GRA, Incorporated
Economic Counsel to the Transportation Industry

ECONOMIC VALUES FOR FAA INVESTMENT AND REGULATORY DECISIONS, A GUIDE

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NOTE

This report was prepared under a contract with the U.S. Federal Aviation Administration. While FAA and the Aviation Rulemaking Cost Committee provided input for this report, the contractor is responsible for the facts and accuracy of the analyses presented in the report. The contents of the report do not necessarily reflect the views of the Federal Aviation Administration or the sponsoring office.

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EXECUTIVE SUMMARY

This report provides an update of economic values used in investment and regulatory decisions of the Federal Aviation Administration (FAA). This report follows previous guidance in this area but expands upon the number of economic values included and reflects greater industry participation in the development of specific values.[1] The Aviation Rulemaking Cost Committee (ARCC)[2] was established by FAA Order 1110.132, dated September 13, 2002. It resulted from recommendations of FAA's Management Advisory Council (MAC) that standardized methods and costs to be used in all regulatory economic analyses to the extent possible. The objective of the ARCC was to recommend new standardized methodologies and cost assumptions that could be used in performing regulatory evaluations, including industry comment and update on those standardized methods and values that are already established by the FAA.

Economic values, often referred to as "critical values," are used in the conduct of benefit-cost and other evaluations of investments, including certain Airport Improvement Program (AIP) grants, and regulations subject to FAA decision-making. They are also used by others, including airports, in benefit-cost analysis of proposed investments. Application of these values to their corresponding physical quantities permits valuation of the physical quantities in dollars. Conceptually, they can be thought of as measures of the dollar sacrifice associated with each physical quantity outcome—avoided fatality, airframe damage, etc.—resulting from a potential investment or regulatory action that society and users should be willing to make to undertake that investment or regulatory action.

Values presented fall into three general groups: passenger related values, aircraft related values, and labor related values. Passenger related values consist of the value of passenger time, the value of an avoided fatality, and the value of avoided injury. Aircraft related values include aircraft capacity and utilization factors, aircraft operating and ownership costs, and aircraft replacement and restoration costs. Passenger related values are established by Department of Transportation policy, which is applicable to all Modal Administrations within the Department. Aircraft related values have been developed by the Office of Aviation Policy and Plans from public and proprietary data sources. Labor related values are now included in this publication. They were developed from a number of sources and will provide more uniformity in

[1] See ***Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Decisions***, FAA-APO-98-8 (June 1998)
[2] See page A-1 of this report.

investment and regulatory analyses. This report also provides estimated accident investigation costs that are incurred by industry and government.

AVIATION RULEMAKING COST COMMITTEE

One objective of the ARCC was to prepare a specific set of cost items and quantify the specific values it recommends that the FAA use in future regulatory evaluations. This report was developed through a consultative process involving the ARCC, FAA and its support contractor. In this update of the economic values guidance, additional values have been incorporated and existing values have been restructured to make them more relevant to investment and regulatory programs. For example, wage and salary information covering aviation industry employees has been included to provide input to those analyses requiring a value for additional labor expended. In addition, a number of special topics were investigated at the request of the ARCC. These include the costs of regulations that require removal of a passenger seat in terms of revenue foregone, the valuation of schedule disruptions, the valuation of aircraft down time and accident investigation costs to both industry and government.

NEW USER CATEGORIES AND AIRCRAFT GROUPS STRUCTURE

Another change made with this version of the report has been to restructure the user categories in the report to provide a closer relationship to FAA's regulatory structure. For example, the air carrier and general aviation guidance now consider both operating regulations (Part 91, Part 121, Part 135, etc.) as well as aircraft certification regulations (Parts 23, 25, 27 and 29) in recognition that many regulatory changes involve these specific FAR parts. The ARCC recommended that, to the extent possible, cost and activity data be aligned along the dimensions of operating and certification regulations. This has resulted in changes to the aircraft groupings used in prior guidance (e.g., FAA-APO-98-8) and these are described more fully in the various sections of the report.

SUMMARY OF ECONOMIC VALUES

Summary values, applicable to benefit-cost analyses, are presented in Table ES-1 below. *These are summary values only. Analysts and other users should refer to the text of the report for further detailed values*. The values reflect the considerable restructuring of the aviation industry and its cost levels that have taken place over the last few years. The table also identifies the base year of the data used in this study. Where appropriate, these values should be converted to current dollars using appropriate indices.

For aircraft related values, detail for most measures is available by specific aircraft model, by generic aircraft classification (such as two engine narrow body, four engine wide body, or single engine piston) and by user profiles (such as scheduled commercial service, general aviation, or commuter). The various generic categories and user profiles have been constructed so as to anticipate the needs of analysts conducting investment and regulatory studies. Other measures can be developed from the underlying source data. Requests for assistance in developing information required for specific projects should be addressed to the Office of Aviation Policy and Plans.

The values presented in this report can be expected to change with the passage of time because of price and income level movements, aviation industry changes, advances in theoretical and empirical research, and policy changes. The Office of Aviation Policy and Plans will provide periodic updates to these values to reflect such changes. Pending such updates, aircraft specific values may be adjusted using the methodology contained in Section 9.

Estimates of labor costs can be summarized in a variety of ways and their use depends on the regulatory impact of interest. The analyst should refer to Section 7 when selecting the appropriate labor cost estimates.

Table ES-1: Economic Values for Use in Analyses

Physical Units	Value	Year
Value of Passenger Time Per Hour		
Air Carrier:		
Personal	$23.30	2000
Business	$40.10	2000
All Purposes	$28.60	2000
General Aviation:		
Personal	$31.50	2000
Business	$45.00	2000
All Purposes	$37.20	2000
Avoided Fatality	$3,000,000	2001
Avoided Injuries		
Injury Value by AIS Category (per injury):		
Minor (AIS 1)	$6,000	2001
Moderate (AIS-2)	$46,500	2001
Serious (AIS-3)	$172,500	2001
Severe (AIS-4)	$562,500	2001
Critical (AIS-5)	$2,287,500	2001
Fatal after 30 Days (AIS-6)	$3,000,000	2001
Other Costs by AIS Category (per victim):		
Minor (AIS 1)	$2,500	2001
Moderate (AIS-2)	$7,100	2001
Serious (AIS-3)	$21,200	2001
Severe (AIS-4)	$111,600	2001
Critical (AIS-5)	$300,000	2001
Fatal after 30 Days (AIS-6)	$132,700	2001

Table ES-1 (continued)

Physical Units	Value	Year
Injury and Other Costs by ICAO Category (per victim):		
Minor	$42,900	2001
Serious	$580,700	2001
Aircraft Capacity and Utilization Factors		
Large (Form 41) Passenger Carriers:		
Passenger Capacity	157 seats	2002
Crew Size	5	2002
Cargo Capacity	23.6 tons	2002
Passenger Load Factor	72%	2002
Cargo Load Factor	55%	2002
Daily Utilization	9.5 hours	2002
Average Block Speed	365 mph	2002
Large (Form 41) Cargo Carriers:		
Crew Size	3	2002
Cargo Capacity	47.3 tons	2002
Cargo Load Factor	60%	2002
Daily Utilization	4.2 hours	2002
Average Block Speed	410 mph	2002
Form 298-C Non-Alaskan Carriers:		
Passenger Capacity	38 seats	2001
Crew Size	3	2001
Cargo Capacity	4.5 tons	2001
Form 298-C Alaskan Carriers:		
Passenger Capacity	11 seats	2001
Crew Size	2	2001
Cargo Capacity	1.5 tons	2001
General Aviation:		
Passenger Capacity	4 seats	1982-2003
Passenger Load Factor	52.70%	1982-2003
Average Gross Weight	3,384 lbs.	1982-2003
Aircraft Operating Costs		
Large (Form 41) Passenger Carriers:		
Variable Operating Cost per Hour	$2,096	2002
Fixed Cost per Hour	$640	2002
Total Cost per Hour	$2,736	2002
Large (Form 41) Cargo Carriers:		
Variable Operating Cost per Hour	$4,339	2002
Fixed Cost per Hour	$1,583	2002
Total Cost per Hour	$5,922	2002
Regional (Form 41) Passenger Carriers:		
Variable Operating Cost per Hour	$3,218	2002
Fixed Cost per Hour	$1,008	2002
Total Cost per Hour	$4,226	2002
Regional (Form 41) Cargo Carriers:		
Variable Operating Cost per Hour	$3,235	2002
Fixed Cost per Hour	$702	2002
Total Cost per Hour	$3,938	2002

Table ES-1 (continued)

Physical Units	Value	Year
Aircraft Operating Costs (continued)		
Form 298-C Alaskan Carriers:		
Variable Operating Cost per Hour	$359	2001
Fixed Cost per Hour	$108	2001
Total Cost per Hour	$467	2001
Form 298-C Non-Alaskan Carriers:		
Variable Operating Cost per Hour	$622	2001
Fixed Cost per Hour	$256	2001
Total Cost per Hour	$878	2001
General Aviation:		
Variable Operating Cost per Hour	$362	2003
Fixed Cost per Hour	$728	2003
Total Cost per Hour	$1,090	2003
Military:		
Total Cost per Hour	$6,640	2002
Replacement Costs of Destroyed Aircraft		
Air Carrier - Passenger	$11,460,000	2003
Air Carrier - Cargo	$10,640,000	2003
General Aviation	$361,943	2003
General Aviation (pre 1982 aircraft)	$94,661	2003
General Aviation (1982 and later aircraft)	$1,817,062	2003
Military	$24,400,000	2003
Restoration Costs of Damaged Aircraft		
Air Carrier - Passenger	$3,700,000	1990-2003
Air Carrier - Cargo	$2,900,000	1990-2003
General Aviation	$35,070	Several years
General Aviation (pre 1982 aircraft)	$25,508	Several years
General Aviation (1982 and later aircraft)	$85,154	Several years
Military	$700,000	2003
Aviation Accident Investigation Costs		
Air Carrier (including Air Taxi)	$449,000	2002
General Aviation	$35,100	2002

Note: Form 41 contains financial information on large certified air carriers, small certified air carriers (regionals), and some air taxis. Carriers reporting on Form 298-C operate at least five scheduled round trips per week and their entire fleet consists of aircraft of 60 or fewer seats.

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SECTION 1: TREATMENT OF VALUES OF PASSENGER TIME IN AIR TRAVEL

1.1 APPROACH

This section addresses the treatment of the value of passenger time saved or lost as a result of investments in transportation facilities or regulatory actions. It is based upon guidance furnished by the Office of the Secretary of Transportation (OST).[3]

Time is a valuable economic resource that may be devoted to work or leisure activities. Because traveling consumes time, it imposes an opportunity cost equal to the individual's value of time in the forgone work or leisure activity. Moreover, since travel may take place under undesirable circumstances, including waiting or riding aboard a crowded or uncomfortable vehicle, it can impose an additional cost on travelers. Travel time saved or lost as a result of investments or regulatory actions should be valued in benefit-cost analyses to reflect both the opportunity cost and discomfort, if any, people experience when traveling.

Simple economic theory postulates that individuals will adjust the amount of time they devote to work and leisure such that an additional small increment of either may be valued at the wage rate.[4] More realistic models recognize that constraints on the ability of workers to alter work schedules or the conditions under which time is devoted to either work or leisure can cause the value people place on an incremental gain or loss of time to deviate, perhaps significantly, from the wage rate.[5] Nonetheless, contemporary practice is to value travelers' time as a proportion of the wage rate.

1.2 RECOMMENDED VALUES

The Department of Transportation (DOT) recommended values for aviation passenger travel time, as derived from the wage rates, are presented by user type in Table 1-1. These values are used by the FAA and are not to be updated for changes in

[3] "Treatment of Values of Passenger Time in Economic Analysis," Federal Aviation Administration, APO Bulletin, APO-03-1, March 2003; and "Revised Departmental Guidance—Valuation of Travel Time in Economic Analysis," Office of the Secretary of Transportation Memorandum, February 11, 2003.
[4] For a presentation of the conventional theory, see James M. Henderson and Richard E. Quandt, *Microeconomic Theory-A Mathematical Approach*, New York, McGraw-Hill, 1958, pp. 23-24.
[5] Nils A. Bruzelius, *The Value of Travel Time: Theory and Measurement*, London: Croom Helm, 1979, and Kenneth A. Small, *Urban Transportation Economics*, Reading, Harwood, 1992, pp. 36-45.

price levels. Data for the value of time for military aircraft operations are not contained in the DOT Guidance and are not included in this section.

Table 1-1: Recommended Hourly Values of Travel Time Savings (2000 U.S. dollars per person)

Category	Recommendation	Sensitivity Range	
		Low	High
Air Carrier:			
Personal	$23.30	$20.00	$30.00
Business	$40.10	$32.10	$48.10
All Purposes*	$28.60	$23.80	$35.60
General Aviation:			
Personal	$31.50	NR	NR
Business	$45.00	NR	NR
All Purposes	$37.20	NR	NR

*The all purpose values have increased proportionally less relative to previously published values than the personal and business values because of an increase in the ratio of personal to total travelers.

NR: No recommendation.

Sources: "APO Bulletin APO-03-1—Treatment of Values of Travel Time in Economic Analysis," FAA Office of Aviation Policy and Plans, March, 2003, and "Revised Departmental Guidance—Valuation of Travel Time in Economic Analysis," Office of the Secretary of Transportation Memorandum, February 11, 2003

For air carrier passengers, the time values are derived from the Air Transport Association of America *Air Travel Survey*, last conducted in 1998, adjusted for the increase in median annual income for U.S. households from 1998 to 2000 as reported in U.S. Census Bureau, *Income 2000*, Table 1. The value for business travel is 100 percent of the annual income category in the survey for "business" divided by 2,000 hours of work per year. The value for personal travel is 70 percent of the annual income category in the survey for "other" divided by an assumed 2,000 hours of work per year. When considering general aviation passengers as a separate category, a value of 70 percent of the median hourly income of Aircraft Owners and Pilots Association (AOPA) members is established for personal travel and 100 percent of median hourly income for business travel.

The fractions of 70 percent and 100 percent were recommended by a panel of transportation economists.[6] High and low values representing a plausible range of values based on variation in panel member opinions are furnished for use in conducting sensitivity analysis.

[6] Those consulted were: Don Pickrell (Volpe Center), Clifford Winston (Brookings Institution), Steven Morrison (Northeastern University), David Lewis (Hickling Lewis Brod), Ted Miller (National Public Services Research Institute), and Daniel Brand (Charles River Associates).

1.3 APPLICATION

General Applications: The values in Table 1-1 for air carrier passengers should be used when considering investments and regulations that impact aviation from an overall perspective. Depending on data availability, the separate values for business and personal travel can be applied to travel time savings or losses experienced. Composite averages can be developed using weights characteristic of the specific application, or the air carrier value for all purposes may be used.

General Aviation Values: Where the composition of air traffic affected by an FAA action can be shown to include an unusually large share of general aviation, the values for general aviation passengers in Table 1-1 may be used in appropriately weighted averages. In such cases, the weights should be selected so as to correspond to the proportion of time saved or lost by each user group as a result of the action under consideration. An analytically equivalent procedure would be to calculate time saved or lost separately for air carrier passengers and general aviation passengers and apply the respective hourly values for each.

Value of Small Time Savings or Losses: There has been significant discussion about whether small increments of time should be valued at lower rates than larger increments. Arguments for valuing smaller increments of time less than larger ones emphasize the difficulties of making effective use of smaller increments, particularly when unanticipated. However, the present state of theoretical and empirical knowledge does not appear to support valuing small increments of time less than larger ones. Therefore, the values in Table 1-1 should be used for all valuations, irrespective of the size of individual increments of time either saved or lost.

Sensitivity Analysis: Because uncertainty surrounds the recommended values, a range of values is also presented in Table 1-1. Analysts should test the sensitivity of analyses to the ranges of uncertainty specified. Should the outcome of an analysis change across the range of values, this should be identified and reported.

Updating Values: Updates of the recommended values utilizing newly published source data upon which the recommended values are built will be provided periodically by OST. Pending such updates, analysts should not make interim adjustments using economy-wide measures of general price inflation.

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SECTION 2: TREATMENT OF THE VALUES OF LIFE AND INJURY IN ECONOMIC ANALYSIS

2.1 APPROACH

This section addresses the treatment of the values of life and injury in economic analyses that support regulatory actions or investment decisions by the FAA. It is based on guidance furnished by the Office of the Secretary of Transportation (OST) via memorandum dated January 29, 2002. This guidance provides recommendations to all modal administrators on the treatment of the values of life and injury in economic analyses. It specifies that values of life and injury be based on the "willingness to pay" (WTP) by society for reduced risks of fatalities and injuries.[7]

WTP is the theoretically correct approach to valuing all benefits arising from public investments or regulatory actions including fatalities and injuries avoided as a result of aviation accident risk reduction. WTP values the risk of injury or loss of life because it is the maximum value of other goods and services that individuals would be willing to forgo and still be as well off after the introduction of an accident risk reduction as they were before it.

The basic approach taken to value an avoided fatality is to determine how much an individual or group of individuals is willing to pay for a small reduction in risk. Once this amount is known, it is necessary to determine how much risk reduction is required to avoid one fatality. The total willingness to pay for the amount of risk reduction required to avoid one fatality is termed the value of life or sometimes the value of a statistical life.[8] For example, if people are willing to pay $3 to eliminate an incremental risk of a fatality with a one in one million chance of occurrence, this implies that they would be willing as a group to pay $3 million to prevent one fatality. From another perspective, $3 million represents the amount a group as a whole would be willing to pay to purchase the risk reduction necessary to avoid one expected fatality among its members.

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[7] "Revised Departmental Guidance—Treatment of Value of Life and Injuries in Preparing Economic Evaluations," Office of the Secretary of Transportation Memorandum, January 29, 2002. This memorandum establishes the specific value of life to be used in all DOT analyses. The original guidance establishing willingness to pay as the appropriate type of measure is contained in an OST memorandum dated January 8, 1993.

[8] The terms value of life and value of statistical life are misleading at best in that they refer to the sum of payments associated with many small fatality risk reductions undertaken prior to the occurrence of a fatality. They have no application to placing a value on the death of any specific individual.

In theory, the same approach (assessing the willingness to pay to avoid various kinds of injury) could be used to value injuries. However, in practice it cannot currently be done because of data limitations. As will be indicated below, an alternative approach is used which values avoided injuries as a fraction of an avoided fatality.

2.2 VALUE OF LIFE

For the analysis conducted in 1993, OST guidance suggested that $2.5 million be used as the minimum value of a statistical fatality avoided. This value was based upon a survey of studies performed by Ted Miller and others at the Urban Institute, adjusted to 1993 dollars.[9] The guidance also provided that OST would update this value early each year using the Gross Domestic Product implicit price deflator. Subsequently, OST updated the value of life for analyses to be conducted in 1994 to $2.6 million per fatality averted[10] and in 1995 and 1996 to $2.7 million.[11] The latest OST guidance establishes a minimum value of $3 million per fatality averted. This $3 million value (and the injury values based on it presented below) should be used in all FAA analyses until revised by OST.[12]

In addition, some recent studies have examined the value per fatality avoided, including a meta-analysis by Ted Miller and similar studies by Viscusi and Aldy and Mrozek and Taylor.[13] These provide information on the range of values used in other applications.

2.3 VALUE OF INJURIES

The January 8, 1993 OST guidance also established a procedure for valuing averted injuries based on the current value of life and the Abbreviated Injury Scale (AIS). AIS is a comprehensive system for rating the severity of accident-related injuries that recognizes six levels of injury severity. It classifies nonfatal injuries into five

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[9] Ted R. Miller et al., *The Costs of Highway Crashes*, (Washington, DC: Urban Institute, 1991).

[10] "Update of Value of Life and Injuries for Use in Preparing Economic Evaluations," Department of Transportation Memorandum, March 15, 1994.

[11] "Update of Value of Life and Injuries for Use in Preparing Economic Evaluations," Department of Transportation Memorandum, March 14, 1995, and "Update of Value of Life and Injuries for Use in Preparing Economic Evaluations," Department of Transportation Memorandum, 1996.

[12]"*Revised Departmental Guidance*, Treatment of Value of Life and Injuries in Preparing Economic Evaluations," Office of the Secretary of Transportation Memorandum, January 29, 2002.

[13] Ted R. Miller, "Variations between Countries in Values of Statistical Life," *Journal of Transport Economics and Policy Vol. 34* (May 2000): 169-188; W. Kip Viscusi and JosephE. Aldy, *The Value of Statistical Life: A Critical Review of Market Estimates Throughout the World*, National Bureau of Economic Research, February 2003, Working Paper 9487; Janusz R. Mrozek and Laura O. Taylor, "What Determines the Value of Life? A Meta-Analysis", *Journal of Policy Analysis and Management Vol.21* (2002): 253-270.

categories depending on the short-term severity of the injury. A sixth category corresponds to injuries that result in death 30 or more days after the accident. The five nonfatal AIS categories are based primarily upon the threat to life posed by an injury. Table 2-1 gives an overview of the classification of different injuries by AIS level and their threat to life.

Table 2-1: Selected Sample of Injuries by the Abbreviated Injury Scale (AIS)

AIS Code	Injury Severity Level	Selected Injuries
1	Minor	Superficial abrasion or laceration of skin; digit sprain; first-degree burn; head trauma with headache or dizziness (no other neurological signs).
2	Moderate	Major abrasion or laceration of skin; cerebral concussion (unconscious less than 15 minutes); finger or toe crush/amputation; closed pelvic fracture with or without dislocation.
3	Serious	Major nerve laceration; multiple rib fracture (but without flail chest); abdominal organ contusion; hand, foot, or arm crush/amputation.
4	Severe	Spleen rupture; leg crush; chest-wall perforation; cerebral concussion with other neurological signs (unconscious less than 24 hours).
5	Critical	Spinal cord injury (with cord transection); extensive second- or third-degree burns; cerebral concussion with severe neurological signs (unconscious more than 24 hours).
6	Fatal	Injuries, which although not fatal within the first 30 days after an accident, ultimately result in death.

To establish a valuation for each AIS injury severity level, the level is related to the loss of quality and quantity of life resulting from an injury typical of that level. This loss is expressed as a fraction of the value placed on an avoided fatality. The WTP to avoid an injury of a particular AIS level is estimated by multiplying the fractional fatality value associated with the AIS level by the value of life. AIS levels, their associated fractional fatality values,[14] and the corresponding WTP value of each injury level (based on a $3 million value of life) are provided in Table 2-2.

Where specific information is available on separate injuries by AIS level, the Office of Aviation Policy and Plans (APO) recommends that the WTP to avoid each specific injury be separately valued according to Table 2-2. Often, more than one injury will be associated with a person injured in an aviation accident. If the valuation is presented on a per victim basis, the WTP values for each injury suffered by the same person should be aggregated.

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[14] These values were derived from Ted R. Miller, Stephen Luchter and C. Philip Brinkman, "Crash Costs and Safety Investment," *Accident Analysis and Prevention Vol 21(4): 303-315, 1989.*

Table 2-2: WTP Values Per AIS Injury Level (2001 dollars)

AIS Code	Description of Injury	Fraction of WTP Value of Life	WTP Value
AIS 1	Minor	0.20%	$6,000
AIS 2	Moderate	1.55%	$46,500
AIS 3	Serious	5.75%	$172,500
AIS 4	Severe	18.75%	$562,500
AIS 5	Critical	76.25%	$2,287,500
AIS 6	Fatal	100.00%	$3,000,000

2.4 OTHER COSTS

Costs other than WTP values are generally associated with transportation fatalities and injuries. These include the costs of emergency services, medical care, and legal and court services (the cost of carrying out court proceedings—not the cost of settlements). These other avoided costs should be considered as separate benefits, additional to the WTP value.

Because medical and legal costs of separate injuries to the same victim are not necessarily additive, APO advises that medical and legal costs be valued on a per victim basis. Table 2-3 provides direct per victim medical and legal costs classified according to the worst AIS injury sustained by each aviation accident victim. Thus, the values in Table 2-3 should be added only once to the aggregated sum of the WTP values for injuries suffered by any particular individual.[15]

Table 2-3: Per Victim Medical and Legal Costs Associated with Injuries (2001 dollars)

AIS Code	Description of Maximum Injury	Emergency/ Medical	Legal/Court	Total Direct Costs
AIS 1	Minor	$600	$1,900	$2,500
AIS 2	Moderate	$4,000	$3,100	$7,100
AIS 3	Serious	$16,500	$4,700	$21,200
AIS 4	Severe	$72,500	$39,100	$111,600
AIS 5	Critical	$219,900	$80,100	$300,000
AIS 6	Fatal	$52,600	$80,100	$132,700

Source: Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs, FAA-APO-89-10, October 1989, Section 3, as adjusted for price level changes.

[15] Similar direct costs apply in the case of fatalities. However, APO estimates that these direct costs are less than $50,000 per fatality--not enough to shift the $3 million WTP value after allowances for the rounding convention--to the nearest $100,000--used by OST.

2.5 ICAO INJURY CLASSIFICATIONS

Although the methodology specified above should be used when possible, aviation injury data are often incomplete and/or unavailable at the AIS level. Most frequently, aviation injuries are reported by the number of victims suffering "serious" and "minor" injuries as defined by the International Civil Aviation Organization (ICAO). Under this classification, serious injury victims are typically (but not always) those with at least one injury at AIS 2 or higher, whereas minor injury victims typically (but not always) have injuries at the AIS 1 level only.

To calculate economic values for the ICAO serious and minor injury categories, APO analyzed aviation injury data maintained by the National Transportation Safety Board (NTSB) that contain both ICAO and complete AIS injury codes. AIS values for all injuries sustained by accident victims in each ICAO category were summed and then divided by the number of victims in each category to determine per victim WTP values.[16] These WTP values are reported in Table 2-4. Medical and legal direct costs reported in Table 2-4 reflect weighted averages of the values listed in Table 2-3.

Table 2-4: Average Per Victim Injury Values for Serious and Minor Injuries (2001 dollars)

ICAO Code	WTP Values	Emergency/ Medical	Legal/ Court	Total Value
Minor (ICAO 2)	$37,900	$2,300	$2,700	$42,900
Serious (ICAO 3)	$536,000	$31,300	$13,400	$580,700

[16] Eric Gabler, "Update of FAA Values of Avoided Injury," Draft Working Paper, Office of Aviation Policy and Plans, February 1994.

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SECTION 3: AIRCRAFT CAPACITY AND UTILIZATION FACTORS

3.1 INTRODUCTION

Aircraft capacity and utilization factors apply primarily to the evaluation of FAA investment and regulatory programs that affect time spent in air transportation, system capacity and aircraft utilization. The utilization of available capacity affects the benefits and costs that accrue directly to aircraft operators and indirectly to users and society.

3.1.1 User Group Concept and Definitions

In this report, data are presented for four user groups together with the sub-groupings shown below[17]:

Group 1: Air carrier operations of passenger aircraft.
- A: Form 41 large and regional air carriers[18]
- B: Form 298 commuter air carriers

Group 2: Air carrier operations of all-cargo aircraft.
- A: Form 41 large and regional air carriers
- B: Commuter data not available

Group 3: General aviation aircraft by the Federal Aviation Regulation (FAR) that the activity was conducted under:
- A: General aviation only
- B: Air taxi only

Group 4: Military aircraft

The overall user group structure is the same as that used in the prior report (FAA-APO-98-8); however, some aircraft categories have changed to reflect the current fleet. Details are provided in the sections below. In addition, an effort was made to align the data with the certification category of aircraft and the operating regulations that apply to them. This was done to provide a better basis for the evaluation of investment or regulatory programs affecting portions of the aircraft fleet.

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[17] In some cases, more disaggregate data are presented.
[18] Form 41 and Form 298 refer to activity and financial data filed with the U.S. Department of Transportation by air carriers.

3.1.2 Regulatory Structure

Title 14 of the Code of Federal Regulations (CFR) covers Aeronautics and Space. There are two types of regulations in Title 14 with direct applicability to this report: aircraft airworthiness certification, and aircraft operations regulations. Aircraft may be grouped by the FAR Part under which they are certificated for one type of analysis, and by the Part (or Parts) under which they are operated for another, or both.[19] These data also may be used in the analysis of investment and regulatory decisions not affecting aircraft certification or operating regulations.

3.1.2.1 Certification Part—In order for an aircraft to be flown in the United States, it must be considered airworthy.[20] To obtain standard airworthiness certificate, an aircraft must conform to a type certificate and be in a condition for safe operation. A type certificate is a document issued by the FAA to an applicant who has proven that an aircraft meets the requirements of the pertinent FAR(s). The issuance of a type certificate approves the type design. There are four Parts under Title 14 which deal with airworthiness standards for aircraft[21]:

Part 23 covers "Normal, Utility, Acrobatic and Commuter Category Airplanes." Normal, Utility and Acrobatic aircraft are limited to a maximum of nine passenger seats and a maximum takeoff weight (MTOW) of 12,500 pounds. Commuter airplanes, which must have two or more propeller-driven engines, are limited to a maximum of 19 passenger seats and a MTOW of 19,000 pounds.

Part 25 covers "Transport Category Airplanes," which applies to all fixed-wing aircraft that do not meet the standards of Part 23.

In general terms, piston-powered fixed-wing aircraft are certificated under Part 23, as are turboprops with fewer than 20 seats. Larger turboprops and all jet-powered airplanes are certificated under Part 25.

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[19] These are the principal regulations affecting U.S. aircraft manufacturers and aircraft operators that are used to categorize the population of civil aircraft. For the purposes of presentation, we have grouped aircraft certified under the Civil Air Regulations (CARs) with the same size and category of aircraft under the current Federal Aviation Regulations (FARs). This distinction would likely only arise in a evaluation for a regulatory specific aircraft make-model at which point the exact certification basis could be determined.

[20] There are exceptions to this for homebuilt and experimental aircraft. Such aircraft may not be sold or operated commercially. They are generally small, piston-powered aircraft that would otherwise be certificated under FAR Part 23 (fixed-wing) or FAR Part 27 (rotorcraft) regulations.

[21] Some aircraft were certified to the regulations—Civil Air Regulations—that preceded the FARs. In this report, these aircraft are classified into the current regulatory structure. These account for a small part of aviation activity.

Part 27 covers "Normal Category Rotorcraft." These rotorcraft are limited to a MTOW of 7,000 pounds[22] and nine passenger seats. They may be piston- or turbine-powered, and have single or multiple engines.

Part 29 covers "Transport Category Rotorcraft," which applies to all rotary-wing aircraft that do not meet the standards of Part 27.

3.1.2.2 Operating FAR—Standards for conducting civilian flights in the United States are contained in several parts of Title 14.

Part 91 contains general regulations for the operation of powered aircraft (excluding ultralights). Part 91 regulations are sometimes referred to as "General Aviation" operations. It is the least restrictive category of operation for such aircraft. Operations that do not include activities that are regulated under one of the other parts operate by default under Part 91.

In order to conduct operations on a commercial basis, an operator must have an air carrier or other operating certificate, issued under **Part 119**, Certification: Air Carriers and Commercial Operators.

Part 121 contains standards applicable to the domestic and flag operations of the holders of air carrier or operating certificates under Part 119. Domestic and flag operations involve common carriage, the transportation of people or goods for compensation, in aircraft with more than nine passenger seats or a cargo capacity of more than 7,500 pounds. This is the structure under which most large airlines operate.

Part 125 regulates non-commercial operations conducted with fixed-wing aircraft with 20 or more seats, which do not fit into Parts 121, 129, 135 or 137. Part 125 applies when common carriage is not involved.

Part 133 governs the operation of any rotary wing aircraft carrying an external load.

Part 135 covers commuter (using aircraft of nine seats or less and a maximum payload of 7,500 lbs or less) or on-demand operations by holders of air carrier or other operating certificates, which are required for certain activities: transportation of mail, certain sightseeing or air tour flights, air taxi (on-demand) flights, and commuter

[22] While the maximum certified takeoff weight for Part 27 is at 7,000 pounds, the weights assigned for aircraft in the GA Survey were developed through an analysis of secondary source data. Thus, it is possible that some rotorcraft with weights less than (but close to) 7,000 pounds are included in Part 29, which applies to larger rotorcraft. However, we do not believe that this has a large impact on the reported results.

flights. Scheduled passenger carrying operations with turbojet aircraft having one or more seats must be conducted under Part 121.

Part 137 applies to all operations involving the aerial application of substances. This application may be in support of agriculture, firefighting, public health sprayings or cloud seeding.

3.1.3 Aircraft Groupings

Aircraft are placed into groups likely to be relevant to conducting regulatory analyses. Within each group, data are reported by generic aircraft classifications. Groupings are discussed in the following sections, and detailed in the tables. Finally, user profiles are constructed for selected user groupings.

The factors in Table 3-1 are reported for air carrier, general aviation, and military user types, respectively, with differences based on data limitations.

Table 3-1: Factors Presented by User Type

Factor	Air Carrier	General Aviation	Military
Aircraft seating capacity	x	x	—
Number of crew (including flight attendants)	x	—	—
Cargo capacity	x	—	—
Passenger load factor	x	x	—
Cargo load factor	x	—	—
Aircraft utilization	x (day)	x (year)	x (hours)
Average speed	x	—	—
Total useful load	—	x	—

The air carrier sub-groupings for passenger and freight are defined by type of aircraft. All cargo aircraft are those that report no passenger traffic. Passenger aircraft can produce both passenger and cargo services by using empty space in the aircraft divided into a number of compartments to carry air freight. Air cargo capacity on passenger aircraft is estimated as total aircraft capacity minus passenger capacity utilized. Commuter aircraft data do not allow for a ready distinction of all cargo aircraft operations.

General aviation capacity data are also divided into a number of subgroups depending on the type of operation. In this section, GA aircraft and activity are also categorized by the parts of aircraft certification and operating regulations that the activity falls under.

Information on capacity and utilization factors for military aircraft are also presented in this section. From a regulatory or system investment standpoint, FAA actions will primarily affect military flight time; the costs of military operations are covered in Sections 4 and 5.

Data limitations do not allow for complete analysis of each capacity factor for each aircraft type or classification. The most complete data are available for the large air carriers, while small commuter air carriers report less detailed data, and general aviation activity data are somewhat limited. The individual tables show specific definitions for each data element.

