriers industry. Substantial commitments of capital funds failed to yield the projected cash flows. And this failure produced an ever-increasing tension between borrower and lender. The 1976-7 aircraft financing was limited. Where equity was used it was very expensive. This statement, however, does not characterize all carriers and one must examine the record of each carrier more carefully to determine future financing possibilities in the industry.

G.3 INVESTMENT PROFITABILITY AND SOURCES OF EARNINGS

Relatively high debt levels are a desirable result under certain circumstances. As noted earlier, the tax deductibility of interest payments means that debt funds can be obtained at a lower, after-tax rate than equity funds. To the extent that earnings are stable, the returns on the assets financed by debt will increase stockholder wealth. However, unstable (uncertain) earnings' streams are not consistent with high relative levels of debt funding, since this instability increases default probabilities. Even instability of earning may be tolerated should average returns on invested funds be sufficiently above zero.

The data in Parts E and F of Table 24 allow us to review the level and variation in trunk carrier profitability. Return on equity is simply the ratio of after-tax profits to equity.

The generally low level of profitability observed is most striking. Indeed, any industry mean will be distorted by the performance of two carriers: Braniff and Delta. It is axiomatic that highly-levered firms will experience greater after-tax earnings variability than less-levered firms, and this is seen in Part F. Of definite concern here is the return on assets record. Return on assets is here defined as the ratio of taxable income plus interest obligations to total assets. With the exception of the two carriers mentioned earlier, the record is not a good one: (i) several carriers recorded persistent growth during the seventies (NAL, NWA, UAL, WAL) only to have the trend destroyed by the recession of 1975; (ii) the remaining carriers exhibit trendless and chronically low returns throughout the period.

Return on assets is, however, but one ingredient in the return to equity holders calculation. And it is the equity return which required our attention. Specifically, given the highly levered capital structure in the industry, the major future external source can only be equity (i.e., income retention or sale of stock). The extent to which equity financing can be obtained depends on the return-risk characteristics of any new issue. To determine the prospective return, we turn to a detailed analysis of the sources of after-tax profits in the trunkline sector.

The level and growth of after-tax profits is the result of two forces: economy-wide developments in prices and income, and managerial decisions on supply, financing and tax policy. One

approach to separating these influences follows. Define the following variables:

Y: after tax profits

L: total liabilities

E: equity

X: before tax profits

I: interest payments

T: all tax payments

We also define several ratios of interest,

$$\pi = (X + I)\ (E + L)^{-1}$$

$$\iota = IL^{-1}$$

$$\theta = TX^{-1}$$

Using these definitions one may derive an expression for the proximate determinants of profits:

$$Y = (1-\theta)\ \{\pi - \iota\}\ L$$

With a stable capital structure (constant E and L) shifts in profitability may come from changes in: (i) operating profitability, (ii) interest charges, and (iii) tax policy. Rising fuel prices, for example, would lower π *ceterus paribus*. Similarly a decline in short-term interest rates will lower average interest costs; and a switch in depreciation policy to accelerated methods will raise depreciation charges and lower tax liabilities.

This view of equity returns gives rise to Table 25 which examines the ten-year history of earnings sources in the trunkline industry. Data are shown for eleven carriers. The following

TABLE 25

COMPONENTS OF EQUITY EARNINGS 1966-1975

Firm	Year	Return on Assets	Financial Gain	Effective Tax Rate	Earnings Per Share
AAL	1966	.097	.057	.378	2.90
	67	.072	.033	.295	2.38
	68	.055	.018	.211	1.75
	69	.056	.019	.210	1.90
	70	-.002	-.035	.282	-1.30
	71	.025	-.016	.083	.11
	72	.023	-.011	.121	.20
	73	-.015	-.051	.213	-1.69
	74	.045	.003	.250	.72
	75	-.002	-.028	.221	-.72
BNF	1966	.084	.057	.147	.95
	67	.046	.002	.000	.25
	68	.072	.023	.223	.55
	69	.058	.007	.206	.32
	70	.026	-.023	.311	-.13
	71	.073	.034	.280	.49
	72	.069	.045	.247	.86
	73	.102	.060	.263	1.16
	74	.123	.050	.311	1.31
	75	.087	.030	.243	1.02
CAL	1966	.201	.169	.474	1.59
	67	.120	.089	.401	1.57
	68	.040	.004	.190	.37
	69	.039	-.002	.244	.25
	70	.010	.000	.285	.29
	71	.057	.010	.392	.59
	72	.060	.014	.470	.64
	73	.037	-.019	1.086	.01
	74	.074	-.008	.277	.57
	75	.026	-.040	.430	-.68
DAL	1966	.218	.191	.466	1.81
	67	.260	.222	.459	2.57
	68	.155	.117	.449	1.69
	69	.176	.092	.466	2.05
	70	.142	.072	.431	2.33
	71	.073	.025	.289	1.57
	72	.104	.060	.383	2.20
	73	.145	.101	.432	3.32
	74	.159	.104	.438	4.56
	75	.083	.021	.340	2.42

TABLE 25 (continued)

Firm	Year	Return on Assets	Financial Gain	Effective Tax Rate	Earnings Per Share
EAL	1966	.047	.018	.000	1.47
	67	.057	.030	.240	2.12
	68	.017	-.027	.248	1.02
	69	.033	-.013	.282	-.19
	70	.044	-.003	.256	.46
	71	.044	-.009	.239	.33
	72	.052	.011	.242	1.21
	73	-.009	-.056	.199	-2.69
	74	.056	-.008	.240	.41
	76	.003	-.051	.000	-2.61
NAL	1966	.221	.192	.464	2.62
	67	.163	.129	.458	2.03
	68	.139	.111	.469	2.51
	69	.132	.081	.464	2.25
	70	.037	-.004	.192	.61
	71	.002	-.051	.650	-.46
	72	.086	.041	.331	2.32
	73	.090	.039	.396	2.36
	74	.133	.062	.429	3.58
	75	.054	-.011	.126	1.33
NWA	1966	.243	.221	.465	2.90
	67	.237	.210	.468	3.21
	68	.157	.140	.472	2.74
	69	.112	.101	.364	2.46
	70	.055	.036	.003	2.10
	71	.026	-.013	-.810	1.01
	72	.028	-.001	-.025	.82
	73	.065	.030	.069	2.40
	74	.107	.048	.342	3.00
	75	.053	.012	.078	2.01
TWA	1966	.086	.043	.389	3.29
	67	.064	.031	.120	4.12
	68	.035	.001	-.396	2.15
	69	.035	.001	-.174	1.95
	70	-.030	-.073	.295	-6.09
	71	.029	-.010	-1.268	.27
	72	.051	.026	.187	3.50
	73	.056	.029	.329	3.71
	74	.020	-.022	-.033	-1.82
	75	-.019	-.062	.166	-6.35

TABLE 25 (continued)

Firm	Year	Return on Assets	Financial Gain	Effective Tax Rate	Earnings Per Share
UAL	1966	.068	.040	.386	2.31
	67	.089	.059	.324	3.96
	68	.063	.030	.460	2.27
	69	.067	.025	.453	2.43
	70	.003	-.037	.187	-2.22
	71	.024	-.019	.144	-.24
	72	.040	-.001	.406	.97
	73	.068	.025	.500	2.41
	74	.109	.066	.549	4.17
	75	.021	-.020	-.023	-.72
WAL	1966	.191	.151	.467	1.22
	67	.110	.082	.453	.82
	68	.056	.027	.359	.56
	69	-.034	-.092	.553	-.81
	70	.036	-.023	1.360	.04
	71	.068	.008	.306	.39
	72	.081	.033	.360	.74
	73	.121	.075	.422	1.35
	74	.132	.081	.424	1.59
	75	.032	-.009	-.190	.34

series are presented: return on assets as defined above, "financial gain" (the difference between return on assets and average interest cost), and the effective tax rate. The last of these would have a maximum value of .48 were there no "other taxes" included in T, no income averaging procedures available to corporations, no tax on capital gains, or special treatment of foreign income. (That these conditions do not always obtain accounts for effective tax rates outside the interval 0 to .48).

Perhaps the best way to examine the Components of Equity Earnings, Table 25, is on an average basis. The trends developed for the industry can then be compared with individual carriers at the reader's convenience. Return on assets statistics were earlier examined only for the 1970s. Within the context of the past decade further remarks are in order. Specifically, dramatic declines in asset profitability characterize the 1966-1975 period, with the exception of BNF and UAL. Of greater concern is the fact that return rates for the industry have fallen dramatically relative to economy wide returns. While the sources of this decline in profitability are manifold, two factors seem critical: (i) rapid escalation of input unit prices - first labor, then fuel; and (ii) inadequate productivity gains associated with aging, or oversized, craft and fleets.

Financial gain ($\pi - \iota$) measures the extent to which asset profitability exceeds the average cost of borrowing to provide these assets. In a sense this statistic describes corporate gains from

leverage. We noted earlier the extremely high leverage in the industry, as well as the potential value of debt instruments; and turn now to *ex post* performance. The reported values of this statistic are extremely disappointing. The rapid inflation rates of the past decade caused problems through the business sector: interest rates rose rapidly to reflect inflationary expectations, while asset returns failed to keep pace. In other sectors, however, this development simply narrowed the amounts of financial gain. In the air trunkline group, the same trend caused numerous carriers' financial gain to become negative, i.e., on average these firms were actually obtaining less from all assets than the cost of borrowed funds. A painful result under any circumstances, the impact of after-tax earnings in such a highly leveraged industry was devastating. (This remark is simply a restatement of the "double whammy" implicit in leverage).

A few carrier-specific remarks on financial gain are in order: Note first that, with the exception of DAL, all of the trunks are experienced in negative financial gain. In several cases these problems were associated with the rapid growth of interest on short-term business loans during the 1969-1970 period and were not persistent. However, several carriers have faced regularly negative values for financial gain, and in some cases the situation had worsened. Finally, we note that the inflation of 1975, and the resultant increase in short-term borrowing rates, produced negative financial gain figures for all but three (BNF, DAL, NWA)

carriers. Worst hit by the events of 1975 were those carriers which have substantial bank revolving credit agreements (CAL, EAL, PAA, TWA) since these loans carry interest rates which float with the money market rates. It should be added that the problems of 1975 were made the more severe by credit agreements which required higher effective rates above prime and further restricted financial management practice.

Tax policy can, of course, exert a strong and potentially counter-cyclical influence on corporate earnings. While there are numerous ways of lowering the effective tax rate, thus raising after-tax profits, the leading technique in the airline industry has been accelerated depreciation. Acceleration is only a temporary avoidance, but in a world of postive interest rates it is a desirable strategy. And in certain firms asset growth may proceed at sufficiently high rates to produce indefinite postponement. (While this situation is unusual, it is not far from the case which existed when wide-bodied aircraft started to join the trunk carrier fleet).

Effective tax rates for the trunks are given in Table 26. With the exception of Delta these rates are not typical of the economy. This is due to: (i) the high levels (and age) of capital investment in airlines relative to other sectors, and (ii) the propensity of airline management to select accelerated depreciation schemes. The following Table 26 - derived from the COMPUSTAT data base - illustrates this point.

TABLE 26

COMPARISON OF EFFECTIVE TAX RATES

Industry or Firm	Effective Tax Rate 1966	1975
Communication	.48	.45
Utilities	.38	.32
Transportation	.38	.35
AAL	.38	.22
BNF	.15	.24
CAL	.47	.43
DAL	.47	.34
EAL	.00	.00
NAL	.46	.13
NWA	.47	.08
PAA	.39	.15
TWA	.39	.17
UAL	.39	-.02
WAL	.47	-.19

Clearly the airline industry has employed investment tax credits and tax deferral schemes to an extent not at all common to other regulated, capital intensive sectors. We emphasize this point because the value of such deferrals is conditional on the level of taxable income. To the extent that the low return record of the past several years continues through the remainder of the decade, one must conclude that tax policy will not continue to provide substantial capital fund sources.

Equity return data are of interest because they condition the level of capital sources: return levels provide measures of the extent to which new equity can be sold in the industry, as well

as determining the desirability of investing income retentions. If equity returns are adequate then the firm can obtain new equity, or re-invest cash flows, without lowering the wealth of its stockholders. The picture for future equity financing is a mixed one: two carriers, Braniff and Delta, have produced substantial per share earnings. As the earlier discussion shows, Delta has accomplished this with substantially less debt per share than Braniff; and has not relied as heavily on tax deferral schemes. For these carriers - and Delta in particular - equity financing remains an easy source of funds. National, Northwest, and Western have provided positive returns to equity holders throughout the decade with two exceptions (NAL, 1971; WAL, 1969). The critical question is one of trend. While the 1975 results were not favorable, the return trends for these carriers are upward.

During the 1971-1975 period four carriers exhibit improving equity returns if we abstract from 1975: National, Northwest, United and Western. However, since Northwest and United begin from extremely low bases, we must distinguish between the four. The growing equity returns for these carriers were not the result of leverage since liability-equity ratios remained relatively constant. In the case of National and Western, the return records are simply the result of increased operational profitability in the face of rising interest costs. Northwest and United produced equity return growth via different strategies, the former relying heavily on tax reductions via acceleration schemes, while the

latter depended on efficiencies in operations and balance sheet management. Distinguishing again between the four carriers, we note that only National and Western generated equity returns which would make retention investments attractive.

Equity returns at Pan Am have been persistently negative and do not warrant further discussion here. We turn instead to the remaining trunk carriers: American, Continental, Eastern, and TWA. All of these firms exhibit declining returns on equity in the 1971-1975 period. While the rate of decline for AAL is almost imperceptible, the trend in the other cases is definite. However, the poor performance of these carriers can largely be laid to the following factors: first, persistently low return on assets. Second, all of these carriers maintained large revolving credit agreements with commercial banks during the period, and in most cases paid interest rates in excess of their return on assets. This performance has been such that it will be difficult indeed to attract new equity to these firms, much less to justify income retention should earnings not improve in the near term. That both AAL and TWA appeared in this group was a source of concern here, since these carriers held a large proportion of the older craft in the trunkline fleet.

The leverage and coverage statistics discussed in Section G.2 go a long way toward describing risk associated with airline industry common stock. That is, high levels of debt relative to permanent capital imply high fixed charges, and low values of

coverage ratios indicate possibilites of default on these charges. In recent years it has been suggested that the relation of changes in specific security returns relative to average shifts in the securities market average returns provide a measure of the "risk" which is specific to a given firm. Define the following variables:

R_j: return on security j (dividend yield plus capital gain)

R_m: average return on a "market portfolio" composed of all securities:

Now, from the equation

$$R_j = \alpha_j + \beta_j R_m + \epsilon_j \qquad (3)$$

we derive the following view of risk: the variance of returns on security j (σ_j^2) is the sum of systematic or market, influences ($\beta^2\sigma_m^2$) and firm-specific risk σ_ϵ^2. Accordingly, computed values of β_j derived from fitting (3) to prior years' experience are thought to express the relationship between risk in a given security and market risk, i.e., values for β_j in excess of unity indicate greater "systematic" risk in security j than in the portfolio of market securities, and vice versa. Stocks with computed values of β_j in excess of one thus rise faster than a bull market, and fall faster than a bear market returns.

One security research firm provides regular reports of a statistic very similar to the β in (3). This is the Value Line service which excludes dividend yield from its return definition. However, given the paucity of airline industry dividends, we have in the Value Line statistics a useful measure of risk in equity

instruments. For the eleven carriers the computed values are:

Firm	β
AAL	1.45
BNF	1.60
CAL	1.60
DAL	1.35
EAL	1.45
NAL	1.70
NWA	1.60
PAA	1.50
TWA	1.85
UAL	1.60
WAL	1.60

As these coefficients are derived by least-squares of fits of (D-3) for the 60 months prior to October 1975, the values reported are random variables. Accordingly it is difficult to conclude that there exist important differences among these values. Rather these values are reported because of their excess over unity. On this measure of risk, airline equity investments are risky indeed. Note that the lowest estimate in the group is 1.35 - a value exceeded by only 118 of the 1600 firms in the Value Line sample. (Excepting the DAL figure, trunk air carriers constitute 8.5% of the 188 firms).

G.4 REPLACEMENT FINANCING POSSIBILITIES: THE 1970-1975 RECORD

The preceding remarks clearly documented the disastrous financial performance of the domestic trunk airline industry, 1970-1975. The message in this record for replacement decisions in the short-term was clearly negative. To wit, excess leverage had produced

debilitating impacts on equity returns, and had raised borrowing costs to unusually high levels. Further debt financing without improved earnings and better balance sheet management was an impossibility for all but a few carriers. Indeed, deteriorating coverage positions raised serious questions as to the appropriateness of further leasing - and this in spite of the substantial tax incentives for such activity. Our work indicated that greater equity financing (either through income retention or new stock issues) would be the only serious long run approach to form a base for the massive replacement program ahead. The same work shows that future equity funding would require much higher rates of return than have previously been typical. These higher rates follow from several developments: (1) declining rates of return on assets produced by quantum jumps in fuel costs and what proved to be overbuying of wide-bodied aircraft, (2) increasing interest rates associated with excessive leverage, and (3) investor uncertainty generated by deregulation discussion and uncertainty as to noise abatement retrofit, refanning, or replacement financing legislation.

G.5 REPLACEMENT FINANCING CAPABILITY 1976-1979: A TURNAROUND?

Based on economics, academic theorists in 1976 could say that the market place was working well to deny financing except at very high rates to most airlines. To add or replace capacity where none was needed was unwise and the financial institutions were only

following sound economic principles in shunning airlines and in loaning to other industries who could employ assets more productively at much lower risk. Unfortunately this did not answer the question of where the money would come from to retrofit, re-engine or replace aircraft to comply with the proposal to require such action for environmental reasons -- a proposal which became a regulation in December 1976. This regulation, 91-136, led to an intense drive by the airlines, through ATA, the aircraft manufacturers and the airport operators, to obtain financing legislation which would reduce risk so that the financial community would lend the necessary sums at reasonable rates. Details of this legislation are chronicled elsewhere in this report.

A series of cost cutting moves, including the disposal of some excess capacity, coupled with traffic growth, resulted in 1976 financial figures better than those of 1975. However, it was not until the first quarter of 1977 that the financing picture began to change positively. American Airlines, a carrier with a high degree of financial leverage and a relatively high proportion of older aircraft in its fleet, moved to begin replacement of its 707-100 aircraft so as to comply with the new 91-136 rule. American's past irregular return on equity, associated with high interest costs relative to return on assets, had made future debt financing nearly impossible. American offered 5 million shares of $2.1875 preferred stock (with 5 million warrants to purchase shares of its common stock at $14) for $25 per unit on March 20, 1977.

The net proceeds of this issue were $18.5 million. The impact on American's balance sheet was substantial: debt declined from 41% to 37% of its long-term capital structure. While it would be easy to over-state the impact of this move, it was an indication of sound financial management. Later in 1977 EAL and TWA engaged in similar financing.