3.2 AIR CARRIER AIRCRAFT

One of the objectives in this economic values report was to align the aircraft group structure more closely to the FAA regulatory structure. Table 3-2 shows the air carrier aircraft categories used in this report, and how they relate to the categories used in the prior economic values report. The groups in this report cover both the operating and certification standards relevant for each category.[23]

Table 3-2: Air Carrier Aircraft Categories

This Report		Prior Report (FAA-APO-98-8)	
Economic Values Category		Economic Values Category	
1	Two-Engine Narrow-Body	1	Two-Engine Narrow-Body
2	Two-Engine Wide-Body	2	Two-Engine Wide-Body
3	Three-Engine Narrow-Body	3	Three-Engine Narrow-Body
4	Three-Engine Wide-Body	4	Three-Engine Wide-Body
5	Four-Engine Narrow-Body	5	Four-Engine Narrow-Body
6	Four-Engine Wide-Body	6	Four-Engine Wide-Body
7	Regional Jet under 70 seats	7	Regional Jet under 40 seats
8	Regional Jet 70 to 100 seats	8	Regional Jet with 40-59 seats
9	Turboprops under 20 seats (Part 23)	9	Regional Jet over 59 seats
10	Turboprops under 20 seats (Part 25)	10	Turboprops under 20 seats
11	Turboprops with 20 or more seats	11	Turboprops with 20 or more seats
12	Piston Engine (Part 23)	12	Piston
13	Piston Engine (Part 25)		

[23] Aircraft certified under Part 23 and Part 25 were recorded based on *Jane's All the World's Aircraft* (various editions). If no certification part is listed in a table, they are assumed to be certified to Part 25 (or predecessor regulations).

3.2.1 Air Carrier Aircraft Groups, Certification and Operating FARs

Aircraft capacity and utilization factors for calendar year 2002 were obtained from data submitted by air carriers on Bureau of Transportation Statistics (BTS) Form 41 for large air carriers and regional carriers, and for the year ending September 2001 on Form 298C for small (commuter) carriers.[24] Data Base Products summarized the large air carrier data by aircraft type, group, and other appropriate cost categories using BTS quarterly data for calendar year 2002. The commuter airline data for the four quarters ending September 2001[25] were obtained from BTS, and analyzed by aircraft type, location of carrier (Alaska and non-Alaska), type of operating authority (Part 121 or Part 135) and the certification basis (Part 23 or Part 25) for the aircraft operated. Data are summarized in following tables for aircraft classification groups and for the total fleet. Supporting data are available on the APO website.

As noted above, air carriers were divided into those operating under Part 121 and those operating under Part 135. The data source for aviation activity and financial information for large and some regional air carriers is BTS Form 41. Smaller carriers use BTS Form 298. Many of the carriers that file Form BTS-298 are located in Alaska. Table 3-3 provides a summary of activity for all air carriers considered in this study. Data are reported for both block hours (gate-to-gate) and airborne hours (wheels-up to wheels-down). The vast majority of hours are operated under Part 121. This is because scheduled passenger operations under Part 135 are restricted to aircraft with nine passenger seats or less.[26] The table also notes those aircraft that come under Part 23 versus Part 25. Aircraft without an aircraft certification basis noted are Part 25 aircraft.

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[24]*Form 41 Traffic and Financial Data*, and *Form 298-C-Commuter Airlines*, (Washington, DC: Bureau of Transportation and Statistics, various dates).

[25] Data were incomplete for later periods, and reporting requirements changed in 2002, making it impossible to develop a consistent and useful source of Form 298 data for later periods. In addition, service was disrupted by September 11, 2001 terrorist acts, and made the period ending with the September quarter perhaps the least disrupted period to use for this study. While one quarter of the year chosen was affected, two or more quarters after the September 2001 quarter were seriously disrupted.

[26] On-demand Part 135 activities are reported in Section 3.3, General Aviation Aircraft.

Table 3-3: Summary Air Carrier Activity by Aircraft Certification and Operating Authority

Economic Values Category	Part 121		Part 135		Total	
	Total Block Hours	Total Airborne Hours	Total Block Hours	Total Airborne Hours	Total Block Hours	Total Airborne Hours
Two-Engine Narrow-Body	11,512,852	9,599,796	NR	NR	11,512,852	9,599,796
Two-Engine Wide-Body	2,191,418	1,968,223	NR	NR	2,191,418	1,968,223
Three-Engine Narrow-Body	409,095	330,025	NR	NR	409,095	330,025
Three-Engine Wide-Body	593,574	530,968	NR	NR	593,574	530,968
Four-Engine Narrow-Body	92,510	78,669	NR	NR	92,510	78,669
Four-Engine Wide-Body	437,135	405,655	NR	NR	437,135	405,655
Regional Jet under 70 seats	1,683,830	1,291,866	790	601	1,684,620	1,292,467
Regional Jet 70 to 100 seats	102,049	77,911	NR	NR	102,049	77,911
Turboprops under 20 seats (Part 23)	317,961	266,252	61,638	51,589	379,599	317,841
Turboprops under 20 seats (Part 25)	25,545	21,382	NR	NR	25,545	21,382
Turboprops with 20 or more seats	1,012,411	807,962	6,902	5,777	1,019,313	813,739
Piston Engine (Part 23)	32,153	27,313	188,474	157,692	220,627	185,005
Piston Engine (Part 25)	14,891	12,266	133	111	15,024	12,377
Total	**18,425,424**	**15,418,288**	**257,937**	**215,770**	**18,683,361**	**15,634,058**

Source: GRA analysis of Form 41 and Form 298 data.
NR = none reported

Air carrier data are provided in two tables for large air carriers. Form 41 air carrier passenger operations are shown in Table 3-4. There were 4,562 aircraft reported for these carriers (fractional aircraft result from less than full year operations.) The column dealing with crew size includes both flight crew and cabin crew. The number of flight deck crew for the aircraft in each grouping is identified by reference to the relevant editions of *Jane's All the World's Aircraft*.[27] The number of flight attendants varies based on the size of the aircraft and staffing policy of individual carriers.[28] Previous editions of this study recommend estimating flight attendants for aircraft groups using an average of one flight attendant per 45 seats (rounding up).[29] This assumption has changed in this report to one flight attendant per 50 seats, reflecting the fact that most carriers now provide the minimum number of required flight attendants. As can be seen, the 4,562 aircraft accounted for 6.9 million departures in 2002. These aircraft are utilized for 9.5 hours per day on average and have an average capacity of 157 passenger seats. The average passenger load factor is 72 percent.

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[27] *Jane's All the World's Aircraft,* (Alexandria, VA, Jane's Information Group Limited, various years).
[28] FAR 121.391(a) general: requires a minimum of one flight attendant for each 50 installed seats in an aircraft, for aircraft above 9 seats (depending on aircraft weight).
[29] *Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs,* FAA-APO-98-8 (Washington, DC, 1998).

Table 3-4: 2002 Passenger Air Carrier Capacity and Utilization Factors

	1	2	3	4	5	6	7	8	9	10	11
Economic Values Category	**Number of Aircraft**	**Departures**	**Passenger Capacity**	**Passenger Load Factor**	**Capacity (Tons)**	**Capacity Load Factor**	**Crew Size**	**Block Hours**	**Average Block Speed (MPH)**	**Daily Utilization (Hours)**	**Fuel Burn Per Hour**
Two-Engine Narrow-Body	3,329	5,272,091	142	70%	18.7	55%	5	11,396,083	361	9.4	863
Two-Engine Wide-Body	471	366,849	226	75%	42.8	54%	7	1,880,513	455	10.9	1,743
Three-Engine Narrow-Body	90	94,192	139	67%	19.2	55%	6	186,857	338	5.7	1,238
Three-Engine Wide-Body	90	44,826	278	75%	49.5	54%	9	264,759	466	8.1	2,484
Four-Engine Narrow-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Four-Engine Wide-Body	90	44,325	368	82%	66.2	63%	10	321,888	429	9.8	3,466
Regional Jet under 70 seats	288	650,860	49	65%	6.0	51%	3	933,530	283	9.0	380
Regional Jet 70 to 100 seats	40	76,248	79	62%	10.1	49%	4	102,049	296	7.1	540
Turboprops under 20 seats (Part 23)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops with 20 or more seats	165	306,837	33	60%	3.8	51%	3	370,523	168	6.2	136
Piston Engine (Part 23)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Piston Engine (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
All Aircraft	**4,562**	**6,856,228**	**157**	**72%**	**23.6**	**55%**	**5**	**15,456,202**	**365**	**9.5**	**1,008**

Source: Form 41 Data, Year End 2002.
NR = none reported
Col 1: "Aircraft Days Assigned to Service" divided by the number of days in the period reported.
Col 2: "Revenue Departures Performed."
Col 3: "Available Seat Miles" divided by "Revenue Aircraft Miles."
Col 4: "Revenue Passenger Miles" divided by "Available Seat Miles."
Col 5: "Available Ton Miles" divided by "Revenue Aircraft Miles."
Col 6: "Revenue Ton Miles" divided by "Available Ton Miles."
Col 7: Pilot Flight crew from Jane's All The World's Aircraft. Flight Attendants are estimated as one for each 50 passenger seats above 19 seats.
Col 8: "Block Hours Flown" are calculated from the elapsed time from gate to gate.
Col 9: "Revenue Aircraft Miles" divided by "Block Hours Flown."
Col 10: "Block Hours Flown" divided by "Aircraft Days Assigned to Service."
Col 11: "Gallons of Fuel" divided by "Block Hours Flown."

Table 3-5 shows capacity and utilization figures for all cargo aircraft reported on Form 41. In 2002, 800 all cargo aircraft were reported by these carriers. As can be seen, these aircraft have much lower levels of daily utilization (4.2 block hours per day on average) than the passenger aircraft.

Table 3-5: 2002 All Cargo Carrier Capacity and Utilization Factors

	1	2	3	4	5	6	7	8
Economic Values Category	**Number of Aircraft**	**Departures**	**Cargo Capacity (Tons)**	**Cargo Load Factor**	**Crew Size**	**Block Hours**	**Average Block Speed (MPH)**	**Daily Utilization (Block Hours)**
Two-Engine Narrow-Body	90	63,655	35.3	49%	2	116,769	393	3.6
Two-Engine Wide-Body	157	119,590	51.9	61%	2	310,905	404	5.4
Three-Engine Narrow-Body	261	130,265	25.6	53%	3	222,238	358	2.3
Three-Engine Wide-Body	112	90,744	78.6	63%	3	328,815	466	8.0
Four-Engine Narrow-Body	82	37,451	45.4	46%	3	92,510	382	3.1
Four-Engine Wide-Body	55	20,971	101.6	61%	3	115,247	465	5.7
Regional Jet under 70 seats	19	5,620	3.0	20%	2	8,842	300	1.3
Regional Jet 70 to 100 seats	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 23)	1	1,717	1.4	34%	1	1,482	177	3.3
Turboprops under 20 seats (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops with 20 or more seats	5	3,804	23.7	34%	3	9,076	330	5.0
Piston Engine (Part 23)	7	4,299	1.6	58%	1	5,375	148	2.1
Piston Engine (Part 25)	11	8,166	15.0	55%	2	14,653	190	3.6
All Aircraft	**800**	**486,282**	**47.3**	**60%**	**3**	**1,225,912**	**410**	**4.2**

Source: Form 41 Data, Year End 2002.
NR: none reported
Col 1: "Aircraft Days Assigned to Service" divided by the number of days in the period reported.
Col 2: "Revenue Departures Performed."
Col 3: "Available Ton Miles" divided by "Revenue Aircraft Miles."
Col 4: "Revenue Ton Miles" divided by "Available Ton Miles."
Col 5: Pilot Flight crew from *Jane's All The World's Aircraft.*
Col 6: "Block Hours Flown" are calculated from the elapsed time from gate to gate.
Col 7: "Revenue Aircraft Miles" divided by "Block Hours Flown."
Col 8: "Block Hours Flown" divided by "Aircraft Days Assigned to Service."
Note: The following aircraft types were reported in Form 41, but are not included due to incomplete filings: L-188A, DC-9-30 and DC-10-40.

With the exception of some larger commuter operators, who report results on Form 41, smaller air carriers generally report on Form 298-C. The actual reporting requirements vary for air carriers based on size. Limited information on capacity and utilization by aircraft type is reported on Form 298-C. The form does not report the number of aircraft so factors such as fleet size or average daily utilization cannot be calculated. Most aircraft operated by carriers filing Form 298 operate mostly smaller aircraft. Data on capacity and utilization for non-Alaskan operators filing Form 298 are reported in Table 3-6. The average aircraft had 38 passenger seats. These aircraft accounted for almost 1.7 million block hours in the year examined.

Table 3-6: 2001 Non-Alaskan Form 298-C Operators Capacity and Utilization Factors (Weighted by Block Hours)

	1	2	3	4	5
Economic Values Category	**Seats**	**Crew Size**	**Cargo Capacity (Tons)***	**Total Block Hours**	**Total Airborne Hours**
Two-Engine Narrow-Body	NR	NR	NR	NR	NR
Two-Engine Wide-Body	NR	NR	NR	NR	NR
Three-Engine Narrow-Body	NR	NR	NR	NR	NR
Three-Engine Wide-Body	NR	NR	NR	NR	NR
Four-Engine Narrow-Body	NR	NR	NR	NR	NR
Four-Engine Wide-Body	NR	NR	NR	NR	NR
Regional Jet under 70 seats	49	3	6.1	739,853	575,982
Regional Jet 70 to 100 seats	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 23)	18	2	3.0	272,093	227,743
Turboprops under 20 seats (Part 25)	19	2	2.4	25,545	21,382
Turboprops with 20 or more seats	33	3	4.0	614,451	514,297
Piston Engine (Part 23)	8	1	1.1	5,510	4,612
Piston Engine (Part 25)	4	1	NR	133	111
Non-Alaskan Total	**38**	**3**	**4.5**	**1,657,585**	**1,344,127**

Source: Analysis of 4 quarters ending September 2001 Form 298C data.
NR = No data reported
*Cargo capacity weighted averages refer only to aircraft with known cargo capacity. Because of this, the number of hours used in computing weighted cargo capacity averages may be lower than total block hours.
Col 1: *Jane's All The World's Aircraft* (various issues) op. cit.
Col 2: Standard flight crew complements per analysis of *Jane's All The World's Aircraft*, op. cit., plus one flight attendant per each 50 passenger seats.
Col 3: *Jane's All The World's Aircraft*, op. cit., and Form 41 (available ton miles divided by revenue aircraft miles).
Col 4: Block hours from Form 298-C
Col 5: Block hours from Form 298-C multiplied by ratio of airborne hours/block hours for similar aircraft from Form 41.

The results for Alaskan Form 298-C carriers have been separated from other Form 298-C carriers to provide information on the unique operating environment in Alaska. Table 3-7 shows capacity and utilization factors for Alaskan air carriers who file Form 298. These represent about 20-25 percent of the activity for all Form 298 operators. Most of the activity is with small Part 23 aircraft. The average aircraft has 11 seats. These aircraft accounted for 343,662 block hours in the year reported.

Table 3-7: 2001 Alaskan Form 298-C Operators Capacity and Utilization Factors (weighted by block hours)

New Economic Values Category	1 Seats	2 Crew Size	3 Cargo Capacity (Tons)*	4 Total Block Hours	5 Total Airborne Hours
Two-Engine Narrow-Body	NR	NR	NR	NR	NR
Two-Engine Wide-Body	NR	NR	NR	NR	NR
Three-Engine Narrow-Body	NR	NR	NR	NR	NR
Three-Engine Wide-Body	NR	NR	NR	NR	NR
Four-Engine Narrow-Body	NR	NR	NR	NR	NR
Four-Engine Wide-Body	NR	NR	NR	NR	NR
Regional Jet under 70 seats	8	2	3.5	2,395	1,821
Regional Jet 70 to 100 seats	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 23)	15	2	2.3	106,024	88,741
Turboprops under 20 seats (Part 25)	NR	NR	NR	NR	NR
Turboprops with 20 or more seats	34	3	3.6	25,263	21,146
Piston Engine (Part 23)	6	1	0.9	209,742	175,492
Piston Engine (Part 25)	28	3	3.8	238	199
Alaskan Total	**11**	**2**	**1.5**	**343,662**	**287,399**

Source: Analysis of 4 quarters ending September 2001 Form 298C data.
NR = No data reported
*Cargo capacity weighted averages refer only to aircraft with known cargo capacity. Because of this, the number of hours used in computing weighted cargo capacity averages may be lower than total block hours.
Col 1: *Jane's All The World's Aircraft* (various issues) op.cit.
Col 2: Standard flight crew complements per analysis of *Jane's All The World's Aircraft*, op.cit., plus one flight attendant per each 50 passenger seats.
Col 3: *Jane's All The World's Aircraft*, op. cit., and Form 41 (available ton miles divided by revenue aircraft miles).
Col 4: Form 298-C
Col 5: Block hours from Form 298-C multiplied by ratio of airborne hours/block hours for similar aircraft from Form 41.

3.3 GENERAL AVIATION AIRCRAFT

Data from the 2001 GA Survey by FAA's Office of Aviation Policy and Plans (APO-100) was used to estimate the number of active aircraft and annual utilization.[30] The actual sample size for the 2001 GA Survey was 30,472.[31] There were 16,432 responses received, of which 11,666 indicated that the aircraft was active (flew at least once) during 2001. Using the GA Survey's weighting methodology, these 11,666 records represent 211,446 U.S.-registered active GA aircraft.

[30] *General Aviation and Air Taxi Activity Survey*. (Washington, DC: Federal Aviation Administration, 2003).
[31] Data provided by PA Consulting.

3.3.1 Aircraft Categories

The GA Survey puts each aircraft into one of 19 aircraft types based on criteria such as engine type and number of seats. The aircraft type groups used in the GA Survey are shown on the left hand side of Table 3-8. However, an objective of this report was to disaggregate information based on the aircraft certification and operating regulations. For purposes of the Economic Values report, new categories were created to align with the aircraft certification regulatory structure, and which consider factors like engine horsepower (for piston-powered aircraft) and aircraft weight (for jets and rotorcraft).[32]

Table 3-8: GA Survey Aircraft Classification Groups

GA Survey Group	Aircraft Description
1	Single-Engine Fixed Wing - Piston: 1 - 3 seats
2	Single-Engine Fixed Wing - Piston: 4+ seats
3	Twin-Engine Fixed Wing - Piston: 1 - 6 seats
4	Twin-Engine Fixed Wing - Piston: 7+ seats
5	Other Fixed Wing - Piston
6	Single-Engine Fixed Wing - Turboprop
7	Twin-Engine Fixed Wing - Turboprop: 1 - 12 seats
8	Twin-Engine Fixed Wing - Turboprop: 13+ seats
9	Other Fixed Wing - Turboprop
10	Twin-Engine Fixed Wing - Turbojet
11	Other Fixed Wing - Turbojet
12	Piston-Engine Rotorcraft
13	Single-Engine Turbine Rotorcraft
14	Multi-Engine Turbine Rotorcraft
15	Gliders
16	Lighter-than-air
17	Amateur
18	Exhibition
19	Other

Source: FAA General Aviation and Air Taxi Activity Survey CY 2002.

The mapping of the GA Survey categories to those used in this report is illustrated in Table 3-9. Aircraft were also grouped into categories based on year of manufacture: pre-1982, and 1982 and later. The categorization was performed as follows:

- GA Survey records were grouped by Make-Model-Series, which allowed comparison among identical aircraft.

[32] The expansion of the GA Survey sample to groups not included in the original sample design may reduce the level of reliability of some estimates. However, the provision of detailed data by aircraft certification regulation and type of operating authority provides data more relevant to regulatory evaluations. Readers should be cautious when using data from strata with few active aircraft.

- The GA Survey included a Horsepower field. However, many respondents left this field blank. For piston-powered aircraft, blank horsepower responses were filled in based on comparison with other aircraft of the same Make-Model-Series or from aircraft reference sources.[33]

- The GA Survey included a Year of Manufacture field. However, many respondents left this field blank. Blank Year of Manufacture responses were classified as pre and post 1982 based on comparison with other aircraft of the same Make-Model-Series or from aircraft reference sources, when these methods indicated that a particular MMS was made only before or after 1982. If the production run of an MMS spanned the 1982 dividing year, no Year of Manufacture fields for that MMS were assigned.

- Jet aircraft and rotorcraft were grouped into weight categories based on data in the aircraft reference sources cited above.

The GA Survey aircraft type categories, as shown on the right hand side of Table 3-9, were used to develop the 18 Economic Values aircraft groups.

Table 3-9: Relationship Between GA Survey and Economic Values Aircraft Groups

Economic Values Category	Aircraft Type	Certification	GA Survey Groups				
1	Piston engine airplanes 1 to 3 seats (<=200hp)	Part 23	1				
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	1				
3	Piston engine airplanes 4 to 9 seats one-engine (<=200hp)	Part 23	2				
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	Part 23	2				
5	Piston engine airplanes 4 to 9 seats multiengine	Part 23	4	3			
6	Piston engine airplanes 10 or more seats	Part 23	4	5			
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	6				
8	Turboprop airplanes 1 to 9 seats multiengine	Part 23	7				
9	Turboprop airplanes 10 to 19 seats	Part 23	6	7	8		
10	Turboprop airplanes 20 or more seats	Part 25	8	9			
11	Turbojet/Turbofan airplanes <=12,500 lbs	Part 23/25	10				
12	Turbojet/Turbofan airplanes>12,500 lbs and <=65,000lbs	Part 25	10	11			
13	Turbojet/Turbofan airplanes >65,000 lbs	Part 25	11	10			
14	Rotorcraft piston <=6,000 lbs	Part 27	12				
15	Rotorcraft turbine <=6,000 lbs	Part 27	13	14			
16	Rotorcraft piston >6,000 lbs	Part 29	12				
17	Rotorcraft turbine >6,000 lbs	Part 29	13	14			
18	Other		15	16	17	18	19

Source: GRA analysis

[33] *Jane's All the World's Aircraft*, various editions. *The Complete Encyclopedia of World Aircraft*, New York: Barnes and Noble, 2002. Various on-line sources, including Aircraft Identification Library at http://iat.nifc.gov/aircraft_library/index.asp.

3.3.2 Flight Hours by Activity Type and Aircraft Age

The GA Survey asked respondents how many total hours the aircraft flew during 2001, and the percentage of hours that were flown in each of 15 activity types. GRA grouped these activity types into the operating regulation parts that cover them to produce the percentage of time each aircraft flew under each part.

The following GA survey categories were assigned to the operating authorities to develop the following groups[34]:

- **Part 91**—Personal, business, instructional, corporate, sightseeing and work
- **Part 125**—Airplanes (not rotorcraft) 20 or more seats and not Part 135 or 137
- **Part 133**—Rotorcraft hours reported as external lift
- **Part 135**—Air taxi, air tours and medical
- **Part 137**—Aerial application in agriculture and forestry and other aerial application

The GA Survey provides a weighting factor for each record, which allows projection of the sample data to the aircraft population. The reported hours flown were multiplied by the weighting factor, and the percentages calculated for each of the above groups to produce the number of hours flown by the population under each operating regulation. In addition to the regulatory structure above, selected aircraft and hours flown information was tabulated from the GA Survey responses and FAA Registry, and reported for the following categories[35]:

- **Fractional Ownership**—Aircraft reported in FAA Aircraft Registry but not additive with above
- **Public**—Aircraft reported as public use
- **Air Taxi**—Reported air taxi aircraft and hours of usage on survey[36]

Table 3-10 shows the active general aviation aircraft by aircraft category. The 211,244 estimated active aircraft accounted for 27.0 million flight hours in 2002. It also shows the number of aircraft that reported air taxi usage as well as those that were reported as public aircraft. There were 13,311 aircraft that reported some air taxi use and almost 8,000 public aircraft in FY 2002. The listing for fractionally owned aircraft was taken from the FAA Aircraft Registry because the survey responses to this question did not appear reliable. Also shown are the average annual hours flown for each

[34] All assignments based on reported actual use in GA Survey. While the categories used in the GA Survey do not exactly correspond to the operating regulations, this allows a reasonable estimate of the activity levels under each part.
[35] The aircraft or hours reported are not additive with other aircraft data in the GA Survey.
[36] Assignments based on definition of activity and FAR regulatory requirements.

aircraft category. Overall, general aviation aircraft averaged 128 hours of flight time in 2002. The more sophisticated aircraft have much higher levels of utilization.

Table 3-10: Estimated Active General Aviation Aircraft and Hours Flown for FY 2002

	Economic Values Category	Certification	1 All Aircraft	2 Air Taxi Aircraft	3 Public Aircraft	4 Fractionally-Owned Aircraft	5 GA Survey Total Hours	6 Average Annual Hours All Aircraft
1	Piston engine airplanes 1 to 3 seats (<=200hp)	Part 23	33,050	1,252	548	7	2,947,937	89
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	6,079	261	263	1	1,026,415	169
3	Piston engine airplanes 4 to 9 seats one-engine (<=200hp)	Part 23	54,352	2,428	1,230	15	6,776,608	125
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	Part 23	49,993	2,858	1,624	15	5,569,662	111
5	Piston engine airplanes 4 to 9 seats multiengine	Part 23	16,783	1,616	977	2	2,399,533	143
6	Piston engine airplanes 10 or more seats	Part 23	801	204	122		166,266	208
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	1,004	188	65	1	393,588	392
8	Turboprop airplanes 1 to 9 seats multiengine	Part 23	2,150	309	220	3	431,823	201
9	Turboprop airplanes 10 to 19 seats	Part 23	3,650	507	415	41	1,008,164	276
10	Turboprop airplanes 20 or more seats	Part 25	219	123	54		72,668	332
11	Turbojet/Turbofan airplanes <=12,500 lbs	Part 23/25	2,029	342	57	101	541,463	267
12	Turbojet/Turbofan airplanes>12,500 lbs and <=65,000lbs	Part 25	4,969	1,049	31	329	1,725,676	347
13	Turbojet/Turbofan airplanes >65,000 lbs	Part 25	1,204	320	64	9	426,000	354
14	Rotorcraft piston <=6,000 lbs	Part 27	2,326	139	221	1	449,561	193
15	Rotorcraft turbine <=6,000 lbs	Part 27	3,640	604	1,477		1,173,330	322
16	Rotorcraft piston >6,000 lbs	Part 29	25	0	6		3,985	159
17	Rotorcraft turbine >6,000 lbs	Part 29	657	51	267	5	248,839	379
18	Other		28,313	1,060	246	169	1,678,582	59
All Aircraft			**211,244**	**13,311**	**7,887**	**699**	**27,040,100**	**128**

Source: All Aircraft, Air Taxi Aircraft and Public Aircraft--Analysis of responses to the FAA *General Aviation and Air Taxi Activity Survey,* CY *2002. Fractionally-Owned Aircraft--Analysis of FAA Aircraft Registry as of October, 2004.*

Note 1: Certification regulations assigned based on the current regulatory structure; many GA aircraft are certified to regulations which pre-date these.

Note 2: Columns are not additive; aircraft may be used for multiple purposes during a year.

Cols 1 - 3 and 5 - 6: Analysis of responses to the FAA General Aviation and Air Taxi Activity Survey, CY 2002.

Col 1: Aircraft reported.

Col 2: Aircraft for which Air Taxi hours reported. The number of aircraft in this category is significantly higher than the number of aircraft for which air taxi operations are their **primary** use.

Col 3: Aircraft for which Public hours reported.

Col 4: Analysis of FAA Aircraft Registry as of October, 2004. Aircraft with "Fractional Ownership" field marked "Y."

Col 5: Total hours reported.

Col 6: Column 5 divided by Column 1.

Table 3-11 shows the estimated general aviation hours flown by operating and certification part. As can be seen, a large proportion of the hours were flown under Part 91, the general flight rules. Activities under Part 135 (commuter and air taxi) and Part 137 (aerial application) are the next two most prevalent uses of general aviation aircraft. The total hours distributed by FAR part differ slightly from the total hours reported in the survey.

Table 3-11: GA Hours Flown by Operating Rule and Aircraft Type

		1	2	3	4	5	6	7
Economic Values Category		GA Survey Total Hours	Operating Rules					Total Hours
			Part 91	Part 125	Part 133	Part 135	Part 137	
1	Piston engine airplanes 1 to 3 seats (<=200hp)	2,947,937	2,912,064	0	0	11,492	24,382	2,947,937
2	Piston engine airplanes 1 to 3 seats (>200hp)	1,026,415	277,144	0	0	17,149	732,122	1,026,415
3	Piston engine airplanes 4 to 9 seats one-engine (<=200hp)	6,776,608	6,623,769	0	0	126,768	26,072	6,776,608
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	5,569,662	5,269,227	0	0	265,095	35,340	5,569,662
5	Piston engine airplanes 4 to 9 seats multiengine	2,399,533	2,037,916	0	0	341,192	20,425	2,399,533
6	Piston engine airplanes 10 or more seats	166,266	55,304	19,801	0	76,020	15,141	166,266
7	Turboprop airplanes 1 to 9 seats one-engine	393,588	63,696	0	0	108,922	220,970	393,588
8	Turboprop airplanes 1 to 9 seats multiengine	431,823	338,840	0	0	81,694	11,289	431,823
9	Turboprop airplanes 10 to 19 seats	1,008,164	810,259	0	0	181,765	16,140	1,008,164
10	Turboprop airplanes 20 or more seats	72,668	413	26,314	0	38,164	7,777	72,668
11	Turbojet/Turbofan airplanes <=12,500 lbs	541,463	485,484	0	0	55,957	23	541,463
12	Turbojet/Turbofan airplanes>12,500 lbs and <=65,000lbs	1,725,676	1,352,921	204,357	0	167,406	992	1,725,676
13	Turbojet/Turbofan airplanes >65,000 lbs	426,000	0	394,221	0	31,716	63	426,000
14	Rotorcraft piston <=6,000 lbs	449,561	385,795	0	471	5,426	58,340	450,032
15	Rotorcraft turbine <=6,000 lbs	1,173,330	732,432	153	37,301	336,389	104,356	1,210,631
16	Rotorcraft piston >6,000 lbs	3,985	3,345	0	3,345	0	640	7,330
17	Rotorcraft turbine >6,000 lbs	248,839	91,053	42,486	47,738	72,962	42,337	296,577
18	Other	1,678,582	1,592,736	15,140	0	18,224	52,482	1,678,582
All Aircraft		**27,040,100**	**23,032,398**	**702,471**	**88,856**	**1,936,340**	**1,368,891**	**27,128,956**

Source: Analysis of responses to the FAA *General Aviation and Air Taxi Activity Survey, CY 2002.*

Individual responses were sorted to classifications and expanded. Totals may not add due to rounding.

Note: The GA Survey provided total hours flown (Total Hours) and hours by category which are grouped here into FAR parts.

The total of hours by category differs slightly from the total hours flown.

Col 1: Total hours reported.

Cols 2 - 6: Hours reported under categories which correspond to Operating Rules shown.

Col 7: Sum of hours reported under all categories.

Table 3-12 shows the active general aviation aircraft and hours flown distributed by aircraft age. The general line of demarcation is aircraft built before 1982, and those built in 1982 and beyond. In 1982, most general aviation aircraft production in the United States ceased, especially for piston engine airplanes. It is interesting to note that about 75 percent of the active aircraft were built before 1982. However, more turboprop and jet hours were flown in aircraft produced after 1982.

Table 3-12: Active Aircraft and Hours Flown by Age Category

	Economic Values Category	Certification	1	2	3	4	5	6
			Total Hours Flown			Active Aircraft		
			All Aircraft	Aircraft Built Before 1982	Aircraft Built in 1982 and After	All Aircraft	Aircraft Built Before 1982	Aircraft Built in 1982 and After
1	Piston engine airplanes 1 to 3 seats (<=200hp)	Part 23	2,947,937	2,664,367	283,570	33,050	31,246	1,804
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	1,026,415	592,056	434,360	6,079	4,364	1,714
3	Piston engine airplanes 4 to 9 seats one-engine (<=200hp)	Part 23	6,776,608	5,591,128	1,185,480	54,352	49,970	4,382
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	Part 23	5,569,662	4,455,188	1,114,474	49,993	41,924	8,069
5	Piston engine airplanes 4 to 9 seats multiengine	Part 23	2,399,533	2,077,526	322,007	16,783	15,187	1,596
6	Piston engine airplanes 10 or more seats	Part 23	166,266	160,547	5,719	801	783	18
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	393,588	20,384	373,204	1,004	62	942
8	Turboprop airplanes 1 to 9 seats multiengine	Part 23	431,823	299,081	132,742	2,150	1,546	603
9	Turboprop airplanes 10 to 19 seats	Part 23	1,008,164	444,583	563,580	3,650	1,690	1,960
10	Turboprop airplanes 20 or more seats	Part 25	72,668	54,138	18,530	219	148	72
11	Turbojet/Turbofan airplanes <=12,500 lbs	Part 23/25	541,463	147,642	393,822	2,029	710	1,319
12	Turbojet/Turbofan airplanes>12,500 lbs and <=65,000lbs	Part 25	1,725,676	415,251	1,310,425	4,969	1,524	3,445
13	Turbojet/Turbofan airplanes >65,000 lbs	Part 25	426,000	94,994	331,006	1,204	473	731
14	Rotorcraft piston <=6,000 lbs	Part 27	449,561	151,934	297,627	2,326	1,107	1,219
15	Rotorcraft turbine <=6,000 lbs	Part 27	1,173,330	468,192	705,138	3,640	2,004	1,636
16	Rotorcraft piston >6,000 lbs	Part 29	3,985	2,430	1,555	25	18	6
17	Rotorcraft turbine >6,000 lbs	Part 29	248,839	111,553	137,286	657	333	324
18	Other		1,678,582	472,990	1,205,592	28,313	7,504	20,810
All Aircraft			**27,040,100**	**18,223,983**	**8,816,116**	**211,244**	**160,592**	**50,651**

Source: Analysis of responses to the FAA *General Aviation and Air Taxi Activity Survey,* CY *2002.*

Individual responses were sorted to classifications and expanded. Totals may not add due to rounding.

Col 1: Total hours reported.

Col 2: Total hours reported for aircraft built in 1981 or earlier.

Col 3: Total hours reported for aircraft built in 1982 or later.

Col 4: Aircraft reported.

Col 5: Aircraft reported which were built in 1981 or earlier.

Col 6: Aircraft reported which were built in 1982 or later.

Table 3-13 shows the number of reported air taxi aircraft and hours flown from the GA Survey. As noted above, there were approximately 13,300 air taxi aircraft, which flew an estimated 1.3 million flight hours. As can be seen, the larger piston and turboprop airplanes have the highest percentage of air taxi hours flown.