While such financing was astute, it did not seem entirely congruent with the positions taken in some of the Congressional hearings that any of financing was out of the question. The ATA maintained its posture that there was no way airlines could retire their fleets and replace them unless a financial assistance bill was passed. However, by the end of 1977 further improvements in airline operating results, coupled with the need to replace aircraft for noise compliance led to rumors that some of the better situated carriers would not wait for a noise financing bill before ordering new equipment.

This information was not missed by those in Congress opposed to legislation involving financial assistance; and in February, the Treasury Department and others, concerned over political and budgetary implications of the Anderson noise bill, testified before the House Ways and Means Committee against the type of financing involved. At the same time, ATA was having difficulty in keeping the actions of its members consistent with the party line of financial inability. Beginning in January 1978, the press began to carry accounts of an impending purchase of Airbus A-300s

by Eastern and of Lockheed L-1011s by Pan American. Additionally, the Chairman of TWA told a Society of Airline Analysts meeting in New York that TWA was in its strongest financial position in years. Thus it was not the well financed Deltas or Northwests that were subject of rumors of orders, but several carriers which had been depicted at death's door a year earlier.

As time moved along there were each month reports of increasing load factors and profits. A special report on aircraft financing capability was published in the March 1978 edition of Air Transport World. The report, in covering the opinions of analysts, banks, insurance companies, consultants, lessors and airlines, concluded that the airlines would have no difficulty in financing equipment. In April, Thomas Craig, Boeing's Director of Market Research, made a country-wide tour publicizing the company's report on "Airline Capital Formation and Boeing's New-Airplane Family" in which it was concluded that of a total capital need of $50 billion for the next decade of aircraft purchases, the carriers could finance two thirds from internal sources. A 10% RoI would be sufficient. During the same month (April) Eastern announced the purchase of a number of Airbus A-300s involving a $778 million package of which $552 million would be externally financed. Pan American's announced purchase plans for the Lockheed L-1011-500s involved about $500 million. Initially it was argued that the Pan American and Eastern purchases were made possible by overgenerous subsidies from foreign government sources. However, it developed

that American banks would have liked to have financed the purchases but "could not get a piece of the action." The ability of these two carriers, who not long ago had been said to be on the verge of bankruptcy, to obtain financing is indicative of the rapid change in the assessment by the financial community of airline earning power.

While announcement of the Pan American and Eastern purchases, just as the noise financing bill was getting into trouble,was less than a stroke of managerial genius from the standpoint of obtaining legislative aid, it did unscore the brightened outlook of the carriers. As hearings on the Senate noise financing bill approached there was more good news concerning financial viability. Late in May Eastern filed for a $50 million issue of convertible subordinated debentures. Additionally, publication of the first quarter financial results indicated that various airlines were "awash" with cash and short term investments. Three examples are listed below:

Company	Cash & short-term investments
American	$ 447,600,000
United	529,000,000
Pan American	178,000,000

By the time of the Senate hearings on the noise bill (May and June 1978), members of Congress began to question the need for any financial assistance at all. Senator Cannon attempted

to substitute a $20 billion loan guarantee concept for the idea of tax money going into a separate fund. However, it gathered no support. Although the 1977 testimony of the financial community concerning the need for financing assistance was positive and extensive, the correlative June of 1978 testimony was brief and low key. In general the financial community was reasonably optimistic about earnings but stated that financing would be more readily available if the uncertainty over reform and noise legislation could be turned to certainty. Alfred Kahn, then Chairman of the CAB, was more blunt in concluding that with earnings of the carriers running around 12% on investment, and some over 16% on equity, the airlines would have little trouble in financing equipment purchases.[46/]

As if to punctuate Chairman Kahn's testimony, a series of confirming events took place in midsummer and early fall. On July 17th the Wall Street Journal carried the story of United's purchase of 30 new technology jets and 30 current technology jets for $1.6 billion. The timing was two days before the House rules committee was to consider moving on the noise bills. Rumors were rife that American was about to announce a similar order. Glowing second quarter earnings were regularly being released to the press, including a whopping increase of 71% by TWA. Not surprisingly some new bills were now being introduced in Congress without any

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46/ U.S. Congress, Senate Subcommittee on Aviation of the Committee on Commerce Science & Transportation. 95th Cong. 2nd Session 1978. Aircraft and Airport Noise Reductions, Hearings on A.747, S.3064, and HR 8729 pp 272-300.

funding mechanism for replacement airplanes. Early in September, with the final processing of the noise legislation at the end of the 95th Congress just weeks away, Eastern, in announcing the purchase of $560 million worth of new technology airplanes, predicted that a large portion of the financing would be internal. Two weeks later both Eastern and Pan American called for redemption issues of their Convertible Subordinated Debentures. The financing provision in the Senate bill was withdrawn and the noise legislation never reached the floor in the last hours of the session - too late for a compromise with the House version.

At the end of 1978 the U.S. scheduled airlines reported a net profit of $1.2 billion, a dramatic change from the $84 million loss of 1975 a mere three years previously. Lest one jump to the conclusion that the rosy picture represented the solution to the airlines' problems, let us up-date Tables 24 and 25.

Our previous analysis, based upon the financial misfortunes of the 1970-1975 period, indicated that a continuation of past experience would indeed force most carriers to retain old inefficient equipment. In our progress report to NASA early in 1978 we noted the beginnings of carrier efforts at balance sheet strengthening to provide a basis on which lenders could make loans. We now move from these isolated examples to a general survey of what has happened the last three years.

Table 27, Selected Financial Ratios, and Table 28, Components of Equity Earnings, up-date Tables 24 and 25 and provide compar-

TABLE 27

SELECTED FINANCIAL RATIOS

U.S. Domestic Trunks Plus Pan Am

	Firm	1971	1975	1976	1977	1978
A. Long Term Debt/ Long Term Debt Plus Equity	AAL	.572	.528	.493	.492	-
	BNF	.682	.608	.591	.590	-
	CAL	.744	.746	.703	.635	.516
	DAL	.550	.580	.547	.489	.419
	EAL	.654	.700	.626	.572	-
	NAL	.594	.580	.548	.502	.417
	NWA	.446	.397	.327	.326	-
	PAA	.708	.760	.679	.753	-
	TWA	.732	.787	.754	.649	-
	UAL	.672	.644	.631	.577	.567
	WAL	.680	.550	.599	.583	-
B. Long Term Debt Plus Lease Payments/L.T. Debt Plus Equity Plus Lease Payments	AAL	.768	.800	.794	.780	-
	BNF	.855	.825	.812	.799	-
	CAL	.804	.810	.786	.750	.675
	DAL	.619	.755	.657	.606	.556
	EAL	.859	.878	.857	.861	-
	NAL	.700	.696	.681	.666	.633
	NWA	.497	.470	.416	.406	-
	PAA	.802	.863	.827	.812	-
	TWA	.870	.905	.893	.867	-
	UAL	.806	.780	.778	.747	.652
	WAL	.795	.777	.826	.789	-
C. Times Interest Earned*	AAL	4.0	4.3	9.5	9.2	-
	BNF	4.2	4.2	4.8	5.1	-
	CAL	3.9	1.9	3.1	4.0	5.0
	DAL	8.4	6.4	8.5	13.4	18.8
	EAL	3.2	1.9	4.3	4.4	-
	NAL	2.6	4.3	3.7	5.1	9.3
	NWA	7.8	9.2	14.5	29.9	-
	PAA	1.9	2.3	2.9	3.2	-
	TWA	3.8	1.4	4.0	5.6	-
	UAL	3.8	4.0	4.5	5.9	7.3
	WAL	4.9	5.5	7.4	7.0	-

* Includes book depreciation.

TABLE 27 (Continued)

	Firm	1971	1975	1976	1977	1978
D. Coverage**	AAL	1.6	1.1	2.0	2.2	-
	BNF	1.9	1.9	2.1	2.4	-
	CAL	2.7	1.5	2.2	2.6	3.1
	DAL	4.6	3.0	4.5	5.9	7.0
	EAL	1.4	1.0	1.8	1.7	-
	NAL	1.6	2.4	1.9	1.9	3.0
	NWA	3.2	3.8	5.1	6.8	-
	PAA	1.2	1.4	1.6	2.4	-
	TWA	1.7	.7	2.0	2.2	-
	UAL	1.8	1.9	2.1	2.6	4.5
	WAL	2.9	2.1	2.7	2.9	-
E. Return on Equity	AAL	.005	-.038	0.92	.107	-
	BNF	.106	.122	.139	.166	-
	CAL	.070	-.066	.059	.144	.215
	DAL	.106	.102	.130	.149	.178
	EAL	.017	-.190	.102	.103	-
	NAL	-.032	.058	.026	.016	.071
	NWA	.045	.070	.078	.124	-
	PAA	-.103	-.180	-.024	.125	-
	TWA	.004	-.317	.110	.151	-
	UAL	-.013	-.008	.024	.102	.257
	WAL	.068	.037	.128	.111	-
F. Return on Assets	AAL	.025	-.002	.056	.051	-
	BNF	.074	.087	.096	.109	-
	CAL	.058	.026	.064	.078	.113
	DAL	.078	.083	.098	.121	.150
	EAL	.044	.003	.071	.062	-
	NAL	.002	.054	.031	.021	.067
	NWA	.026	.053	.098	.125	-
	PAA	-.001	-.001	.030	.076	-
	TWA	.029	-.020	.067	.072	-
	UAL	.024	.021	.033	.053	.117
	WAL	.058	.032	.078	.071	-

** Includes book depreciation. Coverage is ratio of earnings before interest and taxes to interest plus one-third of rentals.

ative data for the eleven trunk carriers. At first glance viewing the last three years in comparison with the immediately preceding years, there has been an impressive recovery. Specifically the most dramatic area has been Item C. Times Interest Earned, where a number of carriers (AAL, DAL, NAL, NWA and UAL) have doubled or more than doubled coverage. On closer analysis, using other tabulations, one finds qualification to optimism. Although there has been a long term decline in the ratio of Long Term Debt to Long Term Debt plus Equity (Item A), the ratios are still higher than for Delta and Northwest back in 1971. Thus there is still a way to go to reach desirable figures.

A look at Item D which is coverage (including book depreciation) indicates that the situation has not improved a lot through 1977 except for Northwest. However, in 1978 United and Delta showed a large improvement.

Turning our attention to Table 28, Components of Equity Earnings, we see that American's Return on Assets were less in 1977 than in 1969. However, the Earnings per Share had a substantial increase from $1.90 to $2.86, in large measure because of a zero effective tax rate. Continental's change to a return on assets is a spectacular 11.3% in 1978 in comparison with it's 3.9% in 1969. Braniff has doubled it's ROA and has carried a lot down to net. It is interesting to note that proverbial industry leaders in profit, Delta and Northwest, are not a great deal more profitable than they were back in 1969 - Delta's return was 13.6

TABLE 28

COMPONENTS OF EQUITY EARNINGS

Firm	Year	Return on Assets	Financial Gain	Effective Tax Rate	Earnings Per Share
AAL	1969	.056	.019	.210	1.90
	1970	-.002	-.035	.282	-1.30
	1975	-.002	-.028	.221	-.72
	1976	.057	.034	.241	1.97
	1977	.053	.030	.000	2.86
BNF	1969	.058	.007	.206	.32
	1970	.026	-.023	.311	-.13
	1975	.087	.030	.243	1.02
	1976	.096	.041	.256	1.32
	1977	.109	.052	.256	1.82
CAL	1969	.039	-.002	.244	.25
	1970	.040	.000	.285	.29
	1975	.026	-.040	.430	-.68
	1976	.064	.002	.315	.64
	1977	.078	.021	.036	1.79
	1978	.113	.050	.034	3.30
DAL	1969	.136	.092	.466	2.05
	1970	.142	.072	.431	2.33
	1975	.083	.021	.340	2.48
	1976	.098	.043	.359	3.53
	1977	.121	.071	.404	4.65
	1978	.150	.109	.417	6.60
EAL	1969	.033	-.013	.282	-.19
	1970	.044	-.003	.256	.46
	1975	.003	-.051	.000	-2.61
	1976	.071	.023	.240	1.77
	1977	.062	.013	.000	1.75
NAL	1969	.132	.081	.464	2.25
	1970	.037	-.004	.192	.61
	1975	.054	-.011	.126	1.33
	1976	.031	-.028	-.829	.59
	1977	.021	-.024	-.508	.35
	1978	.067	.022	.397	1.68

TABLE 28

(Continued)

Firm	Year	Return on Assets	Financial Gain	Effective Tax Rate	Earnings Per Share
NWA	1969	.112	.101	.364	2.46
	1970	.055	.036	.003	2.10
	1975	.053	.012	.078	2.01
	1976	.098	.046	.473	2.39
	1977	.125	.094	.395	4.29
TWA	1969	.035	.001	-.174	1.95
	1970	-.039	-.073	.295	-6.09
	1975	-.020	-.063	.166	-6.35
	1976	.068	.024	.407	2.62
	1977	.073	.034	.218	4.10
UAL	1969	.067	.025	.453	2.43
	1970	.003	-.037	.187	-2.22
	1975	.021	-.019	-.023	-.22
	1976	.033	-.007	.310	.77
	1977	.054	.017	.061	3.77
	1978	.118	.073	.105	11.52
WAL	1969	-.034	-.092	.553	-.81
	1970	.036	-.023	1.360	.04
	1975	.032	-.009	-.190	.34
	1976	.078	.039	.377	1.18
	1977	.071	.030	.376	1.13

in 1969 and 15% in 1978. Northwest earned 11.2% in 1969 and 12.5% in 1977. Two companies significantly ahead of 1969 and fantastically ahead of 1970 are United and Continental which joined Northwest and Delta in double digit return on assets.

Conclusion

The financial history of the airlines in recent years in one of a highly leveraged industry which is very sensitive to business cycles. Therefore, excellent as are the 1977 and 1978 results which if continued would enable the carriers to arrange financing at will to retire undesirable equipment, one cannot assume with a high degree of certainty that the problem of financing replacements has disappeared forever. Within the industry there is a disparity of financial quality with only a very few comparing favorably with sound companies outside of the air tranport field.

H.

SUMMARY AND CONCLUSIONS

This study of factors affecting aircraft retirement indicates that prior to the introduction of the narrow-bodied 707, DC-8, and Convair turbojet aircraft in 1958, retirements were the result of progressive development of technically and economically more efficient aircraft -- i.e., the better mouse trap syndrome. Age of aircraft was not a factor. Nor is age as such a factor with the current turbojet and fanjet planes. However, several new factors i.e., (1) noise regulations (2) fuel efficiency (3) inflation have become important elements in the retirement equation.

H.1 NOISE REGULATIONS AS A FACTOR IN RETIREMENT

Developed at a time when fuel was cheap and when the previous type of piston engine noise had not resulted in significant public disapproval, the jets introduced higher and more annoying noise levels. Public dissatisfaction with the noise emissions was almost instantaneous. Within two years the somewhat quieter fanjet was introduced. Some carriers retrofitted their existing fleets and all new aircraft were delivered with the quieter and more fuel-efficient fan jets.

Nevertheless, so extensive were the noise complaints that the federal government took action in 1969 by promulgation of a rule

(FAR 36) requiring that future aircraft be quieter than current fanjets. After 1974 all transport production was required to meet the 1969 standard. However, this rule left 80% of the existing fleet exempt from noise limits - limits already being criticized as too lenient. Proposals were made which would require the 80% to be retired or modified to meet the 1969 standards. As airlines were suffering from poor or negative earnings, they wished to retain the status quo arguing that economics should decide retirement and not a retroactive rule. If the government required retirement or modification of aircraft, it should, they maintained, assist in the financing involved.

Late in 1976 the FAA decreed (FAR 91-136) that all aircraft would have to comply with the 1969 rule. No financial assistance was suggested. The next three years saw efforts by the ATA to obtain legislation which would assist the carriers in replacing their noisy fleets, or provide relief from the requirements of 91-136. During the 1977-1978 period various bills alternately favored retrofit, re-engining or replacement, thus making it impossible for carrier managements to make the most economic decision as to retiring or modifying their noisy aircraft. Conflicting bills on the extent to which, if at all, FAR 91-136 should be modified made their appearance in 1979. Further, some carriers now openly support the rule feeling that long run noncompliance will alienate the public to the point where the entire industry will suffer from operating constraints imposed by airport authorities at the behest of af-

fected citizens. Thus it can be said that noise emission is a powerful factor in pushing certain aircraft towards retirement.

H.2 FUEL COST AS A NEW ELEMENT IN THE RETIREMENT DECISION

For a number of years, fuel was such a small portion of operating costs that it played no part in acquisition or retirement decisions. However, between 1973 and 1979 a four-fold increase from 13¢ a gallon to over 50¢ resulted in an increase from 20% of cash operating costs to as much as 50%. The figure is higher when related to an early turbojet. Accordingly, those carriers which had not converted to fanjets began to phase out the fuel guzzling JT3s and JT4s as early as 1975. By 1979, with much higher fuel prices, their use could not be justified.

The deterioration in the economics of narrow-bodied aircraft because of rising fuel costs generated intense activity by the engine manufacturers to develop more fuel-efficient engines. Fortunately, the high bypass engines developed for wide bodies combine significant fuel efficiency with low noise. Efforts to design new engines such as the CFM56 and the JT10D for narrow bodies, have continued.

The following aircraft became progressively slated for retirement because of fuel costs: the 707, DC-8 and early models of the 727 and DC-9. Illustrative is TWA's announcement of dis-

continuance of some 707 service because increased fuel prices made the operation unprofitable at a 100% load factor. Recently, a number of airlines concluded that re-engining the DC-8-61 with the CFM56 engine will save that aircraft from the retirement predicted less than a year ago.

H.3 INFLATION AS A NEW ELEMENT IN RETIREMENT OF AIRCRAFT

The rapid rise of inflation has had a delaying effect on aircraft retirement. While technological progress has continued, its costs effectiveness has been blunted by inflation. Each unit of technical progress has become more expensive to develop so that the capital cost of the finished product has reached the point that, when ownership costs are amortized, the economic benefits are sharply reduced if not eliminated. Managements wince at the prospect of retiring a 707 which cost between $5 million and $10 million with a somewhat larger 767 for $40 million, even though there may be a stream of savings in operating expenses for as long as 15 or 20 years. Applying present value computations to such a stream of benefits makes them look small in comparison with the contemplated capital outlay.

H.4 ECONOMIC ENVIRONMENT AS A FACTOR IN AIRCRAFT RETIREMENT

Air transport has been an industry sensitive to the business cycle. Additionally, many firms have been highly leveraged. As

a consequence the industry experiences periods of low or negative earnings during which some carriers have neither the desire nor the ability to make capital commitments for replacing old aircraft with new. Our survey showed that on an industry-wide basis, orders followed profits. As a consequence, retirements often have not followed an orderly replacement plan. This study began in a period of economic gloom. Overcapacity existed and there was little ability to finance compliance with new environmental regulations. Completion of the study occured during a period of high profits and an increasing surge of orders. It is quite clear that the financial ability to support replacement purchases is an important factor in retirement decisions.