Table 3-13: Estimated Total Active Aircraft and Hours Flown for All Aircraft and Reported Air Taxi Aircraft

	Economic Values Category	Certification	1 Active Aircraft	2 Air Taxi Aircraft	3 Estimated Total Hours Flown	4 Estimated Air Taxi Hours Flown	5 Percent Air Taxi Hours	6 Estimated Average Hours Total	7 Estimated Average Hours-Air Taxi
1	Piston engine airplanes 1 to 3 seats (<=200hp)	Part 23	33,050	1,252	2,947,937	9,549	0%	89.2	7.6
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	6,079	261	1,026,415	15,785	2%	168.9	60.4
3	Piston engine airplanes 4 to 9 seats one-engine (<=200hp)	Part 23	54,352	2,428	6,776,608	92,513	1%	124.7	38.1
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	Part 23	49,993	2,858	5,569,662	228,702	4%	111.4	80.0
5	Piston engine airplanes 4 to 9 seats multiengine	Part 23	16,783	1,616	2,399,533	307,011	13%	143.0	190.0
6	Piston engine airplanes 10 or more seats	Part 23	801	204	166,266	74,717	45%	207.6	366.8
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	1,004	188	393,588	108,224	27%	391.9	576.9
8	Turboprop airplanes 1 to 9 seats multiengine	Part 23	2,150	309	431,823	40,312	9%	200.9	130.3
9	Turboprop airplanes 10 to 19 seats	Part 23	3,650	507	1,008,164	115,121	11%	276.2	226.9
10	Turboprop airplanes 20 or more seats	Part 25	219	123	72,668	38,133	52%	331.6	310.7
11	Turbojet/Turbofan airplanes <=12,500 lbs	Part 23/25	2,029	342	541,463	54,850	10%	266.9	160.5
12	Turbojet/Turbofan airplanes>12,500 lbs and <=65,000lbs	Part 25	4,969	1,049	1,725,676	155,770	9%	347.3	148.5
13	Turbojet/Turbofan airplanes >65,000 lbs	Part 25	1,204	320	426,000	31,693	7%	353.8	99.0
14	Rotorcraft piston <=6,000 lbs	Part 27	2,326	139	449,561	5,012	1%	193.3	36.1
15	Rotorcraft turbine <=6,000 lbs	Part 27	3,640	604	1,173,330	58,690	5%	322.4	97.2
16	Rotorcraft piston >6,000 lbs	Part 29	25	0	3,985	0	NA	161.1	NA
17	Rotorcraft turbine >6,000 lbs	Part 29	657	51	248,839	3,413	1%	378.6	67.3
18	Other		28,313	1,060	1,678,582	6,536	0%	59.3	6.2
All Aircraft			**211,244**	**13,311**	**27,040,100**	**1,346,032**	**5%**	**128.0**	**101.1**

Source: Analysis of responses to the FAA *General Aviation and Air Taxi Activity Survey, CY 2002.*
Individual responses were sorted to classifications and expanded. Totals may not add due to rounding.
Note: NA indicates that the population for which costs were available was insufficient to provide reliable results.
Col 1: Active aircraft are those flown at least once during the year.
Col 2: Active air taxi aircraft.
Col 3: Total hours flown by active aircraft, including air taxi.
Col 4: Reported air taxi hours (also included in Column 3). The number of aircraft in this category is significantly higher than the number of aircraft for which air taxi operations are their **primary** use.
Col 5: Column 4 divided by Column 3.
Col 6: Column 3 divided by Column 1.
Col 7: Column 4 divided by Column 2.

Table 3-14 shows a distribution by five-year increments of age for the active general aviation aircraft in the fleet and hours flown by operating regulation. Aircraft manufactured in 2002 are included with those manufactured between 1997 and 2001, making this a six-year increment. There were few such aircraft in the GA survey, and this was done to have a five-year increment begin with 1982. As can be seen, many of the aircraft hours flown are by aircraft produced between 1967 and 1981.

Table 3-14: Hours Flown Distribution of GA Aircraft by 5-Year Increments of Age

	1	2	3	4	5	6	7
Age Increment	Active Aircraft	Hours Flown					
Year of Manufacture		Part 91	Part 125	Part 133	Part 135	Part 137	Total FAR Hours
1997 - 2002	21,775	3,444,091	271,786	1,313	276,647	213,138	4,206,975
1992 - 1996	9,610	1,006,850	164,759	879	89,725	154,451	1,416,663
1987 - 1991	7,405	762,935	53,673	6,901	117,125	134,017	1,074,652
1982 - 1986	11,861	1,729,664	32,156	5,645	248,494	116,605	2,132,564
1977 - 1981	38,174	5,270,621	62,968	23,621	573,212	209,470	6,139,892
1972 - 1976	34,149	3,812,170	20,603	8,057	259,893	286,385	4,387,109
1967 - 1971	24,632	2,363,328	48,621	11,771	177,403	104,931	2,706,055
1962 - 1966	22,472	1,928,410	26,330	28,177	69,380	60,852	2,113,149
1957 - 1961	13,790	1,105,722	9,053	37	48,567	26,131	1,189,510
1952 - 1956	7,132	584,581	10,454	622	41,085	16,685	653,427
1947 - 1951	7,878	408,753	0	1,833	9,859	14,683	435,128
1942 - 1946	9,245	448,710	1,944	0	22,102	30,959	503,716
1941 or Earlier	3,121	166,564	122	0	2,847	583	170,116
All Aircraft	**211,244**	**23,032,398**	**702,471**	**88,856**	**1,936,340**	**1,368,891**	**27,128,956**

Source: Analysis of responses to the FAA *General Aviation and Air Taxi Activity Survey, CY 2002.*
Col 1: Aircraft reported.
Cols 2 - 6: Hours reported under categories which correspond to Operating Rules shown.
Col 7: Sum of hours reported under all categories.

3.3.3 GA Capacity and Utilization

Table 3-15 shows the average capacity (in seats and gross weight) as well as the average percentage of seats occupied for each aircraft group. These data were tabulated from the NTSB accident record for the 1982 to 2003 time period. In this time period, there were 49,180 accidents and incidents with reported data on aircraft seating capacity and 52,229 accidents and incidents with gross weight data. This period was selected to provide a large number of observations. It assumes that number of seats, occupants, and gross weight of accident aircraft apply to the population of aircraft within each group. The average GA aircraft has about 3.7 seats and flies about half full. It should be noted that the jet category of more than 65,000 hours includes airline-type aircraft that were flown under Part 91.

Table 3-15: GA Capacity and Utilization

	Economic Values Category	Certification	1 Average Seats Occupied	2 Percent of Seats Occupied	3 Average Gross Weight
1	Piston engine airplanes 1 to 3 seats (<=200hp)	Part 23	1.8	76.3%	1,414
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	1.8	78.2%	3,011
3	Piston engine airplanes 4 to 9 seats one-engine (<=200hp)	Part 23	4.3	43.1%	2,556
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	Part 23	4.4	48.8%	2,748
5	Piston engine airplanes 4 to 9 seats multiengine	Part 23	5.9	43.1%	6,252
6	Piston engine airplanes 10 or more seats	Part 23	13.4	36.1%	9,826
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	1.8	77.8%	6,334
8	Turboprop airplanes 1 to 9 seats multiengine	Part 23	6.1	47.7%	11,411
9	Turboprop airplanes 10 to 19 seats	Part 23	13.1	45.5%	11,414
10	Turboprop airplanes 20 or more seats	Part 25	25.4	45.3%	18,478
11	Turbojet/Turbofan airplanes <=12,500 lbs	Part 23/25	5.2	51.2%	8,413
12	Turbojet/Turbofan airplanes >12,500 lbs and <= 65,000 lbs	Part 25	9.0	43.8%	22,847
13	Turbojet/Turbofan airplanes >65,000 lbs	Part 25	108.0	28.2%	279,474
14	Rotorcraft piston <=6,000 lbs	Part 27	2.4	66.4%	1,863
15	Rotorcraft turbine <=6,000 lbs	Part 27	4.9	49.8%	3,507
16	Rotorcraft piston >6,000 lbs	Part 29	5.2	27.7%	12,881
17	Rotorcraft turbine >6,000 lbs	Part 29	6.8	40.7%	10,997
18	Other		2.6	38.1%	1,387
19	**All**		**3.7**	**52.7%**	**3,384**

Source: GRA analysis of NTSB accident and incident data for the 1982 to 2003 time period.
Note: Only data reported for accidents that were operating under Part 91, 125, 133, 135, and 137 are included.
Col 1: Average (weighted) number of seats for aircraft in NTSB accident and incident data from 1982 to 2003.
Col 2: Number of seats divided by number of passengers.
Col 3: Weighted average gross weight.

3.3.4 Alternate Estimate of Air Taxi Hours

Table 3-16 shows an alternative estimate of air taxi hours flown using FAA data that report the number of aircraft that are authorized to conduct on-demand operations under Part 135 and the activity data from the CY 2002 GA Survey. Using this method produces an estimate of 1.7 million hours for on-demand Part 135 operations. This can be contrasted with the 1.3 million "air taxi" or 1.9 million Part 135 hours tabulated from the GA Survey. There is uncertainty about the actual levels of on-demand Part 135 activity. Analysts can consult APO-110 staff analysts to get further information on Part 135 activity.

Table 3-16: Alternate Estimate of Air Taxi Hours Flown

	1	2	3	4	5
Aircraft Type	**Unique Aircraft**	**Average Annual Total Hours**	**Estimated Annual Total Hours**	**Average Annual Air Taxi Hours**	**Estimated Annual Air Taxi Hours**
Single-Engine Piston	2,246	148.5	333,605	51.0	114,473
Multiengine Piston	2,670	281.3	750,959	209.8	560,167
Turboprop	1,762	388.4	684,420	267.7	471,748
Jet	2,163	316.1	683,710	141.6	306,342
Rotorcraft Piston	165	239.6	39,541	36.1	5,959
Rotorcraft Turbine	2,065	330.1	681,685	94.9	195,984
Other	1	51.0	51	6.2	6
Total	**11,072**		**3,173,971**		**1,654,679**

Source: Unique aircraft from FAA Operating Specification Subsystem (Data as of July 2001); average total and air taxi hours from 2002 GA Survey.
Col 1: Total unique aircraft in FAA Operating Specification Subsystem, by aircraft type.
Col 2: Average annual hours from GA Survey.
Col 3: Column 1 multiplied by column 2.
Col 4: Average annual air taxi hours from GA Survey, by aircraft type.
Col 5: Column 1 multiplied by column 4.

3.4 MILITARY AIRCRAFT

Military aircraft can impact FAA investment decisions because they utilize the resources in the national airspace system. The data sources for the U.S. military aircraft fleet came from the *2002 Aviation and Aerospace Almanac* produced by McGraw-Hill. Data on annual hours flown by aircraft type were obtained from the military services either via the worldwide web or through telephone interviews with relevant officials. Data were divided into the same categories as were used in the prior economic values publication (FAA-APO-98-8). As shown in Table 3-17, the total military fleet contains almost 16,000 aircraft. These aircraft average almost 400 hours a year in flight time. The largest aircraft category is rotary wing aircraft. The aircraft types with the largest average annual hours flown are turbojet and turbofan aircraft with three or more engines. These typically are transports, tankers, or surveillance aircraft.

Table 3-17: U.S. Military Fleet and Utilization Levels (Average Weighted by Fleet)

	1	2	3
Aircraft Type	**Total Fleet**	**Average Annual Flight Hours Per Aircraft**	**Total Flight Hours**
Piston	3	N/A	N/A
Rotary Wing Aircraft	7,125	297	2,117,609
Turbojet/fan 3+ Engines	1,167	995	1,160,763
Turbojet/fan Attack/Fighter	4,051	323	1,309,960
Turbojet/fan Other	1,587	452	717,209
Turboprop	2,017	487	981,308
Other	22	N/A	N/A
N/A	2	N/A	N/A
Total	**15,974**	**394**	**6,286,849**

Source: Fleet data from Aviation and Aerospace Almanac, McGraw-Hill, 2002. Hours per aircraft from military services.
Col 1: Total number of aircraft (by aircraft type) in military service.
Col 2: Average annual flight hours, weighted by fleet.
Col 3: Total flight hours.

SECTION 4: AIRCRAFT OPERATING COSTS

4.1 INTRODUCTION

This section provides estimates of variable and fixed aircraft operating costs. Aircraft variable operating costs are important factors in the evaluation of FAA investment and regulatory programs that concern the time spent in air transportation. The variable operating costs of aircraft affect aircraft operators directly and users of air service indirectly in the form of higher or lower fares or taxes. Fixed aircraft costs may also be important in evaluating the effects of FAA investment and regulatory programs that affect fleet size, cause aircraft to be more productive, or cause aircraft to be out of service for extended periods of time.

To put airline costs in perspective, this section first shows the relationship of aircraft operating costs to total airline operating costs and then presents another disaggregation of total airline costs. After this, aircraft operating costs are presented in more detail. Costs in this section are shown for large air carrier, general aviation and military equipment types. Data are presented for aircraft categories identical to those in Section 3. More detailed data are provided in tables available on the APO website (www.faa.gov/regulations_policies/policy_guidance/benefit_cost/) Summary data are weighted by block or airborne hours.

Cost data are defined for air carrier and general aviation aircraft as variable or fixed. Variable costs change in proportion to aircraft usage, and include fuel and oil, maintenance and crew costs.[37] Fixed costs show little or no change in proportion to changes in activity. For example, in the short-term, a change in activity may not affect an operator's decision about a specific aircraft or fleet of aircraft. In the longer-term, the operator could change its fleet and ownership costs.

There are two estimates of fixed costs provided. The first is fixed accounting charges including depreciation, insurance, and rental charges reported by carriers in Forms 41 and 298-C, or which have been estimated for GA aircraft. The second is provided for commercial aircraft only. If an FAA initiative improves system efficiency, an operator may be able to provide the same service with fewer aircraft; alternatively, an FAA initiative may cause aircraft to be out of service or to be removed from the fleet entirely. In either case, an estimate of the benefit or cost to the carrier of an FAA initiative would include the carrier's opportunity costs—the value of the aircraft in its

[37] Some analysts assume that crew costs are fixed in the short run; this is especially the case for entities that operate one or a small number of aircraft.

next best use. One immediate alternative use of an aircraft might be to lease it out to another operator. Since there is a well-defined market for operating (short-term) leases for most aircraft types, one can use the average monthly lease rate as a good proxy for the benefit or cost over a defined period of time.

4.1.1 Average Versus Incremental Cost

By necessity, the operating cost data presented in this chapter represent average costs. Cost categories such as ownership costs are reported separately so they can be included or excluded in a specific analysis. However, economists typically look at the concept of incremental costs (i.e., the changes in costs from small changes in levels of activity). Incremental costs may differ from the average costs used in this chapter, but the data from Form 41 and other sources using average costs are well-accepted industry standards. Analysts are cautioned, however, that average costs may not always be the most appropriate measure.

4.1.2 Change in Industry Structure and Implications for Airline Operating Cost Trends

The U.S. airline industry has undergone considerable financial restructuring following the events of September 11, 2001. This, coupled with a shift in the business cycle, caused severe losses for U.S. air carriers, and a situation where the supply of seats in the industry well exceeded demand at existing price levels. In response, carriers reduced fares to maintain traffic levels, or took aircraft out of service. This in turn reduced airline revenues and caused carriers to enter into significant cost reduction programs. Some carriers reorganized their finances and obligations through the bankruptcy process. During this time, the “old line” carriers actually reduced their level of output while the “low cost carriers” increased market share.

Because the Form 41 data represent aggregations across the industry, these trends in reduced costs by carrier and a change in the composition of the industry likely have had some impact on average hourly aircraft operating costs and are likely to continue to do so at least in the near future. Readers are cautioned that the values reported below were developed during a period of industry restructuring. As such, not all cost or fleet changes are reflected in the reported data.

4.1.3 Direct and Indirect Costs

Table 4-1 shows direct and indirect operating expenses for major air carriers.[38] As can be seen, direct costs are below 50 percent of total costs for major air carriers. The direct costs will be examined in more detail below. However, this table provides a

[38] Major air carriers are those with annual revenues of more than $1 billion; direct and indirect costs are categories used on Schedule P.7 of Form 41.

perspective on overall carrier costs and the relative magnitudes of each category of costs. Industry costs for carriers filing Schedule P-7 of Form 41 totaled $104.8 billion in 2002. Overall, the average total operating cost per block hour for these air carriers was $7,126 in 2002.

Table 4-1: Major Carrier Costs – Direct and Indirect Costs
Year 2002

Category	Costs (US$millions)	Percent	Cost Per Block Hour	Cost Per Airborne Hour
Total Crew Cost	$11,965	11.42%	$814	$963
Total Fuel & Oil	$11,264	10.75%	$766	$907
Total Maintenance	$10,538	10.06%	$717	$848
Total Rentals	$5,877	5.61%	$400	$473
Total Depreciation	$4,275	4.08%	$291	$344
Total Insurance	$273	0.26%	$19	$22
Other Costs	$2,375	2.27%	$162	$191
Total Direct	**$46,567**	**44.45%**	**$3,168**	**$3,749**
Passenger Service Expense	$9,685	9.24%	$659	$780
Aircraft Service Expense	$6,593	6.29%	$448	$531
Traffic Service Expense	$11,431	10.91%	$778	$920
Reservations and Sales Expense	$7,447	7.11%	$507	$600
Administration and Publicity Expense	$8,708	8.31%	$592	$701
Maintenance And Depreciation Ground	$2,589	2.47%	$176	$208
Depreciation Expense - Maintenance Equip	$223	0.21%	$15	$18
Amortization (Non-Flight Equipment)	$319	0.30%	$22	$26
Service Sales and General Operating Expenses	**$46,995**	**44.86%**	**$3,197**	**$3,784**
Transport Related Expenses	$11,202	10.69%	$762	$902
Total Indirect	**$58,198**	**55.55%**	**$3,959**	**$4,686**
Total Operating Expenses	**$104,765**	**100.00%**	**$7,126**	**$8,435**

These costs figures are from Schedule P-7 - Operating Expenses by Functional Grouping.
The total includes all Major Scheduled Passenger and Other Carriers with the exception of DHL which did not file a P-7 in the last three quarters of 2002.
Note: Part 25 aircraft unless otherwise noted.

Table 4-2 shows air carrier costs per block hour by objective grouping.[39] These data are divided into passenger and all cargo carriers and then into the groupings of Major, National, and Regional carriers.[40] In general, all cargo carriers have higher total block hour costs than passenger carriers. As can be seen, transport-related expenses are a large proportion of total costs for Major and National all cargo air carriers.

[39] The block hour data in Tables 4-1 and 4-2 are not directly comparable because there are different groupings of carriers (e.g., Table 4-1 contains data for both passenger and all cargo carriers.)
[40] Major air carriers have annual revenues of more than $1 billion; national carriers have annual revenues of more than $100 million.

Table 4-2: Large Air Carrier Operating Expenses per Block Hour by Objective Groupings Year 2002

Expense Category	Passenger			All Cargo			Total
	Majors	Nationals	Regionals	Majors	Nationals	Regionals	Carriers
General Management Personnel	$30	$44	$197	$82	$103	$131	$37
Flight Personnel	$816	$329	$563	$935	$454	$349	$751
Maintenance Labor	$238	$94	$165	$663	$156	$156	$245
Aircraft and Traffic Handling	$480	$183	$68	$576	$69	$95	$439
Other Personnel	$252	$89	$83	$380	$279	$88	$238
Total Salaries	**$1,817**	**$739**	**$1,076**	**$2,636**	**$1,060**	**$820**	**$1,710**
Total Fringe Benefits	$768	$256	$466	$824	$428	$327	$696
Total Salaries and Benefits	**$2,584**	**$995**	**$1,541**	**$3,459**	**$1,487**	**$1,147**	**$2,406**
Total Materials	$1,136	$617	$1,473	$1,891	$2,551	$1,407	$1,133
Total Services	$1,131	$701	$1,255	$1,213	$1,433	$1,214	$1,083
Landing Fees	$138	$73	$384	$222	$193	$29	$136
Rentals	$570	$510	$928	$1,038	$1,060	$568	$598
Depreciation	$362	$98	$196	$872	$577	$328	$361
Amortization	$42	$4	$9	$19	$74	$10	$35
Other	$120	$141	$424	$1,094	-$101	$336	$186
Transport Related Expenses	$291	$17	$4	$6,502	$2,304	$82	$670
Total Operating Expenses	**$6,375**	**$3,156**	**$6,215**	**$16,311**	**$9,579**	**$5,113**	**$6,609**
Total Non-Operating Expenses	$70	$110	$274	$378	$264	$52	$98
Total Expenses	**$6,445**	**$3,267**	**$6,489**	**$16,689**	**$9,844**	**$5,164**	**$6,707**

The Operating Expenses come directly from DOT Schedule P6 "Operating Expense by Objective Grouping."
The "Other Information" is from DOT Schedule P1.2 "Statement of Operations" and DOT Schedule T-2 "Traffic Statistics."
Note: Part 25 aircraft unless otherwise noted.

4.2 AIR CARRIER AIRCRAFT OPERATING COST DATA

Cost data for air carriers were derived from Bureau of Transportation Statistics (BTS) Form 41 and Form 298-C data. Form 41 data cover large air carriers (generally those with annual revenues of at least $100 million).[41] Form 298-C data cover smaller air carriers (generally smaller carriers operating under FAR 121 and/or FAR 135) and were available for the 12-month period ending September 2001.[42] Table 4-3 shows aggregate average aircraft operating cost per block hour and activity data for Part 121 and Part 135 air carriers. Part 135 air carriers represent a very small proportion of the air carrier industry.[43] This table includes all carriers that report on either Form 41 or Form 298-C. However, because certain carriers provide different levels of information, the data in the sections that follow are presented in three groups:

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[41] Some carriers have exemptions from reporting Form 41 data.
[42] Data were incomplete for later periods, and reporting requirements changed in 2002, making it impossible to develop a consistent and useful database for later periods. In addition, service was disrupted by September 11, 2001 terrorist acts, and made the period ending with the September 2001 quarter perhaps the least disrupted period to use for this study. While one quarter of the year chosen was affected, two or more quarters after the September 2001 quarter were seriously disrupted.
[43] Regulatory changes in the late 1990s caused many carriers to shift from Part 135 to Part 121.

- Large Form 41
- Regional Form 41
- Form 298-C

For Part 121 air carriers, average variable aircraft operating costs are $2,103 and average total costs are $2,766 per block hour. Comparable costs for Part 135 aircraft are $287 and $377 per block hour, respectively. Data are shown for the following categories of cost for each equipment type:

- Crew: Includes flight deck crew.
- Fuel and Oil: Aircraft fuel and oil costs are the dollar value of stocks issued for flight operations.
- Maintenance: Maintenance costs include labor, parts, materials, and burden for aircraft and engine maintenance.
- Rentals: The amortization (for capital leases) and rental charges (for operating leases) for fixed assets are recorded in this category. Air carriers that file on Form 298-C do not report separate amounts for rentals and amortization.
- Depreciation: Depreciation measures the consumption of a fixed asset over its life, due to use and time. Depreciation charges recorded by air carrier flight equipment, engines and related equipment are included in this category. Depreciation is based on the historical cost of the aircraft.
- Insurance: These are charges typically paid by coverage that indemnifies operators for accidents.
- Other: Insurance costs are reported as "other" costs in Form 298-C.[44, 45]

The variable operating costs in each table are comprised of Fuel and Oil, Total Maintenance, and Crew. Selected ownership costs are those most closely related to the carrier's cost of ownership of the aircraft, namely depreciation, amortization, rentals, and insurance.

[44] See Part 298.63 reporting requirements for complete definitions.
[45] "Other" is defined as including "general (hull) insurance and all other expenses incurred in the in-flight operation of aircraft and holding of aircraft and aircraft operational personnel in readiness for assignment to in-flight status, which are not provided for otherwise in this schedule." See Part 298.63(d)(l)(iii).

Table 4-3: Summary Air Carrier Average Aircraft Operating Costs and Block Hours

	1	2	3	4	5	6	7	8	9
	Part 121 (Form 41 and 298-C carriers)			Part 135 (298-C Carriers)			Total (Part 121 + Part 135)		
Economic Values Category	Average Variable Costs Per Block Hour	Average Total Costs Per Block Hour	Total Block Hours*	Average Variable Costs Per Block Hour	Average Total Costs Per Block Hour	Total Block Hours*	Average Variable Costs Per Block Hour	Average Total Costs Per Block Hour	Total Block Hours*
Two-Engine Narrow-Body	$1,894	$2,456	11,512,186	NR	NR	NR	$1,894	$2,456	11,512,186
Two-Engine Wide-Body	$3,343	$4,403	2,191,418	NR	NR	NR	$3,343	$4,403	2,191,418
Three-Engine Narrow-Body	$3,723	$4,459	409,095	NR	NR	NR	$3,723	$4,459	409,095
Three-Engine Wide-Body	$4,501	$6,359	593,434	NR	NR	NR	$4,501	$6,359	593,434
Four-Engine Narrow-Body	$4,908	$6,177	92,226	NR	NR	NR	$4,908	$6,177	92,226
Four-Engine Wide-Body	$5,945	$8,054	437,135	NR	NR	NR	$5,945	$8,054	437,135
Regional Jet under 70 seats	$728	$1,055	1,683,830	$661	$1,657	790	$728	$1,055	1,684,620
Regional Jet 70 to 100 seats	$1,139	$1,707	102,049	NR	NR	NR	$1,139	$1,707	102,049
Turboprops under 20 seats (Part 23)	$560	$719	317,961	$424	$580	61,638	$538	$697	379,599
Turboprops under 20 seats (Part 25)	$710	$1,027	25,545	NR	NR	NR	$710	$1,027	25,545
Turboprops with 20 or more seats	$649	$914	912,817	$728	$973	6,902	$650	$914	919,719
Piston Engine (Part 23)	$316	$371	32,153	$225	$283	188,474	$238	$296	220,627
Piston Engine (Part 25)	$1,784	$1,809	14,891	$51	$71	133	$1,769	$1,793	15,024
Total	**$2,103**	**$2,766**	**18,324,740**	**$287**	**$377**	**257,937**	**$2,078**	**$2,733**	**18,582,677**

Source: Form 41 and Form 298

*Note: Form 41 Carriers Utilization Hours are slightly lower in Chapter 4 from the numbers reported in Chapter 3 because costs are not reported for all aircraft.

Note: Part 25 aircraft unless otherwise noted.

Col 1: Average variable cost (weighted by block hours), combined data for large passenger and air freight Form 41 operators, regional passenger and air freight Form 41 operators, Alaskan and Non-Alaskan Part 121 operators.

Col 2: Average total cost (weighted by block hours), combined data for large passenger and air freight Form 41 operators, regional passenger and air freight Form 41 operators, Alaskan and Non-Alaskan Part 121 operators.

Col 3: Total block hours for large passenger and air freight Form 41 operators, regional passenger and air freight Form 41 operators, Alaskan and Non-Alaskan Part 121 operators.

Col 4: Average variable cost (weighted by block hours) for Alaskan and Non-Alaskan Part 135 operators.

Col 5: Average total cost (weighted by block hours) for Alaskan and Non-Alaskan Part 135 operators.

Col 6: Total block hours for Alaskan and Non-Alaskan Part 135 operators.

Col 7: Average variable cost (weighted by block hours), combined data for large passenger and air freight Form 41 operators, regional passenger and air freight Form 41 operators, and Alaskan and Non-Alaskan (Part 121 and Part 135) operators.

Col 8: Average total cost (weighted by block hours), combined data for large passenger and air freight Form 41 operators, regional passenger and air freight Form 41 operators, and Alaskan and Non-Alaskan (Part 121 and Part 135) operators.

Col 9: Total block hours, combined data for large passenger and air freight Form 41 operators, regional passenger and air freight Form 41 operators, and Alaskan and Non-Alaskan (Part 121 and Part 135) operators.

Block hours are the common industry measure for presenting operating cost data and are used in this report. Tables are also provided on the APO website for costs broken down by airborne hours. Analysts using the data need to identify the appropriate value, block or airborne hours. (Section 6 discusses cost by phase of flight, which divides elapsed block times into component flight segments.) Variable costs include all aircraft operating cost elements, except rentals, depreciation and insurance. This provides an industry-wide perspective for passenger and all cargo operators combined.

4.2.1 Large Form 41 Passenger and All-Cargo Cost Per Block Hour

Table 4-4 summarizes variable and fixed costs per block hour for large passenger (Form 41) air carriers. Total operating costs average $2,741 per block hour while variable costs average $2,100 per block hour. On average, each category—crew, fuel and oil, maintenance and ownership, insurance—comprise about one-fourth of total operating costs. Two-engine wide-body and narrow-body aircraft along with regional jets with less than 70 seats are the groups that comprise the majority of activity, measured in block hours.

Table 4-4: Large (Form 41) Passenger Part 121 Air Carrier Operating and Fixed Costs Per Block Hour

	1	2	3	4	5	6	7	8	9	10
	Per Block Hour									
Economic Values Category	Crew	Fuel & Oil	Total Maintenance	Total Variable Costs	Rentals	Depreciation	Insurance	Total Fixed Costs	Total Costs	Block Hours
Two-Engine Narrow-Body	$674	$616	$589	$1,879	$357	$180	$15	$552	$2,432	11,353,179
Two-Engine Wide-Body	$1,120	$1,225	$941	$3,285	$409	$509	$31	$949	$4,234	1,878,384
Three-Engine Narrow-Body	$1,196	$807	$496	$2,499	$79	$390	$9	$478	$2,976	170,762
Three-Engine Wide-Body	$1,369	$1,753	$1,363	$4,485	$723	$1,259	$46	$2,027	$6,512	255,679
Four-Engine Narrow-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Four-Engine Wide-Body	$1,941	$2,455	$1,655	$6,051	$1,275	$784	$42	$2,102	$8,153	321,888
Regional Jet under 70 seats	$235	$304	$208	$748	$203	$102	$7	$312	$1,060	933,530
Regional Jet 70 to 100 seats	$353	$443	$343	$1,139	$448	$70	$50	$567	$1,707	102,049
Turboprops under 20 seats (Part 23)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops with 20 or more seats	$266	$147	$562	$975	$330	$56	$7	$393	$1,369	270,929
Piston Engine (Part 23)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Piston Engine (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
All Aircraft	**$737**	**$722**	**$641**	**$2,100**	**$377**	**$246**	**$17**	**$640**	**$2,741**	**15,286,400**

Source: BTS Form 41 for year-end 2002. Also Schedule P5.2.
NR: None reported
Note: Part 25 aircraft unless otherwise noted.
Col 1: Total flight deck (pilot) costs divided by total block hours.
Col 2: Cost of total fuel and oil consumed divided by total block hours.
Col 3: Airframe and Engine Maintenance, plus overhead (burden).
Col 4: Columns 1+2+3.
Col 5: Total amortization (for capital leases) and rental charges (for operating leases) divided by total block hours.
Col 6: Total depreciation charges divided by block hours.
Col 7: Total insurance costs divided by total block hours.
Col 8: Columns 5+6+7.
Col 9: Columns 4+8.
Col 10: Block hours reported in Form 41.

Table 4-5 reports operating cost data for Form 41 all-cargo airlines. Many of these aircraft have been converted to all-cargo configurations from passenger aircraft. Total operating costs average $5,922 per block hour while variable costs average $4,339 per block hour. No smaller aircraft are reported by large all cargo carriers, which raises the average cost per block hour. As above, each of the major categories comprises about one-fourth of total operating costs.

Table 4-5: Large (Form 41) Air Cargo Carrier Operating and Fixed Costs Per Block Hour

	1	2	3	4	5	6	7	8	9	10
	Per Block Hour									
Economic Values Category	**Crew**	**Fuel & Oil**	**Total Maintenance**	**Total Variable Costs**	**Rentals**	**Depreciation**	**Insurance**	**Total Fixed Costs**	**Total Costs**	**Block Hours**
Two-Engine Narrow-Body	$1,339	$886	$1,068	$3,293	$105	$1,082	$97	$1,284	$4,577	116,769
Two-Engine Wide-Body	$1,366	$1,180	$1,133	$3,679	$1,113	$640	$89	$1,842	$5,521	276,283
Three-Engine Narrow-Body	$1,894	$891	$2,171	$4,956	$311	$646	$42	$998	$5,955	190,932
Three-Engine Wide-Body	$1,353	$1,663	$1,396	$4,412	$1,196	$491	$60	$1,746	$6,158	327,390
Four-Engine Narrow-Body	$1,292	$1,713	$1,904	$4,908	$360	$829	$79	$1,268	$6,177	92,226
Four-Engine Wide-Body	$1,182	$2,909	$1,545	$5,636	$1,226	$862	$48	$2,136	$7,772	105,813
Regional Jet under 70 seats	$267	$480	$573	$1,320	$0	$601	$119	$720	$2,040	8,842
Regional Jet 70 to 100 seats	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 23)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops with 20 or more seats	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Piston Engine (Part 23)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Piston Engine (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
All Aircraft	**$1,417**	**$1,443**	**$1,479**	**$4,339**	**$835**	**$680**	**$69**	**$1,583**	**$5,922**	**1,118,255**

Source: BTS Form 41 for year-end 2002. Also Schedule P5.2.
NR: None reported
Note: Part 25 aircraft unless otherwise noted.
Col 1: Total flight deck (pilot) costs divided by total block hours.
Col 2: Cost of total fuel and oil consumed divided by total block hours.
Col 3: Airframe and Engine Maintenance, plus overhead (burden).
Col 4: Columns 1+2+3.
Col 5: Total amortization (for capital leases) and rental charges (for operating leases) divided by total block hours.
Col 6: Total depreciation charges divided by block hours.
Col 7: Total insurance costs divided by total block hours.
Col 8: Columns 5+6+7.
Col 9: Columns 4+8.
Col 10: Block hours reported in Form 41.

4.2.2 Form 41 Passenger and All-Cargo Regional Carriers Cost Per Block Hour

Table 4-6 presents operating cost per block hour data for regional passenger carriers that file Form 41. These carriers report in a different format than the large Form 41 carriers. All of the activity is comprised of two- and three-engine narrow- and wide-body aircraft. The average total cost per block hour is $4,226, while the variable cost[46] per block hour is $3,218.