H.5 TECHNOLOGICAL PROGRESS AS A FACTOR IN AIRCRAFT RETIREMENT

Two quantum jumps in productivity after World War II ((1) four-engined, pressurized, long-range piston aircraft and (2) turbojet aircraft), both compounding the effect of multiplying increases in speed and size, and embodying lower operating costs, were the key factors in accelerating the retirement of predecessor aircraft. The technology which made this possible was all the more effective because it occured during a period of a relatively stable price level so that technological gains were not adversely affected by inflation.

Currently, increases in speed would require the use of more

of scarce and expensive fuel to reach supersonic levels. The impractibility of this approach is illustrated by the fact that the Concorde, despite heroic bookkeeping adjustments, [47] is approaching retirement for economic reasons. In addition, increases in size, while having some limited future application, are not nearly as needed as significant fuel and noise emission improvements in the narrow body category. Thus the focus of technology is now directly on economics without the aid of the very elements which have previously contributed so much to the construction of more economic aircraft and the subsequent retirement of predecessor aircraft. The unavailability of speed and size as a means of increasing productivity, coupled with high rates of inflation, have presented aircraft designers with a most difficult challenge. Since the consensus is that there are diseconomies in shrinking the size of a transport, the challenge to technology for designing economical smaller aircraft is monumental. It was primarily run-away fuel costs which kept making the development of aircraft such as the 757 and 767 look better and better to the potential customers.

In any event, aviation history has shown that technology has been the mechanism by which larger economical and technically efficient aircraft have been developed. When environmental concerns (primarily aircraft noise) became a problem, efforts, again first

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[47] First, development costs were written off followed by a decision to omit depreciation.

applied to large aircraft, led to the second generation high bypass ratio, quiet, fuel-efficient, turbofan engine. This development was the beginning of the end for first generation large narrow-body jet aircraft. Over the years technological progress has been a prime factor in bringing about an aircarrier's decision to retire one series of aircraft in favor of another.

H.6 CONCLUSION

The application of technology to produce ever lower costs per seat-mile or ton-mile while at the same time emphasizing noise control, reached its peak in the high capacity, long-range 747 with high bypass engines. The need for a smaller aircraft to take over high density domestic stage lengths, led to application of the same technology to the DC-10 and L-1011. Higher than expected design and maintenance operating costs, plus a slackening of demand because of a recession, dampened the profitability of these two types of aircraft. From the standpoint of traffic levels, carriers had no need for fleet additions. Given the foregoing scenario, plus the consensus that there were diseconomies in the design and use of smaller aircraft, it is understandable why manufacturers placed their attention on the large aircraft.

When traffic growth resumed manufacturers were happy to sell their existing model narrow bodies. Since a large portion, if not all, of the development costs had been written off, and since manufacturing processes and techniques were well down the "learning

curve", aircraft manufacturers were able to quote a very attractive capital cost in comparison with that for a newly designed aircraft whose current labor, design and material costs would be increased by years of inflation. A further reason for the reluctance of a manufacturer to intiate a move which would render his own production obsolete was his reasoning in regard to federal noise regulations. Air carriers, whom the manufacturers try zealously not to offend, were striving to avoid having stricter noise rules implemented. However, even under the rule in dispute, all current production aircraft (meaning 727/737/DC-9) met Stage 2 requirements. Thus, as long as these aircraft were considered as compliant aircraft there was insufficient motivation to build something new with a doubling of capital cost.

The first generation of narrow bodies (707/DC-8) fell into a different category. They were, first of all, substantially above FAR 36 noise limits, and secondly, they were becoming economically obsolete primarily because of escalating fuel prices. Given the conventional desire to buy a plane a little too large "to grow into", designers attacked the objective of a 200 passenger plane which would satisfy more strict environmental rules for future aircraft and meet a target of very substantial fuel economy. Over several years of efforts, diseconomies of scale (to which was added inflation) more than offset technological progress so that the resulting aircraft did not meet the airlines' required rate of return ("hurdle rate"). However, growing environmental pressure,

plus rapidly rising fuel prices (which magnified the disadvantage of old aircraft over the new), turned the tables in favor of the 767 as a replacement for the early long-range narrow bodies. A slightly smaller capacity shorter range 757 was developed. Originally designed as a derivative of the 727, it has been growing in size and sophistication to the point that it more resembles a 767 than a 727 derivative.

Until recently, because of the difficulties in achieving economies and noise control in smaller aircraft, and because it was hoped that the public would accept continued unconstrained operation of narrow bodies which meet the legal noise requirements of FAR 36, a maximum effort was not launched to develop a new technology replacement for the first generation medium to short range narrow bodies. However, recent experience suggests that the statement that an aircraft "meets Annex 16", or "meets FAR 36", is no longer acceptable to airport neighbors. For example, when the Swiss public found that certain new Annex 16 airplanes (DC-9-50s) were noisier than the non-Annex 16 planes they were replacing (DC-9-30s), their reaction was such that Swissair felt that to continue operations it had to buy a quieter plane (DC-9-Super 80) even though the plane was not of the desired size. In Japan, as a study underway will show, still higher fuel costs and public pressure to constrain the growth of aviation by severe curfews and operational restrictions, make new technology mid-range aircraft necessary. Additionally, recent statements in the U.S. by the general counsels of the CAB and FAA, have given airport

operators encouragement to prescribe further limits and charges for aircraft noise. The foregoing suggest that notwithstanding that (1) current narrowbodies are not "worn out" and (2) that their relatively low capital cost makes them attractive to purchase vis-a-vis a "clean sheet" new technology aircraft, there are strong environmental and economic reasons for their replacement.

The number of the narrowbodies in existence suggest a large market for this size aircraft. As of April 1, 1979 there were about 5,500 jet transport aircraft in the free world fleet [48/] of which about 80 percent were narrow bodies with low bypass engines. One manufacturer alone, Boeing, has indicated total orders for 3,980 aircraft of which 3,359 were of narrow body low bypass ratio design and 621 with high bypass ratio powerplants.[49/] During the past six months the European aviation press has carried stories of increasing activity of European airframe and engine manufacturers focused on aircraft in the 100 to 160 passenger range.

As fuel prices continue to escalate and as noise is a world wide problem, the continued viability of the current offerings in the short to medium range aircraft is a matter of concern. Owners of 727-100s, some DC-9s, the BAC 111 and other narrow body aircraft

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48/ Pratt & Whitney Aircraft Group, U.S. & International Commercial Fleets, May 15, 1979.

49/ Boeing Commercial Airplane Company, "Boeing Jetliner Monthly Summary, Month Ending July 31, 1979.

are already seeking to retire them. Unfortunately, because of the lack of concentration of research on this size category, there are now no new technology replacements available. With resources of private firms in the manufacturing industry fully committed to new larger offerings, and with some manufacturers being financially unable to take the big gamble in the development of a new high technology medium capacity aircraft, it would seem in the public interest for the federal government to support additional economic and technical research to hasten the development of a new technology aircraft in the short to medium range category. Such support would assist the United States in meeting its energy and environmental goals and help maintain our leadership in international air transportation.

More specifically, NASA's energy efficient aircraft program should emphasize those portions of research which are particularly appropriate for the short to medium range category. The 200 passenger 767 design went through many changes to establish its mission, fuselage cross section, number of engines, number of aisles, passenger capacity and its degree of onboard sophistication. The solutions to these problems, though difficult, were less unmanageable because a limited number of companies large enough to launch an airplane had to be satisfied. Even here the slightly differing missions caused problems.

The solution for the smaller airplane is much more difficult. Under deregulation routes and airlines are in a state of flux so that each carrier may want a slightly different airplane. Thus

it is difficult for a manufacturer to freeze a design on size and configuration. Joint meetings on an "industry" agreed upon airplane are inhibited by antitrust laws and by pride of individual airlines. Thus independent research is indicated.

Because midsize midrange aircraft are used the world over, international needs must be considered. If small cities are to continue to be served with reasonable frequencies and at reasonable load factors, designers must be careful not to be swayed by economies of scale, and design an airplane whose seat-mile costs may be admirable but whose revenue passenger-miles result in lower than break even load factors. Because of the difficulties in engineering economies and noise control into smaller aircraft there is a great challenge for both technical and economic research.

H.7 FURTHER RESEARCH

1. Fuselage cross section. In the design competition which resulted in the 7 abreast 2-aisle 767 - a clean paper approach to downsizing - many cross sections were analyzed. Despite the fact that the ultimate selection was a smaller cross section than some preferred, it won out because of lower operating costs while still retaining the desirable two aisles. Since there are those, mainly marketing departments, who think that two aisles are necessary, further aerodynamic studies on cross sections of this type could be made.

2. Range and payload (passengers and cargo). To hold down

operating costs, range and payload must be closely tailored to the optimum needs of the carriers. The recent proliferation of routes under deregulation may be shifting the desired range and load. While air carriers like to look for an all purpose machine to cover short and long hauls, such a design entails economic penalties resulting from carrying needless structural weight and the payment of landing charges based on maximum certificated gross weight. Research aimed at developing the cost penalties associated with oversizing and undersizing would be appropriate.

3. Configuration studies. Given the cross section, range and load, the design of the wing and how the engines are configured are subjects for research. Currently engineers indicate that because of the larger diameter of a high bypass engine there is no practical way to insert such an engine into the tail of a 727 or on a 737. This would seem to suggest that practicality and economics will dictate a twin-engine replacement. However, since no company has attempted to design a "clean sheet" transport of this size for a specific thrust, the matter of the number of engines should not be considered closed. The operational flexibility and possible safety advantages of three engines must be evaluated.

4. Engine research. When one talks with air carriers or airframe manufacturers about replacements for the 727/737/and DC-9 series, one is immediately told (and the engine manufacturers concern) that currently no manufacturer has an engine in production specifically tailored for that category. Generally suggested are

heavier, higher thrust engines (designed with larger craft in mind) which can be de-rated to the desired power. The technology is at hand for the desired thrust, fuel economy and noise control, but the engine manufacturers point out that there is no airplane in design on which to place such an engine. The decision to develop such a plane would have an immediate impact on engine research. Although one or two manufacturers have preliminary designs waiting in the wings, further research is needed. Essentially we do not have a plane because there is no engine for it, and we do not have an engine because there is no plane for it. Since the basic reason for neither plane nor engine has been the manufacturers' fear that the high capital cost of replacement would inhibit sales as long as alternate planes i.e., 737/727/DC-9, were environmentally "legal" and profitable, and since these aircraft are losing both their environmental acceptability and their fuel efficiency (relative to high bypass engines) federally assisted research is needed to accelerate the development of a specifically tailored low noise, high fuel efficiency, low operating cost engine.

5. Noise regulation research. This study has indicated that while economics has, over the years, played a major part in retirement decisions, more recently aircraft noise has spawned a series of regulations and legislative proposals (domestically and internationally) which significantly affect the life of commercial aircraft as well as the design requirements of future aircraft. Accordingly, there is an ongoing need for NASA not only to monitor the legislative and administrative flow of aircraft noise proposals

at various levels of government in the United States and in foreign countries, but also to receive interpretative reports as to their significance for U.S. carriers and the air transport manufacturing industry. Early recognition of, for example, international trends will enable research to be channelled so as to maximize this country's participation in the growth of air transport.

6. Research on still smaller size transports. At present the smallest new technology aircraft with high bypass engines is the 174-passenger 757. A direct 727/737/DC-9 replacement would be closer to 135 to 150 passengers. The question then arises is this a new floor on transport size? If so, what will we use on low density short haul routes which have, in the past, been the preserve of local service carriers. If government policy is to be that essential service must be continued to the towns now certified, research toward new technology aircraft in this category is a matter for consideration.

Evanston, Illinois
August, 1979

APPENDIX A

INVENTORY OF COMMERCIAL JET FLEET, U.S. CARRIERS

Source: Ross, Commercial Jet Replacement Process, Northwestern University, The Transportation Center (1977)

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
U.S. TRUNK	747-100	9	9	1970	YES	6	15,000	5,200	1 100F; 2 100 F76
AMERICAN	720-B	3	0	1961	YES	15	30,000	15,400	10 Convert 720
	707-120B	48	48	1960	YES	17	54,000	27,000	23 Convert.120; Some for sale
	707-320B	10	10	1969	YES	7	25,000	9,800	
	707-320C	31	31	1963	YES	13	30,000	16,700	
	DC-8-50F	2	0	N/A	N/A	N/A	N/A	N/A	Leased to IAS Cargo AL
	DC-8-61F	1	0	N/A	N/A	N/A	N/A	N/A	Leased to Spantex
	727-100	57	57	1964	YES	12	32,000	27,600	
	727-200	55/9	55	1968	YES	8	23,000	18,900	(Is on order ORT 75)
	DC-10-10	25	25	1971	YES	5	12,000	6,000	(11 options dropped)
	CV-990A	4	0	1962	YES	14	-	-	Leased to Spantex
BRANIFF	747-100	1	1	1969	YES	7	27,000	4,400	
	DC-8-50	4	4	1973	NO	14	46,000	16,600	
	DC-8-62	6	6	1967	YES	9	33,000	11,900	
	DC-8-62F	1	1	1967	YES	9	33,000	11,900	
	727-100	12	12	1966	YES	10	32,000	29,800	
	727-100Q/C	17	17	1966	YES	10	33,000	30,900	
	727-200	44	44	1970	YES	6	24,000	23,200	
	BAC-111	-	-	-	-	-	-	-	Corporate Aircraft
CONTINENTAL	720B	5	5	1962	YES	14	52,000	36,500	
	727-100Q/C	1	1	1967	YES	9	21,000	18,500	
	727-200	36/1	36	1968	YES	8	27,000	24,300	
	DC-10-10	8	8	1972	YES	4	16,000	8,200	
	DC-10-10CF	8	8	1974	YES	2	9,000	3,800	
DELTA	747-100	3	3	1970	YES	6	17,000	8,000	Sold to Boeing
	DC-8-50	19	5	1960	YES	17	54,000	35,600	All for sale (6 Units Converted 8-10
	DC-8-61	13	13	1967	YES	9	31,000	20,800	
	727-100	5	5	1972	NO	11	31,000	21,400	Acquire NE Merger
	727-200	71/18	71	1972	YES	8	25,000	18,500	First Units acquired NE Merger
	DC-9-30	62	62	1967	YES	9	27,000	34,000	
	L-1011	17/2	19	1973	YES	3	7,000	5,500	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
EASTERN	727-100	46	46	1963	YES	13	35,000	32,000	
	727-100Q/C	25	25	1966	YES	10	31,000	23,300	
	727-200	42	42	1969	YES	7	20,000	15,800	
	DC-9-10	9	9	1966	YES	10	26,000	24,200	Return to DACO 1978
	DC-9-30	72	72	1967	YES	9	23,000	21,900	
	DC-8-20/30	3	0	1960	YES	16	41,000	19,700	Repossessed
	L-1011	29/6	29	1972	YES	4	10,000	5,700	2 Sold Cathay Pacific
	DC-8-61	5	0	-	-	-	-	-	2 Leased Capitol, 2 JAL
NATIONAL	747-100	2	0	1970	YES	6	16,000	5,000	Sold to NW
	727-100	13	13	1964	YES	12	29,000	31,500	
	727-200	25	25	1968	YES	8	23,000	23,500	
	DC-8-20/30	1	0	1963	NO	16	N/A	N/A	NWAC leased to OV
	DC-10-10	11	11	1971	YES	5	12,000	7,000	
	DC-10-30	4	4	1973	YES	3	10,000	3,000	
NORTHWEST	DC-10-40	22	22	1972	YES	4	9,000	6,000	
	747-100	12	10	1970	YES	6	20,000	6,600	
	747-200B	5	5	1971	YES	5	17,800	5,400	
	747-200F	3	3	1975	YES	1	-	-	
	707-320B	5	5	1963	YES	13	24,000	10,700	
	707-320C	3	3	1964	YES	12	22,000	9,800	Surplus
	727-100	20	15	1964	YES	12	26,000	27,300	Some for sale
	727-100Q	12	12	1966	YES	10	22,000	22,900	
	727-200	31/4	31	1968	YES	8	17,000	15,800	
PAN AM	747-100	32	32	1969	YES	7	23,000	6,300	Two are Freighters
	747-200C	2	2	1974	NO	5	12,000	2,800	Sublease World AW
	747SP	5	5	1975	YES	1	-	-	
	707-320B	51	51	1962	YES	14	50,800	17,475	
	707-320C	19	19	1963	YES	13	45,000	15,800	
	727-100	11	11	1965	YES	11	23,000	25,500	
	727-100Q	2	2	1966	YES	10	22,000	25,600	
	707-320	2	0	1959	YES	17	42,000	14,700	For Sale
TWA	747-100	10	10	1969	YES	7	22,000	4,800	
	707-120B	40	40	1962	YES	14	47,000	19,400	
	707-320B	36	36	1962	YES	14	50,000	14,600	
	707-320C	15	15	1963	YES	13	39,000	15,100	
	727-100	27	27	1964	YES	12	31,000	22,100	
	727-100Q	8	8	1967	YES	9	24,000	17,800	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
TWA Cont'd	727-200	39/14	39	1968	YES	8	22,000	21,200	Delivery deferred
	DC-9-10	19	19	1966	YES	10	20,000	20,600	
	707-320	10	10	1959	YES	17	57,000	18,100	
	L-1011	30	30	1972	YES	4	9,000	3,900	2 Sold to Saudi, More for Sale
	CV-880	25	0	1960	YES	17	-	-	Grounded, For Sale
UNITED	747-100	18	18	1970	YES	6	19,000	4,600	
	DC-8-50	16	16	1961	YES	15	52,000	22,900	6-1-63 5 Converted from 10's
	DC-8-50F	15	15	1964	YES	12	31,000	13,600	
	DC-8-61	30	30	1967	YES	9	29,000	11,900	
	DC-8-62	9	9	1969	YES	7	22,000	7,300	
	727-100	86	86	1963	YES	13	31,000	24,903	
	727-100Q	36	36	1965	YES	10	29,000	20,600	
	727-200	28	28	1968	YES	8	19,000	15,900	
	737-200	59	57	1968	YES	8	14,000	21,600	Two leased out
	DC-8-20-30	31	30	1960	YES	16	52,000	25,000	15 Converted from 10's 61-63
	720	4	0	N/A	N/A	N/A	N/A	N/A	Not operable
	DC-10-10	37	37	1971	YES	5	13,000	6,500	
WESTERN	720B	18	18	1967	YES	15	43,000	31,000	
	707-320C	5	5	1968	YES	8	23,000	9,500	
	727-200	21/5	21	1969	YES	9	18,000	13,200	
	737-200	24	24	1968	YES	8	19,000	24,200	
	DC-10-10	7	7	1973	YES	3	11,000	4,200	
REGIONAL/LOCAL SERVICE									
AIR CALIF	737-200	8	8	1968	YES	8	19,000	32,500	One on sublease to Aloha
ALASKA	727-100	5	5	1969	NO	13	26,000	27,100	Lease PSA; pur. PA
	727-100Q	3	4	1966	YES	10	28,000	22,900	
ALLEGHENY	DC-9-30	43	43	1967	YES	9	26,000	34,600	
	DC-9-50	8	8	1975	YES	1	1,000	1,000	
	BAC-111-200	31	31	1972	NO	11	32,000	42,000	EX, BN, Mohawk