Table 4-6: Regional (Form 41) Passenger Air Carrier Operating and Fixed Costs Per Block Hour

	1	2	3	4	5	6	7	8	9	10
Economic Values Category	**Crew**	**Fuel & Oil**	**Flight Ops Other (Except Rentals)**	**Total Flight Ops (Except Rentals)**	**Maintenance Flight Equip**	**Deprec & Rental Flight Equip**	**Flight Equip Expenses**	**Total Flight Operations Plus Maintenance**	**Total Cost**	**Block Hours**
Two-Engine Narrow-Body	$279	$745	$423	$1,447	$525	$1,087	$1,612	$1,972	$3,059	42,238
Two-Engine Wide-Body	$501	$1,012	$791	$2,305	$857	$1,082	$1,940	$3,162	$4,244	2,129
Three-Engine Narrow-Body	$613	$1,361	$893	$2,867	$749	$708	$1,457	$3,616	$4,324	16,095
Three-Engine Wide-Body	$762	$1,668	$3,198	$5,628	$2,764	$1,161	$3,926	$8,392	$9,553	8,951
Four-Engine Narrow-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Four-Engine Wide-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Regional Jet under 70 seats	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Regional Jet 70 to 100 seats	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 23)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops with 20 or more seats	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Piston Engine (Part 23)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Piston Engine (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
All Aircraft	**$426**	**$1,015**	**$901**	**$2,342**	**$876**	**$1,008**	**$1,884**	**$3,218**	**$4,226**	**69,413**

Source: BTS Form 41 for year-end 2002. Also Schedule P5.1
Note: Part 25 aircraft unless otherwise noted.
Col 1: Total flight deck (pilot) costs divided by total block hours.
Col 2: Cost of total fuel and oil consumed divided by total block hours.
Col 3: Total of all other flight operations expenses (except rentals) divided by total block hours.
Col 4: Columns 1+2+3.
Col 5: Total for maintenance of flight equipment divided by total block hours.
Col 6: Total depreciation and flight equipment rental expenses divided by block hours.
Col 7: Columns 5+6.
Col 8: Columns 4+5.
Col 9: Columns 4+7.
Col 10: Block hours reported in Form 41.

[46] To maintain compatibility with large Form 41 carriers, we define variable costs to be the sum of total flight operations plus maintenance.

Table 4-7 presents similar data for regional all-cargo carriers that file Form 41. These carriers report data for small aircraft. The average total aircraft cost per block hour is $3,938, while the average total flight operations plus maintenance cost is $3,235. Two-engine wide-body and three-engine narrow-body aircraft together comprise about 62 percent of the total block hours.

Table 4-7: Regional (Form 41) Air Freight Carrier Operating and Fixed Costs Per Block Hour

	1	2	3	4	5	6	7	8	9	10
Economic Values Category	**Crew Pilots Only**	**Fuel & Oil**	**Flight Ops Other (Except Rentals)**	**Total Flight Ops (Except Rentals)**	**Maintenance Flight Equip**	**Deprec & Rental Flight Equip**	**Flight Equip Expenses**	**Total Flight Operations Plus Maintenance**	**Total Cost**	**Block Hours**
Two-Engine Narrow-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Two-Engine Wide-Body	$590	$1,277	$348	$2,215	$1,615	$781	$2,396	$3,830	$4,611	34,622
Three-Engine Narrow-Body	$483	$1,167	$328	$1,978	$962	$556	$1,517	$2,940	$3,496	31,306
Three-Engine Wide-Body	$663	$2,068	$92	$2,823	$763	$1,170	$1,933	$3,585	$4,755	1,414
Four-Engine Narrow-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Four-Engine Wide-Body	$570	$2,465	$1,047	$4,082	$1,711	$2,034	$3,745	$5,793	$7,828	9,434
Regional Jet under 70 seats	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Regional Jet 70 to 100 seats	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 23)	$80	$77	$58	$214	$44	$138	$182	$259	$397	1,482
Turboprops under 20 seats (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops with 20 or more seats	$933	$920	$161	$2,014	$1,749	$1,054	$2,803	$3,764	$4,818	9,076
Piston Engine (Part 23)	$106	$134	$20	$260	$169	$18	$187	$429	$447	5,375
Piston Engine (Part 25)	$280	$699	$72	$1,051	$733	$18	$751	$1,784	$1,802	14,653
All Aircraft	**$514**	**$1,177**	**$326**	**$2,017**	**$1,219**	**$702**	**$1,921**	**$3,235**	**$3,938**	**107,362**

Source: BTS Form 41 for year-end 2002. Also Schedule P5.1
Note: Part 25 aircraft unless otherwise noted.
Col 1: Total flight deck (pilot) costs divided by total block hours.
Col 2: Cost of total fuel and oil consumed divided by total block hours.
Col 3: Total of all other flight operations expenses (except rentals) divided by total block hours.
Col 4: Columns 1+2+3.
Col 5: Total for maintenance of flight equipment divided by total block hours.
Col 6: Total depreciation and flight equipment rental expenses divided by block hours.
Col 7: Columns 5+6.
Col 8: Columns 4+5.
Col 9: Columns 4+7.
Col 10: Block hours reported in Form 41.

4.2.3 Alaska and Non-Alaska 298C Cost Per Block Hour

Table 4-8 provides data for Part 298-C carriers in Alaska, which have a unique operating environment. The average total aircraft cost per block hour is $467, while the average variable costs are $359 per block hour. These carriers operate mostly Part 23 aircraft.

Table 4-8: Alaskan Form 298-C Operating and Fixed Cost Per Block Hour

	1	2	3	4	5	6	7	8	9
Economic Values Category	**Crew Expense**	**Fuel & Oil**	**Maintenance**	**Total Variable Costs**	**Depreciation Rental**	**Other**	**Total Fixed Costs**	**Total Costs**	**Total Block Hours**
Two-Engine Narrow-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR
Two-Engine Wide-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR
Three-Engine Narrow-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR
Three-Engine Wide-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR
Four-Engine Narrow-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR
Four-Engine Wide-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR
Regional Jet under 70 seats	$239	$308	$367	$914	$475	$48	$523	$1,437	2,395
Regional Jet 70 to 100 seats	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 23)	$127	$142	$199	$468	$120	$41	$161	$629	106,024
Turboprops under 20 seats (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops with 20 or more seats	$235	$243	$412	$890	$190	$52	$242	$1,132	25,263
Piston Engine (Part 23)	$75	$62	$95	$232	$35	$25	$60	$292	209,742
Piston Engine (Part 25)	$315	$226	$1,247	$1,788	$320	$104	$425	$2,213	238
Alaskan Total	**$104**	**$102**	**$153**	**$359**	**$76**	**$32**	**$108**	**$467**	**343,662**

Source: Tabulated by GRA from Form 298 filings for the four quarters ending September 30, 2001.
Note: Part 25 aircraft unless otherwise noted.
Col 1: Total flight deck (pilot) costs divided by total block hours.
Col 2: Cost of total fuel and oil consumed divided by total block hours.
Col 3: Total for maintenance costs divided by total block hours.
Col 4: Columns 1+2+3.
Col 5: Total depreciation and rental expenses divided by block hours.
Col 6: Other expenses divided by block hours.
Col 7: Columns 5+6.
Col 8: Columns 4+7.
Col 9: Block hours reported in Form 41.

Table 4-9 reports operating cost per block hour for all other Part 298-C carriers. Most of the activity for these carriers is by regional jets and large turboprop aircraft. These carriers have an average total aircraft cost per block hour of $878 and an average variable cost of $622 per block hour.

Table 4-9: Non Alaskan Form 298-C Operating and Fixed Costs Per Block Hour

	1	2	3	4	5	6	7	8	9
Economic Values Category	**Crew Expense**	**Fuel & Oil**	**Maintenance**	**Total Variable Costs**	**Depreciation Rental**	**Other**	**Total Fixed Costs**	**Total Costs**	**Total Block Hours**
Two-Engine Narrow-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR
Two-Engine Wide-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR
Three-Engine Narrow-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR
Three-Engine Wide-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR
Four-Engine Narrow-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR
Four-Engine Wide-Body	NR	NR	NR	NR	NR	NR	NR	NR	NR
Regional Jet under 70 seats	$168	$286	$241	$695	$307	$34	$341	$1,036	739,853
Regional Jet 70 to 100 seats	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 23)	$126	$128	$314	$567	$140	$17	$157	$725	272,093
Turboprops under 20 seats (Part 25)	$194	$288	$227	$710	$297	$21	$318	$1,027	25,545
Turboprops with 20 or more seats	$189	$165	$204	$557	$163	$34	$197	$754	614,451
Piston Engine (Part 23)	$74	$82	$106	$263	$28	$18	$46	$308	5,510
Piston Engine (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Non-Alaskan Total	**$169**	**$214**	**$238**	**$622**	**$225**	**$31**	**$256**	**$878**	**1,657,585**

Source: Tabulated by GRA from Form 298 filings for the four quarters ending September 30, 2001.
Note: "Sum of Unknown Types" and aircraft with 0 airborne hours not included
Note: Part 25 aircraft unless otherwise noted.
Col 1: Total flight deck (pilot) costs divided by total block hours.
Col 2: Cost of total fuel and oil consumed divided by total block hours.
Col 3: Total for maintenance costs divided by total block hours.
Col 4: Columns 1+2+3.
Col 5: Total depreciation and rental expenses divided by block hours.
Col 6: Other expenses divided by block hours.
Col 7: Columns 5+6.
Col 8: Columns 4+7.
Col 9: Block hours reported in Form 41.

More detailed information for airborne hours, type of operating authority, and detailed aircraft type is provided in web-based tables.

4.3 GENERAL AVIATION OPERATING COSTS

4.3.1 Data Sources for Operating Costs

The primary source for the variable and fixed operating costs for general aviation aircraft was *The Aircraft Cost Evaluator*, published by Conklin and de Decker Associates, Inc.[47] The following variable cost categories were obtained from *The Aircraft Cost Evaluator* for use in this study:

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[47] Conklin and de Decker Associates, Inc., *The Aircraft Cost Evaluator* (Orleans, MA, Spring, 2003).

- Fuel
    - Fuel (assuming fuel price of $2.51 per gallon for avgas and $2.41 for turbine fuel (Jet A)—costs obtained by Conklin and de Decker from Fillup Flyer Fuel Finder
    - Fuel Additives
    - Lubricants

- Maintenance
    - Maintenance Labor
    - Parts Airframe/Engine/Avionics
    - Engine Restoration
    - Thrust Reverser Overhaul
    - Propeller Overhaul
    - APU Overhaul
    - Dynamic Components/Life Limited Parts

- Crew Salaries (based on *2002 NBAA Salary Survey* and other sources)
    - Captain
    - Co-pilot
    - Flight Engineer/Other
    - Benefits

Maintenance labor costs represent the average cost of routine, scheduled, and unscheduled maintenance labor. Labor hours are based on data from operator experience, manufacturer's data and surveys. Crew salaries are derived for each aircraft type from a recognized pilot salary survey, and benefits are typically an additional 30 percent of wages. Salaries are counted for the entire crew, which depending on the aircraft type can consist of a captain, copilot and flight engineer. Crew salaries and benefits are divided by an estimated 356 flight hours per year in order to obtain hourly crew costs. The 356 flight hours is a weighted average derived from *2002 NBAA Compensation & Benchmark Survey*[48] about the typical annual flight hours of a pilot of large GA aircraft. *The Aircraft Cost Evaluator* also provided the following fixed costs:

- Hangar

- Insurance
    - Hull
    - Admitted Liability
    - Legal Liability

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[48] National Business Aviation Association, *NBAA Compensation & Benchmark Survey* (Washington, DC, 2002).

- ✈ Miscellaneous Overhead
    - o Recurrent Training
    - o Aircraft Modernization
    - o Navigation Chart Services
    - o Refurbishing
    - o Computerized Maintenance Management Program
    - o Weather Service
    - o Other Fixed Cost
    - o Fractional Cost/Year + Tax

The Aircraft Cost Evaluator provides different cost categories based on the type of operation for which an aircraft is used. It was assumed that piston and turboprops (groups 1-10) are used in business operations; turbojets (groups 11-13) are used in corporate operations; piston engine rotorcraft (groups 14 and 16) are used in utility operations; and turbine rotorcraft engine (groups 15 and 17) are used in commercial operations. Business operating costs from Conklin and de Decker assume that the aircraft is owner-flown and therefore no crew salaries are included as costs. However, for the purposes of economic analysis, the costs of pilot's time should be considered in some circumstances. To allow for this, all piston engine and turboprop airplanes for which air taxi hours are a small percentage of total hours flown (i.e. all piston engine airplanes with fewer than 10 seats), it is assumed that the crew cost per hour equals the value of General Aviation Business travel time, or $45.00[49] per hour. For the other groups that used business aircraft operating costs from Conklin and de Decker, it is assumed that crew costs are the same as those for aircraft used in corporate operations. For piston engine rotorcraft, air taxi hours are a small percentage of total hours flown. Therefore, it was assumed that the crew cost per hour equals the value of time ($45.00).

The Aircraft Cost Evaluator was the primary source for the GA operating costs. However, since it did not cover all aircraft types in the FAA GA Survey, PlaneQuest.com[50] was used as a secondary source. It was occasionally necessary to change assumptions (for example fuel cost) in order to make the estimated costs comparable to those obtained from Conklin and de Decker. Following are the variable operating cost categories obtained from PlaneQuest.com:

- ✈ Fuel
    - o Fuel (assuming fuel price of $2.51 per gallon for avgas and $2.41 for turbine fuel)
    - o Oil

[49] FAA, APO. *Treatment of Values of Passenger Time in Economic Analysis*, APO Bulletin, APO-03-1. (March 2003)
[50] http://www.planequest.com/operationcosts/default.asp

- Maintenance
  - Maintenance Cost
  - Hourly Engine Reserve
  - Propeller and Thrust Reverser Reserve

PlaneQuest.com does not provide the crew cost data so it was assumed that the crew costs for a specific aircraft type are the same as the crew cost for the majority of aircraft types found in the economic values category that the aircraft belongs to. Fixed operating costs obtained from PlaneQuest.com consist of:

- Annual Insurance
- Annual hangar/Tiedown
- Training

4.3.2 Depreciation

In order to reflect general aviation aircraft ownership costs, estimates based on replacement costs were developed for this report. The large number of older GA aircraft in use and the fact that these aircraft are still bought and sold suggests that depreciation measures that divide original acquisition costs over a fixed time period may not be appropriate. One of the reasons why general aviation aircraft retain their value for a longer period of time is that these aircraft, especially older GA aircraft, get modernized, overhauled, fitted with new avionics, etc. In order to estimate depreciation that allows for these factors, the geometric depreciation method was used. This method assumes that each aircraft retains a fixed percentage of its current market value from year to year. The annual amount of depreciation is the change in this value for one year. It is based on the aircraft age and market value as shown below.

In this report we assume that aircraft retain 95 percent of their value from year to year.

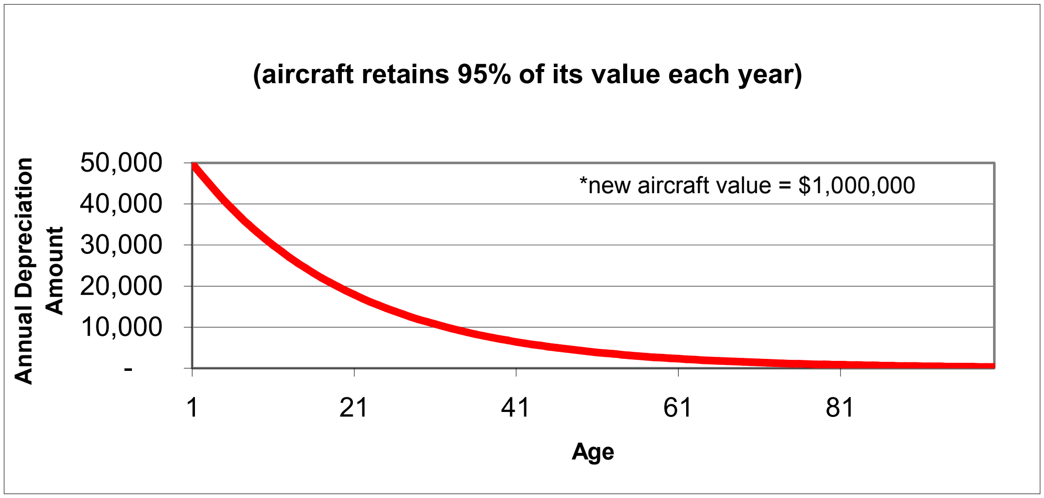
$$\textit{Change in Value of Aircraft of age "t+1"} = CMV_t - CMV_t\ (R)$$

where:

CMV = Current market value for aircraft of age "t"
R = Remaining value percentage

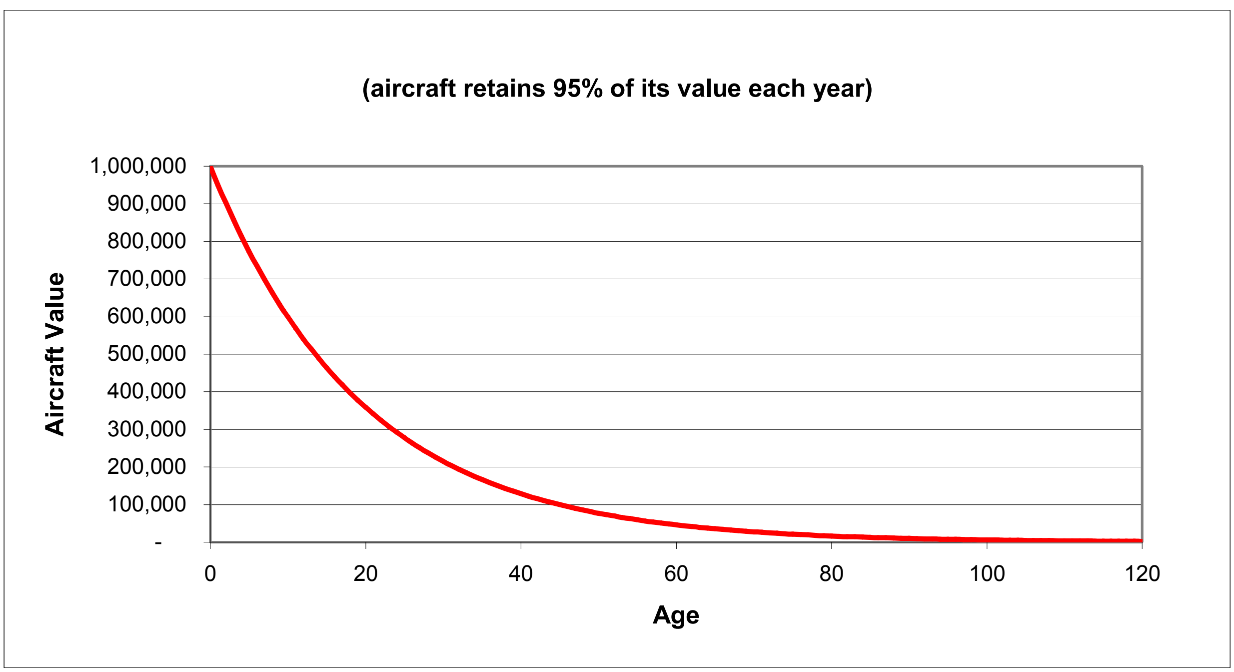
To illustrate, assume an aircraft is worth $1,000,000 at age "t". In the following year, at age of "t+1", the aircraft retains 95 percent of its market from the previous year. Thus, the annual change in value or depreciation is $50,000 ($1,000,000 - $1,000,000 (0.95)). Figure 4-1 illustrates retained value curve for aircraft of various ages.

Figure 4-1: Geometric Depreciation – Annual Depreciation Amount Over Time



This value is divided by the annual flight hours to calculate depreciation per flight hour. Figure 4-2 illustrates the change in aircraft market value over time assuming it retains 95 percent of its value from year to year.

Figure 4-2: Geometric Depreciation – Market Value Over Time



Depreciation is a significant component of the fixed costs for general aviation aircraft. PlaneQuest.com does not report book depreciation. In Conklin and de Decker's database, book depreciation generally assumes the new price of an aircraft and depreciates it over 8 years to a 20 percent residual value (i.e., 10 percent per year). A recent article in *Airfinance Journal*[51] supports the 5 percent depreciation assumption of this report. The article suggests that the currently common depreciation practice of depreciating an aircraft over 25 years with a residual value of 15 percent (i.e., 3.4 percent per year) should actually be increased to 5 percent or to 6 percent depreciation each year.

Table 4-10 summarizes general aviation aircraft operating cost per flight hour by each of the economic values categories. While the average total cost per hour is about $1,000, it ranges from about $100 per hour to over $6,000 per hour, depending on the size, complexity and age of the aircraft within each group. Average variable costs per hour including flight crews are $362, while they are $253 per hour if crew costs are not counted.

Table 4-10: GA and Air Taxi Operating and Fixed Costs (weighted by hours)

	Economic Values Category	Certification	1 Crew	2 Fuel & Oil	3 Maintenance	4 Variable Operating Costs (Including Crew)	5 Variable Operating Costs (Excluding Crew)	6 Annual Fixed Cost Other (Without Depreciation)	7 Annual Depreciation	8 Fixed Cost Per Hour
1	Piston Engine Airplanes 1 to 3 seats (<=200hp)	Part 23	$45	$12	$30	$87	$42	$2,251	$1,338	$34
2	Piston Engine Airplanes 1 to 3 seats (>200hp)	Part 23	$45	$42	$56	$143	$98	$21,147	$4,855	$215
3	Piston Engine Airplanes 4 to 9 seats One-Engine (<=200hp)	Part 23	$45	$30	$40	$116	$71	$15,198	$2,897	$139
4	Piston Engine Airplanes 4 to 9 Seats One-Engine (>200hp)	Part 23	$45	$43	$61	$150	$105	$20,024	$6,310	$235
5	Piston Engine Airplanes 4 to 9 Seats Multi-Engine	Part 23	$45	$94	$118	$257	$212	$27,761	$8,770	$256
6	Piston Engine Airplanes 10 or more Seats	Part 23	$112	$118	$141	$372	$259	$32,130	$8,816	$107
7	Turboprop Airplanes 1 to 9 seats One-Engine	Part 23	$181	$139	$142	$462	$281	$83,021	$59,166	$340
8	Turboprop Airplanes 1 to 9 seats Multi-Engine	Part 23	$238	$214	$410	$862	$623	$65,408	$36,501	$479
9	Turboprop Airplanes 10 to 19 seats	Part 23	$244	$271	$396	$911	$667	$86,486	$65,555	$543
10	Turboprop Airplanes 20 or more seats	Part 25	$433	$323	$357	$1,113	$681	$92,475	$56,876	$532
11	Turbojet/Turbofan Airplanes <=12,500 lbs	Part 23/25	$475	$445	$433	$1,353	$878	$139,144	$167,669	$1,058
12	Turbojet/Turbofan Airplanes >12,500 lbs and <=65,000 lbs	Part 25	$559	$631	$677	$1,868	$1,309	$325,350	$324,828	$1,737
13	Turbojet/Turbofan Airplanes >65,000 lbs	Part 25	$713	$1,217	$807	$2,737	$2,024	$473,248	$978,930	$3,419
14	Rotorcraft Piston <=6,000 lbs	Part 27	$45	$34	$97	$176	$131	$78,113	$7,936	$381
15	Rotorcraft Turbine <=6,000 lbs	Part 27	$188	$94	$259	$539	$353	$159,656	$35,783	$561
16	Rotorcraft Piston >6,000 lbs	Part 29	NR	NR	NR	NR	NR	NR	NR	NR
17	Rotorcraft Turbine >6,000 lbs	Part 29	$233	$231	$596	$1,060	$827	$254,891	$94,957	$1,075
18	Other	NR	NR	NR	NR	NR	NR	NR	NR	NR
All Aircraft			**$109**	**$114**	**$138**	**$362**	**$253**	**$54,587**	**$46,503**	**$728**

Sources of cost data: GRA analysis of 2002 GA Survey and 1) Conklin and de Decker, Aircraft Cost Evaluator, Spring 2003; 2) http://www.planequest.com/; 3)Aircraft Bluebook, Summer 2003; 4) Ai Guidelines 2002-2003; 5) GRA estimate of aircraft prices.

Note: Class 8 Turboprops also included Cessna 421 which is a piston aircraft. For this reason we have not included this aircraft type in our calculations. Class 11 Turbojets also included PC-12 whi reason we have not included this aircraft type in our calculations.

NR = Not Reported

Col 1: Crew: for GRA groups 1-5, 14 and 16, crew cost = value of time = $45 and assumes a single pilot; for other categories, crew cost includes salaries and benefits reported by Conklin and de De flight hours (based on 2002 NBAA salary survey, p. 136).

Col 2: Fuel, oil and additives used per hour, with fuel at $2.51 per gallon for pistons and $2.41 per gallon for all other economic values groups.

Col 3: Total Maintenance cost, including labor, parts, engine allowances, propeller/thrust reverser overhaul, and APU overhaul* if applicable.

Col 4: Variable Operating Cost Total. Addition of columns 1, 2 and 3.

Col 5: Maintenance and Fuel only (Column 2 plus Column 3).

Col 6: Annual fixed cost including hangar cost, insurance cost, training cost, services* typically used by air taxi and commercial operators (e.g., Weather service, maintenance programs, etc.).

Col 7: Average annual aircraft depreciation assuming that aircraft retain 95% of their value from year to year.

Col 8: Fixed Cost per hour, assuming hours of utilization reported in Column 10 = (Column 6 + Column 7)/Column 10.

Col 9: Total Cost per Hour: Column 4 plus Column 8.

Col 10: Average (weighted) hours of utilization for each economic values group for all aircraft with both operating cost data and price data used in calculating annual depreciation.

* Conklin and de Decker only

[51] John Morrison, "Lessors Face Black Hole", *Airfinance Journal*, December 2003/January 2004. p. 24-29.

Table 4-11 shows variable and total aircraft operating costs for aircraft under the various parts of the operating regulations. Part 125 aircraft have the highest total cost per hour ($12,568) because they are much larger than the aircraft in other groups. The Part 133 costs per hour ($2,646) reflect the higher operating costs of rotorcraft. Finally, Part 91 costs per hour ($800) are a little more than one-half of the costs per flight hour ($1,449) for Part 135 aircraft operations.

Table 4-11: GA Operating and Fixed Costs By Operating Rule Part (weighted by Part hours)

			1	2	1	2	1	2	1	2	1	2
			PART 91		PART 125		PART 133		PART 135		PART 137	
	Economic Values Category (all years)	Certification	Variable Operating Costs (per hour)	Total Cost (per hour)	Variable Operating Costs (per hour)	Total Cost (per hour)	Variable Operating Costs (per hour)	Total Cost (per hour)	Variable Operating Costs (per hour)	Total Cost (per hour)	Variable Operating Costs (per hour)	Total Cost (per hour)
1	Piston engine airplanes 1 to 3 seats (<=200hp)	Part 23	$87	$121	NR	NR	NR	NR	$88	$124	$86	$117
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	$140	$382	NR	NR	NR	NR	$144	$345	$145	$339
3	Piston engine airplanes 4 to 9 seats one-engine	Part 23	$116	$255	NR	NR	NR	NR	$113	$243	$107	$214
4	Piston engine airplanes 4 to 9 seats one-engine	Part 23	$150	$386	NR	NR	NR	NR	$151	$364	$153	$385
5	Piston engine airplanes 4 to 9 seats multiengine	Part 23	$254	$508	NR	NR	NR	NR	$275	$548	$251	$481
6	Piston engine airplanes 10 or more seats	Part 23	$372	$481	NR	NR	NR	NR	$372	$456	$372	$475
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	$484	$900	NR	NR	NR	NR	$452	$756	$462	$814
8	Turboprop airplanes 1 to 9 seats multiengine	Part 23	$861	$1,354	NR	NR	NR	NR	$855	$1,266	$954	$1,372
9	Turboprop airplanes 10 to 19 seats	Part 23	$892	$1,453	NR	NR	NR	NR	$997	$1,455	$981	$1,519
10	Turboprop airplanes 20 or more seats	Part 25	$4,591	$7,128	$811	$1,382	NR	NR	$1,067	$1,493	$1,901	$2,885
11	Turbojet/Turbofan airplanes <=12,500 lbs	Part 23/25	$1,365	$2,492	NR	NR	NR	NR	$1,460	$2,579	NR	NR
12	Turbojet/Turbofan airplanes>12,500 lbs and <=65,000	Part 25	$1,827	$3,579	$2,746	$5,774	NR	NR	$1,643	$2,475	$1,615	$2,530
13	Turbojet/Turbofan airplanes >65,000 lbs	Part 25	NR	NR	$2,728	$6,179	NR	NR	$3,215	$4,913	NR	NR
14	Rotorcraft Piston <=6,000 lbs	Part 27	$171	$567	NR	NR	$174	$474	$175	$584	$217	$474
15	Rotorcraft turbine <=6,000 lbs	Part 27	$514	$1,055	NR	NR	$515	$1,021	$599	$1,213	$502	$1,013
16	Rotorcraft Piston >6,000 lbs	Part 29	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
17	Rotorcraft turbine >6,000 lbs	Part 29	$1,024	$2,412	$2,062	$3,159	$1,909	$2,988	$1,031	$1,872	$920	$1,658
18	Other	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
All Aircraft			**$295**	**$800**	**$2,690**	**$12,568**	**$968**	**$2,646**	**$579**	**$1,449**	**$299**	**$828**

Source: GRA analysis of 2002 GA Survey and estimated hourly costs by aircraft type.
NR = Not Reported
Col 1: Variable operating costs include crew, fuel and oil, and maintenance costs.
Col 2: Total costs per hour include variable costs (Col 1) and fixed costs*** (depreciation* and other fixed costs**).
Comments:
Crew: for GRA groups 1-5, 14 and 16, crew cost = value of time = $45; for other categories, crew cost includes salaries and benefits reported by Conklin and de Decker and assumes 356 flight hours (based on 2002 NBAA Salary Survey, p. 136).
*Average annual aircraft depreciation calculated assuming that aircraft retain 95% of their value from year to year.
**Annual fixed cost including hangar cost, insurance cost, training cost, services typically used by air taxi and commercial operators (e.g., Weather service, maintenance programs, etc.).
***Fixed costs first weighted by Part hours than divided by average hours for all Parts, as reported in Table 4-10 Column 10.

4.3.3 Fractional Ownership Operating Costs

Table 4-12 presents operating costs for fractionally owned aircraft. The FAA Aircraft Registry (March, 2003) was used to identify the fractionally owned aircraft.[52] The *Aircraft Cost Evaluator* from Conklin & de Decker was then used as a source of operating cost data for aircraft types identified as fractionally owned through the FAA Aircraft Registry. Operating costs for fractional aircraft were weighted by the number of fractional aircraft in order to arrive at average operating costs by economic values category as well as for all fractionally owned aircraft.

[52] The Aircraft Registry uses an algorithm to identify fractional ownership aircraft. These aircraft were not tracked until very recently and there was no mandatory reporting.

Operating costs for fractionally owned aircraft are not directly comparable to those of other general aviation aircraft. This is because the Conklin & de Decker data, as can be seen in Table 4-12, does not report the operating cost components (i.e., fuel, maintenance, etc.) only the hourly operating costs. In addition, costs in *Aircraft Cost Evaluator* are reported by fractional ownership provider and fractional ownership share. One fractional ownership provider was chosen to represent all aircraft in those aircraft types owned by more than one provider because costs do not differ significantly between the different providers of services of the same aircraft type. The hourly operating costs reported in Table 4-12 assume quarter share ownership and no depreciation. Average total operating costs per hour for all fractionally owned aircraft are higher than those of general aviation aircraft.

Table 4-12: Fractional Ownership Costs (averages weighted by the number of aircraft)

		1	2	3	4	5	6	7
	Economic Values Category and Manufacturer Name	Total Aircraft	Quarter Share Acquisition	Fixed Annual Budget	Fixed Cost Per Hour	Hourly Variable Operating Cost + Tax	Total Operating Cost Per Hour	Contract Block Hours Per Year
1	Piston engine airplanes 1 to 3 seats (<=200hp)	11	N/A	N/A	N/A	N/A	N/A	N/A
2	Piston engine airplanes 1 to 3 seats (>200hp)	2	N/A	N/A	N/A	N/A	N/A	N/A
3	Piston engine airplanes 4 to 9 seats one-engine (<=200hp)	7	N/A	N/A	N/A	N/A	N/A	N/A
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	3	N/A	N/A	N/A	N/A	N/A	N/A
5	Piston engine airplanes 4 to 9 seats multiengine	3	N/A	N/A	N/A	N/A	N/A	N/A
6	Piston engine airplanes 10 or more seats	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	Turboprop airplanes 1 to 9 seats one-engine	5	$838,000	$107,628	$615	$615	$1,230	$175
8	Turboprop airplanes 1 to 9 seats multiengine	1	N/A	N/A	N/A	N/A	N/A	N/A
9	Turboprop airplanes 10 to 19 seats	32	N/A	N/A	N/A	N/A	N/A	N/A
10	Turboprop airplanes 20 or more seats	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	Turbojet/Turbofan airplanes <=12,500 lbs	126	$780,000	$172,800	$864	$1,070	$1,934	$200
12	Turbojet/Turbofan airplanes>12,500 lbs and <=65,000 lbs	376	$3,171,007	$330,758	$1,654	$2,068	$3,722	$200
13	Turbojet/Turbofan airplanes >65,000 lbs	38	$5,705,556	$518,533	$2,593	$3,191	$5,784	$200
14	Rotorcraft Piston <=6,000 lbs	1	N/A	N/A	N/A	N/A	N/A	N/A
15	Rotorcraft turbine <=6,000 lbs	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	Rotorcraft Piston >6,000 lbs	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	Rotorcraft turbine >6,000 lbs	4	$1,412,792	$240,888	$964	$860	$1,824	$250
18	Other	8	N/A	N/A	N/A	N/A	N/A	N/A
Grand Total		**617**	**$3,287,687**	**$339,671**	**$1,698**	**$2,114**	**$3,812**	**200**

Source: Aircraft types and counts come from FAA Aircraft Registry, March 2003; Fractional ownership costs come from the Aircraft Cost Evaluator by Conklin & de Decker, Spring, 2003.
*PC-12 was in the FAA Aircraft Registry's economic values class #11 but was moved to class # 7 where it should be; Gulfstream 200 was in economic values class #13 but was moved to class #12.
Col 1: Total number of fractionally owned aircraft by economic values group as reported in FAA Aircraft Registry.
Col 2: Quarter share acquisition, from Conklin & de Decker.
Col 3: Fixed annual cost, does not include depreciation, Conklin & de Decker.
Col 4: Fixed costs per hour: column 3 divided by column 7.
Col 5: Variable hourly operating cost with tax, Conklin & de Decker.
Col 6: Total operating costs per hour: column 4 plus column 5.
Col 7: Contract block hours as reported by Conklin & de Decker.