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
ALOHA	737-100	2	2	1973	NO	8	11,000	19,800	EX AVIANCA
	737-200	4	4	1969	YES	7	14,000	38,000	2 UA
FRONTIER	737-200	19	19	1969	YES	7	20,000	24,900	5 Used
HAWAIIAN	DC-9-30	4	4	1967	YES	9	17,000	25,500	
	DC-9-30F	1	1	1972	NO		20,000	30,000	Lease OV
	DC-9-50	8	8	1975	YES	1	2,000	3,000	
HUGHES AIR	DC-9-10	4	4	1968	YES	8	25,000	36,800	
	DC-9-10F	12	11	1973	NO	8	25,000	34,900	EX CO
	DC-9-30	17	17	1968	YES	6	24,000	33,800	
	B727-200	0/3	-	-	-	-	-	-	
NORTH CENTRAL	DC-9-30	21	21	1967	YES	9	21,000	35,100	
	DC-9-50	3/3	3	1976	-	-	-	-	
OZAR	DC-9-10	6	4	1966	YES	10	23,000	37,500	
	DC-9-30	19	18	1968	YES	8	22,000	33,900	
PACIFIC SW	727-200	22	22	1967	YES	9	20,000	31,200	
	737-200	3	3	1968	YES	8	16,000	24,900	
	L-1011	2/3	0	1974	YES	2	1,000	1,800	2 Grounded; 3 Order Dispute
PIEDMONT	737-200	19	19	1968	YES	8	20,000	32,100	
SOUTHERN	DC-9-10	21	21	1967	YES	9	29,000	50,800	
	DC-9-30	6	6	1969	YES	7	19,000	27,400	
SOUTHWEST	737-200	5	5	1971	YES	5	12,000	17,900	
TEXAS INT.	DC-9-10	13	13	1966	YES	10	25,000	33,800	
	DC-9-10F	3	3	1967	YES	9	25,000	33,800	
	DC-9-30	5	5	1969	YES	8	19,000	28,500	
WIEN AIR	737-200Q	7	7	1968	YES	8	14,000	16,800	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
SUPPLEMENTAL/CARGO									
AIRLIFT INT	DC-8-50F	2	2	1967	YES	9	45,000	21,000	
	DC-8-63F	3	3	1968	YES	8	30,000	9,000	
	727-100Q	1	0	1967	YES	9	26,000	14,700	Leased out
	707-300	2	0	-	-	-	-	-	Leased to Aerolineas Argentinas
CAPITOL INT	DC-8-61	2	2	1971	NO	9	27,000	8,100	PUR. fm NA
	DC-8-63F	2	1	1968	YES	8	25,000	7,800	One lease CV
	DC-8-20/30	4	4	1967	NO	16	52,000	25,000	EX BN, EX NA
FLYING TIGER	747-100F	3/3	3	1974	NO	7	16,000	5,100	
	DC-8-63F	14	14	1968	YES	8	28,000	8,400	
McCULLOCH INT	DC-8-20/30	1	0	1975	NO	17	43,000	19,800	EX UA
	B720	3	3	1975	NO	-	-	-	
OVERSEAS NAT	DC-8-61F	2	2	1972	NO	8	26,000	6,500	
	DC-8-63F	2	2	1968	YES	8	29,000	7,300	
	DC-9-30F	4	4	1967	YES	9	25,000	22,000	
	DC-8-20/30	6	4	1973	NO	16	46,000	13,800	2 Cannibalized
	DC-10-30F	0/2	0	1973	YES	-	-	-	Del 1977
SATURN	DC-8-61F	1	0	-	-	-	-	-	Leased to Seaboard Wld
SEABOARD WLD	747-200F	2	2	1974	YES	2	8,000	1,000	
	DC-8-50F	1	1	1964	YES	11	37,000	10,400	
	DC-8-61F	5	5	1973	NO	9	32,000	8,000	
	DC-8-63F	5	5	1968	YES	8	34,000	8,500	
TRANS INT	DC-8-63F	6	6	1968	YES	8	29,000	7,300	
	DC-10-30F	3	3	1973	YES	3	11,000	2,700	
	DC-8-61	1	0	-	-	-	-	-	Leased to Seaboard Wld
WORLD	747-200C	3	1	1973	YES	3	10,000	2,200	1 Sublease PA; 1 Sublease Korean
	DC-8-63F	6	6	1971	YES	7	28,000	7,300	
	747-100Q	4	0	1967	YES	9	27,000	17,000	Leased to PSA

APPENDIX B

INVENTORY OF NON-U.S. COMMERCIAL JET FLEET (Free World Only)

Source: Ross, Commercial Jet Replacement Process, Northwestern University, The Transportation Center

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOLD	HIGH LAND	REMARKS
CANADA									
AIR CANADA	747-100	5	5	1971	YES	5	14,000	4,600	
	747-200B	1	1	1975	YES	1	4,000	1,700	
	DC-8-50	2	2	1963	YES	8	24,000	11,500	
	DC-8-50F	5	5	1963	YES	13	41,000	15,200	
	DC-8-61	7	7	1967	YES	9	25,000	9,600	
	DC-8-63	12	12	1969	YES	7	22,000	8,600	
	727-200	14	14	1974	YES	2	4,000	5,200	
	DC-9-10F	8	8	1972	NO	9	22,000	33,400	Ex CO
	DC-9-30	44	44	1967	YES	9	22,000	31,600	
	DC-9-30F	1	1	1973	NO	9	21,000	12,600	Ex OV Nat'l
	L-1011	10	10	1973	YES	3	8,000	4,100	
	DC-8-40	11	8	1960	YES	16	45,000	20,700	
CP AIR	747-200B	4	4	1975	YES	1	8,000	2,600	
	DC-8-50	1	1	1966	YES	10	40,000	12,400	
	DC-8-50F	1	1	1967	NO	10	35,000	10,850	Ex PG
	DC-8-63	5	5	1968	YES	8	37,000	10,700	
	727-100	4	4	1970	YES	6	20,000	15,100	
	727-200	2	2	1975	YES	1	3,000	2,300	
	737-200	7	7	1971	YES	4	24,000	18,600	
	DC-8-40	5	4	1961	YES	15	61,000	18,900	
EASTERN PRO	737-200	7	7	1969	YES	7	37,000	27,300	
NORDAIR	DC-8-61F	1	1	1973	NO	9	31,000	14,900	Lease from TIA
	737-200	1	1	1969	YES	7	12,000	10,400	
	737-200C	5	5	1968	YES	8	21,000	13,500	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
PACIFIC WEST	707-120B	1	1	1967	NO	15	50,000	20,600	Ex Quantas
	707-320C	1	1	1972	NO	11	37,000	13,000	Ex NW
	727-100Q	2	2	1972	NO	8	22,000	13,600	Ex Air Asia, TIA
	737-200	10	10	1968	YES	8	14,000	20,350	
	737-200C	1/1	1	1969	YES	7	19,000	23,400	
QUEBECAIR	727-100	1	1	1974	NO	12	30,000	25,000	Ex EA
	BAC-111-300	3	3	1969	NO				Ex British Eagle, Phil. Air
TEMPAIR	707-220/320	1	1	1974	NO	16	54,000	19,900	Ex PA
WARDAIR	747-100	2	2	1973	YES	5	16,000	5,300	Ex CO
	707-320C	2	2	1968	YES	8	17,000	11,800	
INTERNATIONAL									
AEROCONDOR	720B	2	2	1972	NO	15	38,000	21,176	Ex AA
COLUMBIA	707-120B	1	1	1975	NO	-	-	-	
AERO PERU	DC-8-50	3	3	1974	NO	14	55,000	13,800	Ex BIASA, KLM
	727-100	1	1	1974	NO	13	35,000	30,100	Ex EA
	F28	3/1	3	1974	NO				Merger SATCO
AERO TRANSPORT ITALIANI	DC-9-30	16	16	1969	YES	7	13,000	19,500	
AERO MEXICO	DC-8-50	5	5	1962	YES	14	42,000	21,000	1 EX NA
	DC-9-10	9	9	1967	YES	9	26,000	26,000	
	DC-9-30	7	7	1974	YES	2	7,000	7,000	
	DC-10-30	2	2	1974	YES	2	9,000	3,300	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
AER QUISQUE-YANAS	DC-8-20/30	2	0	1974	NO	6	39,000	14,800	Ex JA
	707-200	2	2	1974	NO	15	40,000	14,000	Ex PA
AFFRETAIR (GABON)	DC-8-50F	2	2	1972	NO	11	44,000	11,000	Ex SB, [illegible]
AFRICAN SAFARI	DC-8-20/30	1	1	1973	NO	16	48,000	12,000	Ex Martinair
AIR AFRIQUE	DC-8-50	2	2	1963	YES	13	43,000	16,300	
	DC-8-50F	3	3	1966	YES	10	45,000	16,700	
	DC-8-63F	1	1	1970	YES	6	23,000	5,800	
	Caravelle 10R	1	1	1973	NO	11			Ex Alia Roy Jordan
	Caravelle 11R	2	2	1967	YES	9			
	DC-8-20/30	1	1	1967	NO	15	46,000	18,200	Ex UTA
	DC-10-30	2	2	1973	YES	3	10,000	4,100	
AIR ALGERIE	727-200	4	4	1971	YES	5	14,000	9,200	
	737-200	6	6	1970	YES	6	12,000	8,300	
	737-200C	2	2	1972	YES	4	10,000	7,600	
	Caravelle 3	3	3	1960	YES	16			
	Caravelle 6	1	1	1961	YES	15			
AIR BRUNEI (BORNEO)	737-200	2	2	1975	YES	1	2,000	500	
AIR CENTRA-FRIQUE	Caravelle 6R	2	2	1975	NO	14			Ex Sterling
AIR CEYLON	DC-8-50	1	1	1972	NO	16	51,000		Ex UTA (NW)
	HS-121-1E	1	1	1969	YES	7			

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
AIR CHARTER	727-200	2	2	1971	NO	9	18,000	22,800	Ex PCC, SW
INT'L FRANCE	Caravelle 3	5	4	1971	NO	13			Ex Air France
AIR FRANCE	747-100	14	14	1970	YES	6	21,000	6,000	
	747-200F	1	1	1974	YES	2	6,000	1,200	
	707-320B	6	6	1962	YES	14	46,000	14,000	
	707-320C	11	11	1965	YES	11	36,000	8,000	
	727-200	20	20	1963	YES	8	16,000	15,000	
	737-200	2	2	1973	NO	8	16,000	20,800	Ex MA
	707-220/230	17	17	1959	YES	17	47,000	14,200	
	747-200F(GE)	0/1	0	-	YES	-	-	-	
	A300	7	7	1975	YES	1	3,000	2,000	
	Concorde	0/4	2	1975	YES	-	-	-	
	Caravelle 3	36	33	1959	YES	17			
AIR INTER FRANCE	Caravelle 12	5	5	1972	YES	6			
	Mercure 100	9/1	9	1974	YES	2			
	Caravelle 3	17	17	1967	YES	9			
AIR INDIA	747-200B	5	5	1971	YES	5	16,000	8,600	
	707-320B	3	3	1964	YES	12	36,000	14,800	
	707-320C	2	2	1967	YES	9	30,000	12,400	
	707-420	4	4	1960	YES	16	51,000	22,600	
AIR HAITI	DC-8-20/30	2	0	1973	NO	16	40,000	15,800	Ex EA
AIR JAMAICA	DC-8-50	3	3	1971	NO	14	40,000	15,600	Ex EA
	DC-8-61	2	2	1969	NO	9	25,000	6,300	Ex EA
	DC-8-62	1	1	1973	NO	7	22,000	5,500	Ex EA
	727-200	5	5	1974	YES	2	4,000	3,800	
	DC-9-30	3	3	1969	YES	7	16,000	8,000	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
AIR MADAGASCAR	737-200	2	2	1969	YES	7	10,000	10,100	
AIR MALI	727-100Q	1	1	1971	NO	9	17,000	12,400	Ex WLD
AIR MALTA	720B	2	2	1974	NO	16	43,000	20,500	Lease from Pakistan Int'l
	BAC-111-500	1	1	1975	NO	10			Lease from B. CAL
AIR MICRONESIA	727-100Q	2	2	1968	NO	9	23,000	15,500	
AIR NAURU	737-200Q	1	1	1975	YES	1	-	-	
AIR NEW ZEALAND	DC-8-50	6	6	1965	YES	16	52,000	23,900	2 Ex UA
	DC-10-30	7	7	1973	YES	3	14,000	3,700	
AIR PANAMA	727-100	3	3	1972	NO	11	20,000	19,000	Ex All Nippon
AIR RHODESIA	720	3	3	1973	NO	May Not Be Operable Any More			Ex CAL Air
AIR SIAM	747-100	1	1	1973	NO	5	11,000	5,100	Lease Air Linguis
	DC-10-10CF	1	1	1974	YES	2	6,000	1,600	
	A300B2	1	0	1974	YES	2	-	-	No Longer Operable
AIR SPAIN	DC-8-20/30	2	0	1971	NO	16	41,000		Ex EA
AIR VIETNAM	727-100Q	1	0	1968	NO	-	-	-	Ex PA
AIR VIKING (ICELAND)	720	3	3	1974	NO	16	32,000	19,000	Ex UA (May Not Be Operable)

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
AIR ZAIRE (Air Congo)	DC-8-63F	2	2	1970	YES	6	9,000		
	737-200C	3	3	1973	YES	3	5,000	5,300	
	Caravelle 11R	2	2	1967	YES	9			
	DC-8-20/30	2	2	1967	NO	16	40,000	16,000	Ex PA
	DC-10-30	2	2	1974	YES	2	5,000	2,000	
ALIA JORDAN	720B	2	2	1972	NO	16	38,000	23,800	Ex PA
	707-320C	6	6	1971	YES	13	42,000	12,700	2 Ex PA
	727-200	3	3	1974	YES	2	5,000	4,400	
ALISARDA (Italy)	DC-9-10	2	2	1974	NO	10	26,000	41,600	Ex Southern
	DC-9-30	0/2	-	-	-	-	-	-	
ALITALIA	747-100	2	2	1970	YES	6	21,000	4,300	
	747-200B	3	3	1971	YES	5	18,000	4,900	
	DC-8-62	8	8	1967	YES	9	30,000	7,500	
	DC-8-62F	2	2	1968	YES	8	28,000	7,000	
	DC-9-30	33	33	1967	YES	9	18,000	18,000	
	DC-9-30F	3	2	1968	YES	8	14,000	14,000	
	DC-10-30	8	8	1973	YES	3	11,000	4,600	
	DC-8-40	11	6	1960	YES	16	49,000	20,000	
	Caravelle 16N	14	11	1960	YES	16			
ALL NIPPON	727-200	26	26	1969	YES	5	16,000	15,000	
	737-200	14	14	1969	YES	7	17,000	17,400	
	L-1011	15/8	15	1973	YES	3	5,000	3,800	
ALM DUTCH ANTILLES	DC-9-30	3	3	1975	YES	1	3,000	2,500	
ALYMEDA S. YEMEN	720B	1	1	1974	NO	16	Not Reported		Ex AA
ANSETT AIR-LINES (Australia)	727-100	4	4	1964	YES	12	39,000	23,000	
	727-100Q	2	2	1969	YES	7	24,000	16,900	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
	727-200	7	7	1972	YES	4	13,000	9,200	
	DC-9-30	12	12	1967	YES	9	25,000	24,300	
	F28	5	5						
ARIANA	720B	1	1	1973	NO	16	36,000	19,000	Ex PA
AFGHAN	727-100Q	2	2	1968	YES	7	16,000	8,800	Ex Jet Av
AEROLINEAS	747-100	1	1	1975	NO	6	13,000	6,800	Lease from mfr
ARGENTINAS	707-320B	5	5	1966	YES	10	33,000	9,500	(Ex Delta
	707-320C	4	4	1968	YES	8	29,000	8,500	
	737-200	10	10	1970	YES	6	16,000	18,700	
	737-200Q	2	2	1970	YES	6	14,000	16,300	
	F28	3	3	1975	YES	1			
	747-200B	0/1	-	-	-	-	-	-	
AUSTRIAN	DC-9-30	9	9	1971	YES	5	17,000	17,000	
	DC-9-50	2	2	1976	YES	1	2,000	2,000	
	Caravelle 6	3	3	1963	YES	13			
AUENSA VENEZUELA	DC-9-10	1	1	1967	YES	9	?	?	
AVIACO, SPAIN	DC-8-50	5	5	1973	NO	16	40,000	20,000	Lease from IB
	DC-8-50F	1	1	1973	NO	13	38,000	19,000	Lease from Capitol
	DC-9-30	8	8	1974	YES	2	5,000	3,200	
	DC-9-30F	0/4		-	-	-	-	-	
	Caravelle 10R	4	4	1973	NO	10			Ex IB
	Caravelle 6	5	4	1972	NO	14			EX IB

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
AVIANCA	720B	7	7	1961	YES	16	40,000	17,400	
COLUMBIA	707-320B	2	2	1968	YES	8	29,000	11,800	
	727-100	8	8	1966	YES	10	22,000	25,200	
	727-100Q	2	2	1971	NO	8	13,000	13,800	Ex CO
BALAIR,	DC-8-50F	1	1	1971	NO	10	38,000	9,500	Ex Universal
SWITZERLAND	DC-8-63	1	1	1973	NO	7	25,000	6,500	Ex EA
	DC-9-30F	1	1	1970	YES	6	12,000	6,500	
BANGLADESH BIMAN	707-320C	1	1	1973	NO	10	23,000	10,300	
BRAATHENS,	737-200	5/1	5	1969	YES	7	25,000	16,700	
NORWAY	737-200C	1	1	1971	YES	4	17,000	14,600	
BRITANNIA,	737-200	11/2	11	1968	YES	8	25,000	15,100	
U.K.	737-200C	2	2	1970	YES	6	20,000	10,700	
BRITISH	707-320C	11	11	1967	YES	9	49,000	10,400	
CALEDONIAN	707-320	1	1	?	?	?	53,000	19,700	
	BAC-111-200	7	7	1965	YES	11			
	BAC-111-500	11	11	1969	YES	7			
BRITISH	747-100	17/1	17	1970	YES	6	19,000	5,700	
AIRWAYS	707-320B	2	2	1970	YES	6	18,000	5,300	
(OVERSEAS	707-320C	9	9	1965	YES	11	37,000	12,100	
DIVISION)	Concorde	1/4	1	1976	YES	-	-	-	
	747-200B(RR)	0/4	-	-	-	-	-	-	
	VC-10 Std.	4	4	1964	YES	12			
	VC-10 Super	15	15	1965	YES	11			
	707-420	8	6	1960	YES	16	56,000	19,500	
	Comet	2	0	1959	YES	17	-	-	Scrapped
(EUROPEAN	L-1011	7/8	7	1974	YES	2	2,000	2,000	
DIVISION)	BAC-111-500	18	18	1968	YES	8			

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
	HS-121-1C	20	20	1963	YES	13			
	HS-121-2E	15	15	1968	YES	8			
	HS-121-3B	26	26	1974	YES	2			
BRITISH WEST INDIAN AIRWAYS	707-120B	2	2	1969	NO	14	37,000	21,900	Ex Quantas
	707-320C	4	4	1974	NO	10	26,000	11,600	Ex NW
TRINIDAD (BWIA)	707-220	4	2	1971	NO	17	45,000	25,900	Ex BN (All for Sale)
CAAC, CHINA	707-320B	4	4	1975	YES	1	2,000	1,000	
	707-320C	6	6	1975	YES	1	2,000	1,000	
	HS-121-1E	3	3	1970	NO				Ex Pakistan Int'l
	HS-121-2C	18/15	18	1972	YES	4			
	HS-121-3B	2	2	1974	YES	2			
CAMERON AIR	707-320C	1	1	1972	YES	4	7,000	2,200	
	737-200Q	2	2	1972	YES	4	7,000	11,600	
CARGOLUX, LUXEMBURG	DC-8-63F	3	3	1973	NO	8	28,000	7,000	1 purchased from FT 2 lease from SB
CATHAY PACIFIC HONG KONG	707-320B	4	4	1971	NO	13	43,000	19,600	Ex NW
	707-320C	8	8	1972	NO	12	38,000	14,900	Ex NW
	L-1011	2	2	1975	YES	1	2,000	1,500	
	CV-880 M	0	0	1962	YES	14	-	-	May have been sold 75
CHOAN AIRLINES TAIWAN	747-100	1	1	1975	NO	6	19,000	9,500	Lease from mfr. (Ex Delta)
	707-320B	1	1	1971	NO	13	42,000	18,100	Ex NW
	707-320C	5	5	1969	YES	7	43,000	14,300	3 Ex CO
	727-100	2	2	1967	YES	9	24,000	16,400	
	727-100Q	1	1	1969	YES	7	20,000	13,100	
	Caravelle 3	2	2	1971	NO	16			Ex SAS

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
CONAIR, DENMARK	720	5	4	1971	NO	15	38,000	23,500	From mfr. (Ex EA)
CONDOR	747-200B	2	2	1971	YES	5	15,000	4,000	
FLUGDIENST	707-300B	1	1	1969	NO	12	39,000	13,800	Lease from Lufthansa
GERMANY	727-100	7	7	1965	NO	12	29,000	18,200	Ex Lufthansa
	727-200	3	8	1973	YES	3	8,000	7,800	
CRUZEIRO, BRAZIL	727-100	8	8	1971	YES	12	32,000	15,700	1 Sabena, 1 Wardair, 2 Ex EA, 1 Hughes
	737-200	6	6	1971	YES	1	2,000	2,100	
	Caravelle 6	6	0	May have been traded in 70 Boeing for 737s.					
CYPRUS	DC-9-10	2	2	1975	NO	10	21,000	23,100	Ex KL
	HS-121-2E	2	1	1969	YES	7			
	BAC-111-500	1	1	1974	NO	6			Lease from Courtline
DELTA (BELGIUM)	720	1	1	?	NO	15	33,000	20,000	May not be operable
DAN AIR U.K.	727-100	5	5	1972	NO	11	25,000	19,800	Ex CAL
	707-320	2	2	1971	NO	17	54,000	19,100	Ex PA
	BAC-111-200	2	2	1975	NO	10			Ex Zambia
	BAC-111-300	2	2	1969	NO				Ex British Eagle
	BAC-111-400	3	3	1969	NO	11			Ex AA, Bavaria
	BAC-111-500	4	4	1971	NO	7			Lease from mfr. (Ex Court-
	Comet 4BK	16	9	1965	NO	16			Ex BOAC line)
D.E.T.A.	737-200	3	3	1970	YES	6	13,000	12,500	
MOZAMBIQUE	737-200Q	1	1	1971	YES	5	9,000	8,300	
DOMINICANA	727-100	1	1	1972	YES	4	6,000	3,100	
	727-200	1	1	1975	YES	1	3,000	1,700	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
EAST AFRICAN AIRWAYS	707-320C	1	1	1974	NO	11	29,000	16,300	Ex AA
	DC-9-30	3	3	1971	YES	5	11,000	11,000	
	VC-10 Super	4	4	1966	YES	10			
ECUATORIAN	720B	3	3	1974	NO	15	30,000	17,700	Ex PA (May be out of service)
	Caravelle	2	2						
EGYPTAIR (UNITED ARAB)	707-320C	9	9	1968	YES	8	23,000	9,600	
	737-200	2/5	2	1974	YES	2	13,000	-	1 Lease
	Comet	4	0	1964	NO	6	-	-	Ex UAR
EL AL	747-200B	3	3	1971	YES	5	15,000	3,000	
	747-200C	1	1	1975	YES	1	-	-	
	720B	2	2	1962	YES	14	41,000	17,100	
	707-320B	3	3	1966	YES	10	49,000	13,900	
	707-320C	2	2	1965	YES	7	25,000	6,100	
	707-420	3	3	1961	YES	15	51,000	15,000	
ETHIOPIAN AIRLINES	720B	4	4	1962	YES	14	51,000	32,400	2 Ex CO, AL
	707-320C	2	0	-	-	-	-		Leased to Saudi Arabian Airlines
FAUCETT, PERU	727-100	1	1	1968	YES	8	20,000	25,800	
	BAC-111-475	2	2	1971	YES	5			

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
FINNAIR	DC-8-62	1	1	1975	NO	8	30,000	9,000	Ex UT
	DC-8-62F	2	2	1969	YES	7	25,000	6,500	
	DC-9-10	7	7	1969	NO	10	23,000	34,500	Ex Air Canada
	DC-9-10F	2	2	1972	NO	9	20,000	30,000	Ex Texas Int'l
	DC-9-50	3/3	3	1976	YES	-	-	-	
	Caravelle 10B	9	9	1964	YES	12			
	DC-10-30	2	2	1975	YES	1	5,000	1,600	
GARUDA INDONESIAN	DC-8-50	3	3	1965	NO	14	54,000	21,600	Ex KLM
	DC-9-30	12	12	1969	YES	7	17,000	13,300	
	DC-10-30	2	2	1973	NO	1	1,000	4,000	Lease KLM (New one this year)
	F-28	16	16	1971	YES	5			
HAPAG-LLOYD FLUG (W. GER)	727-100	8	8	1972	NO	12	24,000	23,000	Ex All Nip, Pacific S.W., Sabena, TCA, JAL
IBERIA	747-100	2	2	1970	YES	6	16,000	3,400	
	747-200B	1	1	1972	YES	4	14,000	2,800	
	DC-8-50F	1	1	1968	YES	8	21,000	9,500	
	DC-8-63	5	5	1968	YES	8	26,000	6,500	
	DC-8-63F	1	1	1968	YES	8	24,000	6,000	
	727-200	29	29	1972	YES	4	9,000	8,800	
	DC-9-3(	31	31	1967	YES	9	19,000	20,000	
	DC-9-30F	3	3	1973	YES	3	10,000	10,500	
	DC-10-30	6	6	1973	YES	3	9,000	2,800	
	F-28	2	2	1970	YES	6			
	DC-8-50	1	1	1961	YES	10	28,000	12,600	
ICELANDAIR	727-100Q	2	2	1967	YES	10	20,000	10,900	1 Ex AA
ICELANDIC	DC-8-63F	3	3	1970	NO	8	37,000	9,300	Lease from SB

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
INDIAN	737-200	12/1	12	1970	YES	6	13,000	13,100	
AIRLINES	A300	0/3	-	-	-	-	-	-	
CORP.	Caravelle 6	6	8	1963	YES	13			
INER ADRIA,	DC-9-30	3/1	3	1969	YES	7	12,000	8,500	1 Ex Purdue Fluof Pan Adria
YUGOSLAVIA	DC-9-30F	2	2	1971	YES	5	18,000	12,300	1 Ex CNA
INVICTA (GR BR)	720B	2	2	1974	NO	13	35,000	17,500	Ex AA
IRANAIR	747SP	0/3	-	-	-	-	-	-	
	747-200B	0/2	-	-	-	-	-	-	
	707-320B	1	1	1975	NO	11	37,000	12,700	Ex PA
	707-320C	5	4	1970	YES	6	34,000	12,300	2 Ex PA
	727-100	4	4	1965	YES	11	25,000	19,100	1 Ex All Nippon
	727-200	5	5	1974	YES	2	5,000	3,900	
	737-200	2	2	1971	YES	5	11,000	16,500	
	737-200C/QC	2	2	1971	YES	5	10,000	16,500	
IRISH INT'L	707-320C	4	4	1964	YES	12	37,000	13,700	
AER LINGUS	737-200	3	3	1969	YES	7	15,000	16,100	Lease from VA (1)
	737-200C/QC	4	4	1969	YES	7	13,000	18,300	
	BAC-111-200	4	4	1965	YES	11			
	747-100	1	0	1970	-	-	-	-	Lease to Air Siam
IRAQI	747-200C	0/2	-	-	-	-	-	-	
	707-320C	3	3	1974	YES		3,000	2,300	
	727-200	2/1	2	1976	-	-	-	-	
	737-200C/QC	1/1	1	1975	YES	1	2,000	2,400	
	HS-121-1E	3	2	1965	YES	11			

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LONG	REMARKS
KOREAN AIRLINES	747-200B	2	2	1973	YES	3	10,000	2,500	
	747-200C	1	1	1974	NO	3	5,000	1,500	Sublease from World
	707-320C	4	4	1971	YES	11	34,000	12,100	2 Leased from World; 1 purchased from World
	DC-8-63F	1	1	1972	NO	7	24,000	7,200	Lease from SO
	727-100	3	3	1972	NO	10	23,000	22,500	2 Leased from JAL; 1 purchased from JAL
	720	2	2	1969	NO	15	17,000	25,200	Ex BA
	DC-10-30	3	3	1975	YES	1	5,000	1,000	
	A300B4	2/4	2	1976	YES	1	-	-	
KUWAIT AIRWAYS	707-320C	7	7	1960	YES	10	22,000	10,500	1 Ex PA
	737-200	1	1	1976	YES	-	-	-	
	HS-121-1E	1	1	1966	YES	10			
LAB, BOLIVIA	727-100	2	2	1969	YES	7	31,000	29,600	1 Ex BN
	727-100C/QC	1	1	1974	NO	8	10,000	10,500	Ex Trans Int'l
	727-200	1	1	1975	YES	1	1,000	1,000	
LAKER AIRWAYS U.K.	707-120B	2	2	1960	NO	16	48,000	20,800	Ex Quantas
	DC-10-10	3	3	1972	YES	4	9,000	2,500	
	BAC-111-300	5	5	1967	YES	9			
LAN-CHILE	707-320B	2	2	1967	NO	13	32,000	16,000	Ex Lufthansa
	707-320C	2	2	1969	YES	10	27,000	11,100	1 Ex [illegible]
	727-100	1	1	1963	YES	8	20,000	15,000	
	727-100C/QC	3	3	1968	YES	8	22,000	10,000	
	Caravelle 6	3	3	1964	YES	12			
LAV, VENEZUELA	DC-9-10	4	4	1968	YES	9	20,000	30,000	3 Ex Saudia
	DC-9-30	1	1	1970	NO	9	20,000	20,000	Ex Pacific Southwest

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
LIBYAN ARAB	707-320C	0/1	-	-	-	-	-	-	
	727-200	4/2	4	1970	YES	6	12,000	7,500	
	Caravelle 6	3	3	1965	YES	15			1 Ex BA
LTU,GERMANY	Caravelle 10R	4	4	1967	YES	9			
	L-1011	2	2	1973	YES	3	9,000	4,700	
	SPEY-JR-528	2	0	1967	YES	9			May have been sold to mfr.
LUFTHANSA	747-100	2	2	1970	YES	6	23,000	5,700	
	747-200B	2	2	1971	YES	5	20,000	8,900	
	747-200F	1	1	1972	YES	4	18,000	3,000	
	707-330B	9	9	1968	YES	13	49,000	12,000	
	707-320C	6	6	1965	YES	11	48,000	11,800	
	727-100C/QC	11	11	1967	YES	9	24,000	27,900	
	727-200	19	19	1971	YES	5	12,000	7,500	
	737-100	22	22	1967	YES	9	18,000	28,200	
	737-200C/QC	6	6	1969	YES	7	10,000	13,300	
	747-200B	0/1	-	-	-	-	-	-	GE engine
	DC-10-30	10	10	1973	YES	3	10,000	3,000	
	A300	2/1	2	1976	YES	-	-	-	
	707-420	4	4	1960	YES	16	61,000	21,000	
LUXAIR, LUXEMBOURG	707-320C	1	1	1972	NO	11	34,000	11,000	Ex Aer Lingis
	Caravelle 6	4	4	1970	NO	12			Ex SAVA
MAERSK AIR DENMARK	720B	5	4	1972	NO	15	37,000	23,800	Ex BW (1 Lease to Monarch)
MALAYSIA	707-320C	3	3	1972	NO	12	35,000	13,000	Ex Quantas
	737-200	8	8	1972	YES	4	9,000	10,100	
	737-200C/QC	1	1	1975	YES	1	1,000	1,000	
	DC-10-30	0/2	-	-	-	-	-	-	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
MARTINAIR, NETHERLANDS	DC-8-50F	2	2	1968	NO	10	36,000	9,000	Ex GV Nat'l, Seaboard World
	DC-9-30	1	1	1971	YES	5	13,000	7,500	
	DC-9-30F	2	2	1968	YES	8	17,000	9,900	
	DC-10-30CF	2/1	2	1973	YES	3	9,000	2,400	
	SPEY-JR-F28	1	1	1969	YES	7			
MEXICANA	727-100	7	7	1966	YES	10	29,000	35,800	
	727-200	13	13	1970	YES	6	17,000	17,400	
MIDDLE EAST, LEBANON	747-200B	3	3	1975	YES	1	3,000	600	
	720B	16	16	1965	NO	15	41,000	20,500	Ex AA, WA (More WA coming)
	707-320C	3	3	1968	YES	8	20,000	7,900	
MONARCH, G. BRITAIN	720B	4	4	1971	NO	15	42,000	26,300	Ex NW
	BAC-111-500	2	2	1975	NO	8			Lease from mfr. (Ex Court-line)
NEW ZEALAND NATIONAL	737-200	9	9	1968	YES	8	17,000	23,300	2 Ex PSA
NIGERIA	707-320C	2	2	1970	YES	5	14,000	5,000	
	737-200	2	2	1972	YES	4	5,000	6,900	
	SPEY-JR-F28	5/2	5	1972	YES	4			
OLYMPIC, GREECE	747-200B	2	2	1973	YES	3	10,000	1,800	
	720B	7	7	1972	NO	15	38,000	27,000	Ex NW
	707-320B	2	2	1968	YES	8	24,000	6,900	
	707-320C	4	4	1966	YES	10	30,000	9,200	
	727-200	6	6	1968	YES	8	17,000	13,500	
PAKISTAN INTERNATIONAL	720B	5	4	1961	YES	15	38,000	27,500	1 Lease out; 1 Ex WA
	707-320C	6	6	1966	YES	10	41,000	11,800	
	DC-10-30	3/1	3	1974	YES	2	8,000	3,200	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
PHILIPPINE AIRLINES	DC-8-50	3	3	1961	YES	15	59,000	14,800	1 Ex KLM
	DC-8-30	2	2	1970	NO	16	49,000	12,000	Ex KLM
	DC-8-63	2	2	1963	NO	7	27,000	6,800	Lease KLM
	DC-10-30	3	3	1974	NO	2	13,000	3,900	Lease from KLM
	BAC-111-500	8	8	1971	NO	5			
	707-300	3	3	-	NO	16	44,000	17,300	Ex PA May not be operable
QUANTAS, AUSTRALIA	747-200B	11	11	1971	YES	5	18,000	6,600	
	707-320C	11	11	1965	YES	11	33,000	12,200	
ROYAL AIR MAROC, MOROCCO	727-200	4	4	1970	YES	6	14,000	9,900	
	737-200	0/3	-	-	-	-	-	-	
	Caravelle 3	4	4	1960	YES	16			
	707-300	1	1	1971	NO	16	38,000	13,500	Lease from Air France, May be grounded
ROYAL BRUNEI	737-200	1/1	1	1975	YES	1	-	-	
ROYAL NAPAL	727-100	1	1	1972	YES	4	7,000	4,600	
SABENA, BELGIUM	747-100	2	2	1970	YES	6	20,000	3,900	
	707-320C	6	6	1965	YES	11	37,000	9,300	
	727-100QC	3	3	1967	YES	9	17,000	15,700	
	737-200	11	11	1974	YES	2	6,000	5,700	
	737-200X/QC	4	4	1975	YES	1	3,000	3,200	
	707-320	6	6	1959	YES	17	54,000	14,500	
	DC-10-30CF	3	3	1973	YES	3	10,000	3,100	
	Caravelle 6	4	4	1961	YES	15			
SAHSA, HONDURAS	737-200	1	1	1974	YES	2	5,000	6,900	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
SAS, SCANDINAVIA	747-200B	2	2	1971	YES	5	21,000	4,500	
	DC-8-50	2	2	1965	YES	11	43,000	10,800	
	DC-8-62	5	5	1967	YES	9	34,000	8,500	
	DC-8-62F	3	3	1968	YES	8	33,000	8,300	
	DC-8-63	5	4	1968	YES	8	31,000	7,000	1 Leased to Thai Airways
	DC-9-20	10	9	1963	YES	8	16,000	24,000	1 grounded
	DC-9-30F	2	2	1969	YES	7	15,000	14,900	
	DC-9-40	37/2	37	1968	YES	8	20,000	21,000	
	DC-10-30	4/1	4	1974	YES	2	6,000	2,000	
	Caravelle 3	13	3	1960	YES	16			10 Out of service
SATA, SWITZERLAND	DC-8-63F	1	1	1974	NO	8	23,000	5,800	Ex Flying Tigers
	Caravelle 10R	4	4	1970	YES	6			
SAUDIA	720B	3	3	1961	YES	15	50,000	35,100	
	Caravelle 10R	9	9	1968	YES	8	48,000	11,400	1 Ex World; 1 Lease from Ethiopian
	737-200	5	5	1972	YES	4	12,000	11,400	
	737-200C/QC	2	2	1972	YES	4	11,000	11,100	
	L01011	4	4	1975	YES	1	2,000	1,000	2 Ex TWA
SCANAIR, SWEDEN	727-100	2	2	1967	YES	9	29,000	11,900	
	727-100C/QC	1	1	1968	YES	8	27,000	11,200	
SINGAPORE	747-200B	4/1	4	1973	YES	3	10,000	5,400	
	707-320B	3	3	1968	YES	8	26,000	11,453	
	707-320C	7	7	1971	NO	11	34,000	21,200	Ex BN, CO, Quantas
	737-100	5	5	1969	YES	7	16,000	18,400	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
SOUTH AFRICAN AIRWAYS	747-SP	0/5	-	-	-	-	-	-	
	747-200B	5	5	1971	YES	5	15,000	4,800	
	707-320B	2	2	1965	YES	11	33,000	8,800	
	707-320C	4	4	1968	YES	8	26,000	7,100	
	727-100	6	6	1965	YES	11	23,000	25,000	
	727-100C/QC	3	3	1967	YES	9	18,000	19,100	
	737-200	6	6	1968	YES	8	13,000	17,700	
	707-320	2	2	1960	YES	16	43,000	16,700	
	A300B4	0/4	-	-	-	-	-	-	
SPANTEX, SPAIN	DC-8-61F	2	2	1973	NO	9	23,000	7,000	Lease & Sublease from AA
	DC-9-10	2	2	1974	NO	10	28,000	47,600	Ex Southern
	-23-990A	12	12	1967	NO	15			Ex AA, Modern, Air Trans, Swissair
STERLING, DENMARK	727-200	5	5	1973	YES	3	9,000	3,200	2 Leased from NALS
	Caravelle 10B	5	5	1965	YES	11			
	Caravelle 12	6	6	1971	YES	5			
	Caravelle 6R	11	5	1971	NO	15			Ex UA (5 leased out)
SUDAN	707-320C	2	2	1973	YES	3	6,000	4,700	
	737-200C/QC	2	2	1975	YES	1	1,000	-	
	Comet A11	2	0	1962	YES	14			Grounded
SWISSAIR	747-200B	2	2	1971	YES	5	16,000	3,800	
	DC-8-50	1	1	1963	YES	16	63,000	30,700	Convert from 30
	DC-8-62	5	5	1967	YES	9	37,000	16,700	
	DC-8-62F	2	2	1968	YES	8	32,000	14,400	
	DC-9-30	21	21	1967	YES	9	21,000	25,200	
	DC-9-30F	1	1	1969	YES	7	14,000	13,700	
	DC-9-50	7/3	7	1975	YES	1	2,000	2,000	
	DC-10-30	8	8	1972	YES	4	14,000	4,400	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
SYRIAN ARAB	747-SP	0/2	-	-	-	-	-	-	
	727-200	0/3	-	-	-	-	-	-	
	Caravelle 10B	4	4	1966	YES	10			
	707-420	2	2	1974	NO	16	53,000	19,400	Lease from Brit. Air Tours
TAAG, ANGOLA	737-200C/QC	1	1	1975	YES	1	1,000	-	
TAE, SPAIN	DC-8-20-30	2	2	1973	NO	16	46,000	11,500	Leased from UT
TAN, HONDURAS	737-200	1	1	1974	NO	7	10,000	12,100	Ex Pluna
TAP, PORTUGAL	747-200B	4	4	1972	YES	4	12,000	4,400	
	707-320B	7	7	1966	YES	10	41,000	11,800	
	707-320C	3	3	1973	NO	12	40,000	10,000	2 Ex B. Cal:
	727-100	4	4	1967	YES	9	21,000	16,500	1 Ex World
	727-100C/QC	3	3	1968	YES	8	24,000	16,300	1 Ex Airlift Int'l
	727-200	2	2	1975	YES	1	3,000	3,200	
	Caravelle 6	3	3	1962	YES	14			
TAROM, RUMANIA	707-320C	4	4	1974	YES	2	5,000	2,500	
	BAC-111-400	7	7	1968	YES	8			1 Ex AA
	BAC-111-500	-	-	-	-	-	-	-	Del. 1977
THAI INT'L	DC-8-63	3	3	1974	NO	8	32,000	8,000	Ex SAS)1 leased)
	DC-8-30	6	6	1970	NO	16	54,000	21,600	Ex SAS, Ex Atlantis
	DC-10-30	2	2	1975	NO	3	12,000	3,600	1 leased from UTA; 1 leased from GARUDA
TOA DOMESTIC JAPAN	DC-9-40	14	14	1975	YES	1	3,000	3,000	