4.4 MILITARY OPERATING COSTS

Data on military aircraft operating costs were developed in consultation with the various branches of the armed services. Data were obtained both from public websites as well as telephone interviews with appropriate personnel. Because averages are reported, it is assumed that they apply to all aircraft within a group, even if data were not available for some aircraft in that group. In general, the values were applied on an aircraft-type-by-aircraft type basis where there were cost observations from at least one military air service. In cases where there were no observed costs for a specific aircraft type, the group average was applied.

The military operating costs include crews and reflect the varying sizes of crews for a specific aircraft. For example, most military rotary wing aircraft operate with a pilot, co-pilot and one or two other crew members. Some of the larger turbojet aircraft with three or more engines conduct electronic surveillance operations and have large on-board crews. The crew costs reported in Table 4-13 reflect this. The military aggregates costs somewhat differently than the airlines or general aviation operators. In general, operating costs exclude crew because these are viewed as a fixed cost in that the number of military pilots does not generally change with annual flight hours. Costs are also shown including crew costs and then shown with total costs, which includes other costs. This latter category includes some measure of ownership costs for some of the services, but not all. The relatively high cost per hour of military aircraft reflects the composition of the military fleet, which includes many large turbine-powered multi-engine airplanes and rotorcraft. More detailed data are provided in tables on the APO website.

Table 4-13: Estimated Military Operating Costs Per Hour (FY2002) (average weighted by flight hour)

	1	2	3	4	5	6	7
Aircraft Type	**Crew**	**Fuel**	**Maintenance**	**Other**	**Total Operating Costs (Excluding Crew)**	**Total Operating Costs (Including Crew)**	**Total Costs Per Hour (Including Crew)**
Rotary Wing Aircraft	$888	$186	$6,360	$768	$6,546	$7,434	$8,202
Turbojet/fan 3+ Engines	$2,203	$1,921	$4,357	$421	$6,279	$8,482	$8,856
Turbojet/fan Attack/Fighter	$397	$1,103	$8,230	$488	$9,333	$9,730	$10,219
Turbojet/fan Other	$1,571	$764	$2,929	$600	$3,694	$5,265	$5,772
Turboprop	$550	$393	$3,121	$418	$3,424	$3,974	$4,368
Average Weighted Total	**$940**	**$665**	**$4,588**	**$535**	**$5,198**	**$6,138**	**$6,640**

Sources: Army, Army Reserve and National Guard (Department of Defense FY2002); Air Force, Air Force Reserve and Air National Guard (US Air Force and Planning Factors); Navy, Naval Reserve, Marine Corps, and Marine Corps Reserve (Navy Visibility and Management of Operations and Support Cost); Coast Guard (The Aircraft Cost Evaluator, Conklin & de Decker).

Note: Operating costs were not available for all aircraft types.

Col 1: Crew cost, average weighted by flight hours.
Col 2: Fuel cost, average weighted by flight hours.
Col 3: Maintenance costs, average weighted by flight hours.
Col 4: Other Costs, average weighted by flight hours.
Col 5: Sum of columns 2 and 3.
Col 6: Sum of columns 1,2 and 3.
Col 7: Sum of columns 1, 2, 3 and 4.

SECTION 5: UNIT REPLACEMENT AND RESTORATION COSTS OF DAMAGED AIRCRAFT

5.1 INTRODUCTION

The cost of damage to aircraft in aviation accidents is borne directly by operators and indirectly by users and society in the form of higher fares and costs.[53] Determining these costs provides a measure for evaluation of FAA investment and regulatory programs that affect the likelihood of aircraft being damaged or destroyed.

5.1.1 Replacement

For the purpose of evaluating the cost of aircraft replacement, a destroyed aircraft is assigned the value of a replacement. This valuation assumption is consistent with the opportunity cost of the loss of the use of a typical aircraft; the value of a new aircraft would overstate the typical loss. (Even though a destroyed aircraft might be replaced by a new aircraft, the new aircraft provides additional value over the one it replaces.) The aircraft values reported below are based on transactions in the well-defined market for used aircraft, except for military aircraft which will be discussed later in this section. The aircraft value in an orderly market without excess aircraft capacity or excess demand for aircraft is referred to as the "base" value, which reflects the long-run relationship between current value, age and original price of an aircraft. At present, the current market for commercial aircraft has substantial excess capacity and the current market values of aircraft are well below the base values.[54] Current market values are also reported below. For general aviation aircraft, estimated market values are used.

5.1.2 Restoration

The NTSB classifies aircraft involved in accidents as "destroyed," having "substantial damage," having "minor damage," or having "no damage." The cost incurred as a result of "minor damage" to aircraft is generally a negligible percentage of the market value and is not evaluated in this report. An aircraft with "substantial damage" is one that is damaged but repairable; industry data discussed below provide

[53] Insurance represents a transfer payment between the insurance company and the insured and does not directly affect the economic losses in an accident.
[54] A base value reflects historic trends and may be more appropriate if the expected accidents to be valued occur over a long time period.

a means of estimating the relationship between the cost of damage and the total value of the aircraft.

5.2 AIR CARRIER AIRCRAFT

5.2.1 Replacement

Replacement values for air carriers were derived from a proprietary database developed by Aviation Specialists Group (AVSPEC).[55] The first step in establishing an average fleet valuation is to develop an industry database covering each aircraft and aircraft type in the U.S. fleet. The average value was developed using an estimated value for each aircraft delivered in a given year, and then aggregating these values into the economic values aircraft categories.

The valuation database uses industry data on recent sales and asking prices of airplanes on the used market. There is an active market in used commercial aircraft, and thus it is possible to obtain reliable estimates of a destroyed aircraft. Both the base and market values are reported so that analysts can determine an appropriate range of values.

The summary of values for passenger and all cargo air carrier aircraft are shown in Table 5-1. Detailed data by equipment type are contained on the APO website. The first column for each operator group reports the number of aircraft in the AVSPEC database that were used in developing weighted averages.[56] The second column shows the base value, which assumes an orderly market for aircraft transactions. The third column reports current market (circa 2003) values (which are lower than base values). The average base value of a passenger aircraft is about $13.5 million. The market value is $2.0 million less. The range in values among the aircraft groups is quite large reflecting the different average size and average age of aircraft in each group. Similar results hold for all cargo aircraft.

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[55] Aviation Specialists Group, 1037 Sterling Road, Suite 203, Herndon, VA 20170.

[56] This differs from the Form 41 fleet sizes because they consider all aircraft in the U.S. fleet, including aircraft out of service, aircraft in non-commercial service and other circumstances.

Table 5-1: Estimated Market Values of Air Carrier Aircraft ($2003)

	1	2	3	1	2	3
	Air Carrier - Passenger			Air Carrier - Cargo		
Economic Values Category	Number of Aircraft	Weighted Average Base Value US$ Millions	Weighted Average Estimated Current Market Value US$ Millions	Number of Aircraft	Weighted Average Base Value US$ Millions	Weighted Average Estimated Current Market Value US$ Millions
Two-Engine Narrow-Body	3,913	$16.47	$13.67	128	$14.99	$11.23
Two-Engine Wide-Body	554	$49.24	$42.26	177	$26.35	$23.03
Three-Engine Narrow-Body	368	$0.71	$0.71	348	$1.08	$1.02
Three-Engine Wide-Body	169	$7.77	$6.44	163	$20.22	$16.90
Four-Engine Narrow-Body	50	$0.32	$0.32	128	$2.92	$2.92
Four-Engine Wide-Body	133	$38.42	$30.02	121	$27.79	$19.33
Regional Jet Under 70 seats	976	$14.07	$13.23	NR	NR	NR
Regional Jet 70 to 100 seats	101	$14.99	$13.40	NR	NR	NR
Turboprop Under 20 seats (Part 23)	1,147	$0.48	$0.56	NR	NR	NR
Turboprop Under 20 seats (Part 25)	112	$0.10	$0.10	NR	NR	NR
Turboprops with 20 or more seats	1,143	$1.95	$2.19	NR	NR	NR
Piston Engine (Part 23)	NR	NR	NR	NR	NR	NR
Piston Engine (Part 25)	NR	NR	NR	NR	NR	NR
All Aircraft	**8,666**	**$13.48**	**$11.46**	**1,065**	**$13.14**	**$10.64**

Source: Aviation Specialists Group
NR = None Reported

Note: Air Carrier fleet counts are higher than those reported in section 3. This is because the data from Aviation Specialists group includes all US registered aircraft while section 3 data comes from Form 41 which is filed by certain air carriers only.
Col 1: Aircraft fleet count.
Col 2: Total base value of aircraft fleet, divided by column 1.
Col 3: Total estimated current market value of aircraft fleet, divided by column 1.

Table 5-2 provides base and current market values for passenger (and passenger/freight combination) carrier aircraft. It also shows the standard deviation of each aircraft group value, which is based on the number and value of each aircraft within the group. The average monthly lease rates for each aircraft group are also shown. (In general, the monthly aircraft operating lease rate is from one to two percent of the market value.)

Table 5-2: 2003 Passenger Air Carrier Fleet Sizes and Values

	1	2	3	4	5	6
Economic Values Category	**Number of Aircraft**	**Weighted Average Base Value US$ Millions**	**Standard Deviation of Base Value US$ Millions**	**Weighted Average Estimated Current Market Value US$ Millions**	**Standard Deviation of Market Value US$ Millions**	**Weighted Average Projected Monthly Lease Rate US$ Thousands**
Two-Engine Narrow-Body	3,913	$16.47	$4.34	$13.67	$3.31	$143.29
Two-Engine Wide-Body	554	$49.24	$10.81	$42.26	$9.18	$417.44
Three-Engine Narrow-Body	368	$0.71	$0.32	$0.71	$0.20	$17.33
Three-Engine Wide-Body	169	$7.77	$3.84	$6.44	$3.07	$168.23
Four-Engine Narrow-Body	50	$0.32	NR	$0.32	NR	NR
Four-Engine Wide-Body	133	$38.42	$17.23	$30.02	$11.99	$395.31
Regional Jet under 70 seats	976	$14.07	$1.85	$13.23	$1.72	$126.88
Regional Jet 70 to 100 seats	101	$14.99	$2.11	$13.40	$1.70	$129.96
Turboprops under 20 seats (Part 23)	1,147	$0.48	$0.34	$0.56	$0.29	$19.53
Turboprops under 20 seats (Part 25)	112	$0.10	N/A	$0.10	N/A	N/A
Turboprops with 20 or more seats	1,143	$1.95	$0.97	$2.19	$0.87	$35.09
Piston Engine (Part 23)	NR	NR	NR	NR	NR	NR
Piston Engine (Part 25)	NR	NR	NR	NR	NR	NR
All Aircraft	**8,666**	**$13.48**	**$3.60**	**$11.46**	**$2.86**	**$140.81**

Source: Aviation Specialists Group
NR = None Reported

Note: Air Carrier fleet counts are higher than those reported in section 3. This is because the data from Aviation Specialists group includes all US registered aircraft while section 3 data comes from Form 41 which is filed by certain air carriers only.
Col 1: Aircraft fleet count.
Col 2: Total base value of aircraft fleet, divided by column 1.
Col 3: Standard deviation of base values.
Col 4: Total estimated current market value of aircraft fleet, divided by column 1.
Col 5: Standard deviation of current market values.
Col 6: For jets, projected monthly lease rate (from base value). For turboprops, estimated current market lease rate.

Table 5-3 shows base and current market values for all cargo aircraft. While the average values are approximately the same as for passenger aircraft, the higher standard deviation reflects a greater variability in the underlying data.

Table 5-3: 2003 Cargo Air Carrier Fleet Sizes and Values

Economic Values Category	1 Number of Aircraft	2 Weighted Average Base Value US$ Millions	3 Standard Deviation of Base Value US Millions	4 Weighted Average Estimated Current Market Value US$ Millions	5 Standard Deviation of Market Value US Millions	6 Weighted Average Projected Monthly Lease Rate US$ Thousands
Two-Engine Narrow-Body	128	$14.99	$10.16	$11.23	$6.99	$208.04
Two-Engine Wide-Body	177	$26.35	$7.26	$23.03	$6.17	$259.42
Three-Engine Narrow-Body	348	$1.08	$0.41	$1.02	$0.26	$32.51
Three-Engine Wide-Body	163	$20.22	$9.08	$16.90	$7.34	$318.67
Four-Engine Narrow-Body	128	$2.92	NR	$2.92	NR	NR
Four-Engine Wide-Body	121	$27.79	$12.41	$19.33	$9.26	$169.10
Regional Jet under 70 seats	NR	NR	NR	NR	NR	NR
Regional Jet 70 to 100 seats	NR	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 23)	NR	NR	NR	NR	NR	NR
Turboprops under 20 seats (Part 25)	NR	NR	NR	NR	NR	NR
Turboprops with 20 or more seats	NR	NR	NR	NR	NR	NR
Piston Engine (Part 23)	NR	NR	NR	NR	NR	NR
Piston Engine (Part 25)	NR	NR	NR	NR	NR	NR
All Aircraft	**1,065**	**$13.14**	**$5.03**	**$10.64**	**$4.00**	**$153.67**

Source: Aviation Specialists Group
NR = None Reported

Note: Air Carrier fleet counts are higher than those reported in section 3. This is because the data from Aviation Specialists group includes all US registered aircraft while section 3 data comes from Form 41 which is filed by certain air carriers only a
Col 1: Aircraft fleet count.
Col 2: Total base value of aircraft fleet, divided by column 1.
Col 3: Standard deviation of base values.
Col 4: Total estimated current market value of aircraft fleet, divided by column 1.
Col 5: Standard deviation of current market values.
Col 6: For jets, projected monthly lease rate (from base value). For turboprops, estimated current market lease rate.

5.2.2 Restoration

Restoration costs were estimated for commercial air carriers by analysis of the CASE database developed by Airclaims, Inc.[57] The database covers all commercial aircraft accidents throughout the world, and includes the insured hull value of the aircraft and the value of the claim. Aircraft that were destroyed were excluded from the analysis because the replacement cost is assumed to equal the current market value of the aircraft. Based on discussions with Airclaims, it is believed that the dataset excludes minor accidents because they would fall below the typical insurance deductible amount.

As shown in Table 5-4, the average insured value of a passenger aircraft involved in an accident was $28.0 million, while the average hull loss was $3.7 million. Restoration costs are estimated to be 13 percent of the aircraft value. For all cargo aircraft, the restoration percentage is 15 percent. The restoration percentages by aircraft group should be applied to the aircraft values in the above sections. Readers should be aware that there were a limited number of accidents in some of the aircraft categories.

[57] *Case Database*. Airclaims Group, Ltd., London Heathrow Airport, England.

Table 5-4: Restoration Costs – Air Carrier Passenger and All-Cargo Aircraft ($2003)

	1	2	3	4	1	2	3	4
	Air Carrier - Passenger				Air Carrier - All-Cargo			
Economic Values Category	Number of Accident Aircraft	Average of Hull Value US$ Millions	Average of Gross Hull Loss US$ Millions	Loss/ Value (%)	Number of Accident Aircraft	Average of Hull Value US$ Millions	Average of Gross Hull Loss US$ Millions	Loss/ Value (%)
Two-engine narrow body jet	128	$23.6	$3.5	15%	NR	NR	NR	NR
Two-engine wide body jet	50	$65.1	$7.4	11%	2	$50.5	$27.2	54%
Three-engine narrow body jet	87	$21.3	$3.9	18%	6	$5.3	$1.7	33%
Three-engine wide body jet	19	$66.7	$7.3	11%	7	$63.0	$5.1	8%
Four-engine narrow body jet	4	$5.3	$1.8	33%	25	$7.9	$1.7	22%
Four-engine wide body jet	48	$82.7	$8.5	10%	15	$62.7	$7.0	11%
Regional jet under 70 seats	5	$17.7	$1.4	8%	NR	NR	NR	NR
Regional jet with 70 seats of more	7	$20.7	$1.6	8%	1	$19.7	$1.3	6%
Turboprops under 20 seats Part 23	40	$2.4	$0.4	15%	17	$1.0	$0.5	45%
Turboprops under 20 seats Part 25	NR	NR	NR	NR	NR	NR	NR	NR
Turboprops with 20 seats or more	127	$5.5	$1.3	24%	19	$1.8	$0.6	36%
Piston Engine (Part 23)	NR	NR	NR	NR	NR	NR	NR	NR
Piston Engine (Part 25)	NR	NR	NR	NR	NR	NR	NR	NR
All Aircraft	**515**	**$28.0**	**$3.7**	**13%**	**92**	**$19.4**	**$2.9**	**15%**

Source: GRA analysis of Airclaims data for the period 1990-2003.
Col 1: Number of aircraft involved in accidents.
Col 2: Total hull value of aircraft fleet, divided by column 1.
Col 3: Total hull loss value divided number of aircraft with reported hull loss data.
Col 4: Column 3 divided by column 2.

5.3 GENERAL AVIATION AIRCRAFT

5.3.1 Replacement

Replacement values for general aviation aircraft were based on a methodology similar to that used for commercial air carriers. The primary source of data was the *Aircraft Bluebook -Price Digest (Summer, 2003)*.[58] For aircraft types not covered in the *Aircraft Bluebook*, a secondary data source was used: *Aircraft Types and Price Guidelines 2002-2003*.[59] Finally, GRA estimated prices of some aircraft whose make and model were covered in either of the two sources mentioned but not for a desired year of manufacture. For example, the *Aircraft Bluebook* provided price data on a specific make and model back to the year 1970 but the GA survey listed that make and model manufactured in 1969, GRA would estimate the value of the needed aircraft as somewhat lower than that for 1970. Aircraft in the fleet were assigned to one of the 18 economic value classifications. The average age of all aircraft of a particular type was calculated based on detailed data from the *General Aviation Survey, Calendar Year 2002*

[58] *Aircraft Bluebook – Price Digest*, (Overland Park, KS: Primedia Business Directories & Books, Summer 2003).
[59] *Aircraft Types and Price Guidelines, Including Turbine Engines 2002-2003*, (London, England: CTC Services Aviation (LAD), 2003).

data set.[60] The value for the average aircraft for each type was identified from the *Aircraft Bluebook*; these averages were used together with the relative numbers of aircraft of each type in a particular Economic Value Class to obtain a weighted average value for that class.

The summary of valuation for the general aviation aircraft groups is shown in Table 5-5. This valuation is provided in terms of an average value per aircraft, a minimum and maximum value per aircraft, and a statistical standard derivation that applies to the average value. Overall, the average GA aircraft has a value of $361,943; the large standard deviation reflects the broad range of values in some aircraft categories.

Table 5-5: Estimated Market Values of General Aviation Aircraft ($2003)

			1	2	3	4	5	6
			All Years					
	Economic Values Category	Certification	Number of Aircraft	Average Value Per Aircraft	Minimum Value Per Aircraft	Maximum Value Per Aircraft	Standard Deviation of Average Aircraft Value	Average Aircraft Age (in 2003)
1	Piston engine airplanes 1 to 3 seats (<200hp)	Part 23	33,050	$24,249	$4,000	$135,000	$4,970	40
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	6,079	$123,843	$18,000	$535,000	$32,478	33
3	Piston engine airplanes 4 to 9 seats one-engine (<200hp)	Part 23	54,352	$46,095	$14,500	$225,000	$4,530	33
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	Part 23	49,993	$114,594	$30,000	$685,000	$14,832	30
5	Piston engine airplanes 4 to 9 seats two-engine	Part 23	16,783	$152,680	$33,000	$900,000	$21,699	30
6	Piston engine airplanes 10 or more seats	Part 23	801	$137,688	$74,000	$290,000	$19,632	34
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	1,004	$803,011	$143,000	$2,100,000	$226,704	8
8	Turboprop airplanes 1 to 9 seats two-engine	Part 23	2,150	$517,788	$63,000	$1,850,000	$112,440	24
9	Turboprop airplanes 10 to 19 seats	Part 23	3,650	$1,222,412	$325,000	$4,650,000	$243,009	19
10	Turboprop airplanes 20 or more seats	Part 25	219	$2,014,790	$194,500	$9,500,000	$1,043,081	22
11	Turbojet/Turbofan two-engine airplanes <12,500 lbs.	Part 23	2,029	$2,568,083	$370,000	$6,300,000	$248,989	14
12	Turbojet/Turbofan airplanes >12,500 lbs. And <65,000 lbs.	Part 25	4,969	$5,851,422	$580,000	$23,500,000	$1,146,736	12
13	Turbojet/Turbofan airplanes >65,000 lbs.	Part 25	1,204	$17,549,160	$2,800,000	$32,000,000	$1,639,628	13
14	Rotorcraft piston <6,000 lbs.	Part 27	2,326	$135,430	$19,800	$338,000	$31,342	16
15	Rotorcraft turbine <6,000 lbs.	Part 27	3,640	$606,739	$72,000	$5,000,000	$195,610	18
16	Rotorcraft piston >6,000 lbs.	Part 29	25	NA	NA	NA	NA	NA
17	Rotorcraft turbine >6,000 lbs	Part 29	657	$1,888,082	$430,000	$6,000,000	$605,067	23
18	Other		28,313	NA	NA	NA	NA	NA
All Aircraft			**211,244**	**$361,943**	**$4,000**	**$32,000,000**	**$368,204**	**31**

Source: GA Survey 2002; Aircraft Bluebook Price Digest (Summer, 2003); Aircraft Types and Price Guidelines 2002-2003; GRA estimate
NA=Not Available

Note: "Other" economic values class is included in calculating fleet total for all aircraft but not in calculating estimated market values and age for all aircraft.

Col 1: Total number of aircraft in GA Survey.
Col 2: Average aircraft value weighted by the number of aircraft.
Col 3: The lowest aircraft value reported for each economic values class.
Col 4: The highest aircraft value reported for each economic values class.
Col 5: Square root of (n*(x-average price)^2)/(n*(n-1)) where n is the number of observations and x is aircraft price.
Col 6: Average aircraft age (weighted) for data with known aircraft value and year of manufacture.

There have been significant changes in the composition of the general aviation fleet since the early 1980's which make it desirable to have additional information on aircraft values. There was a major decline in GA aircraft production—primarily smaller

[60] Data provided by PA Consulting. The analysis here used the actual sample records and appropriate expansion factors.

piston aircraft—after 1981. The fleet age profile for smaller piston aircraft is significantly different than that for larger turbine aircraft. Moreover, there is wide variation in the values of pre- and post-1982 aircraft.

As was noted previously, no data were available in certain aircraft categories. As a result, average values are less relevant for at least some economic evaluations. For example, FAA may be faced with an investment or regulatory decision that disproportionately affects GA piston or GA turbine operators. In extreme cases, these decisions may affect only one group or the other. Other decisions may affect aircraft of only certain ages, such as a requirement to bring an old design up to a modern standard. The values relevant for use in such a benefit-cost study should reflect the aircraft actually affected. One way to reflect such value differences is to use either pre-1982 or post-1982 data depending upon which is most representative. Table 5-6 shows the estimated market values for the 160,592 aircraft manufactured before 1982. As can be seen, these aircraft are 35 years old on average and have an average market value of approximately $95,000.

Table 5-6: Estimated Market Values of Pre-1982 General Aviation Aircraft ($2003)

	Economic Values Category	Certification	1 Pre-1982 Number of Aircraft	2 Average Value Per Aircraft	3 Minimum Value Per Aircraft	4 Maximum Value Per Aircraft	5 Standard Deviation of Average Aircraft Value	6 Average Aircraft Age (in 2003)
1	Piston engine airplanes 1 to 3 seats (<200hp)	Part 23	31,246	$21,496	$4,000	$67,000	$3,176	42
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	4,364	$72,982	$18,000	$160,000	$10,658	42
3	Piston engine airplanes 4 to 9 seats one-engine (<200hp)	Part 23	49,970	$40,991	$14,500	$103,000	$2,810	34
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	Part 23	41,924	$85,927	$30,000	$210,000	$6,484	34
5	Piston engine airplanes 4 to 9 seats two-engine	Part 23	15,187	$132,754	$33,000	$380,000	$16,566	32
6	Piston engine airplanes 10 or more seats	Part 23	783	$130,762	$74,000	$235,000	$15,682	34
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	62	$187,976	$143,000	$196,000	$9,061	24
8	Turboprop airplanes 1 to 9 seats two-engine	Part 23	1,546	$383,106	$63,000	$800,000	$52,928	27
9	Turboprop airplanes 10 to 19 seats	Part 23	1,690	$773,026	$325,000	$1,150,000	$59,427	25
10	Turboprop airplanes 20 or more seats	Part 25	148	$699,467	$194,500	$1,230,000	$153,833	27
11	Turbojet/Turbofan two-engine airplanes <12,500 lbs.	Part 23/25	710	$824,692	$370,000	$1,500,000	$50,808	29
12	Turbojet/Turbofan airplanes >12,500 lbs. and <65,000 lbs.	Part 25	1,524	$1,715,000	$580,000	$6,400,000	$285,221	25
13	Turbojet/Turbofan airplanes >65,000 lbs.	Part 25	473	$3,878,931	$2,800,000	$6,200,000	$219,840	29
14	Rotorcraft piston <6,000 lbs.	Part 27	1,107	$69,630	$19,800	$99,000	$7,749	33
15	Rotorcraft turbine <6,000 lbs.	Part 27	2,004	$319,045	$72,000	$1,330,000	$53,942	27
16	Rotorcraft piston >6,000 lbs.	Part 29	18	NA	NA	NA	NA	NA
17	Rotorcraft turbine >6,000 lbs	Part 29	333	$1,047,191	$430,000	$2,625,000	$183,096	32
18	Other		7,504	NA	NA	NA	NA	NA
All Aircraft			**160,592**	**$94,661**	**$4,000**	**$6,400,000**	**$57,420**	**35**

Source: GA Survey 2002; Aircraft Bluebook Price Digest (Summer, 2003); Aircraft Types and Price Guidelines 2002-2003; GRA estimate
NA = Not Available

Note: "Other" economic values class is included in calculating fleet total for all aircraft but not in calculating estimated market values and age for all aircraft.

Col 1: Total number of aircraft in GA Survey manufactured before 1982.
Col 2: Average aircraft value weighted by the number of aircraft.
Col 3: The lowest aircraft value reported for each economic values class.
Col 4: The highest aircraft value reported for each economic values class.
Col 5: Square root of (n*(x-average price)^2)/(n*(n-1)) where n is the number of observations and x is aircraft price.
Col 6: Average aircraft age (weighted) for data with known aircraft value and year of manufacture.

Table 5-7 shows the market values for the 50,651 GA aircraft that were manufactured in 1982 or later. These aircraft have an average age of 10 years and an average market value of $1.8 million, which reflects both higher average values within each category as well as a higher proportion of large turbine engine aircraft in the post-1982 fleet.

Table 5-7: Estimated Market Values – 1982 and Later General Aviation Aircraft ($2003)

			1	2	3	4	5	6
			1982 and Beyond					
	Economic Values Category	Certification	Number of Aircraft	Average Value Per Aircraft	Minimum Value Per Aircraft	Maximum Value Per Aircraft	Standard Deviation of Average Aircraft Value	Average Aircraft Age (in 2003)
1	Piston engine airplanes 1 to 3 seats (<200hp)	Part 23	1,804	$76,108	$17,000	$135,000	$8,536	9
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	1,714	$256,885	$33,000	$535,000	$39,631	10
3	Piston engine airplanes 4 to 9 seats one-engine (<200hp)	Part 23	4,382	$108,914	$48,000	$225,000	$6,521	11
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	Part 23	8,069	$264,955	$56,000	$685,000	$20,144	10
5	Piston engine airplanes 4 to 9 seats two-engine	Part 23	1,596	$360,326	$145,000	$900,000	$30,378	15
6	Piston engine airplanes 10 or more seats	Part 23	18	$290,000	$290,000	$290,000	$0	19
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	942	$824,903	$170,000	$2,100,000	$226,032	8
8	Turboprop airplanes 1 to 9 seats two-engine	Part 23	603	$918,754	$115,000	$1,850,000	$131,405	14
9	Turboprop airplanes 10 to 19 seats	Part 23	1,960	$1,628,946	$476,500	$4,650,000	$258,069	13
10	Turboprop airplanes 20 or more seats	Part 25	72	$3,179,785	$750,000	$9,500,000	$1,279,249	18
11	Turbojet/Turbofan two-engine airplanes <12,500 lbs.	Part 23	1,319	$3,187,683	$1,000,000	$6,300,000	$211,507	9
12	Turbojet/Turbofan airplanes >12,500 lbs. And <65,000 lbs.	Part 25	3,445	$7,170,976	$1,650,000	$23,500,000	$1,141,863	9
13	Turbojet/Turbofan airplanes >65,000 lbs.	Part 25	731	$22,347,618	$6,800,000	$32,000,000	$1,173,882	7
14	Rotorcraft piston <6,000 lbs.	Part 27	1,219	$166,504	$69,000	$338,000	$31,056	8
15	Rotorcraft turbine <6,000 lbs.	Part 27	1,636	$856,887	$131,000	$5,000,000	$223,641	10
16	Rotorcraft piston >6,000 lbs.	Part 29	6	NA	NA	NA	NA	NA
17	Rotorcraft turbine >6,000 lbs	Part 29	324	$2,620,187	$530,000	$6,000,000	$679,377	14
18	Other		20,810	NA	NA	NA	NA	NA
All Aircraft			**50,651**	**$1,817,062**	**$ 17,000**	**$32,000,000**	**$ 871,932**	**10**

Source: GA Survey 2002; Aircraft Bluebook Price Digest (Summer, 2003); Aircraft Types and Price Guidelines 2002-2003; GRA estimate

NA = Not Available

Note: "Other" economic values class is included in calculating fleet total for all aircraft but not in calculating estimated market values and age for all

Col 1: Total number of aircraft in GA Survey manufactured in 1982 or later.

Col 2: Average aircraft value weighted by the number of aircraft.

Col 3: The lowest aircraft value reported for each economic values class.

Col 4: The highest aircraft value reported for each economic values class.

Col 5: Square root of (n*(x-average price)^2)/(n*(n-1)) where n is the number of observations and x is aircraft price.

Col 6: Average aircraft age (weighted) for data with known aircraft value and year of manufacture.

5.3.2 Restoration

Restoration values for general aviation aircraft were estimated using the data from Airclaims and AVEMCO. The values are reported by the economic values category only because a further breakdown by aircraft type is not feasible. The two sources provide average hull value of aircraft, average hull damage and the number of aircraft losses. Average hull value and average hull damage values were weighted by the number of aircraft with data to obtain averages for all aircraft. Average hull damage value was then divided by the average hull value, resulting in "damage/value" percentage for all aircraft as well as for each economic values category.

The economic values categories not covered in the AVEMCO or Airclaims database(s) were estimated using general aviation replacement costs from section 5.3.1. Average hull value obtained from Section 5.3.1 for each economic values category was multiplied by the "damage/value" percentage for all aircraft. The number of aircraft for those categories whose values were obtained from the Section 5.3.1 was not reported nor was it used in calculating weighted averages for all aircraft. Table 5-8 presents the summary of restoration costs for general aviation aircraft groups.

Table 5-8: General Aviation Restoration Costs ($2003)

			1	2	3	4	5	6	7
Economic Values Category		Certification	Number of Aircraft	Average of Hull Value	Average of Hull Damage	Damage/ Value	Aircraft with Hull Value Data	Aircraft with Hull Damage Data	Source
1	Piston engine airplanes 1 to 3 seats (<200hp)	Part 23	610	$ 38,637	$ 11,714	30%	584	554	AVEMCO
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	76	$ 111,164	$ 20,516	18%	73	70	AVEMCO
3	Piston engine airplanes 4 to 9 seats one-engine (<200hp)	Part 23	1,200	$ 50,326	$ 10,981	22%	1,171	1,130	AVEMCO
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	Part 23	953	$ 104,269	$ 18,916	18%	936	902	AVEMCO
5	Piston engine airplanes 4 to 9 seats two-engine	Part 23	327	$ 125,382	$ 30,010	24%	320	307	AVEMCO
6	Piston engine airplanes 10 or more seats	Part 23	2	$ 232,500	$ 24,364	10%	2	2	AVEMCO
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	NR	$ 803,011	$ 163,650	20%	NR	NR	N/A*
8	Turboprop airplanes 1 to 9 seats two-engine	Part 23	NR	$ 517,788	$ 105,523	20%	NR	NR	N/A*
9	Turboprop airplanes 10 to 19 seats	Part 23	1	$ 900,000	$ 6,607	1%	1	1	AVEMCO
10	Turboprop airplanes 20 or more seats	Part 25	NR	$ 2,014,790	$ 410,605	20%	NR	NR	N/A*
11	Turbojet/Turbofan two-engine airplanes <12,500 lbs.	Part 23/25	NR	$ 2,568,083	$ 523,364	20%	NR	NR	N/A*
12	Turbojet/Turbofan airplanes >12,500 lbs. And <65,000 lbs.	Part 25	67	$ 4,532,030	$ 933,119	21%	66	67	Airclaims
13	Turbojet/Turbofan airplanes >65,000 lbs.	Part 25	4	$ 12,625,000	$ 771,250	6%	4	4	Airclaims
14	Rotorcraft piston <6,000 lbs.	Part 27	NR	$ 135,430	$ 27,600	20%	NR	NR	N/A*
15	Rotorcraft turbine <6,000 lbs.	Part 27	NR	$ 606,739	$ 123,651	20%	NR	NR	N/A*
16	Rotorcraft piston >6,000 lbs.	Part 29	NR	NR	NR	NR	NR	NR	NR
17	Rotorcraft turbine >6,000 lbs	Part 29	NR	$ 1,888,082	$ 384,783	20%	NR	NR	N/A*
18	Other		422	$ 64,272	$ 15,473	24%	325	294	AVEMCO
All Aircraft			**3,662**	**$ 172,084**	**$ 35,070**	**20%**	**3,482**	**3,331**	**AVEMCO & Airclaims**

Note: *Where source of data is not available, it is assumed that Average Hull Value equals Average Market Value from the table 5-5; Average Hull Damage equals "Damage/Value" for *All Aircraft* (~20%) multiplied by Average Hull Value; "Damage/Value" equals "Damage/Value" for All Aircraft.
N/A = Not Available
NR = Not Reported
Col 1: Total number of aircraft in the database.
Col 2: Average aircraft hull value for each economic values class.
Col 3: Average aircraft hull damage value for each economic values class.
Col 4: Column 2 divided by column 1.
Col 5: Number of aircraft with hull value data.
Col 6: Number of aircraft with hull damage data.
Col 7: Source of data.

Table 5-9 shows general aviation restoration values for aircraft that were manufactured before 1982. Average hull damage for all aircraft reported through AVEMCO and Airclaims is about 26 percent of average hull value.

Table 5-9: General Aviation Restoration Costs – Pre 1982 Aircraft ($2003)

	Economic Values Category	Certification	Number of Aircraft	Average of Hull Value	Average of Hull Damage	Damage/ Value	Aircraft with Hull Value Data	Aircraft with Hull Damage Data	Source
			1	2	3	4	5	6	7
1	Piston engine airplanes 1 to 3 seats (<200hp)	Part 23	545	$ 31,506	$ 10,587	34%	520	491	AVEMCO
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	38	$ 93,778	$ 18,586	20%	36	36	AVEMCO
3	Piston engine airplanes 4 to 9 seats one-engine (<200hp)	Part 23	1,155	$ 47,682	$ 10,559	22%	1,126	1,086	AVEMCO
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	Part 23	840	$ 89,119	$ 17,739	20%	824	793	AVEMCO
5	Piston engine airplanes 4 to 9 seats two-engine	Part 23	316	$ 117,903	$ 28,940	25%	309	296	AVEMCO
6	Piston engine airplanes 10 or more seats	Part 23	2	$ 232,500	$ 24,364	10%	2	2	AVEMCO
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	NR	$ 187,976	$ 48,936	26%	NR	NR	N/A*
8	Turboprop airplanes 1 to 9 seats two-engine	Part 23	NR	$ 383,106	$ 99,734	26%	NR	NR	N/A*
9	Turboprop airplanes 10 to 19 seats	Part 23	1	$ 900,000	$ 6,607	1%	1	1	AVEMCO
10	Turboprop airplanes 20 or more seats	Part 25	NR	$ 699,467	$ 182,093	26%	NR	NR	N/A*
11	Turbojet/Turbofan two-engine airplanes <12,500 lbs.	Part 23/25	NR	$ 824,692	$ 214,693	26%	NR	NR	N/A*
12	Turbojet/Turbofan airplanes >12,500 lbs. And <65,000 lbs.	Part 25	39	$ 2,361,256	$ 734,641	31%	39	39	Airclaims
13	Turbojet/Turbofan airplanes >65,000 lbs.	Part 25	1	$ 6,500,000	$ 2,000,000	31%	1	1	Airclaims
14	Rotorcraft piston <6,000 lbs.	Part 27	NR	$ 69,630	$ 18,127	26%	NR	NR	N/A*
15	Rotorcraft turbine <6,000 lbs.	Part 27	NR	$ 319,045	$ 83,057	26%	NR	NR	N/A*
16	Rotorcraft piston >6,000 lbs.	Part 29	NR	NR	NR	NR	NR	NR	NR
17	Rotorcraft turbine >6,000 lbs	Part 29	NR	$ 1,047,191	$ 272,617	26%	NR	NR	N/A*
18	Other		71	$ 39,145	$ 12,933	33%	55	52	AVEMCO
All Aircraft			**3,008**	**$ 97,982**	**$ 25,508**	**26%**	**2,913**	**2,797**	**AVEMCO & Airclaims**

Note: *Where source of data is not available, it is assumed that Average Hull Value equals Average Market Value from the table 5-5; Average Hull Damage equals "Damage/Value" for *All Aircraft* (~20%) multiplied by Average Hull Value; "Damage/Value" equals "Damage/Value" for All Aircraft.
N/A = Not Available
NR = Not Reported
Col 1: Total number of aircraft in the database.
Col 2: Average aircraft hull value for each economic values class.
Col 3: Average aircraft hull damage value for each economic values class.
Col 4: Column 2 divided by column 1.
Col 5: Number of aircraft with hull value data.
Col 6: Number of aircraft with hull damage data.
Col 7: Source of data.

Restoration values for the aircraft manufactured in 1982 or later are summarized in Table 5-10. Average hull damage for all aircraft reported through AVEMCO and Airclaims is about 15 percent of average hull value.

Table 5-10: General Aviation Restoration Costs – 1982 and Later Aircraft ($2003)

			1	2	3	4	5	6	7
	Economic Values Category	**Certification**	**Number of Aircraft**	**Average of Hull Value**	**Average of Hull Damage**	**Damage/ Value**	**Aircraft with Hull Value Data**	**Aircraft with Hull Damage Data**	**Source**
1	Piston engine airplanes 1 to 3 seats (<200hp)	Part 23	65	$96,580	$20,496	21%	64	63	AVEMCO
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	38	$128,081	$22,559	18%	37	34	AVEMCO
3	Piston engine airplanes 4 to 9 seats one-engine (<200hp)	Part 23	45	$116,483	$21,414	18%	45	44	AVEMCO
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	Part 23	113	$215,730	$27,483	13%	112	109	AVEMCO
5	Piston engine airplanes 4 to 9 seats two-engine	Part 23	11	$335,455	$58,799	18%	11	11	AVEMCO
6	Piston engine airplanes 10 or more seats	Part 23	NR	$290,000	$44,782	15%	NR	NR	N/A*
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	NR	$824,903	$127,381	15%	NR	NR	N/A*
8	Turboprop airplanes 1 to 9 seats two-engine	Part 23	NR	$918,754	$141,873	15%	NR	NR	N/A*
9	Turboprop airplanes 10 to 19 seats	Part 23	NR	$1,628,946	$251,541	15%	NR	NR	N/A*
10	Turboprop airplanes 20 or more seats	Part 25	NR	$3,179,785	$491,021	15%	NR	NR	N/A*
11	Turbojet/Turbofan two-engine airplanes <12,500 lbs.	Part 23/25	NR	$3,187,683	$492,240	15%	NR	NR	N/A*
12	Turbojet/Turbofan airplanes >12,500 lbs. And <65,000 lbs.	Part 25	28	$7,667,593	$1,209,571	16%	27	28	Airclaims
13	Turbojet/Turbofan airplanes >65,000 lbs.	Part 25	3	$14,666,667	$361,667	2%	3	3	Airclaims
14	Rotorcraft piston <6,000 lbs.	Part 27	NR	$166,504	$25,712	15%	NR	NR	N/A*
15	Rotorcraft turbine <6,000 lbs.	Part 27	NR	$856,887	$132,320	15%	NR	NR	N/A*
16	Rotorcraft piston >6,000 lbs.	Part 29	NR	NR	NR	NR	NR	NR	NR
17	Rotorcraft turbine >6,000 lbs	Part 29	NR	$2,620,187	$404,608	15%	NR	NR	N/A*
18	Other		351	$69,390	$16,019	23%	270	242	AVEMCO
All Aircraft			**654**	**$551,448**	**$85,154**	**15%**	**569**	**534**	**AVEMCO & Airclaims**

Note: *Where source of data is not available, it is assumed that Average Hull Value equals Average Market Value from the table 5-5; Average Hull Damage equals "Damage/Value" for *All Aircraft* (~20%) multiplied by Average Hull Value; "Damage/Value" equals "Damage/Value" for All Aircraft.
N/A = Not Available
NR = Not Reported
Col 1: Total number of aircraft in the database.
Col 2: Average aircraft hull value for each economic values class.
Col 3: Average aircraft hull damage value for each economic values class.
Col 4: Column 2 divided by column 1.
Col 5: Number of aircraft with hull value data.
Col 6: Number of aircraft with hull damage data.
Col 7: Source of data.

5.4 MILITARY AIRCRAFT

5.4.1 Replacement

Estimating replacement values for military aircraft is considerably more complex than it is for air carrier or general aviation aircraft. One problem is that used military aircraft do not sell in the large numbers that commercial equipment does. The second problem is that there is a complex procurement process for military aircraft, which often makes unit cost estimates for individual types inappropriate as measures of opportunity costs.

The example of the B-52 bomber illustrates the two problems discussed above. First, there is no used market for this aircraft. It is an aircraft for which there are few substitutes. Second, what would it cost to actually replace a B-52 that is lost in an accident? It is not possible to buy one B-52 or a newer plane that has similar characteristics.[61] A new military procurement program would cost a substantial sum of money, which could not be counted as a cost against one aircraft lost in an accident.

[61] The B-52 aircraft program has had a number of aircraft upgrades, which adds to the complexity in determining a market value.

Data on military aircraft replacement values were obtained from each branch of the services. They are based on unit production costs of each aircraft. Summary values are reported in Table 5-11.

5.4.2 Restoration

Data on military restoration costs were also obtained from the military services. They are based on the repair cost of aircraft damaged in accidents. Because the government self-insures, it is likely that the accident data reflect a high proportion of accidents with relatively low levels of damage. Estimated restoration costs average 3 percent of aircraft value as shown above in Table 5-11. However, if the avoided accidents are likely to involve substantial damage, a higher value would be appropriate. In this case, the value of 13 percent for air carrier aircraft restoration is recommended because of the similarities of aircraft types involved.

Table 5-11: Summary of Military Aircraft Values and Restoration Costs (FY2003) average weighted by fleet ($ millions)

	1	2	3	4
Aircraft Type	**Number of Aircraft**	**Average Replacement Value**	**Average Restoration Value**	**Restoration Percentage**
Piston	3	$0.1	NA	N/A
Rotary Wing Aircraft	7,125	$10.9	$0.7	6.1%
Turbojet/fan 3+ Engines	1,167	$74.9	$0.4	0.5%
Turbojet/fan Attack/Fighter	4,051	$34.7	$0.7	1.9%
Turbojet/fan Other	1,587	$12.3	$0.9	7.5%
Turboprop	2,017	$31.9	$1.3	4.0%
Other	22	$23.2	NA	N/A
N/A	2	NA	NA	N/A
Total	**15,974**	**$24.4**	**$0.7**	**3.0%**

Sources-Aircraft Restoration: Navy and Marine Corps restoration Costs
Sources-Aircraft Replacement: Army, Army Reserve and National Guard (TB_43_0002_3.pdf); Air Force, Air Force Reserve and Air National Guard U.S. Air Force (U.S. Airforce and Planning Factors); Navy, Naval Reserve, Marine Corps, and Marine Corps Reserve (Ser AIR=1.1.1A/AAC03); Coast Guard
Note: Replacement and restoration values were not available for all aircraft types.
Col 1: Total number of aircraft for each aircraft type in military service.
Col 2: Average replacement value for each aircraft type, weighted by fleet.
Col 3: Average restoration value for each aircraft type, weighted by fleet.
Col 4: Column 3 divided by column 2.

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SECTION 6: ECONOMIC VALUES RELATED TO AIRCRAFT PERFORMANCE FACTORS

6.1 INTRODUCTION

Certain types of investment programs or regulatory changes can affect aircraft performance. This can occur by changing the weight of the aircraft as well as altering the time in certain phases of flight. This section covers two elements related to aircraft performance:

- The additional fuel use caused by incremental changes in aircraft weight
- The proportion of time spent in various phases of flight on representative aircraft missions

Measures are developed for air carrier and general aviation aircraft. Data were not available on military aircraft performance. This section also contains data on the price of aviation fuel and sources for updated information on fuel prices.

The objective of this section is to provide values for use in economic analyses related to investment and regulatory decisions that alter the performance of aircraft. For example, increases in aircraft weight affect fuel burn. The issue of when mandated increases in aircraft weight affect the suitability of an aircraft for specific missions is not directly examined in this section. For example, aircraft are designed with a target mission in terms of payload and range in mind, and these are performed at an assumed maximum aircraft weight. If a regulation were to cause a large change in aircraft weight, then the aircraft may not be capable of performing some of the missions for which it was designed. In this section, the values presented assume that the incremental changes in aircraft weight do not occur at the limits of the payload-range envelope.

When regulatory actions occur during the aircraft design phase, aircraft weight increases will often cause an increase in installed power, fuel capacity, and so forth to maintain the target payload-range capability. Essentially, the increase in aircraft weight requires an increase in the amount of fuel used to fly the same mission. The increase in fuel used adds weight to the aircraft requiring additional fuel to be carried. The aircraft design would then be optimized for these new performance parameters. The re-optimization of an aircraft design is not considered in the values developed below. Re-optimization of a design may be the most appropriate type of analysis in some cases; however, it is not possible to capture this in a standard economic value.

6.2 APPROACH

The aircraft selected for analysis in this chapter were based on review of FAA's enhanced traffic management system (ETMS) and *Official Airline Guide* (OAG) data regarding the types of aircraft operating in the National Airspace System (NAS) and the typical missions in terms of stage length at which they were operated.[62] GRA selected the most frequently observed aircraft within each aircraft type/user group combination and determined the median stage length for the missions performed by this aircraft. These form the basis for the mission lengths over which the increases in fuel burn (based on increases in aircraft weight) were calculated, as well as the lengths of mission for which flight segment times were developed. Research conducted for the prior economic values study (FAA-APO-98-8: Tables 7-16 and 7-18) showed that the incremental fuel burn per pound of additional weight was relatively constant over the range weight added. Weight penalties used in this report range from 100 to 500 pounds depending on aircraft type.

6.2.1 Air Carrier Aircraft

Air carrier aircraft operated by passenger/combination carriers were selected using the *OAG* for February 2003. Aircraft were selected for each economic values category based on total hours flown. The aircraft types having the greatest hours flown were chosen to represent all aircraft within a category. In general, one to three aircraft were selected to represent an aircraft category. Only data for the domestic and international operations of U.S. air carriers were included. Commuter and regional aircraft also were selected using the *OAG*. All-cargo aircraft were selected using data from ETMS.

6.2.2 General Aviation Aircraft

Air taxi aircraft models were identified using a tabulation from the Operating Specification Subsystem maintained by FAA Flight Standards Organization. Aircraft that were approved for use in Part 135 operations were analyzed to determine the most common aircraft types. GA aircraft were selected based on flight frequencies in ETMS.

6.2.3 Aircraft Performance Data

The data presented in this analysis were based on flight test results obtained at aircraft certification and represent the nominal level of performance at aircraft delivery. The performance manuals are produced by the aircraft manufacturer and represent the optimal performance achievable by the operator. Due to external and internal

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[62] The ETMS provides data on flights that were operated in the NAS while the OAG provides data on scheduled flights.

configuration changes, the aircraft's actual performance will vary as a factor of weight, operating conditions, etc. In addition, it can be expected that actual aircraft performance will degrade as the aircraft ages, further restricting its capabilities. For example, no factor has been applied to allow for degradation in fuel efficiency over time.

6.2.3.1 General Assumptions—The analysis was performed in accordance with Approved Transport Category Operations, in particular Part 25, paragraph 25.121 and amendment 42. Regulatory performance is calculated with air conditioning bleeds off. Some aircraft performance is determined with reference to Part 23, Part 27, Part 29 or Part 135 requirements.

Climb, cruise, descent and holding fuel flows are calculated on the basis of an economic air conditioning mode. Takeoff performance is calculated for zero wind, dry, hard and level runway, and no obstacles. Holding and diversion fuel allowances were calculated for the respective aircraft weights at the beginning of the hold or diversion profile.

6.2.3.2 Aircraft Parameters—The Operational Weight Empty (OWE) is the weight of a typical aircraft as equipped for passenger operations. Included in the OWE is the manufacturer's empty weight plus standard and operational items. Standard items include: unusable fuel, seats, carpet, engine oil, emergency equipment, toilet fluids and chemicals, galley, buffet, etc. Operational items include things such as crew, baggage, manuals, food, beverages, and life vests.

The Maximum Zero Fuel Weight (MZFW) is the maximum allowable weight of the aircraft before fuel is added.

The Maximum Structural Payload is the difference between the MZFW and the OWE. For purposes of this analysis 70 percent of the maximum structural payload was assumed for the base case performance analysis. An additional calculation involving either a 100 or 500 pound payload increment was then performed. The difference in fuel burn against the base case was determined to be the incremental fuel burn for the weight increment.

The Maximum Landing Weight (MLW) is the certified maximum allowable weight of the aircraft at touchdown.

Mission Takeoff Weight is the total of OWE, passenger and/or cargo weight, mission fuel weight and reserve fuel weight. Takeoff weight may be limited by aircraft performance. Mission Takeoff Weight may be less than the Maximum Takeoff Weight.

The combination of maximum payload and maximum fuel weight plus the OWE may exceed the MZFW. In such situations, the operator must balance payload, reserves, and mission needs to achieve the requirements of the flight profile. This involves a tradeoff between the payload and fuel load carried, and generally affects the maximum range that can be achieved.

6.2.3.3 Flight Profile—A mission is conducted over a specified distance. The effects of wind were not included in the analysis. The mission distance is applied from takeoff point (origin airport) to landing point (destination airport). No distance credit is taken for the taxi-out, takeoff, approach and landing, and taxi-in, as these segments may not be in the same direction as the desired flight path.

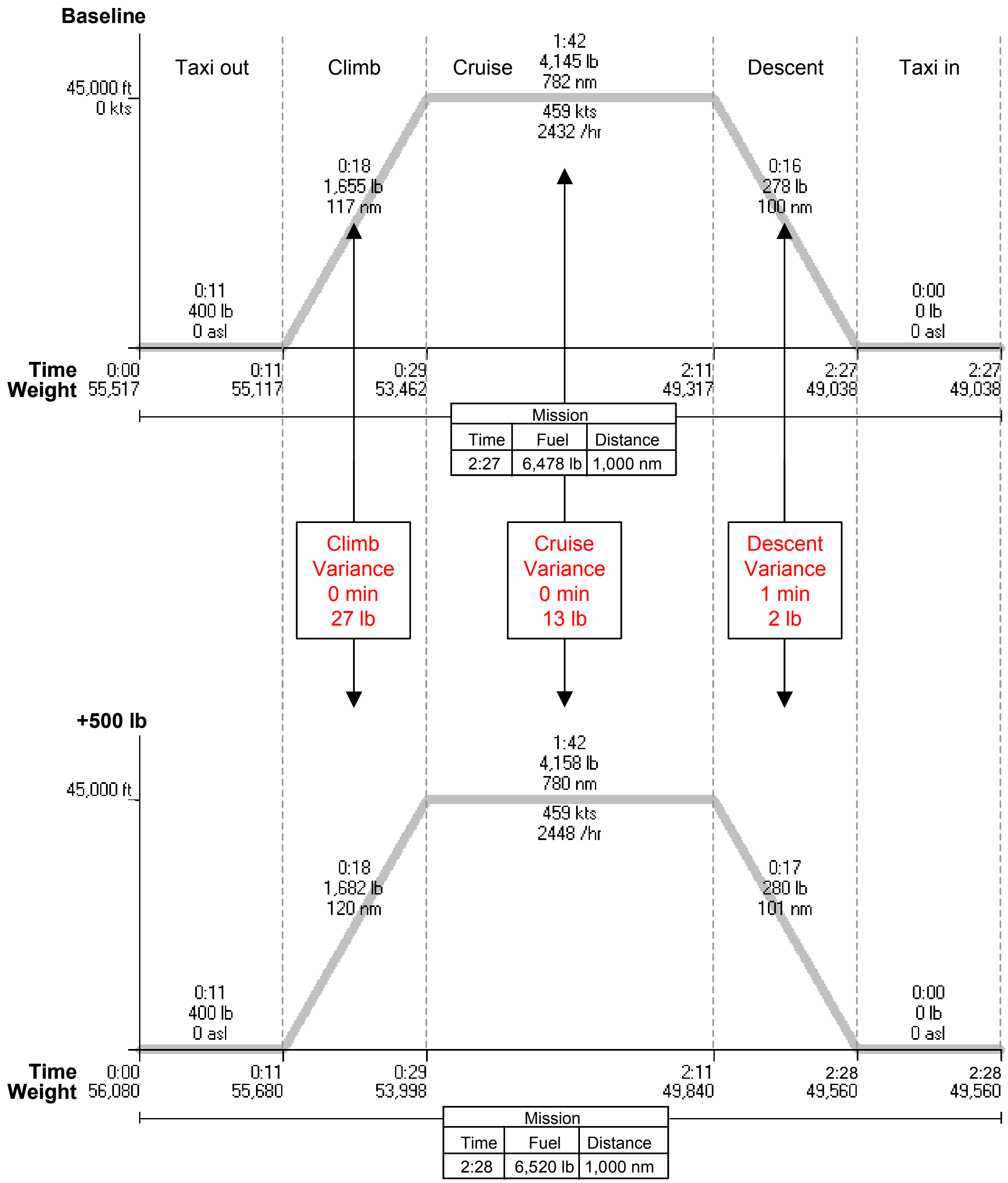
All of the factors shown above must be taken into account for proper mission planning. A computer model was used with given parameters to calculate the optimal result. For optimization purposes, the computer model iterates to achieve the best payload vs. time ratio. This is due to most costs being time based.

The current industry practice is to allow the aircraft to maintain straight and level flight (in the mission cruise portion) for a minimum of 30 percent of the mission distance. This is to allow for safe movement about the cabin and the servicing of passengers.

Figure 6-1 illustrates the development of performance changes related to a 500-pound weight penalty for a Gulfstream IV operating at a 1,000 nm stage length. The assumptions include an instrument standard (ISA) day, zero winds, level operation, 70 percent payload, Mach 0.8 cruise speed and National Business Aviation Association (NBAA) instrument flight rules (IFR) reserves. It shows the mission time, fuel burn and distance for each flight segment. The top part of the figure is the baseline mission and the bottom part is the same mission with a 500-pound weight penalty. The mission with the 500-pound weight penalty uses 42 more pounds of fuel, while the flight time for the mission is increased by one minute from 2 hours 27 minutes to 2 hours 28 minutes.

The performance models and manufacturer data also permit estimation of the time aircraft spend in various mission segments of a flight including taxi-out, takeoff, climb, cruise, descent, landing, and taxi-in. Not all mission segments are available for each aircraft analyzed, using manufacturer data.

Figure 6-1: Gulfstream IV Illustrative Performance Calculations
1,000nm Stage Length and 500 lb Weight Penalty*



Total variance for 500 lb weight increase = 1 min of additional flight time and 42 lb or 6.3 usg of additional fuel

* Range 1,000 nm, ISA, zero winds, sea level takeoff, 70% payload, cruise at Mach 0.80 and NBAA IFR reserves

6.3 AIR CARRIER AIRCRAFT

This section presents the analysis of weight penalties and mission segments for large commercial aircraft. It considers aircraft used in passenger (combination) service as well as those used in all-cargo service.

6.3.1 Incremental Fuel Burn

As noted above, incremental fuel burn related to an increase in aircraft weight was calculated for selected aircraft types and selected stage lengths. The aircraft types selected present a sampling of the most common aircraft in use within each economic values category. Mission lengths were based on typical mission lengths for each aircraft type. For most aircraft models, multiple mission lengths were analyzed. A weight penalty of 500 pounds was used for all jet aircraft, while a weight penalty of 100 pounds was used for turboprop and piston engine aircraft.

Table 6-1 presents the results for all large commercial aircraft (includes both passenger and all-cargo aircraft). The table presents the aircraft type, passenger or cargo configuration, the stage lengths analyzed, the weight penalty and the incremental fuel burn in pounds per flight.[63] In addition, the incremental fuel burn per pound of weight added is also calculated in U.S. gallons per flight. The incremental fuel burn in gallons per hour per pound of weight added is calculated by dividing the incremental fuel burn per flight per pound of weight added by the flight time. Also shown is the total flight time for the specific mission analyzed.

As noted above, prior research has shown that the incremental fuel per pound of weight added is relatively constant for the weight increases considered in this section. Therefore, the additional fuel consumption per year can be estimated by the amount of weight added times the incremental fuel burn times the annual utilization in flight hours. For example, assume that a regulation imposes a 100-pound weight penalty on a B737-300 that operates over a 250 nm average stage length for 3,000 hours per year. The annual cost at $0.80 per gallon for the additional fuel consumed because of the increase in aircraft weight is $960.00 (3,000 hours x $0.80 per gallon x 0.004 pounds x 100 gallons per pound).

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[63] Fuel weight in pounds is converted to U.S. gallons by using 6.7 lbs per gallon.

Table 6-1: Large Commercial Aircraft – Incremental Fuel Burn

			1	2	3	4	5	6	7
Economic Values Category	**Aircraft Type**	**Passenger/ Cargo**	**Median Stage Length**	**Weight Penalty**	**Part**	**Incremental Fuel Burn Per Flight (lbs.)**	**Incremental Fuel Burn Per Flight Per Pound of Weight Added (usg**)**	**Flight Time (hr)**	**Incremental Fuel Burn per Flight Hour per Pound of Weight Added (usg**)**
Two-Engine Narrow-Body	A320-200	Passenger	250 nm	500	25	21.800	0.007	0.7	0.010
			500 nm	500	25	35.400	0.011	1.2	0.009
	B737-300	Passenger	250 nm	500	25	11.000	0.003	0.8	0.004
			500 nm	500	25	22.000	0.007	1.4	0.005
	B757-200	Passenger/ Cargo	500 nm	500	25	22.000	0.007	1.3	0.005
			1,000 nm	500	25	47.000	0.014	2.4	0.006
	MD 81	Passenger	500 nm	500	25	24.000	0.007	1.3	0.006
			750 nm	500	25	28.000	0.008	1.8	0.005
	DC-9	Cargo	500 nm	500	25	17.000	0.005	1.2	0.004
Two-Engine Wide-Body	A300-600	Cargo	500 nm	500	25	20.000	0.006	1.5	0.004
			750 nm	500	25	30.000	0.009	2.1	0.004
	B767-300	Passenger	3,000 nm	500	25	114.000	0.034	6.7	0.005
			5,000 nm	500	25	200.000	0.060	11.0	0.005
	B777-200	Passenger	3,000 nm	500	25	67.000	0.020	6.0	0.003
			4,400 nm	500	25	143.000	0.043	9.0	0.005
Three-Engine Narrow-Body	B727-200	Cargo	250 nm	500	25	15.000	0.004	0.7	0.006
			500 nm	500	25	24.000	0.007	1.1	0.006
Three-Engine Wide-Body	DC-10-30	Cargo	1,750 nm	500	25	58.000	0.017	4.0	0.004
			2,000 nm	500	25	75.000	0.022	4.5	0.005
Four-Engine Narrow-Body	DC8-60	Cargo	250 nm	500	25	16.000	0.005	0.7	0.007
			500 nm	500	25	18.000	0.005	1.2	0.004
Four-Engine Wide-Body	B747-100	Cargo	500 nm	500	25	15.000	0.004	1.3	0.003
			750 nm	500	25	37.000	0.011	1.8	0.006
	B747-400	Passenger	5,000 nm	500	25	210.000	0.063	10.4	0.006
			7,000 nm	500	25	318.000	0.095	14.4	0.007
Regional Jet under 70 seats	CRJ-200ER	Passenger	250 nm	500	25	10.000	0.003	0.7	0.004
			500 nm	500	25	18.000	0.005	1.3	0.004
	ERJ-135	Passenger	250 nm	500	25	13.000	0.004	0.8	0.005
			500 nm	500	25	19.000	0.006	1.4	0.004
Regional Jet 70 to 100 seats	CRJ-700ER	Passenger	250 nm	500	25	8.000	0.002	0.7	0.003
			500 nm	500	25	19.000	0.006	1.3	0.004
Turboprop under 20 seats (Part 23)	Beech 1900	Passenger	250 nm	100	23	5.300	0.008	1.1	0.007
	C-208	Cargo	250 nm	100	23	0.918	0.001	1.7	0.001
	Swearingen Metro II SA-226	Cargo	250 nm	100	23	2.570	0.004	1.0	0.004
			500 nm	100	23	2.140	0.003	2.1	0.002
Turboprop under 20 seats (Part 25)	*	*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Turboprop 20 seats and over	Dash 8-102	Passenger	250 nm	100	25	1.000	0.001	1.0	0.001
			500 nm	100	25	2.000	0.003	2.0	0.001
Piston Engine (Part 23)	Piper PA-31	Cargo	250 nm	100	23	0.930	0.001	1.5	0.001
Piston Engine (Part 25)	*	*	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Source: GRA analysis of manufacturer data
N/A = Few units in service
*Data for general aviation aircraft may be used to represent these aircraft categories.
**Fuel weight in pounds is converted to U.S. gallons by using 6.7 lbs per gallon
Col 1: Median stage length for the missions performed by each aircraft type.
Col 2: Weight penalty of 500 lbs. was used for all jet aircraft while weight penalty of 100 lbs. was used for all turboprops and pistons.
Col 3: Certification Part.
Col 4: Manufacturer data.
Col 5: Column 4 divided by column 2 divided by 6.7
Col 6: Manufacturer Data.
Col 7: Column 5 divided by column 6.

6.3.2 Flight Profiles

Flight profiles for all carrier aircraft are presented in Table 6-2. These are based on simple averages of the data from the specific aircraft shown in Table 6-1 above.[64] Not all mission segments could be calculated for each aircraft and some have been aggregated. Flight profiles for each mission by each aircraft and type are provided in supporting tables on the APO website.

Table 6-2: Large Commercial Aircraft – Breakdown of Flight Profiles

	1	1a	2	3	4	5
Economic Values Category	Average Flight Profiles (min)					
	Taxi out/ Takeoff/ Climbout		Climb/ Cruise/ Descent	Landing	Taxi-in	Total Minutes
Two-Engine Narrow-Body	10.7		67.2	10.0	5.0	92.9
Two-Engine Wide-Body	10.0		487.9	5.0	5.0	507.9
Three-Engine Narrow-Body	9.0		54.9	NR	5.0	68.9
Three-Engine Wide-Body	25.0		202.4	25.0	NR	252.4
Four-Engine Narrow-Body	14.1		26.4	18.0	NR	58.5
Four-Engine Wide-Body	11.3		735.2	4.0	5.0	755.5
Economic Values Category	Taxi out	Takeoff and Climb	Cruise	Descent and Landing	Taxi in	Total Minutes
Regional Jet under 70 seats	7.5	19.4	28.5	15.7	4.5	75.5
Regional Jet 70 to 100 seats	6.0	25.0	21.0	14.0	4.0	70.0
Turboprop under 20 seats (Part 23)	NR	15.9	56.5	15.1	NR	87.5
Turboprop under 20 seats (Part 25)	N/A	N/A	N/A	N/A	N/A	N/A
Turboprop 20 seats and over	7.5	22.5	72.3	21.0	4.5	127.8
Piston Engine (Part 23)	2.0	16.0	43.9	33.0	2.0	96.9
Piston Engine (Part 25)	N/A	N/A	N/A	N/A	N/A	N/A

Source: GRA analysis of manufacturer data
N/A = Few units in service
NR = Values not reported
Note: Four-Engine Wide-Body does not include B747-100 because B747-100 flight profile was significantly different from other aircraft in the same category.
Col 1-4: GRA sorted the data in flight profiles because the manufacturer data was not reported in the same categories for each aircraft type.
Col 5: Sum of columns 1 through 4.

6.4 GENERAL AVIATION

Table 6-3 contains the results of the performance analysis of weight penalties for selected general aviation and air taxi aircraft. The underlying performance data does

[64] Weighted averages were not calculated because there was not a good representation of the aircraft within each group. Thus, the category averages should be viewed as approximations of the amount of flight time in each flight segment of a typical aircraft mission.

not differentiate between air taxi and other general aviation aircraft. The same mission analysis rules as above were used except that a weight penalty of 100 pounds was applied to all aircraft except for the largest business jet aircraft category. In addition, rotorcraft performance is considered in this section. As can be seen, most aircraft were evaluated over one proposed mission length, except for jet aircraft that were evaluated at two mission lengths. The table shows the amount of the weight penalty, the incremental fuel burn per flight in pounds, and the incremental fuel burn per flight per pound of added weight in gallons. The incremental fuel burn per pound of weight added per flight hour is also shown in this table.

Table 6-4 summarizes performance data for the general aviation and air taxi aircraft. Performance profiles allow consideration of the proportion of mission length spent in each part of the flight profile. This permits calculation of costs by amount of time in each part of the flight using the cost data per flight hour from Section 4.

Table 6-3: General Aviation and Air Taxi Aircraft – Incremental Fuel Burn

			1	2	3	4	5	6	7
	Economic Values Category	Aircraft Type	Mission Stage Length	Weight Penalty	Part	Incremental Fuel Burn Per Flight (lbs.)	Incremental Fuel Burn Per Flight Per Pound of Weight Added (usg*)	Flight Time (hr)	Incremental Fuel Burn Per Flight Hour Per Pound of Weight Added (usg*)
1	Piston engine airplanes 1 to 3 seats (<=200hp)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Piston engine airplanes 1 to 3 seats (>200hp)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Piston engine airplanes 4 to 9 seats one-engine (<=200hp)	C-172	250 nm	100	23	0.920	0.001	2.1	0.001
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	Piston engine airplanes 4 to 9 seats multiengine	PA-31	250 nm	100	23	0.930	0.001	1.5	0.001
6	Piston engine airplanes 10 or more seats	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	Turboprop airplanes 1 to 9 seats one-engine	C-208	250 nm	100	23	0.918	0.001	1.7	0.001
8	Turboprop airplanes 1 to 9 seats multiengine	Cessna 421	250 nm	100	23	0.329	0.000	1.0	0.000
9	Turboprop airplanes 10 to 19 seats	BE-200	250 nm	100	23	1.591	0.002	1.0	0.002
10	Turboprop airplanes 20 or more seats**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	Turbojet/Turbofan airplanes <=12,500 lbs	C550/560	250 nm	100	25	2.000	0.003	0.7	0.004
		C550/560	500 nm	100	25	5.000	0.007	1.4	0.005
12	Turbojet/Turbofan airplanes>12,500 lbs and <=65,000lbs	Lear Jet 35	500 nm	100	25	2.520	0.004	1.2	0.003
		Lear Jet 35	1,000 nm	100	25	2.786	0.004	2.4	0.002
		Lear Jet 60	500 nm	100	25	5.135	0.008	1.2	0.006
		Lear Jet 60	1,000 nm	100	25	11.028	0.016	2.4	0.007
13	Turbojet/Turbofan airplanes >65,000 lbs	Gulfstream G-IV	250 nm	500	25	12.000	0.004	0.6	0.006
		Gulfstream G-IV	1,000 nm	500	25	42.000	0.013	2.3	0.005
14	Rotorcraft Piston <=6,000 lbs	R-22	200 nm	100	27	1.500	0.002	1.8	0.001
15	Rotorcraft Turbine <=6,000 lbs	B-206	200 nm	100	27	5.800	0.009	1.8	0.005
16	Rotorcraft Piston >6,000 lbs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	Rotorcraft Turbine >6,000 lbs	S-76	200 nm	100	29	13.610	0.020	1.5	0.014
18	Other	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Source: GRA analysis of manufacturer data
*U.S. Gallons: Fuel weight in pounds is converted to U.S. gallons by using 6.7 lbs per gallon.
N/A = Few units in service
**Data for large commercial aircraft may be used to represent these aircraft categories.
Col 1: Mission stage length for the missions performed by each aircraft type.
Col 2: Weight penalty of 100 lbs. Or 500 lbs. Depending on aircraft type.
Col 3: Certification Part.
Col 4: Manufacturer data.
Col 5: Column 4 divided by column 2 divided by 6.7.
Col 6: Manufacturer Data.
Col 7: Column 5 divided by column 6.