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
TRANS-AUSTRALIA	727-100	6	6	1964	YES	12	30,000	29,100	
	727-200	6	6	1972	YES	4	12,000	9,100	
	DC-9-30	12	12	1967	YES	9	24,000	24,000	
TRANSAVIA (HOLLAND)	707-120B	1	1	1972	NO	16	50,000	23,300	Ex AA
	737-200C/QC	3	3	1974	YES	2	7,000	3,300	
	Caravelle 3	3	0	1968	NO				3 grounded
	Caravelle 6R	6	4	1970	NO	15			2 grounded Ex UA
	737-200	2	2	1974	NO		13,000	16,400	
TRANSERASIL	727-100C/QC	5	5	1974	NO		32,000	34,500	Ex PA
	BAC-111-500	9	9	1970	YES	6			3 Ex Brit, Midland; 2 Ex Courtline
TRANS EUROPA (SPAIN)	Caravelle 10R	3	3	1970	YES	6			1 lease manufacturer; 1 Ex Royal Jord.
	Caravelle 11R	2	2	1969	YES	7			
TRANS EUROPEAN (BELGIUM)	B-720	2	1	1971	NO	14	32,000	15,000	Ex EA, Ex Aer Lingus
	707-120	3	3	1973	NO	17	43,000	21,700	Ex TWA
	A300	2	2	1974	YES	2	1,500	600	
TRANS-MEDITERRANEAN	747-100	2	2	-	NO	-	-	-	Ex AA
	707-320C	7	7	1970	NO	12	-	-	6 Ex BN; ;Ex AA
TREK SOUTH AFRICA	707-320	1	1	1969	NO	16	45,000	13,900	Ex So Africa
TURKISH AIRLINES	707-100B	4	4	1974	NO	17	42,000	18,900	Lease from PA
	727-200	4	4	1974	YES	2	4,000	3,000	
	DC-9-30	8	8	1968	YES	8			
	DC-10-10	2	2	1972	YES	4	8,000	4,000	
	F-28	3	3	1972	YES	4			

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
TUNIS AIR	727-200	5	5	1972	YES	4	11,000	7,600	
	Caravelle 3	5	4	1961	YES	15			
UTA (FRANCE)	DC-8-50	1	1	1965	YES	16	50,000	12,500	Convert from 30
	DC-8-50F	3	3	1965	YES	11	45,000	11,300	
	DC-8-62	3	3	1968	YES	8	33,000	8,300	
	DC-8-63F	2	2	1973	NO	7	22,000	5,500	Ex EA
	Caravelle 10R	1	1	1966	YES	10			
	Caravelle 12	1	1	-	-	-	-	-	
	DC-10-30	4/1	4	1973	YES	3	12,000	4,100	
VARIG AIRLINES (BRAZIL	707-320C	14	14	1965	YES	14	43,000	11,300	2 Ex SB; 1 Ex 2N 4 Ex CO; 2 Ex AA
	727-100	7	7	1970	YES	12	24,000	15,800	2 Ex DL
	727-100C/QC	2	2	1973	NO	12	25,000	18,400	1 Ex AL; 1 Ex World
	737-200	10	10	1974	YES	2	3,000	4,300	
	DC-8-20/30	1	0	1965	NO	16	38,000	9,500	Ex PA
	DC-10-30	4	4	1974	YES	2	7,000	1,500	
	707-420	2	2	1960	YES	16	49,000	13,900	
VASP (BRAZIL)	737-200	19/1	19	1969	YES	7	18,000	17,800	
	737-200C/QC	1/1	1	1974	YES	2	10,000	13,500	
VIASA (VENEZUELA)	DC-8-50	2	2	1965	NO	15	56,000	14,000	Leased from KL
	DC-8-63	2	2	1968	YES	8	27,000	6,800	
	DC-8-20/30	1	1	1972	NO	15	55,000	13,800	Ex KLM
	DC-10-30	2	2	1974	NO	2	9,000	3,200	Lease from KLM
YUGOSLAV	707-320C	4	4	1974	NO	12	30,000	11,600	Ex NU
	727-200	5	5	1974	YES	2	4,000	4,000	
	DC-9-30	12	12	1969	YES	6	13,000	13,000	
	Caravelle 6	3	3	1963	YES	13			

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
MODERN	23-99CA	6	0	1967	NO				Ex AA, Fleet for sale
AIR GABON	SPEY-JR-F-28	2	2	1975	YES	1			
AIR MALAWI	BAC-111-475	2	2	1972	YES	4			
	VC-10 Std.	1	1	1974	NO				Ex B. Cal.
AIR PACIFIC (FIJI)	BAC-111-475	2							
AREA (ECUADOR)	Comet A11	1							
AUSTRAL (ARGENTINA)	BAC-111-400	4							
	BAC-111-500	4/2							
AVIATECA (GUATEMALA)	BAC-111-500	2	2	1971	YES	5			
	SPEY-JR-F-28	1	1	1974	NO				Lease Transair
BAHAMASAIR	BAC-111-400	3	3	1973	NO				Ex AA
BAVARIA FLUGGESELL-SCHAFT	BAC-111-400	4	4	1967	YES	9			
	BAC-111-500	3	3	1970	YES	6			
BELGIUM INT'L	Caravelle 6	1							
BONAIR (W.GERMANY)	SPEY-JR-F-28	4							
BEA AIRTOURS	Comet A11	9							
CAMBRIAN (U.K.)	BAC-111-400	6							

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
CATAIR (FRANCE)	Caravelle 3	2	2	1971	NO				Ex SAS
	Caravelle 6N	1	1	1974	NO				Ex Sobelair
	Caravelle 6R	2	2	1972	NO				Ex Sterling
	Caravelle 12	1	1	1975	NO				Ex Sterling
CHANNEL AIRWAYS (U.K.)	BAC-111-400	2							
	HS-121-1E	1							
	Comet A11	5							
CIMBER AIR (DENMARK)	VFW-614	0/2							
AURALAIR (FRANCE)	Caravelle 6	2	2	1971	NO				Ex Austrian Al
FAR EASTERN (FORMOSA)	Caravelle 6	2	2	1973	NO				Ex Iberia
GERMANAIR	A300B	1	1	1975	YES	1	2,000	1,000	
	BAC-111-500	6	5	1969	YES	7			
GHANA	SPEY-JR-F28	2	2	1974	YES	2			
	VC-10 Std.	1	1	1964	YES	12			
GULF AIR (BAHRAIN)	L-1011	0/4	2	1976	YES	1	1,000	600	
	BAC-111-400	4	3	1969	NO				Ex Bahamas, Phil Al
	VC-10 Std.	5	5	1974	NO				Ex BA Overseas Div.
LACSA (COSTA RICA)	BAC-111-500	3	3	1971	YES				
LADE (ARGENTINA)	SPEY-JR-F28	5	5	1974	YES	2			
	Caravelle 6N	3	3	1973	NO				Ex Aerolaru
LINJEFLYG (SWEDEN)	SPEY-JR-F28	3/5	3	1973	YES	3			

AIRLINE	AC TYPE	TTL #	# IN SER	1st YR TYPE OPER	ANY NEW PURCH	AGE HIGH YR	HIGH HOUR	HIGH LAND	REMARKS
NORTHEAST (U.K.) (BKS)	HS-121-1E	4							
ORIENTAIR (G. BRITAIN)	BAC-111-400	1							
QUEBECAIR	BAC-111-300	3	3	1969	NO				Ex British Eagle
	727-100	1	1	1974	NO	14	38,000	31,000	Ex EA
ROYAL AIR LAO	Caravelle 3	1	1	1973	NO				Lease from Air France
SAM(ITALY)	Caravelle 6	4							
TACA INT'L (EL SALVADOR)	BAC-111-400	3	3	1966	YES				
TOURAINE (FRANCE)	SPEY-JR-F28	1/1	1	1974	NO				From mfr.
TRANSAIR LTD. (CANADA)	SPEY-JR-F28	1							
TURAVIA (ITALY)	SPEY-JR-F28	1/1							

Data Source Matrix

Equipment Type	Year of Original Delivery	Total Number	First Year Type Operation	Any Purchased New	High Year	High Hour	High Landings
707,720,727 737,747	A	A	C	A & C	D	E	E
DC-8, DC-9	A	A	A	A	A	E	F
DC-10	A	A	A	A	A	E	E
L-1011	A	A	A	A	A	E	E
Convair 880 & 990	B	C	C	C	D	G	G
A300B	A	A	A	A	D	E	E
Caravelle, Mecure, BAC-111, +15 Trident, VC-10, Comet F28, VFW-614	B	C	B	B	D	G	G

Data Source Key

A. Aircraft manufacture published information.

B. "Commercial Aircraft Fleets" Avmark Inc. (Original deliveries which were not listed distributed by author.)

C. "Commercial Aircraft Fleets" Avmark Inc.

D. Based on year of original delivery either to carrier currently operating or original operator.

E. Manufacture supplied observation extrapolated forward to be representative of mid year 1975.

F. Author estimate based on aircraft flying hours on carrier average hop length for equipment type on general operating characteristics of equipment type.

G. Not estimated because of inadequate data.

APPENDIX C

Sample Interview Questions on Retirement of Commercial Jet Aircraft

1. When do you estimate retirement of specific types and why?

2. What is the limit of use of 707s and DC-8s without further maintenance modification?

3. What necessary work has to be done and how extensive is it to reach (a) 80,000 hrs., (b) 100,000 hrs?

4. Will they be scrapped or sold for other operations?

5. What and where will be the market for used aircraft?

6. What is the economic efficiency of the narrow bodied planes? i.e. are unit DOC costs rising?

7. What is the impact of FAR 36 and the current noise proposal hearings on decisions to retire the older narrow bodies?

8. Do the current fuel costs and your estimation of future fuel cost significantly influence your decision as to retiring aircraft?

9. What is the maximum decrease in direct operating costs that can now be built into new aircraft -- various scenarios?

10. For Airlines: How great a decrease in DOC would be necessary to make you want to purchase a new type or derivative aircraft?

11. What is the capital cost of a fleet recquipment?
    (a) airline views
    (b) manufacturer views

12. What is the effect on reliability of new technology?
    (a) airline view
    (b) manufacturer view

Sample Interview Questions on Retirement of Commercial Jet Aircraft
Page 2

13. On derivative and new aircraft or engine technology, how much "up front" money is necessary and how can it be financed?

14. How can airlines finance replacement aircraft?

15. How many separate new types will be built?

16. What impact do the deregulation proposals in Washington have on your equipment plans?

17. Is there a satisfactory new technology or derivative on the drawing board?
    (a) manufacturer response
    (b) airline response

18. What is the mission of the type of airplane you desire for replacement?

APPENDIX D

INDIVIDUALS INTERVIEWED DURING STUDY

ALLIANCE ONE, STAMFORD, CONNECTICUT

Harry Kimbriel, Vice President

AIR TRANSPORT ASSOCIATION, WASHINGTON, D.C.

William O. Becker, Assistant Vice President-Operations
William M. Hawkins, Assistant Vice President-Economics & Finance
K. William Horn, Assistant Vice President-Research
Lee R. Howard, Director-Data Systems and Forecasting
George W. James, Vice President-Economics & Finance

AMERICAN AIRLINES, TULSA

Leo Cody,
W.P. Hannon, System Director of Engineering

AMERICAN AIRLINES, NEW YORK

Earl E. Ditmars, Assistant Vice President-Traffic Analysis & Research
Richard Klaas, Director-Financial Systems Development & Industry Analysis
Franklin W. Kolk, Vice President-Systems Planning
Richard Linn
Donald Lloyd-Jones, Senior Vice President-Operations
John T. Slavin, Assistant Treasurer

BANK OF AMERICA, NEW YORK

James B. Murray, Assistant Vice President
Sanford Sacks, Vice President

BANKERS TRUST COMPANY, NEW YORK

Jasper H. Arnold, III, Assistant Treasurer
John S. Bliven, First Vice President
Don C. Hawley, Senior Financial Analyst
Robert S. Logan, Assistant Vice President

BOEING COMMERCIAL AIRPLANE COMPANY, SEATTLE, WASHINGTON

George N. Bower, Manager-Advanced Freighters
James L. Copenhaver, Director-Central Engineering Design
Thomas R. Craig-Market Research
Richard A. Michelson, Assistant Director-Sales Technology

BOEING COMMERCIAL AIRPLANE COMPANY, SEATTLE, WASHINGTON

Gene A. Pace, Manager-U.S. & Canadian Airline Analysis Marketing Requirements
Gordon Rasmussen, Manager-Sales Technology
John E. Steiner, Vice President
Robert E. Watson, Chief Engineer-Structures Technology
H.W. "Bob" Withington, Vice President-Engineering

CIVIL AERONAUTICS BOARD, WASHINGTON, D.C.

J.C. Constantz, Chief-Economic Analysis Division
Roy Pulsifer-Bureau of Operating Rights
Arthur Simms, Director-Bureau of Economics

CHASE MANHATTAN BANK, NEW YORK

Harry Colwell, III, Vice President
Raymond V. Nelson, Jr., Vice President

CONTINENTAL ILLINOIS NATIONAL BANK, CHICAGO

Arthur J. Bruen, Vice President-Transportation Division

DELTA AIRLINES, ATLANTA, GEORGIA

Cecil O. Brown, Assistant to Assistant Vice President
Arthur C. Ford, Assistant Vice President-Long Range Planning
Gerald Mayo, Senior Attorney
B.L. Terrell, Chief Engineer-Aircraft

EASTERN AIRLINES, MIAMI, FLORIDA

Frank Davis, Vice President-Operations Services
Morton Ehrlich, Vice President-Planning
D. Roger Ferguson, Vice President-Advance Schedule Planning
Paul Johnstone, Vice President-Engineering
Roy M. Rawls, Asst. Controller, Financial Planning and Analysis
Wayne A. Yeoman, Vice President, Finance

EQUITABLE LIFE INSURANCE, NEW YORK

William A. McCurdy, Vice President

FEDERAL AVIATION ADMINISTRATION, WASHINGTON, D.C.

Joan Reynolds Barriage, Office of Environmental Quality
Charles J. Hoch, P.E. Office of Environmental Quality

FIRST NATIONAL BANK OF CHICAGO

Rodney F. Quainton, Vice President

FIRST NATIONAL CITY BANK, NEW YORK

Barnaby C.F. Blatch, Vice President
Frederick W. Bradley, Vice President
George E. Moyer, Jr., Vice President

GENERAL ELECTRIC, CINCINNATI, OHIO

John D. Karraker, Manager, Commercial Market Analysis
Karl Riter, Commercial Market Analysis

GREYHOUND, PHOENIX, ARIZONA

Robert Dell'Artino, Executive Vice President, Lease and Finance

LOCKHEED CALIFORNIA CO., BURBANK, CALIFORNIA

Richard L. Foss, Department of Engineering, Commercial Advanced Design
Michael I. Grove, Commercial Sales Engineering
Henry W. Montgomery, Airline Planning, Commercial Transportation Research
Walter Nubel, Advanced Design
George N. Sarames, Manager, Airline Systems Analysis
Joseph A. Schwartz, Division Manager, Market Development
Ray A. Tedrick, Market Engineer
O.W. Traber, Product Plans and Applications
William J. Wolff, Division Manager, Technical Sales Support
Duane O. Wood, President

LOCKHEED-GEORGIA CO., MARIETTA, GEORGIA

Jys Ruys, Commercial Market Planning

MC DONNELL-DOUGLAS, LONG BEACH, CALIFORNIA

Edward A. Danner, Deputy Manager, Airline Financial Planning
B. Frome
Sidney J. Griffith, Vice President, Treasurer and Secretary
C.W. Heathco, Deputy Director, Advanced Transportation Concepts
R.C.P. Jackson, Vice President, Plans
R.V. MacGregor
R.A. Margulies, Energy Coordinator
John F. McGrath, Manager, Airline Analysis
R.P. Milton, Manager, Special Planning Analysis
G.R. Morrissey, Senior Economist, Advanced Design, Commercial System
Carl T. Norris, Economist, Economic Research
H.B. Norris, Manager, Airline Fleet Planning

MC DONNELL-DOUGLAS, LONG BEACH, CALIFORNIA (continued)

Bill Richards, Market Research
John A. Stern, Manager, Commercial Research
John W. Stroup, Manager, Commercial Operations Research
Andy Tung
June C. Van Abkoude, Airline Systems Analyst, Advanced Design

MC DONNELL-DOUGLAS, ST. LOUIS, MISSOURI

Kenneth Velten, Section Manager, Commercial Market Analysis

METROPOLITAN LIFE INSURANCE CO., NEW YORK

George M. Crandles, Vice President, Corporate Investments
Stuart R. Kennedy, Vice President

NATIONAL AIRCRAFT LEASING, LOS ANGELES, CALIFORNIA

Eric Anderson

NATIONAL AIRLINES, MIAMI, FLORIDA

Fred Luhm, Fleet Planning
Robert J. Sherer, Controller

NORTHWEST AIRLINES, MINNEAPOLIS, MINNESOTA

Donald W. Nyrop, President

PAN AMERICAN AIRLINES, NEW YORK

Henry P. Hill, Staff Vice President, Schedules
J. Keesner, Vice President, Maintenance Operations
John N. Wolgast, Senior Vice President, Technical Operations

SALOMON BROTHERS, NEW YORK

Julius Maldutis, Vice President, Transportation Group

SHIELDS MODEL ROLAND INC., NEW YORK

Edmund S. Greenslet, CFA, Vice President, Research Division

TRANS WORLD AIRLINES, NEW YORK

Melvin Brenner, Vice President, Marketing and Planning
R.A. Garlin, Manager, Fleet Planning

UNITED AIRLINES, CHICAGO, ILLINOIS

Edward A. Beamish, Senior Vice President, Corporate Planning
Richard M. Brannon, Director of Fleet Planning
Andy M. DeVoursney, Group Vice President, Finance and Planning
Harry Lehr, Director of Regulatory Affairs
Sven E. Madsen, Schedule Research Manager, Schedule and Resource Planning
Colin D. Murray, Vice President, Schedule and Resource Planning
Robert A. Ross, Economist
Irving Roth, Vice President, Investor Relations

UNITED STATES DEPARTMENT OF TRANSPORTATION, WASHINGTON, D.C.

Don Bliss, Deputy, General Counsel
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Lawrence P. Greene, Assistant for Aeronautical Research and Development, Office of the Secretary of Transportation
Dan Maxfield, TPI-12, Transportation Systems Analyst
Wynne Teel, Office of General Council

UNITED STATES HOUSE OF REPRESENTATIVES, WASHINGTON, D.C.

David L. Mahan, Assistant Counsel (Aviation), Committee of Public Works and Transportation

UNITED TECHNOLOGIES, EAST HARTFORD, CONNECTICUT

N. George Avram, Manager, Business Planning
Frank W. Gobetz, Chief, Systems Performance Evaluation
Richard Hoff, Vice President, JT10D Program
Albert A. LeShane, Manager, Systems Evaluation
Richard Mulready, General Manager, JT10D Engine Program
S.M. Taylor, Vice President, Marketing U.S. and Canada

APPENDIX E

FAR 36

36.1 Effective 12/1/67

36.2 Effective 12/1/73

Part 36—Noise Standards: Aircraft Type and Airworthiness Certification

Subpart A—General

§ 36.1 Applicability.

(a) This Part prescribes noise standards for the issue of type certificates, and changes to those certificates, and for the issue of certain standard category airworthiness certificates, for subsonic transport category airplanes, and for subsonic turbojet powered airplanes regardless of category.

(b) Each person who applies under Part 21 of this chapter for a type certificate must show compliance with the applicable requirements of this Part, in addition to the applicable airworthiness requirements of this chapter.

(c) Each person who applies under Part 21 of this chapter for approval of an acoustical change described in § 21.93(b) must show that the airplane meets the following requirements in addition to the applicable airworthiness requirements of this chapter:

(1) The noise limits prescribed in Appendix C of this Part, for airplanes that can achieve those noise levels, or lower noise levels, prior to the change in type design.

(2) The noise levels created by the airplane prior to the change in type design, measured and evaluated as prescribed in Appendixes A and B of this Part, for airplanes that cannot achieve the noise limits prescribed in Appendix C of this Part prior to the change in type design.

(d) Each person who applies for the original issue of Standard Airworthiness Certificates under § 21.183, must, regardless of date of application, show compliance with this Part (including Appendix C), as effective on December 1, 1969, for airplanes that have not had any flight time before—

(1) December 1, 1973, for airplanes with maximum weights greater than 75,000 lbs., except for airplanes that are powered by Pratt and Whitney Turbo Wasp JT3D series engines;

(2) December 31, 1974, for airplanes with maximum weights greater than 75,000 lbs. and that are powered by Pratt and Whitney Turbo Wasp JT3D series engines; and

(3) December 31, 1974, for airplanes with maximum weights of 75,000 lbs. and less.

§ 36.2 Special retroactive requirements.

(a) Notwithstanding § 21.17 of this chapter, and irrespective of the date of application, each applicant covered by § 36.201(b) and (c)(1), and § C36.5(c) of this Part who applies for a new type certificate, must show compliance with the applicable provisions of this Part.

(b) Notwithstanding § 21.101(a) of this chapter, each person who applies for an acoustical change to a type design specified in § 21.93(b) of this chapter must show compliance with the applicable provisions of this Part.

§ 36.3 Compatibility with airworthiness requirements.

It must be shown that the airplane meets the airworthiness regulations constituting the type certification basis of the airplane under all conditions in which compliance with this Part is shown, and that all procedures used in complying with this Part, and all procedures and information for the flight crew developed under this Part, are consistent with the airworthiness regulations constituting the type certification basis of the airplane.

§ 36.5 Limitation of Part.

Pursuant to 49 U.S.C. 1431(b)(4), the noise levels in this Part have been determined to be as low as is economically reasonable, technologically practicable, and appropriate to the type of aircraft to which they apply. No determination is made, under this Part, that these noise levels are or should be acceptable or unacceptable for operation at, into, or out of, any airport.

Subpart B—Noise Measurement and Evaluation

§ 36.101 Noise measurement.

The noise generated by the airplane must be measured under Appendix A of this Part or under an approved equivalent procedure.

§ 36.103 Noise evaluation.

Noise measurement information obtained under § 36.101 must be evaluated under Appendix B of this Part or under an approved equivalent procedure.

Subpart C—Noise Limits

§ 36.201 Noise limits.

(a) Compliance with this section must be shown with noise levels measured and evaluated as prescribed in Subpart B of this Part, and demonstrated at the measuring points prescribed in Appendix C of this Part.

(b) For airplanes that have turbojet engines with bypass ratios of 2 or more and for which—

(1) Application was made before January 1, 1967, it must be shown that the noise levels of the airplane are no greater than those prescribed in Appendix C of this Part, or are reduced to the lowest levels that are economically reasonable, technologically practicable, and appropriate to the particular type design; and

(2) Application was or is made on or after January 1, 1967, it must be shown that the noise levels of the airplane are no greater than those prescribed in Appendix C of this Part.

(c) For airplanes that do not have turbojet engines with bypass ratio of 2 or more and for which—

(1) Application was made before December 1, 1969, it must be shown that the lowest noise levels, reasonably obtainable through the use of procedures and information developed for the flight crew under § 36.1501 are determined; and

(2) Application was or is made on or after December 1, 1969, it must be shown that the noise levels of the airplane are no greater than those prescribed in Appendix C of this Part.

(d) For aircraft to which paragraph (b)(1) of this section applies and that do not meet Appendix C of this Part, a time period will be placed on the type certificate. The type certificate will specify that, upon the expiration of this time period, the type certificate will be subject to suspension or modification under Section 611 of the Federal Aviation Act of 1958 (49 U.S.C. 1431) unless the type design of aircraft produced under that type certificate on and after the expiration date is modified to show compliance with Appendix C. With respect to any possible suspensions or modifications under this paragraph, the certificate holder shall have the same notice and appeal rights as are contained in Section 609 of the Federal Aviation Act of 1958 (49 U.S.C. 1429).

Subpart G—Operating Information and Airplane Flight Manual

§ 36.1501 Procedures and other information.

All procedures, any other information for the flight crew, that are employed for obtaining the noise reductions prescribed in this Part must be developed. This must include noise levels achieved during type certification.

§ 36.1581 Airplane Flight Manual.

(a) The approved portion of the Airplane Flight Manual must contain procedures and

other information approved under § 36.1501. Except as provided in paragraph (b) of this section, no operating limitations may be furnished under this section. The following statement must be furnished near the listed noise levels:

> "No determination has been made by the Federal Aviation Administration that the noise levels in this manual are or should be acceptable or unacceptable for operation at, into, or out of, any airport."

(b) If the weight used in meeting the takeoff or landing noise requirements of this Part is less than the maximum weight or design landing weight, respectively, established under the applicable airworthiness requirements, those lesser weights must be furnished, as operating limitations, in the operating limitations section of the Airplane Flight Manual.

FAR 36

Appendix C

Noise Levels for Subsonic Transport Category and Turbojet Powered Airplanes Under Section 36.201

§ C36.1 Noise measurement and evaluation. Compliance with this Appendix must be shown with noise levels measured and evaluated as prescribed, respectively, by Appendix A and Appendix B of this Part, or under approved equivalent procedures.

§ C36.3 Noise measuring points. Compliance with the noise level standards of § C36.5 must be shown—

(a) For takeoff, at a point 3.5 nautical miles from the start of the takeoff roll on the extended centerline of the runway;

(b) For approach, at a point 1 nautical mile from the threshold on the extended centerline of the runway; and

(c) For the sideline, at the point, on a line parallel to and 0.25 nautical miles from the extended centerline of the runway, where the noise level after liftoff is greatest, except that, for airplanes powered by more than three turbojet engines, this distance must be 0.35 nautical miles.

§ C36.5 Noise levels.

(a) *General.* Except as provided in paragraphs (b) and (c) of this section, it must be shown by flight test that the noise levels of the airplane, at the measuring points described in § C36.3, do not exceed the following (with appropriate interpolation between weights):

(1) For approach and sideline, 103 EPNdB for maximum weights of 600,000 lbs. or more, less 2 EPNdB per halving of the 600,000 lbs. maximum weight down to 102 EPNdB for maximum weights of 75,000 lbs. and under.

(2) For takeoff, 108 EPNdB for maximum weights of 600,000 lbs. or more, less 5 EPNdB per halving of the 600,000 lb. maximum weight down to 93 EPNdB for maximum weights of 75,000 lbs. and under.

(b) *Tradeoff.* The noise levels in paragraph (a) may be exceeded at one or two of the measuring points prescribed in § C36.3, if—

(1) The sum of the exceedance is not greater than 3 EPNdB;

(2) No exceedance is greater than 2 EPNdB; and

(3) The exceedances are completely offset by reductions at other required measuring points.

(c) *Prior applications.* For applications made before December 1, 1969, for airplanes powered by more than three turbojet engines with bypass ratios of two or more, the value prescribed in paragraph (b)(1) of this section may not exceed 5 EPNdB and the value prescribed in paragraph (b)(2) of this section may not exceed 3 EPNdB.

§ C36.7 Takeoff test conditions.

(a) This section applies to all takeoffs conducted in showing compliance with this Part.

(b) Takeoff power or thrust must be used from the start of the takeoff to the point at which an altitude of at least 1,000 feet above the runway is reached, except that, for airplanes powered by more than three turbojet engines, this altitude must not be less than 700 feet.

(c) Upon reaching the altitude specified in paragraph (b) of this section, the power or thrust may not be reduced below that power

or thrust that will provide level flight with one engine inoperative, or below that power or thrust that will maintain a climb gradient of at least 4 percent, whichever power or thrust is greater.

(d) A speed of at least V_2+10 knots must be attained as soon as practicable after liftoff, and must be maintained throughout the takeoff noise test.

(e) A constant takeoff configuration, selected by the applicant, must be maintained throughout the takeoff noise test, except that the landing gear may be retracted.

§ C36.9 Approach test conditions.

(a) This section applies to all approaches conducted in showing compliance with this Part.

(b) The airplane's configuration must be that used in showing compliance with the landing requirements in the airworthiness regulations constituting the type certification basis of the airplane. If more than one configuration is used in showing compliance with the landing requirements in the airworthiness regulations constituting the type certification basis of the airplane, the configuration that is most critical from a noise standpoint must be used.

(c) The approaches must be conducted with a steady glide angle of $3°\pm0.5°$ and must be continued to a normal touchdown with no airframe configuration change.

(d) A steady approach speed of not less than $1.30\ V_s+10$ knots must be established and maintained over the approach measuring point.

(e) All engines must be operating at approximately the same power or thrust.

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Part 36—Noise Standards: Aircraft Type and Airworthiness Certification

Subpart A—General

§ 36.1 [Applicability and definitions.]

(a) This Part prescribes noise standards for the issue of the following certificates:

(1) Type certificates, and changes to those certificates, and standard airworthiness certificates, for subsonic transport category large airplanes, and for subsonic turbojet powered airplanes regardless of category.

(2) Type certificates and changes to those certificates, and standard airworthiness certificates and restricted category airworthiness certificates, for propeller driven small airplanes, except airplanes that are designed for "agricultural aircraft operations" as defined in § 137.3 of this chapter, as effective on January 1, 1966, or for dispensing fire fighting materials.

(b) Each person who applies under Part 21 of this chapter for a type or airworthiness certificate specified in this Part must show compliance with the applicable requirements of this Part, in addition to the applicable airworthiness requirements of this chapter. .

(c) Each person who applies under Part 21 of this chapter for approval of an acoustical change described in § 21.93(b) of this chapter must show that the airplane complies with [the applicable provisions of § 36.7 or § 36.9 of this Part] in addition to the applicable airworthiness requirements of this chapter.

(d) Each person who applies for the original issue of a standard airworthiness certificate for a subsonic transport category large airplane or for a turbojet powered airplane under § 21.183, must, regardless of date of application, show compliance with the applicable provisions of this Part (including Appendix C), as effective on December 1, 1969, for airplanes that have not had any flight time before—

(1) December 1, 1973, for airplanes with maximum weights greater than 75,000 lbs, except for airplanes that are powered by Pratt and Whitney Turbo Wasp JT3D series engines;

(2) December 31, 1974, for airplanes with maximum weights greater than 75,000 lbs. and that are powered by Pratt and Whitney Turbo Wasp JT3D series engines; and

(3) December 31, 1974, for airplanes with maximum weights of 75,000 lbs. and less.

(e) Each person who applies for the original issue of a standard airworthiness certificate under § 21.183, or for the original issue of a restricted category airworthiness certificate under § 21.185, for a propeller driven small airplane that has not had any flight time before January 1, 1980, must show compliance with the applicable provisions of this Part.

[(f) For the purpose of showing compliance with this Part for transport category large airplanes and turbojet powered airplanes regardless of category, the following terms have the following meanings:

[(1) A "Stage 1 noise level" means a takeoff, sideline, or approach noise level greater than the Stage 2 noise limits prescribed in § C36.5(a)(2) of Appendix C of this Part.

[(2) A "Stage 1 airplane" means an airplane that has not been shown under this Part to comply with the takeoff, sideline, and approach noise levels required for Stage 2 or Stage 3 airplanes.

[(3) A "Stage 2 noise level" means a noise level at or below the Stage 2 noise limits prescribed in § C36.5(a)(2) of Appendix C of this Part but higher than the Stage 3 noise limits prescribed in § C36.5 (a)(3) of Appendix C of this Part.

[(4) A "Stage 2 airplane" means an airplane that has been shown under this Part to comply with Stage 2 noise levels prescribed in § C36.5 of Appendix C of this Part (including use of the applicable tradeoff provisions) and that does not comply with the requirements for a Stage 3 airplane.

[(5) A "Stage 3 noise level" means a noise level at or below the Stage 3 noise limits prescribed in § C36.5(a)(3) of Appendix C of this Part.

[(6) A "Stage 3 airplane" means an airplane that has been shown under this Part to comply with Stage 3 noise levels prescribed in § C36.5 of Appendix C of this Part (including use of the applicable tradeoff provisions).]

§ 36.2 Special retroactive requirements.

(a) Notwithstanding § 21.17 of this chapter, and irrespective of the date of application, each applicant covered by § 36.201(b) and (c)(1), and § C36.5(c) of this Part who applies for a new type certificate, must show compliance with the applicable provisions of this Part. In addition, for applications for new type certificates made after September 17, 1971, compilance must be shown with the applicable provisions of this Part.

(b) Notwithstanding § 21.101(a) of this chapter, each person who applies for an acoustical change to a type design specified in § 21.93(b) of this chapter must show compliance with the applicable provisions of this Part.

§ 36.3 Compatibility with airworthiness requirements.

It must be shown that the airplane meets the airworthiness regulations constituting the type certification basis of the airplane under all conditions in which compliance with this Part is shown, and that all procedures used in complying with this Part, and all procedures and information for the flight crew developed under this Part, are consistent with the airworthiness regulations constituting the type certification basis of the airplane.

§ 36.5 Limitation of Part.

Pursuant to 49 U.S.C. 1431(b)(4), the noise levels in this Part have been determined to be as low as is economically reasonable, technologically practicable, and appropriate to the type of aircraft to which they apply. No determination is made, under this Part, that these noise levels are or should be acceptable or unacceptable for operation at, into, or out of, any airport.

[§ 36.7 Acoustical change: subsonic transport category large airplanes and subsonic turbojet powered airplanes.

[(a) *Applicability.* This section applies to all subsonic transport category large airplanes and subsonic turbojet powered airplanes for which an acoustical change approval is applied for under § 21.93(b) of this chapter.