Table 6-4: General Aviation and Air Taxi Aircraft – Breakdown of Flight Profiles Flight Segment Categories Limited by Available Data

	Economic Values Category	Aircraft Type	Mission Stage Length	Flight Time (hr)	Breakdown of Flight Profile (min)					Breakdown of Flight Profile (percent)				
			1	2	3	4	5	6	7	8	9	10	11	12
					Taxi-out	Takeoff/ Climbout	Cruise	Descent	Taxi-in	Taxi-out	Takeoff/ Climbout	Cruise	Descent	Taxi-in
1	Piston engine airplanes 1 to 3 seats (<=200hp)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Piston engine airplanes 1 to 3 seats (>200hp)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Piston engine airplanes 4 to 9 seats one-engine (<=200hp)	C-172	250 nm	2.1	NR	13.0	107.0	7.0	NR	0%	10%	84%	6%	0%
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	Piston engine airplanes 4 to 9 seats multiengine	PA-31	250 nm	1.5	2.0	16.0	43.9	33.0	2.0	2%	17%	45%	34%	2%
6	Piston engine airplanes 10 or more seats	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	Turboprop airplanes 1 to 9 seats one-engine	C-208	250 nm	1.7	NR	15.9	69.2	15.0	NR	0%	16%	69%	15%	0%
8	Turboprop airplanes 1 to 9 seats multiengine	Cessna 421	250 nm	1.0	NR	6.2	62.8	11.5	NR	0%	8%	78%	14%	0%
9	Turboprop airplanes 10 to 19 seats	BE-200	250 nm	1.0	NR	13.3	38.6	8.6	NR	0%	22%	64%	14%	0%
10	Turboprop airplanes 20 or more seats*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	Turbojet/Turbofan airplanes <=12,500 lbs	C550/560	250 nm	0.7	NR	13.0	20.0	11.0	NR	0%	30%	45%	25%	0%
		C550/560	500 nm	1.4	NR	24.0	49.0	14.0	NR	0%	28%	56%	16%	0%
12	Turbojet/Turbofan airplanes>12,500 lbs and <=65,000lbs	Lear Jet 35	500 nm	1.2	11.0	14.1	44.9	14.4	NR	13%	17%	53%	17%	0%
		Lear Jet 35	1,000 nm	2.4	11.0	16.6	111.2	15.0	NR	7%	11%	72%	10%	0%
		Lear Jet 60	500 nm	1.2	11.0	11.9	50.2	11.0	NR	13%	14%	60%	13%	0%
		Lear Jet 60	1,000 nm	2.4	11.0	13.6	116.8	11.9	NR	7%	9%	76%	8%	0%
13	Turbojet/Turbofan airplanes >65,000 lbs	Gulfstream G-IV	250 nm	0.6	11.0	12.0	11.0	15.0	NR	22%	24%	22%	31%	0%
		Gulfstream G-IV	1,000 nm	2.3	11.0	18.0	102.0	17.0	NR	7%	12%	69%	11%	0%
14	Rotorcraft Piston <=6,000 lbs	R-22	200 nm	1.8	NR	4.0	103.2	4.0	NR	0%	4%	93%	4%	0%
15	Rotorcraft Turbine <=6,000 lbs	B-206	200 nm	1.8	NR	4.0	103.2	4.0	NR	0%	4%	93%	4%	0%
16	Rotorcraft Piston >6,000 lbs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	Rotorcraft Turbine >6,000 lbs	S-76	200 nm	1.5	NR	4.0	103.2	4.0		0%	4%	93%	4%	0%
18	Other	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Source: GRA analysis of manufacturer data
N/A = Few units in service
NR = Values not reported
*Data for large commercial aircraft may be used to represent these aircraft categories.
Col 1: Stage length for the missions performed by each aircraft type.
Col 2: Flight time - manufacturer data.
Col 3-7: Breakdown of Flight profiles - based on manufacturer data.
Col 8-12: Breakdown of flight profiles - percent of time spent in each stage of flight.

6.5 FUEL COSTS

In order to apply the incremental fuel burn data to an economic analysis, fuel price information is required. Data have been developed for both air carrier (Jet-A) and general aviation fuel (Jet-A and Avgas). Piston engine aircraft consume Avgas while all other aircraft consume Jet-A. (All military aircraft use Jet-A.)

Table 6-5 presents jet fuel (Jet-A) prices reported by carriers filing Form 41. The Air Transport Association of America (ATA) maintains these data on its web site and presents a time series dating back to 1977. Readers should be cautioned that large air carriers generally buy fuel in significant quantities and therefore pay substantially less than other users. In addition, some carriers now purchase hedge contracts to insulate themselves from rapid increases in fuel prices. Smaller carriers may pay more than the average price of fuel for Form 41 carriers.

Table 6-5: Fuel Cost and Consumption—System-wide Operations
U.S. Majors, Nationals and Large Regionals — All Services

Year	Fuel Consumption (gallons)	Fuel Cost (¢/gallon) Nominal Prices	Fuel Cost (¢/gallon) Real Prices (base year-2003)
1977	9,910,427,204	36.21	110.54
1978	10,188,035,462	39.26	111.40
1979	10,694,320,392	57.70	147.30
1980	10,266,539,467	89.17	200.20
1981	10,587,769,025	104.69	213.07
1982	10,400,198,108	98.94	189.68
1983	10,670,862,819	89.61	166.44
1984	11,912,365,223	85.49	152.22
1985	12,602,936,017	80.93	139.15
1986	13,682,326,978	55.77	94.14
1987	14,480,455,202	55.95	91.12
1988	15,180,728,457	53.49	83.65
1989	15,462,437,928	60.50	90.26
1990	16,232,059,039	78.26	110.77
1991	15,327,014,735	69.07	93.82
1992	15,882,983,385	63.66	83.94
1993	16,065,151,010	60.58	77.56
1994	16,662,883,478	55.82	69.68
1995	17,114,062,801	55.83	67.77
1996	17,752,362,587	66.45	78.35
1997	18,477,667,039	64.48	74.32
1998	18,889,501,116	51.31	58.24
1999	19,652,618,771	53.12	58.99
2000	20,319,276,869	80.64	86.63
2001	19,082,056,714	77.72	81.19
2002	17,839,126,707	71.44	73.47
YTD-Oct 2003	**14,862,606,416**	**84.40**	**84.40**

Source : http://www.airlines.org/econ/files/fuel.xls
Data from: DOT Form 41 filings (recent months are preliminary and subject to restatement)
Notes: Costs do not include taxes, into-plane fees, or expenses associated with hedging programs. Real prices were calculated using the CPI inflation calculator. The CPI inflation calculator uses the average Consumer Price Index for a given calendar year. This data represents changes in prices of all goods and services purchased for consumption by urban households. This index value has been calculated every year since 1913. For the current year, the latest monthly index value is used. Link for the CPI inflation calculator can be found on: http://www.bls.gov/cpi/home.htm

Table 6-6 reports general aviation fuel prices for Jet-A and Avgas. These data are for December 2003. Updated data can be obtained from the web site noted in Table 6-6. As can be seen, general aviation fuel costs considerably more per gallon than air carrier fuel, about $3.00 per gallon for general aviation vs. less than $1.00 per gallon for air carriers.

Table 6-6: General Aviation Jet-A and Avgas Per Gallon Fuel Prices ($2003)

Region	Jet-A High Price	Jet-A Low Price	Jet-A Average Price	Avgas High Price	Avgas Low Price	Avgas Average Price
Eastern	$3.99	$2.05	**$3.22**	$4.01	$2.15	**$3.30**
Western	$4.50	$2.44	**$3.11**	$3.95	$2.25	**$3.07**
Central	$3.53	$1.95	**$2.66**	$3.67	$2.28	**$2.92**
Southern	$3.92	$2.49	**$3.20**	$4.21	$2.49	**$3.33**
Nationwide	$3.77	$2.19	**$2.93**	$3.80	$2.29	**$3.05**

The table above shows results of a fuel price survey of U.S. fuel suppliers performed in Dec 2003
Prices include taxes and fees.
Source: Aviation Research Group/U.S. Inc.
http://www.aviationresearch.com/Free/fuel_survey.asp

Table 6-7 shows the average rate of fuel consumption (gallons per hour) and the estimated annual fuel use in millions of gallons for the general aviation fleet in 2002.

Table 6-7: 2002 General Aviation Total Fuel Consumed and Average Fuel Consumption Rate by Aircraft Type
Includes Air Taxi Aircraft; Excludes Commuter Aircraft

Economic Values Category	Aircraft Type	Certification	Average Rate (GPH)	Estimated Fuel Use (Mil. Gal.)	Percent Standard Error	GA Survey Categories
1	Piston engine airplanes 1 to 3 seats (<=200hp)	Part 23	10.9	170	1.8	1 Engine Fixed Wing Piston
2	Piston engine airplanes 1 to 3 seats (>200hp)	Part 23	10.9	170	1.8	1 Engine Fixed Wing Piston
3	Piston engine airplanes 4 to 9 seats one-engine (<=200hp)	Part 23	10.9	170	1.8	1 Engine Fixed Wing Piston
4	Piston engine airplanes 4 to 9 seats one-engine (>200hp)	Part 23	10.9	170	1.8	1 Engine Fixed Wing Piston
5	Piston engine airplanes 4 to 9 seats multiengine	Part 23	28.9	67.1	5.1	2 Engine Fixed Wing Piston
6	Piston engine airplanes 10 or more seats	Part 23	12.9	240.7	2.2	Piston Total
7	Turboprop airplanes 1 to 9 seats one-engine	Part 23	54.4	22.1	5.5	1 Engine Fixed Wing Turboprop
8	Turboprop airplanes 1 to 9 seats multiengine	Part 23	88.6	105.8	3.4	2 Engine Fixed Wing Turboprop
9	Turboprop airplanes 10 to 19 seats	Part 23	82.3	127.9	2.9	Turboprop Total
10	Turboprop airplanes 20 or more seats	Part 25	82.3	127.9	2.9	Turboprop Total
11	Turbojet/Turbofan airplanes <=12,500 lbs	Part 23/25	271.6	654.7	4	Turbojet Total
12	Turbojet/Turbofan airplanes>12,500 lbs and <=65,000lbs	Part 25	271.6	654.7	4	Turbojet Total
13	Turbojet/Turbofan airplanes >65,000 lbs	Part 25	271.6	654.7	4	Turbojet Total
14	Rotorcraft piston <=6,000 lbs	Part 27	15.1	6.4	7.8	Rotorcraft Piston
15	Rotorcraft turbine <=6,000 lbs	Part 27	28.5	32.9	6	Rotorcraft Turbine
16	Rotorcraft piston >6,000 lbs	Part 29	15.1	6.4	7.8	Rotorcraft Piston
17	Rotorcraft turbine >6,000 lbs	Part 29	28.5	32.9	6	Rotorcraft Turbine
18	Other					

Source: Table 5.1 of General Aviation and Air Taxi Activity Survey, CY2002 (May 2004)
www.faa.gov/data_statistics/aviation_data_statistics/general_aviation/CY2002/media/FAA%202002%20chapter%205.xls

SECTION 7: LABOR COST FACTORS

7.1 INTRODUCTION

Many changes to FAA investment or regulatory programs require the expenditure of labor hours to construct, manufacture, modify, operate or service aviation facilities or equipment. In addition, regulations can require additional education or training of personnel. While many of these costs are embedded in other cost factors (e.g., flight crew costs are typically included in aircraft operating costs), there may be a need to separately place a value on labor hours expended. This section of the report summarizes data on labor costs for typical aviation industry employees. It also suggests ways of including these and related costs in benefit-cost studies or regulatory evaluations. There are many types of labor that could be affected by FAA investments or regulations, and labor rates for even the same occupation can vary widely by industry segment, years of experience, and geographic location, among other factors.

Labor costs can be stated in a variety of ways, including the direct salary or wage cost of a unit of labor (annual or hourly), the direct cost plus the cost of benefits, or the "fully loaded" cost, which includes the enterprise's overhead costs that are allocated to labor as well as the direct cost and the cost of benefits. Which cost should be used depends on the regulatory impact of interest, in particular, whether the impact would include the hiring of additional staff or capital investments along with labor impacts. Impacts that are modest in terms of additional labor hour requirements can be best estimated using direct labor costs alone. An impact that includes the hiring of some new workers arguably should include benefits costs as well, and an impact that involves significant expansion of operations and equipment along with employment should also include overhead costs in the labor rates used.

7.2 LABOR COSTS IN AIRCRAFT MANUFACTURING INDUSTRIES

Aircraft and aeronautical manufacturers may be affected by some changes in aviation regulations or investments due to changes they must make to manufacturing processes or related procedures for in-production aircraft or other aeronautical products. Making these changes will usually require specific actions by engineers and production workers within the affected firm. Survey data on labor compensation levels for aerospace and aeronautics firms is used to provide the basis for cost estimates of such impacts. These data are reported as hourly compensation levels for sectors within the aeronautical industry.

Table 7-1 contains data on 2003 aircraft manufacturing labor rates and benefits costs per hour for white-collar occupations and blue-collar occupations. These rates include wages and salaries as well as benefits. However, they do not include overhead costs or general and administrative costs.

Table 7-1: 2003 Aircraft Manufacturing Industry Labor Rates

	Blue-Collar Occupation	White-Collar Occupation
Wages and Salaries	$24.11	$31.59
Benefits	$16.67	$17.45
Total Compensation	**$40.78**	**$49.04**
Overhead*	96%	55%
Total Compensation Including Overhead Costs	**$79.93**	**$76.01**

Source: Aerospace Facts and Figures 2003/2004, Aerospace Industries of America
*Overhead cost levels shown in the table above are based on aircraft manufacturing industry norms.

Within the aircraft manufacturing industry, there is some variability in compensation of production workers, according to the sector of the industry. Table 7-2 reports average 2002 production worker hourly wages for the overall "Aircraft and Parts" industry (SIC 372) and for the subsectors "Aircraft" (SIC 3721), "Engines and Parts" (SIC 3724) and "Other Parts and Equipment" (SIC 3728). This table reports compensation only.

Overhead levels in aircraft manufacturing vary. They can range from about 50 to 100 percent of total compensation. Therefore, the above numbers should be multiplied by 1.5 or 2.0 if consideration of overheads is appropriate.

Table 7-2: Average Hourly Earnings, Aircraft Industry Production Workers (2002)

Sector of Aircraft Industry	Average Hourly Earnings (2002)
Total Aircraft (SIC 372)	$21.72
Aircraft (SIC 3721)	$24.53
Engines & Parts (SIC 3724)	$21.31
Other Parts & Equipment (SIC 3728)	$19.23

Source: Aerospace Facts and Figures 2003/2004, Bureau of Labor Statistics and AIA Estimates.

The terms used to specify aerospace engineering specialties often have an unclear relationship to the types of tasks typically undertaken. Table 7-3 provides data on the relationship between the most common aerospace engineering fields and the type of work usually undertaken by those in the field.

Table 7-3: Types of Work Done Within Aerospace Engineering Fields

Engineering Field	Type of Work
Avionics Electrical	Electrical Design
	Equipment Lines
	Electrical Applications
Mechanical Systems	Crew & Equipment
	Hydraulics
	Auxiliary Mechanics
	Flight Controls
	Reliability
Propulsion Systems	Power Plant
	Environmental Control Systems
Structures	Stress
	Contour Development
	Structural Design
Support	CAD Applications
	Check
	Certification
	Document Control
	EMU
Flight Science	Acoustics
	Propulsion
	Stability and Control
	Aerodynamics
	Loads and Dynamics
Project Engineering	

Source: General Aviation Manufacturers Association.

7.3 SALARIES, BENEFITS AND TRAINING COSTS FOR GA PILOTS

Crew costs are reported for GA operators as part of these operators' overall operating costs in Section 4 of this report. These are reported for aircraft grouped into the 18 Economic Values aircraft classification categories for GA aircraft. The Conklin & de Decker data used to develop these operating costs have also been used to detail per pilot wage and benefits rates for eight of these aircraft categories (those most commonly used for passenger transport by business and corporate users). These compensation data are reported on a per annual flight hour basis in Table 7-4. Pilot pay and benefit costs are reported for all categories of aircraft. For larger aircraft, co-pilot pay and benefits are also reported.[65] Fringe benefit costs are customarily reported by Conklin & de Decker as 30 percent of the pilot or co-pilot salary. The table also reports the average total crew cost for each aircraft category. Because of differences in crew requirements for different aircraft within each category (not all aircraft within a category may require a co-pilot, for example), the pilot and co-pilot per flight hour salary and benefit costs may not sum up to the total per-flight hour crew cost.

Table 7-4: Disaggregated Flight Crew Compensation and Training Costs for Selected GA Operators

	Economic Values Category (All Years)	Average Total Crew Cost	Pilot Direct	Pilot Benefits	Co-Pilot Direct (When Applicable)	Co-Pilot Benefits	Training Costs (Per Crewmember)
6	Piston engine airplanes 10 or more seats	$112	$90	$22	--	--	$4,400
7	Turboprop airplanes 1 to 9 seats one-engine	$181	$139	$42	--	--	$4,537
8	Turboprop airplanes 1 to 9 seats multiengine	$238	$183	$55	--	--	$6,190
9	Turboprop airplanes 10 to 19 seats	$244	$183	$55	$163	$49	$8,572
10	Turboprop airplanes 20 or more seats	$433	$211	$63	$163	$49	$11,706
11	Turbojet/Turbofan airplanes <=12,500 lbs	$475	$214	$64	$158	$47	$10,250
12	Turbojet/Turbofan airplanes >12,500 lbs and <=65,000 lbs	$559	$251	$75	$185	$56	$13,695
13	Turbojet/Turbofan airplanes > 65,000 lbs	$713	$315	$95	$229	$69	$24,401

Source: Tabulated from data for individual aircraft in Conklin and deDecker *Aircraft Cost Evaluator*. Data represent weighted average costs per annual flight hour for aircraft within the category. The column "Average Total Crew Cost" is taken from the "Crew" cost column of Table 4-10.

Table 7-4 also reports per-pilot flight crew training costs for each of the aircraft categories. These data are also taken from the Conklin & de Decker *Aircraft Cost Evaluator* database, and refer to the cost of "flight crew training using a professional, simulator-based training program (if available) or the equivalent." These training cost data represent the level of training to remain qualified and current on a specific aircraft type. These data are reported because regulatory changes that would cause operators of these types of aircraft to hire and train additional pilots do impose new training costs as well as the more direct costs of employing a new pilot.

7.4 AIR CARRIER FLIGHT CREW TRAINING COSTS

Regulatory changes could also cause air carriers to hire additional flight crew, and this would result in new training costs as well as the direct costs of employing a new pilot. As part of its comments on a past FAA NPRM in 1996, the Air Transport

[65] Smaller aircraft generally can be operated by a single pilot while larger aircraft use two flight crew members (pilot and co-pilot). Some older transport aircraft also require a third crew member, a flight engineer.

Association of America (ATA) reported results from a survey of its members regarding training costs.[66] The estimate reported by ATA for the average cost of an initial training session for pilots moving to a new rung on the seniority ladder was $23,384 in 1995, or $26,637 in 2003 dollars, a value that is comparable to that reported by Conklin & de Decker for the largest jet GA aircraft (which includes the Boeing Business Jet and the Airbus Corporate Jet) as shown in Table 7-4.

Costs of pilot training and of the maintaining of type currency by pilots come about because of the many "types" of commercial aircraft and the need for type-specific training and skills for pilots.[67] Pilots (captains or first officers) undergo specific training to achieve a specific "type rating," which will apply to one or more aircraft that qualify as a single "type." For example, the older Airbus A300B2/4 aircraft make up a single type, and require a unique rating for its pilots, while the next generation A300-600 shares a common type rating with the A310-200/-300 aircraft series. There are many other types for Airbus aircraft. Similarly, the older Boeing 737-300/-400/-500 series has a single type rating, as do aircraft in the 737-600/-700/-800/-900(NG) series. There are also numerous other type ratings within the Boeing family of commercial aircraft.

To operate the aircraft for which they have a type rating, pilots must receive recurrent training within the type rating twice annually, as well as an annual line check for one or two flights in the aircraft. Pilot recurrent training generally lasts one to three days per training session (two to six days per year), and involves at least one simulator refresher training session.

A more significant pilot training cost that could be imposed on operators through their compliance with changed regulations is that associated with "type transition training." This training, which can take from 21 to 25 days, is required for pilots who are becoming "type rated" for a different type of aircraft, such as the transition from being type rated on the Airbus A320 aircraft to becoming type rated on the Boeing 777 aircraft. The economic impact of this type of training for operators depends on the frequency with which pilots make such transitions and on the fleet complexity chosen by a given operator. Regulatory changes that cause operators to hire additional pilots will lead to these costs, as pilots are hired across an operator's fleet. The costs associated with these lengthy type transition training sessions include not only the compensation and benefits provided to the pilots undergoing training, but also opportunity costs incurred when pilots are removed from revenue service, housing and other accommodation costs, and costs associated with the operation of the training facilities (which may be owned by the operator or contracted from an outside provider of training services).

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[66] Air Transport Association, *Benefit & Cost Analysis: Pilot Flight Time and Duty Time*, Washington, DC, 1996, pp. 22-23.

[67] "What Savings Can Be Expected from Commonality Benefits?" *Aircraft Commerce* 21: Dec 2003/Jan 2004, pp. 12-16.

While transition training would last from 21 to 25 days, this training could be shorter for transition between aircraft that share some degree of commonality. When there is some degree of commonality, type transition training is sometimes referred to as "differences training." Adjustments to the length of a transition training session varies with the specific differences transition. For example, getting a type rating for an Airbus A330 or A340 may take only eight days for a pilot who is already type rated for an A320. Similarly, differences training for a transition from the Boeing 737-100/200 to the 737NG takes only nine days, while the transition from the Boeing 757 to the 767 takes only four hours.

Paying for these training obligations makes up an important share of the costs that would be associated with regulatory changes that caused operators to adjust their pilot ranks in some way. Due to the multiplicity of aircraft types and the importance of fleet complexity for the costs faced by any given operator, it is not possible to specify costs associated with flight crew adjustments; the impact of any given regulatory change would have to be analyzed on an individual basis. However, general information on these training alternatives is summarized in Figure 7-1.

Figure 7-1: Flight Crew Training Categories for Commercial Airline Operations

Training Category	Duration	Frequency
Initial Type Rating	23 to 25 days	Start of career
Recurrent Training	1 to 3 days	Twice a year
Type Transition Training	21 to 25 days (may be less if there are commonalities between the aircraft types	Depends on airline fleet complexity and size (for example, unnecessary if airline operates only one type rated aircraft)

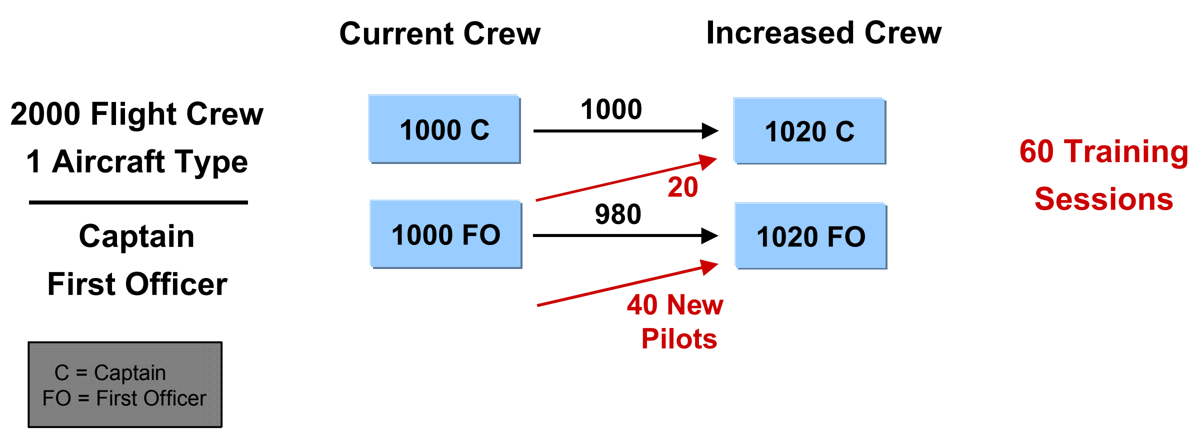
Source: "What Savings Can Be Expected From Commonality Benefits?" *Aircraft Commerce*, December 2003/January 2004, p. 12-18.

The cost impact of changes in FAA regulations or investment requirements that cause commercial air carriers to need additional flight crew for some or all of the aircraft types in their fleet can be further complicated by labor agreements. While the net effect of such changes is the hiring of a number of new pilots, each of whom would need initial training for the aircraft to which they were assigned, the nature of pilot contracts can result in a need for additional training sessions. This is because within a given airline, pilots move up a seniority ladder that is sequenced by aircraft type and seat position (captain or first officer), depending on the airline's pilot contract. If there is a need to increase the number of pilots by a given percentage, the number of training sessions required by a specific airline depends on the number of pilots an airline currently employs and the complexity of the airline's fleet.

This relationship between an airline's need to hire new pilots and the consequent need for training sessions within the airline's seniority ladder is also related to the airline's fleet structure. Suppose a regulatory change, such as one regarding flight and duty time requirements, results in all affected airlines needing to increase their flight crew rosters by two percent. For any airline with a current flight crew roster of 2,000 pilots, this means 40 new pilots must be hired. However, the number of initial training sessions that will be required to meet this need depends on the complexity of the airline's fleet, since pilot labor agreements generally specify a strict seniority ladder by which pilots move from one position to the next, with any newly hired pilot required to start her career at the bottom rung of the seniority ladder.[68]

This relationship is illustrated in the following three figures, which illustrate three contrasting scenarios. Consider first an airline that uses a flight crew roster of 2,000 pilots (1,000 captains and 1,000 first officers), and uses a single (two seat cockpit) aircraft type. This scenario is illustrated in Figure 7-2. Increasing the airline's pilot roster by two percent means that it will need 1,020 captains and 1,020 first officers. Pilot seniority rules require that the 20 new captain slots be filled from the ranks of current first officers, each of whom will need a training session to become qualified for the new position. The airline will also need 40 new first officers, 20 to replace the first officers who have moved up the seniority ladder and 20 to cover the new flight crew requirement. Thus, while there will be only 40 newly hired pilots, there will be 60 initial training sessions required to integrate these new hires into the airline's new flight crew rosters.

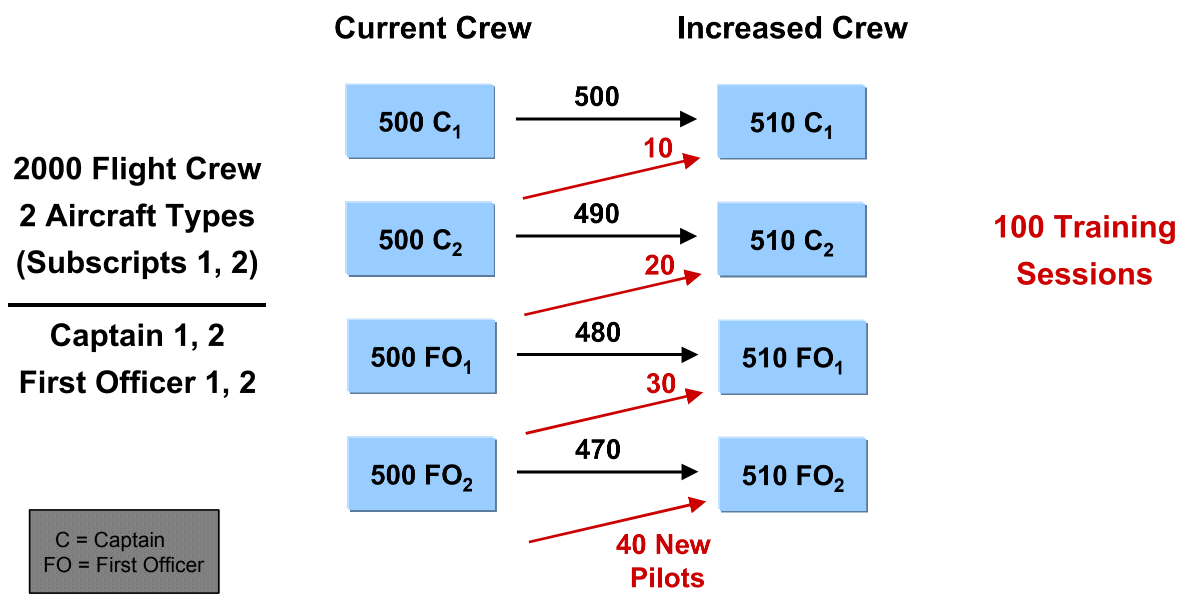
Figure 7-2: Interaction of Regulatory Requirements for New Flight Crew and Flight Crew Seniority Ladder: Example 1 – 2,000 Current Flight Crew Members to be Increased by Two Percent, One Aircraft Type



[68] Not all pilots will choose to exercise their seniority to bid up to a higher level assignment. For example, such a change might require a change in domicile. Or, being the most senior pilot in a lower category may provide more flexibility and value to a pilot than being the most junior pilot in a higher group.

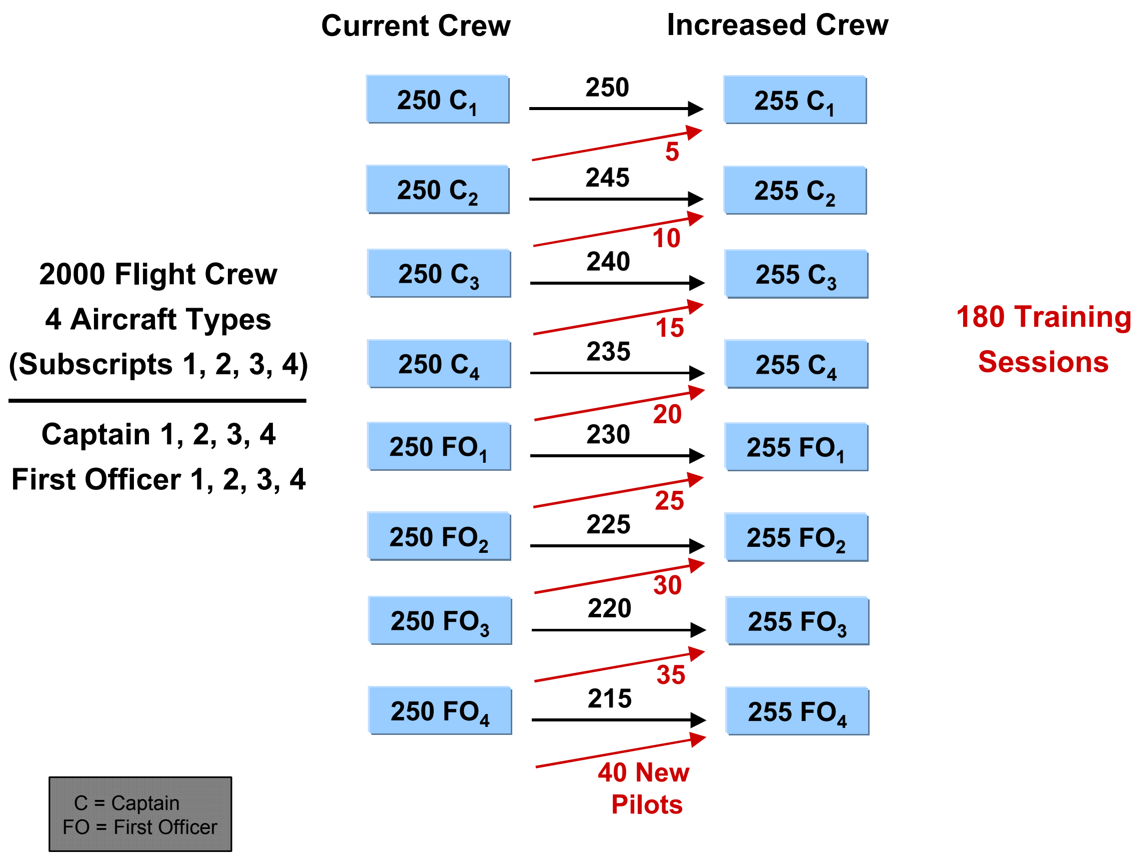
In Figure 7-3, the situation for an airline that uses a pilot roster of 2,000 to operate a fleet made up of equal members of two types of (two seat cockpit) aircraft is presented. In this example, the pilot seniority system is presented as taking pilot employees through the first officer seats and then on to the captain seats; other airlines may rely on bargaining agreements that have differently designed seniority sequences. In the simplified example, the airline is also shown as having a symmetrical fleet in the sense that for each of the two aircraft types, it employees 500 captains and 500 first officers. Of course, fleets for actual airlines may not have this symmetry. For the airline in the example, a two percent increase in pilot requirements means that each new flight crew category must take on 10 new members. As the example in Figure 7-3 shows, the pilot seniority ladder means that the 10 new captains for the senior type of aircraft come from those pilots who are qualified to serve as captains on the junior aircraft, each of whom must take part in a training session, and so forth. With a symmetrical fleet of this type, adding 40 new hires leads to 100 new training sessions (40 + 30 + 20 +10).

Figure 7-3: Interaction of Regulatory Requirements for New Flight Crew and Flight Crew Seniority Ladder: Example 2—2,000 Current Flight Crew Members to be Increased by Two Percent, Two Aircraft Types



A final example, as shown in Figure 7-4, illustrates the effect of the seniority ladder on the training requirements associated with a two percent pilot increase for an airline with 2,000 flight crew members who are equally distributed within a fleet evenly divided among four types of two seat cockpit aircraft. Thus, a two percent increase to 255 in the roster of 250 pilots currently serving as captains in the most senior aircraft would come from the 250 pilots serving as captains on the aircraft one rung down in seniority, and so forth. As the figure illustrates, for a 2,000 pilot airline with the four aircraft fleet as shown, adding two percent more pilots across its fleet leads to 40 new hires, but this requires 180 new training sessions as captains and first officers move up the seniority ladder.

Figure 7-4: Interaction of Regulatory Requirements for New Flight Crew and Flight Crew Seniority Ladder: Example 3—2,000 Current Flight Crew Members to be Increased by Two Percent, Four Aircraft Types



The examples in the figures above are somewhat idealized, since actual airlines would not operate a fleet partitioned so evenly among types of aircraft. These simplified examples do illustrate, however, the complications that a pilot seniority ladder adds to the problem of increasing an airline's ranks of pilots. As the airline's fleet complexity grows, the more steps there will be in the overall seniority ladder, and the more total training sessions may be required for the airline to satisfy a given requirement to increase its pilot ranks. The example also implies that any change that leads to such changes in pilot rosters can be more expensive for an airline with a more complex fleet than for an airline with a less complex fleet.