[(b) *General requirements.* Except as otherwise specifically provided, for each airplane covered by this section, the acoustical change approval requirements are as follows:

[(1) In showing compliance, noise levels must be measured and evaluated in accordance with the applicable procedures and conditions prescribed in Appendices A and B of this Part.

[(2) Compliance with the noise limits prescribed in § C36.5 of Appendix C must be shown in accordance with the applicable provisions of §§ C36.7 and C36.9 of Appendix C of this Part.

[(c) *Stage 1 airplanes.* For each Stage 1 airplane prior to the change in type design, in addition to the provisions of paragraph (b) of this section, the following apply:

[(1) If an airplane is a Stage 1 airplane prior to the change in type design, it may not, after the change in type design, exceed the noise levels created prior to the change in type design. The tradeoff provisions of § C36.5(b) of Appendix C of this Part may not be used to increase the Stage 1 noise levels.

[(2) In addition, for an airplane for which application is made after September 17, 1971—

[(i) There may be no reduction in power or thrust below the highest air-

worthiness approved power or thrust, during the tests conducted before and after the change in type design; and

[(ii) During the takeoff and sideline noise tests conducted before the change in type design, the quietest airworthiness approved configuration available for the highest approved takeoff weight must be used.

[(d) *Stage 2 airplanes.* If an airplane is a Stage 2 airplane prior to the change in type design, in addition to the provisions of paragraph (b) of this section, the following apply:

[(1) *Applications before November 5, 1975.* For an airplane for which an application for acoustical change approval is made before November 5, 1975, the airplane may not be a Stage 1 airplane after the change in type design.

[(2) *Applications on or after November 5, 1975.* For an airplane for which an application for acoustical change approval is made on or after November 5, 1975—

[(i) The airplane may not be a Stage 1 airplane after the change in type design; and

[(ii) During the takeoff and sideline noise tests conducted before the change in type design, the quietest airworthiness approved configuration available for the highest approved takeoff weight must be used.

[(e) *Stage 3 airplanes.* If an airplane is a Stage 3 airplane prior to the change in type design, in addition to the provisions of paragraph (b) of this section, the following apply:

[(1) *Applications before May 5, 1976.* For an airplane for which an application for acoustical change approval is made before May 5, 1976, the airplane may not be a Stage 1 airplane after the change in the type design.

[(2) *Applications on or after May 5, 1976.* For an airplane for which an application for acoustical change approval is made on or after May 5, 1976, the following apply:

[(i) If compliance with Stage 3 noise levels is not required before the change in type design, the airplane must—

[(A) Be a Stage 2 airplane after the change in type design and compliance must be shown under the provisions of paragraph (d)(2) of this section; or

[(B) Remain a Stage 3 airplane after the change in type design and compliance must be shown under the provisions of paragraph (e)(2)(ii) of this section.

[(ii) If compliance with Stage 3 noise levels is required before the change in type design, the airplane must be a Stage 3 airplane after the change in type design.

[§ 36.9 Acoustical change: propeller-driven small airplanes.

[For propeller-driven small airplanes in the normal, utility, acrobatic, transport, and restricted categories for which an acoustical change approval is applied for under § 21.93 (b) of this chapter after January 1, 1975, the following apply:

[(a) If the airplane was type certificated under Appendix F of this Part prior to the change in type design, it may not, after the change in type design, exceed the noise limit that was applied to that approval.

[(b) If the airplane was not type certificated under Appendix F but can achieve the noise limits prescribed in § F36.301(b) of that Appendix prior to the change in type design, it may not exceed those limits, measured and corrected as prescribed in Appendix F, after the change in type design.

[(c) If the airplane cannot achieve the noise limits prescribed in § F36.301(b) of Appendix F prior to the change in type design, it may not, after the change in type design, exceed the noise levels created prior to the change in type design, measured and corrected as prescribed in Appendix F.]

Subpart B—Subsonic Transport Category Large Airplanes and Turbojet Powered Airplanes

§ 36.101 Noise measurement.

The noise generated by the airplane must be measured under Appendix A of this Part or under an approved equivalent procedure.

§ 36.103 Noise evaluation.

Noise measurement information obtained under § 36.101 must be evaluated under Appendix B of this Part or under an approved equivalent procedure.

Subpart C—Noise Limits

§ 36.201 Noise limits.

(a) Compliance with this section must be shown with noise levels measured and evaluated as prescribed in Subpart B of this Part, and demonstrated at the measuring points prescribed in Appendix C of this Part.

[(b) *Airplanes with high bypass ratio engines.* For airplanes that have turbojet engines with bypass ratios of 2 or more, the noise limit requirements are as follows:

[(1) *Applications before January 1, 1967.* If application is made before January 1, 1967, it must be shown that the noise levels of the airplanes are no greater than the Stage 2 noise limits prescribed in § C36.5 (a) (2) of Appendix C of this Part, or are reduced to the lowest levels that are economically reasonable, technologically practicable, and appropriate to the particular type design.

[(2) *Applications on or after January 1, 1967, and before November 5, 1975.* If application is made on or after January 1, 1967, and before November 5, 1975, it must be shown that the noise levels of the airplane are no greater than the Stage 2 noise limits prescribed in § C36.5 (a) (2) of Appendix C of this Part.

[(3) *Applications on or after November 5, 1975.* If application is made on or after November 5, 1975, it must be shown that the noise levels of the airplane are no greater than the Stage 3 noise limits prescribed in § 36.5 (a) (3) of Appendix C of this Part.

[(c) *Airplanes with low bypass ratio engines.* For airplanes that have turbojet engines with bypass ratios of less than 2 (including no bypass ratio), the noise limit requirements are as follows:

[(1) *Applications before December 1, 1969.* If application is made before December 1, 1969, it must be shown that the lowest noise levels, reasonably obtainable through the use of procedures and information developed for the flight crew under § 36.1501, are determined;

[(2) *Applications on or after December 1, 1969, and before November 5, 1975.* If application is made on or after December 1, 1969, and before November 5, 1975, it must be shown that the noise levels of the airplane are no greater than the Stage 2 noise limits prescribed in § C36.5 (a) (2) of Appendix C of this Part.

[(3) *Applications after November 5, 1975.* If application is made on or after November 5, 1975, it must be shown that the noise levels of the airplane are no greater than the Stage 3 noise limits prescribed in § C36.5 (a) (3) of Appendix C of this Part.]

(d) For aircraft to which paragraph (b) (1) of this section applies and that do not meet Appendix C of this Part, a time period will be placed on the type certificate. The type certificate will specify that, upon the expiration of this time period, the type certificate will be subject to suspension or modification under Section 611 of the Federal Aviation Act of 1958 (49 U.S.C. 1431) unless the type design of aircraft produced under that type certificate on and after the expiration date is modified to show compliance with Appendix C. With respect to any possible suspensions or modifications under this paragraph, the certificate holder shall have the same notice and appeal rights as are contained in Section 609 of the Federal Aviation Act of 1958 (49 U.S.C. 1429).

FAR 36 AMENDMENT 7, Effective Oct. 1,1977

Appendix C

Noise Levels for Subsonic Transport Category and Turbojet Powered Airplanes Under Section 36.201

§ C36.1 Noise measurement and evaluation. Compliance with this Appendix must be shown with noise levels measured and evaluated as prescribed, respectively, by Appendix A and Appendix B of this Part, or under approved equivalent procedures.

§ C36.3 Noise measuring points. Compliance with the noise level standards of § C36.5 must be shown—

(a) For takeoff, at a point 3.5 nautical miles from the start of the takeoff roll on the extended centerline of the runway;

(b) For approach, at a point 1 nautical mile from the threshold on the extended centerline of the runway; and

[(c) For the sideline, at the point, on a line parallel to and 0.25 nautical miles from the extended centerline of the runway, where the noise level after liftoff is greatest, except that, for an airplane powered by more than three turbojet engines this distance must be 0.35 nautical miles for the purpose of showing compliance with Stage 1 or Stage 2 noise limits (as applicable).

[§ C36.5 Noise levels.

[(a) *Limits.* Except as provided in paragraphs (b) and (c) of this section, it must be shown by flight test that the noise levels of the airplane, at the measuring points described in § C36.3, do not exceed the following (with appropriate interpolation between weights):

[(1) *Stage 1* noise limits for acoustical changes for airplanes regardless of the number of engines are those noise levels prescribed under § 36.7(c) of this Part.

[(2) *Stage 2* noise limits for airplanes regardless of the number of engines are as follows:

[(i) *For takeoff*—108 EPNdB for maximum weights of 600,000 pounds or more, reduced by 5 EPNdB per halving of the 600,000 pounds maximum weight down to 93 EPNdB for maximum weights of 75,000 pounds and less.

[(ii) *For sideline and approach*—108 EPNdB for maximum weights of 600,000 pounds or more, reduced by 2 EPNdB per halving of the 600,000 pounds maximum weight down to 102 EPNdB for maximum weights of 75,000 pounds and less.

[(3) *Stage 3* noise limits are as follows:

[(i) *For airplanes with more than 3 engines*—

[(A) *For takeoff*—106 EPNdB for maximum weights of 850,000 pounds or more, reduced by 4 EPNdB per halving of the 850,000 pounds maximum weight down to 90 EPNdB for maximum weights of 53,125 pounds or less;

[(B) *For sideline*—103 EPNdB for maximum weights of 850,000 pounds or more, reduced by 2 EPNdB per halving of the 850,000 pounds maximum weight down to 96 EPNdB for maximum weights of 75,130 pounds and less; and

[(C) *For approach*—105 EPNdB for maximum weights of 850,000 pounds or more, reduced by 2 EPNdB per halving of the 850,000 pounds weight down to 98 EPNdB for maximum weights of 75,130 pounds and less.

[(ii) *For airplanes with 3 engines*—

[(A) *For takeoff*—104 EPNdB for maximum weights of 850,000 pounds or more, reduced by 4 EPNdB per halving of the 850,000 pounds maximum weight down to 90 EPNdB for maximum weights of 75,130 pounds and less;

[(B) *For sideline*—103 EPNdB for maximum weights of 882,000 pounds or more, reduced by 2.56 EPNdB per halving of the 882,000 pounds maximum weight down to 96 EPNdB for maximum weights of 132,538 pounds and less; and

[(C) *For approach*—105 EPNdB for maximum weights of 850,000 pounds or more, reduced by 2 EPNdB per halving of the 850,000 pounds weight down to 98 EPNdB for maximum weights of 75,130 pounds and less.

[(iii) *For airplanes with fewer than 3 engines*—

[(A) *For takeoff*—101 EPNdB for maximum weights of 850,000 pounds or more, reduced by 4 EPNdB per halving of the 850,000 pounds maximum weight down to 89 EPNdB for maximum weights of 106,250 pounds and less;

[(B) *For sideline*—103 EPNdB for maximum weights of 882,000 pounds or more, reduced by 2.56 EPNdB per halving of the 882,000 pounds maximum weight down to 94 EPNdB for maximum weights of 77,120 pounds and less; and

[(C) *For approach*—105 EPNdB for maximum weights of 850,000 pounds or more, reduced by 2 EPNdB per halving of the 850,000 pounds weight down to 98 EPNdB for maximum weights of 75,130 pounds and less.

[(b) *Tradeoffs.* Except to the extent limited under §§ 36.7(c)(1) of this Part, the noise level limits prescribed in paragraph (a) of this section may be exceeded at one or two of the measuring points specified in § C36.3 of this appendix, if—]

(1) The sum of the exceedance is not greater than 3 EPNdB;

(2) No exceedance is greater than 2 EPNdB; and

(3) The exceedances are completely offset by reductions at other required measuring points.

(c) *Prior applications.* For applications made before December 1, 1969, for airplanes powered by more than three turbojet engines with bypass ratios of two or more, the value prescribed in paragraph (b)(1) of this section may not exceed 5 EPNdB and the value prescribed in paragraph (b)(2) of this section may not exceed 3 EPNdB.

§ C36.7 Takeoff test conditions.

[(a) This section applies to all takeoff noise tests conducted under this appendix in showing compliance with this Part.]

(b) Takeoff power or thrust must be used from the start of the takeoff to the point at which an altitude of at least 1,000 feet above the runway is reached, except that, for airplanes powered by more than three turbojet engines, this altitude must not be less than 700 feet.

(c) Upon reaching the altitude specified in paragraph (b) of this section, the power or thrust may not be reduced below that power or thrust that will provide level flight with one engine inoperative, or below that power or thrust that will maintain a climb gradient of at least 4 percent, whichever power or thrust is greater.

(d) Except as provided in paragraph (f) of this section, a speed of at least V_2+10 knots must be attained as soon as practicable after liftoff, and must be maintained throughout the takeoff noise test.

(e) A constant takeoff configuration, selected by the applicant, must be maintained throughout the takeoff noise test, except that the landing gear may be retracted.

(f) For applications made after September 17, 1971, the following apply:

(1) The test day speeds and the acoustic day reference speed must be the minimum approved value of V_2+10 knots, or the all-engines-operating speed at 35 feet (for turbine engine powered airplanes) or 50 feet (for reciprocating engine powered airplanes), whichever speed is greater as determined under the regulations constituting the type certification basis of the airplane. These tests must be conducted at the test day speeds ±3 knots. Noise values measured at the test day speeds must be corrected to the acoustic day reference speed.

(2) If a negative runway gradient exists in the direction of takeoff, performance and acoustic data must be corrected to the zero slope condition.

§ C36.9 Approach test conditions.

(a) This section applies to all approaches conducted in showing compliance with this Part.

(b) The airplane's configuration must be that used in showing compliance with the landing requirements in the airworthiness regulations constituting the type certification basis of the airplane. If more than one configuration is used in showing compliance with the landing requirements in the airworthiness regulations constituting the type certification basis of the airplane, the configuration that is most critical from a noise standpoint must be used.

(c) The approaches must be conducted with a steady glide angle of 3°±0.5° and must be continued to a normal touchdown with no airframe configuration change.

(d) Except as provided in paragraph (f) of this section, a steady approach speed of not less than $1.30\ V_s+10$ knots must be established and maintained over the approach measuring point.

(e) All engines must be operating at approximately the same power or thrust.

(f) For applications made after September 17, 1971, the following apply:

(1) A steady approach speed, that is either $1.30\ V_s+10$ knots or the speed used in establishing the approved landing distance under the airworthiness regulations constituting the type certification basis of the airplane, whichever speed is greatest, must be established and maintained over the approach measuring point.

(2) A tolerance of ±3 knots may be used throughout the approach noise testing.

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APPENDIX F

FLEET COMPLIANCE RULE

Title 14—Aeronautics and Space

CHAPTER I—FEDERAL AVIATION ADMINISTRATION, DEPARTMENT OF TRANSPORTATION

[Docket Nos. 13582 and 14317; Amdt. 91-136]

PART 91—GENERAL OPERATING AND FLIGHT RULES

Subpart E—Operating Noise Limits [NEW]

PHASED COMPLIANCE WITH PART 36 NOISE LIMITS BY TURBOJETS WITH MAXIMUM WEIGHTS GREATER THAN 75,000 POUNDS

• The purpose of this amendment to Part 91 of the Federal Aviation Regulations (14 CFR Part 91) is to achieve further relief and protection to the public from aircraft noise by requiring certain previously excepted airplanes to meet present Federal noise standards in accordance with a phased time schedule ending on January 1, 1985. This amendment implements a decision, approved by the President on October 21, 1976, and announced in a comprehensive Aviation Noise Abatement Policy Statement issued by the Secretary of Transportation and the Federal Aviation Administrator on November 18, 1976. It extends current Federal noise standards to domestic commercial airplanes in not more than eight years from January 1, 1977. •

This amendment applies to U.S. registered civil subsonic turbojet airplanes with maximum weights greater than 75,000 pounds. It applies to airplanes with standard airworthiness certificates, if those airplanes are not engaged in foreign air commerce. For airplanes operated under Parts 121 and 135 of the Federal Aviation Regulations, dates for progressive fleet compliance with Part 36 are also prescribed in this amendment, as follows:

1. January 1, 1981, for at least one quarter of the four-engine airplanes with low bypass ratio engines.

2. January 1, 1981, for at least one quarter of the four-engine "pure jets."

3. January 1, 1981, for at least one half of all other airplane types.

4. January 1, 1983, for at least one half of the four-engine airplanes with low bypass ratio engines.

5. January 1, 1983, for at least one half of the four engine "pure jets."

6. January 1, 1983, for all other airplane types.

This document also contains a notice of FAA's decision not to prescribe operating noise limits for aircraft engaged in foreign air commerce (including operations under Part 129 of the Federal Aviation Regulations), or for airplanes weighing 75,000 pounds or less, at this time. This amendment is issued pursuant to § 611 of the Federal Aviation Act of 1958 (herein called "the Act").

While this amendment is expected to produce significant improvements in the noise environment at major airports, substantial local action will be necessary to complement the noise reduction actions of the Federal Government and air carriers. The only successful attack that can be launched on the overall problem of aircraft noise is one that involves the cooperative participation of all levels of government, as well as airport operators, air carriers, manufacturers, and airport neighbors. The responsibilities of all of these parties are stated in detail in the "Aviation Noise Abatement Policy," (herein called "the Policy Statement") of November 18, 1976. That document is in the public rules docket for this amendment.

In addition to the Policy Statement, the FAA has issued a final environmental impact statement (EIS), dated November 10, 1976, concerning this amendment. This document (herein called "the EIS") has been placed in the public rules docket for this amendment. It contains detailed analyses concerning the need for this amendment and its estimated costs and benefits. The EIS contains a detailed listing of the affected civil turbojet fleet and fleet forecasts developed by the FAA. These data were used in the environmental and inflationary impact analyses supporting this regulatory action.

As stated below, compliance with this amendment can be achieved by the acoustical modification, or "retrofit," of noncomplying airplanes or through their replacement with complying airplanes. While the cost and benefit analysis in the EIS indicates that prolonged retention of certain aircraft would be uneconomical due to increased maintenance and higher fuel cost differentials, the replacement policy of individual operators will depend on their capital investment plans and financial capability.

It should therefore be stressed, at the outset, that the purpose of this amendment is not to force the retrofit of older airplanes, but rather to encourage each operator to adopt whatever means of achieving compliance is best suited to his individual economic situation. This may involve replacement of older airplanes by new technology airplanes, the retrofitting of his current fleet, or a mixture of these options. However, the FAA recognizes the advancements in energy efficiency, safety, noise reduction, and engine emissions that are offered by new technology airplanes. This amendment is intended to encourage the introduction of the newest generation of airplanes into the fleet as soon as practicable. To maximize the incentive to replace rather than retrofit older airplanes, this amendment provides for a carefully controlled and limited extension of the January 1, 1981, and January 1, 1983, compliance dates for operators who elect to replace these older airplanes with new airplanes that comply with Part 36.

At the direction of the President, the Secretary, on December 1, 1976, conducted a public hearing on the need for special financing measures to assure timely compliance with this amendment, with particular emphasis on the replacement of the older, noisier four-engine airplanes. The Secretary will make a recommendation to the President by December 31, 1976.