Other factors that can affect the number of training sessions required within overall pilot ranks for accommodating new pilot requirements include contractual restrictions on the frequency of pilot advancement along seniority ladders (pilots may be required to spend a minimum length of time at a training level before advancing further) at individual airlines and the willingness of pilots to elect to move up seniority ladders, for personal or lifestyle reasons. In its 1996 comment on the 1995 Flight and Duty NPRM, the ATA estimated, based on a survey of its members, that on average, a new pilot hire necessitated five pilot training sessions as existing pilots moved their way up the airline's seniority ladder.[69] However, average fleet complexity and pilot contract provisions have changed over time, so this average has also changed. For this reason, analyses of regulatory changes that are likely to lead to significant changes in pilot requirements should include case-by-case investigations of the likely number of pilots who would shift among aircraft equipment types as a consequence of the regulatory change.

7.5 OTHER AVIATION-RELATED LABOR COST DATA

There are many other aviation-related professions and skilled trades that could be affected by changes in regulations or investment requirements. Wage and salary data for these occupations were gathered from industry and government sources. The data in Table 7-5 are the most recent available. They are reported as annual compensation and represent national averages. There is probably variation within each category, depending on such factors as region of country, years of employee experience, whether the position is in an urban or rural setting, and other factors.

The average annual labor costs are reported for flight attendants (air carrier and corporate), air traffic controllers, airfield operations specialists, and certain categories of aircraft maintenance labor. For each annual salary category, the source of the data is also reported. Because of the variety of sources and occupations, the reported salaries do not include fringe benefits, overheads, or other non-salary cost components.

[69] Air Transport Association, *Benefit & Cost Analysis :Pilot Flight Time and Duty Time*, Washington, DC, 1996, pp. 22-23.

Table 7-5: Salary Data for Aviation Occupations

Job Title	Average Annual Salary	Year	Source
Flight Attendant			
Air Carrier (Scheduled)	$51,120	2002	BLS National Compensation Survey
Corporate (Unscheduled)	$47,160	2002	NBAA Compensation & Benchmark Survey
Air Traffic Controller			
Federal	$92,000	2002	BLS National Compensation Survey
Contract Tower (Salary & Benefits)	$55,000	2002	House Aviation Subcommittee Hearing
Airfield Operations Specialist	$40,850	2002	BLS National Compensation Survey
Aircraft Maintenance and Technicians			
A&P Maintenance Technician	$57,614	2002	NBAA Compensation & Benchmark Survey
Aviation Technician	$56,238	2002	NBAA Compensation & Benchmark Survey
Manager of Maintenance	$84,488	2002	NBAA Compensation & Benchmark Survey
Maintenance Foreman	$72,013	2002	NBAA Compensation & Benchmark Survey
Maintenance Technician Helper	$29,671	2002	NBAA Compensation & Benchmark Survey
Avionics Technician	$47,900	2002	Aviation Today
Lead Mechanic	$51,500	2002	Aviation Today
Line Mechanic	$47,500	2002	Aviation Today
Maintenance Directors	$64,900	2002	Aviation Today
Mechanics & Technicians	$48,500	2002	Aviation Today
Mechanic's Assistant	$38,000	2002	Aviation Today

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SECTION 8: AVIATION ACCIDENT INVESTIGATION COSTS[70]

8.1 INTRODUCTION

All costs incurred (or costs avoided) by all parties that may result from proposed FAA investments, regulations, and Airport Improvements Program (AIP) grants should be considered in the conduct of benefit-cost analyses. Avoided accidents are one of the principal benefits of FAA investment and regulatory programs. These are valued using the avoided injury and property damage costs. However, there are other costs to society imposed by aviation accidents. One such cost is the expense of investigating aviation accidents. Investigations involve the expenditure of resources by several entities, including the National Transportation Safety Board (NTSB), the FAA and the private sector. It is assumed that these resources would be put to alternative uses if an accident could be avoided. This analysis estimates costs incurred by governmental entities for accident investigation.[71] It also provides approximations for costs incurred by the private sector.

8.2 DEVELOPMENT OF FEDERAL ACCIDENT INVESTIGATION COST ESTIMATES

The National Transportation Safety Board (NTSB) is responsible for the investigation of all aircraft accidents. It conducts two types of investigations: major investigations which are directed by NTSB headquarters in Washington and field office investigations which are conducted by its field offices. Major investigations are conducted primarily for major air carrier accidents involving numerous fatalities and substantial property damage. These investigations are characterized by the dispatch of an investigative party—"go team"—to the accident site and usually involve substantial support by the FAA and involved private parties such as the airline involved, airframe and engine manufacturers, avionics manufacturers, component and sub-component suppliers, organized labor representatives, and so forth.

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[70] This estimate of costs is based primarily on an analysis and model developed in 2000 by the FAA Office of Aviation Policy and Plans (APO). That analysis was not published at the time, but it is used here as a baseline that was updated to include data through 2002. The analysis also takes into account input from the Aviation Rulemaking Cost Committee (ARCC) members as to specific costs associated with major accidents. Data provided by ARCC members on the subject of their accident investigation costs related to private party costs were limited, but consistent with the cost estimates developed herein.

[71] Aviation incident investigation costs are not analyzed in this report no incident investigation data were available.

Field investigations are divided into regular investigations and limited investigations. Field office regular investigations are much smaller in scope than major investigations. They are conducted for air carrier accidents involving limited loss of human life and for most fatal general aviation accidents. Limited field office investigations are conducted for most other general aviation accidents. FAA provides significant support to NTSB in the conduct of field office investigations.

8.3 METHODOLOGY

NTSB cost estimates were derived from budget, staffing, and activity data. A twelve-year period—FY1991 through FY2002—was selected so as to capture a wide range of accident experience, both in terms of numbers of accidents and complexity of the investigations required. For this period, the total amount of the NTSB budget devoted to aviation safety was first determined. This involved taking the portion of the budget dedicated directly to aviation safety and adding to it a proportional allocation of costs that applied jointly to aviation as well as other forms of transportation, including a portion of policy, administration, and research and development expenditures. Total aviation safety costs were then assigned to five different types of investigations conducted by NTSB:

- Major air carrier investigations
- Field regular investigations
- Field limited investigations
- Foreign major investigations
- Other foreign investigations

This assignment was based on the number of full time equivalent employees dedicated to or supporting each type of investigation relative to the total full time equivalent employees involved in aviation accident investigations. The costs assigned to each type of accident were then divided by the total respective number of accidents in each investigation category to arrive at a per accident investigation cost.

Because FAA is a much larger organization than NTSB and has many responsibilities, only one of which is accident investigation, budget data was not used directly. Rather, it was necessary to determine the amount of costs across FAA that are attributable to accident investigation. This was done by undertaking a special study of accident investigation costs based on models developed for a prior report, *A Cost Allocation Study of FAA's FY 1995 Costs*.[72] This special study identified accident investigation costs attributable to FAA's Office of Accident Investigation, Flight

[72] Prepared by GRA, Incorporated for FAA's Office of Aviation Policy and Plans (March 1997).

Standards Service, Aircraft Certification Service, Office of Aviation Medicine, and to the conduct of flight inspections.[73]

Costs attributable to the Office of Accident Investigation, Flight Standards, and Aircraft Certification were assigned to the same accident categories as NTSB costs. This assignment was made utilizing data on hours expended by FAA to investigate various accident types relative to total investigation hours as compiled by the FAA Office of Accident Investigation's Accident Investigation Quality Assurance Program. Office of Aviation Medicine and flight inspection costs were assigned to major investigations and regular field investigations by dividing their respective amounts by the total number of these types of accidents. This was done to reflect that these cost are approximately constant across these accident investigation types.

8.4 FEDERAL GOVERNMENT ACCIDENT INVESTIGATION COSTS

Allocated Federal costs[74] by type of accident investigation and entity incurring the cost are reported in Table 8-1. The weighted cost is also reported because some air carrier accidents are followed by NTSB major investigations and others by field office regular investigations. It is a weighted average cost of major and field office regular air carrier investigations. Similarly, a general aviation average is presented. It is a weighted average of NTSB field office regular investigations and limited investigations where the weights are the respective number of such investigations conducted.

[73] "FAA FY 1995 Accident Investigation Costs," GRA Incorporated, April 28, 1997. The base year 1995 cost analysis was used, but the dollar values were scaled up to 2002 by applying two factors. The first was the percentage change in the overall budget for the Office of the Associate Administrator for Regulation and Certification (AVR) from 1995 to 2002. This factor accounts for wage changes and increased AVR staffing. The second factor was the 2002 aviation accident count as a percent of the 1995 aviation accident count. The combined factor indicates an eight-year cost increase of 71 percent.
[74] Assumes that resources could be put to alternative uses.

Table 8-1: Federal Accident Investigation Costs by Component (2002 Dollars)

Type of Investigation	NTSB	FAA				Grand Total	Number of Accidents 1991-2002
		AVR	Flight Inspection	Aviation Medicine	FAA Sub-Total		
Major	$1,931,800	$680,100	$1,000	$600	$681,700	$2,613,500	59
Field Office:							
Regular	$38,300	$24,100	$1,000	$600	$25,700	$64,000	6,016
Limited	$300	$13,800	0	0	$13,800	$14,100	18,648
Weighted Average by User Type							
Air Carrier (including Air Taxi)	$110,300	$56,200	$1,000	$600	$57,800	$168,100	1,551
General Aviation	$7,700	$15,900	$200	$100	$16,200	$23,900	23,172

8.5 PRIVATE SECTOR ACCIDENT INVESTIGATION COSTS

The NTSB go team conducts an investigation by forming as many as twelve investigative sub-teams. Each sub-team, led by an NTSB investigator, is responsible for a particular subject matter area such as power plants, airframes, avionics, control systems, operations, human factors, weather, survivability, and air traffic control. Most sub-team members, known as "parties," are from private industry and are invited to participate in the investigation by the NTSB. The party system allows the NTSB to leverage its resources and personnel by bringing to the investigation the technical expertise of the companies and entities (labor representatives, airlines, manufacturers, suppliers of components and sub-components, etc.) of the individuals and equipment that were involved in the accident, or parties that might have specialized knowledge to assist the investigation.

The team procedure results in significant investigation costs for the private sector. No systematic measures are available for this cost. However, an approximation may be made based on NTSB's cost. Discussions with NTSB and examination of NTSB accident reports suggested that about six private sector parties participate in major accident investigations and three private sector parties in regular field investigations. Assuming that each of the private sector parties supports half of the investigative sub-teams at the same level of cost as incurred by NTSB for each sub-team, private costs may be approximated as three times NTSB costs for major investigations and 1.5 times NTSB costs for regular field investigations. In addition, the private sector typically pays to remove aircraft wreckage. Aviation insurance industry sources placed this cost at about $138,000 per major accident.[75]

[75] Clearly, there are major exceptions to this cost such as the expenses of recovering, moving and storing the parts of the TWA 800 wreckage.

Applying these assumptions and values yields the approximation of private sector cost and total costs presented in Table 8-2. They range from an average of $14,100 for a limited investigation of a general aviation accident to $8.5 million for a major investigation of an air carrier accident.[76] For major investigations of some particularly noteworthy accidents, such as TWA 800, the investigation can well exceed $8.5 million per accident.

Table 8-2: Aviation Accident Investigation Costs (2002 Dollars)

Type of NTSB Investigation	Cost					Number of Accidents 1991-2002
	NTSB	FAA	Total Federal	Private	Total	
Major	$1,931,800	$681,700	$2,613,500	$5,933,400	$8,546,900	59
Field Office:						
Regular	$38,300	$25,700	$64,000	$57,400	$121,400	6,016
Limited	$300	$13,800	$14,100	0	$14,100	18,648
Weighted Average by User Type:						
Air Carrier (including Air Taxi)	$110,300	$57,800	$168,100	$280,900	$449,000	1,551
General Aviation	$7,700	$16,200	$23,900	$11,200	$35,100	23,172

[76] Assumes that resources could be put to alternative uses.

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SECTION 9: ADJUSTMENT METHODOLOGY TO UPDATE ECONOMIC VALUES

9.1 INTRODUCTION

The values developed in this report are expected to change with the passage of time, primarily because of price and income level changes, and to a lesser extent, improvements resulting from future empirical or theoretical research. This report will be revised periodically to account for such changes and advancements. Between revisions, users may desire to adjust the base year values to future year values based on the recommendations outlined in this section.

9.2 SECTION 1: VALUE OF TIME

Updated values are provided periodically by DOT. FAA will place updated information on the FAA website
http://www.faa.gov/regulations_policies/policy_guidance/benefit_cost
or
http://ostpxweb.dot.gov/
under a link for reports.

9.3 SECTION 2: VALUE OF LIFE

Updated values are provided periodically by DOT. FAA will place updated information on the FAA website
http://www.faa.gov/regulations_policies/policy_guidance/benefit_cost
or
http://ostpxweb.dot.gov/

under a link for reports.

9.4 SECTION 3: AIRCRAFT CAPACITY AND UTILIZATION FACTORS

These values, developed in Section 3, are based on the physical makeup and operation of the fleet. No economic index approach can be used to easily update these values, as there is no known correlation between the sundry values and general economic indices.

Please note that if revisions or projections of these values are required, the annual *FAA Aviation Forecasts* series provides many of the air carrier and general aviation values for capacity and utilization. The following values are available for scheduled commercial air carriers (both Form 41 and Form 298c) directly from the annual Forecast:

- Load factors
- Aircraft Size (seats)
- Aircraft Utilization Hours
- Daily Utilization (Airborne Hours/(Aircraft x 365))

Flight hours are also available for GA and air taxi operations from this source.

9.4.1 Commercial Aircraft – Air Carriers

The analyst can also use the primary data sources to update capacity and utilization factors. Form 41 and Form 298c data are available from the Bureau of Transportation Statistics of the U.S. DOT.[77] These data are also made available by various commercial services including Data Base Products (Dallas, TX) and Back Associates (Stamford, CT).

Data Base Products, Inc. (DBP) used their 2002 Form 41 product to generate the data for air carrier tables in Section 3 of this report. The following paragraph outlines steps taken in preparing freight and passenger air carrier capacity and utilization tables that can be followed in order to update the material.

The first step in preparing air carrier capacity and utilization data was to specify the thirteen economic values categories for air carriers:

1. Two-engine narrow-body jet
2. Two-engine wide-body jet
3. Three-engine narrow-body jet
4. Three-engine wide-body jet
5. Four-engine narrow-body jet
6. Four-engine wide-body jet
7. Regional jet under 70 seats
8. Regional jet 70-100 seats
9. Turboprops under 20 seats (Part 23)
10. Turboprops under 20 seats (Part 25)

[77] DOT is investigating changes in reporting for air carrier data. The guidance below is predicated on use of existing data systems.

11. Turboprops with 20 or more seats
12. Piston Engine (Part 23)
13. Piston Engine (Part 25)

Each aircraft type with reported data was then assigned to one of the thirteen categories. Having selected the appropriate aircraft types and categories, a user-defined report was generated for all passenger air carriers with the following output categories:

1. Economic Values Class
2. Aircraft Days – Carrier Routes
3. Average Aircraft in Service
4. Revenue Departures Performed
5. Revenue Passenger Miles
6. Available Seat Miles
7. Revenue Aircraft Miles
8. Average Available Seats
9. Passenger Load Factor
10. Revenue Ton Miles
11. Available Ton Miles
12. Average Available Capacity (Tons)
13. Capacity Load Factor
14. Flight Crew
15. Block Hours
16. Average Block Speed (MPH)
17. Aircraft Utilization (Block Hours/Day)
18. Gallons of Fuel
19. Gallons of Fuel per Block Hour
20. Airborne Hours
21. Average Airborne Speed (MPH)

Similar economic value categories and aircraft type selection processes were generated for all freight carriers with the following output categories:

1. Economic Values Category
2. Aircraft Days – Carrier Routes
3. Average Aircraft in Service
4. Revenue Departures Performed
5. Revenue Aircraft Miles
6. Revenue Ton Miles
7. Available Ton Miles
8. Average Available Capacity (Tons)
9. Capacity Load Factor
10. Flight Crew

11. Block Hours
12. Average Block Speed (MPH)
13. Aircraft Utilization (Block Hours/Day)
14. Gallons of Fuel
15. Gallons of Fuel per Block Hour
16. Airborne Hours
17. Average Airborne Speed (MPH)

9.4.2 Commercial Aircraft - Commuters

The following steps were taken to analyze commuter carrier data for the present report and can be followed in order to update the material.

Data were obtained from the Bureau of Transportation Statistics of the DOT. Any update of data should begin with a discussion of data availability from the BTS, as reporting conditions are subject to change. Quarterly data from RSPA Form 298-C Schedule F-2 covering financial data by equipment type should also be collected. Traffic and capacity data for small commuter operators, reported on Form 298-C until September 2002, are now reported on Schedule T-100 of Form 41, and will have to be accumulated by carrier from that source.

Three fields should be added to the BTS records. One field should be added identifying carriers as Alaskan or Non-Alaskan. The identification of carriers as Alaskan or Non-Alaskan is obtained from BTS in an electronic file. A second field for the equipment classification of each equipment type should also be added. The equipment classification can be obtained from the detailed tables provided in the base report, bearing in mind that new equipment entering the fleet in the future will have to be classified by the analyst updating the material. The third field to be added should indicate whether the carrier is operating under Part 121 or Part 135 of the FARs. This determination is made by FAA, and a file can be obtained from *Flight Standards* (AFS-40) with this information.

After the database for commuter carriers is modified as outlined above, creation of the detailed data tables requires summations as appropriate of the database. The output categories (block hours and airborne hours) are established for Alaskan and Other carriers, and sorted either by equipment type and aircraft class, and so forth. Once the utilization factors for the commuter airlines have been established using the Form 298-C, capacity factors are obtained from *Jane's All The World's Aircraft* (various issues).

9.4.3 General Aviation and Military Aircraft

Capacity factors for general aviation aircraft were obtained by analyzing the National Transportation Safety Board (NTSB) accident and incident data from 1982 to 2003. The average capacity and persons on board GA aircraft are not expected to change frequently. The best source of aircraft flight hour utilization data for the GA fleet is the FAA's annual *General Aviation and Air Taxi Activity Survey*.

Fleet data for military aircraft can be obtained from *Aviation and Aerospace Almanac*, published by McGraw-Hill. Hours of operation can be obtained from military services.

9.5 SECTION 4: AIRCRAFT OPERATING COSTS

Aircraft operating costs, developed in Section 4, are presented in terms of variable and fixed costs. The costs are reported for air carrier and commuter aircraft, general aviation aircraft and military aircraft. The best way to update operating cost data is to use the original data sources as cited in the main body of the text:

- For commercial operations: Form 41 and Form 298c data from the sources cited above
- For GA operations, *The Aircraft Cost Evaluator* published by Conklin and de Decker (Orleans, MA) or PlaneQuest.com for aircraft types not covered by Conklin and de Decker.
- For military operations, the various websites indicated in the text.

If an update of original data sources is unavailable, the analyst can use the appropriate forecast prices (as discussed in subsequent sections of this report) in conjunction with the values for the base year to develop an update using the following equation:

$$(P_c/P_b) \times C_b = \text{Adjusted Aircraft Operating Cost}$$

where:

P_c and P_b are the prices or price indices in the current year and base year, and C_b is the cost per block or airborne hour of operation in the base year.

It is recommended that updated operating costs per hour be rounded to the nearest dollar.

9.5.1 Commercial Aircraft – Air Carriers

The analyst can use the primary data sources to update air carrier operating costs. Form 41 and Form 298c data are available from the Bureau of Transportation Statistics of the U.S. DOT, and, as previously stated, are also made available by various commercial services including Data Base Products (Dallas, TX) and Back Associates (Stamford, CT).

Data Base Products used Form 41 to generate air carrier operating and fixed cost data in Section 4 of this report. Below are the steps to follow when updating these data. The two carrier groups (passenger and freight) were divided into two subcategories:

1. Majors and nationals
2. Regionals

A user-defined report was generated for each economic values category for all passenger air carriers in each subcategory. The list below presents all the cost categories obtained by running this report:

1. Pilots and Copilots
2. Other Flight Personnel
3. Personnel Expenses
4. Employee Benefits and Pensions
5. Taxes-Payroll
6. Total Crew Cost
7. FO-AC Fuel
8. FO-AC Oil
9. Total Fuel & Oil
10. Maintenance – Airframe Labor
11. Maintenance – Airframe Outside Rep.
12. Maintenance – Materials-Airframe
13. Total Airframe
14. Maintenance – Engine Labor
15. Maintenance – Engine Outside Rep.
16. Maintenance – Materials – Engines
17. Total Engines
18. Maintenance – Appl. Maintenance Burden -Flight Equipment
19. Total Maintenance
20. Total Variable Costs
21. FO-AC Rentals
22. Amortization – Amortization Cap. Leases Flight Equipment
23. Total Rentals
24. Depreciation – Depreciation Airframes
25. Depreciation – Depreciation Aircraft Engines
26. Depreciation – Depreciation Airframe Parts

27. Depreciation – Depreciation Engine Parts
28. Depreciation – Depreciation Other Flight Equipment
29. Total Depreciation
30. FO-Insurance Purch. – General
31. FO-Insurance Purch. – Other
32. Total Insurance
33. Total Fixed Costs
34. Total Costs
35. Block Hours

Each cost category represents yearly operating costs and was divided by the number of block hours in order to obtain hourly operating costs. The same report was then generated for all freight carriers.

In order to generate operating costs by airborne hour, a user-defined report was generated for all passenger air carriers and the two subcategories as well as for all freight carriers and the two subcategories. The cost categories obtained from this report are identical to the above report except for the last output cost category being Airborne Hours instead of Block Hours.

Major and national passenger carrier costs can also be updated through U.S. Airline Cost Index published by Air Transport Association. Major airlines are those with revenues in excess of $1 billion while nationals have revenues between $100 million and $1 billion. U.S. Airline Cost Index summarizes costs in the following cost categories:

- Labor (salaries, employee benefits, payroll taxes) – Cost per FTE
- Fuel – Cost per Gallon
- Aircraft Ownership (rentals, aircraft depreciation, amortization, capital leases) – Cost per Seat
- Non-Aircraft Ownership – Cost per Enplanement
- Professional Services – Cost per ASM
- Food & Beverage – Cost per RPM
- Landing Fees – Cost per Capacity Ton Landed
- Maintenance Material – Cost per Airborne Hour
- Aircraft Insurance (airframe insurance) – Percent of Hull Net Book Value
- Non-Aircraft Insurance (total insurance – airframe insurance) – Cost per RPM
- Passenger Commissions (services purchased, traffic commissions) – Cost per RPM
- Communication (communication services purchased) – Cost per Enplanement
- Advertising and Promotion – Cost per RPM
- Utilities & Office Supplies – Cost per FTE

- Other Operating Expenses – Implicit GDP Deflator
- Interest (interest on long-term debt and capital and other interest expenses) – Book Interest Rate
- Composite (weighted average of all components, including interest)

These values can be used to update operating costs for the industry using the methodology described above. Because fuel and oil are such an important and variable part of commercial costs, these should be adjusted to current dollar values by use of published fuel price indices (more information on fuel prices can be found in Section 6 of this report). Fuel prices from Form 41 filings are also published monthly on Air Transport Association's website (http://www.airlines.org/economics/energy/).

9.5.2 Commercial Aircraft – Commuters

The steps to be taken in updating the commuter air carriers' data from Form 298-C are the same as those described in section 9.4.2 of this report. Following are the output categories to be obtained:

1. Crew Expenses
2. Total Cost of Fuel and Oil Consumed
3. Total Maintenance Costs
4. Total Depreciation and Rental Expenses
5. Total Block Hours
6. Total Airborne Hours

9.5.3 General Aviation and Military Aircraft

Data to update general aviation aircraft costs are much more sparse. An analyst could use the fuel indices from *FAA Aviation Forecasts* to update the cost of fuel. Jet-A and Avgas fuel prices can be found on Aviation Research Group's website (http://www.aviationresearch.com/Free/fuel_survey.asp). The *Aircraft Cost Evaluator* by Conklin & de Decker was used as a source of aircraft operating costs and is periodically updated. Military operating costs can be obtained by contacting numerous military services cited in the text of section 4. In the absence of other data, it is recommended that other costs for GA operating costs and for all military costs be updated using the *Price Index for Gross Domestic Product Personal Consumption Expenditures*,[78] unless a more specific GA operating cost index becomes available.

[78] *Business Statistics of the United States* (Annual: Berman Press; Lanham, MD) or for the latest update on the Worldwide Web, go to http://www.bea.gov/ and select *GDP*.

9.6 SECTION 5: UNIT REPLACEMENT AND RESTORATION COSTS OF DAMAGED AIRCRAFT

Unit replacement and restoration costs of damaged aircraft, developed in Section 5, should be updated by either specific reference to cited sources, or by applying a price index.

For commercial aircraft, vendors such as Aviation Specialists Group can provide estimates of aircraft values. For general aviation and air taxi aircraft, the best source of updated price data is *Aircraft Bluebook – Price Digest* (Overland Park, KS: PRIMEDIA Publication). A secondary source could be *Aircraft Types and Price Guidelines* (Compiled by CTC Services Aviation (LAD)) Updates on military aircraft values can be obtained from the military services.

Restoration costs for commercial aircraft can be estimated using the data provided by Airclaims. Airclaims data may also be useful for estimating restoration costs of larger GA aircraft but a more complete source of GA restoration data could come from AVEMCO or other insurance companies.

In the absence of a more specific index, it is suggested that the *Producer Price Index for Civilian Aircraft*[79] be used to adjust aircraft replacement and restoration costs to future year dollars. The adjustment method is illustrated below:

$$\text{Adjusted Unit Replacement Cost of a Damaged Aircraft} = (PPI - CA_f/PPI\text{-}CA_b) \times (REP_b)$$

where:

$PPI - CA_f$ and $PPI - CA_b$ are the Producer Price Index for Civilian Aircraft for the future year and base year, and
REP_b is the unit replacement cost of a destroyed aircraft in the base year.

With regard to restoration costs, it is recommended that the analyst apply the percentages of aircraft values shown in Table 5-4 and Table 5-8 (and/or supporting tables where applicable) to update the aircraft values using the methods described immediately above.

It is recommended that adjusted aircraft replacement and restoration costs be rounded to the nearest $1,000 for values less than $1,000,000 and to the nearest $10,000 for values greater than $1,000,000.

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[79] *Business Statistics of the United States* (Annual: Berman Press; Lanham, MD) or for the latest update on the Worldwide Web, go to http://stats.bls.gov/ppi/home.htm, and select *Producer Price Index – Commodity Data*.

9.7 SECTION 6: ECONOMIC VALUES RELATED TO AIRCRAFT PERFORMANCE FACTORS

The types of aircraft operating in the NAS and the typical missions in terms of stage length will probably not change drastically in the near future. However, if the selected aircraft types and mission lengths used by the analyst in his/her analyses fail to represent the most frequently observed aircraft and missions, then the analyst may need to develop new aircraft performance profiles. This could be accomplished by contacting a manufacturer directly in order to obtain aircraft specific data on incremental fuel burn as well as the data on the amount of time an aircraft typically spends in each phase of flight.

Fuel price data for air carriers can be obtained from Form 41 filings. The Air Transport Association publishes monthly fuel prices from Form 41 filings on its website: http://www.airlines.org/economics/energy . Jet-A and Avgas fuel prices can be found on Aviation Research Group's website (http://www.aviationresearch.com/Free/fuel_survey.asp). Prices are based on a fuel price survey of U.S. fuel suppliers. The survey is also published monthly in *Business & Commercial Aviation* magazine.

9.8 SECTION 7: LABOR COST FACTORS

The best way to update the labor costs related to the aviation industry is to refer to the latest versions of the original sources used in developing Section 7 of this report. Aircraft manufacturing labor rates were obtained from Aerospace Facts and Figures, Aerospace Industries of America, and the Bureau of Labor Statistics.

Crew salaries for GA pilots can be obtained from the Conklin & de Decker *Aircraft Cost Evaluator* database. *Aircraft Cost Evaluator* also reports fringe benefit costs as 30 percent of the salary costs. Conklin & de Decker also reports flight crew training costs.

Salary data for numerous aviation occupations was obtained from the *NBAA Compensation & Benchmark Survey*, Bureau of Labor Statistics (National Compensation Survey), House Subcommittee on Aviation Report[80] and Aviation Today[81]. Some of the salary data sources are industry surveys that may not be available in the future, or may be replaced by other industry surveys.

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[80] Congress. House. Committee on Transportation & Infrastructure. Subcommittee on Aviation, *Hearing on the DOT Inspector General's September 4th Report on the Safety of the FAA's Contract Tower Program*, Washington, DC, September 18, 2003.

[81] Kathleen Kocks, "2002 Aviation Maintenance U.S. Salary Survey," *Aviation Maintenance*, July 2002. Rickey, Patricia, "Salary Survey 2002: Hard Realities," *Rotor & Wing*, June 2002.

9.9 SECTION 8: AVIATION ACCIDENT INVESTIGATION COSTS

In order to completely update the aviation accident investigation costs presented in Section 8, the analyst will have to replicate the budget analyses of FAA and NTSB data. However, most of the accident investigations are labor related. Thus, government costs can be updated using the index of labor costs. The same method could be used for private sector costs using a labor cost index for private sector aerospace engineers. A labor cost index for government and private sector employed aerospace engineers can be constructed using wage estimates found on the Bureau of Labor Statistics web page.[82] For example, an aerospace engineer labor cost index for period *t* is calculated using the following formula:

$$\frac{Wt}{Wb} x\, 100$$

where:

Wt = mean wage at time *t*
Wb = mean wage for base year *b*

Labor cost index is then multiplied by the old labor costs in order to update them:

$$Updated\ costs = \left(\frac{Wt}{Wb} x\, 100 \right) x\ old\ costs$$

[82] http://www.bls.gov/oes/2003/may/oes172011.htm The site has average annual wages for both industry and government employees. The site is updated regularly and yearly data can be accessed by varying the year number in the following link: http://www.bls.gov/oes/2002/oes172011.htm For example, year 2000 data is on http://www.bls.gov/oes/2000/oes172011.htm

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APPENDIX A: AVIATION RULEMAKING COST COMMITTEE (ARCC)

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BIBLIOGRAPHY

"The A330-200 Takes on the 767-300/-400," *Aircraft Commerce*, No. 18, August/September 2001, p. 18-24.

"Air Carrier Traffic and Capacity Data by Nonstop Segment and On-Flight Market," Final Rule. *Federal Register*, 67(146): 49217-49235, July 30, 2002.

Air, Inc. *U.S. Airlines Salary Survey and Career Earnings Comparison*. Atlanta, GA, 1998, 2001-2002 editions and 2002 Addendum.

Air Marketing Services, Inc. *Airport Management Compensation Guide, 2000-2001*. White Plains, NY, 2000.

Air Transport Association. *Air Travel Survey.* Washington, DC, 1998.

_____. "Fuel Cost and Consumption Report." Washington, DC, December 2003. http://www.airlines.org/economics/energy/

_____. *Benefit & Cost Analysis - Pilot Flight Time and Duty Time*. Washington, DC, 1996. (Comments on FAA Docket 28081)

_____. *U.S. Airline Cost Index.* Washington, DC. http://www.airlines.org/economics/energy/

Aircraft Bluebook Price Digest. Overland Park, KS: Primedia, Summer 2003.

Aircraft Types and Price Guidelines, Including Turbine Engines 2002-2003. London: CTC Services Aviation(LAD), 2003.

Ashenfelter, Orley and Michael Greenstone. *Using Mandated Speed Limits to Measure the Value of a Statistical Life*. Cambridge, MA: National Bureau of Economic Research, 2002. (Working Paper No. 9094.) http://www.nber.org/papers/w9094

AVEMCO Insurance Company. Frederick, MD. (Special tabulation of restoration costs for general aviation aircraft) http://www.avemco.com/

Aviation & Aerospace Almanac. New York: McGraw-Hill, 2002.

Aviation Research Group/U.S. Inc. "Jet-A and Avgas Per Gallon Fuel Prices." Cincinnati, OH. http://www.aviationresearch.com/Free/fuel_survey.asp

Aviation Specialists Group. Herndon, VA. (Values for aircraft replacement costs) November 2003. http://www.aviationspecialistsgroup.com/

Boeing Air Traffic Management Team. *Cornerstones of ATM System Performance*. Seattle, WA, September 30, 2002.

Boyer, Phil. "Letter to Teledyne Continental Motors," April 28, 1999. http://www.aopa.org/whatsnew/regulatory/tcmcrankletter.html

Brandt, Steven A. et al. *Introduction to Aeronautics: A Design Perspective*. Reston, VA: AIAA, 1997.

Bruzelius, Nils A. *The Value of Travel Time: Theory and Measurement*. London: Croom Helm, 1979.

Bureau of Labor Statistics. *National Compensation Survey*. July 2002. http://www.bls.gov/ncs/

Bureau of Labor Statistics. Occupational Employment Statistics. *Occupational Employment and Wages, 2002: 17-2011 Aerospace Engineers*. http://www.bls.gov/oes/2002/oes172011.htm

Bureau of Transportation Statistics. *Form 298c – Commuter Airlines*. (Data for four quarters, ending September 2001) (Special tabulation) http://www.transtats.bts.gov

Calfee, John and Clifford Winston. "The Value of Automobile Travel Time: Implications for Congestion Policy," *Journal of Public Economics* 69:83-102, 1998.

"Careers 2000, Salary Survey and Jobs Forecast,"*Aviation Week and Space Technology*, February 8, 1999, p. S1-S31.

CASE Database. London, Heathrow Airport: Airclaims Group, Ltd. (Special Tabulation)

Census Bureau. *Income 2000*. http://www.census.gov/

Chew, Russell G. "Free Flight – Preserving Airline Opportunity," American Airlines, September 22, 1997.

Citrenbaum, Daniel and Robert Juliano. *A Simplified Approach to Baselining Delays and Delay Costs for the National Airspace System (NAS)*. Interim Report 12a. Washington, DC: Federal Aviation Administration, May 1999.

Cohen, Stephen B. *The Art of Benefits Prediction and the Statistical Science of Post-Implementation Assessment in Aviation Investment Analysis*. Washington, DC: Federal Aviation Administration, June 15, 2001.

The Complete Encyclopedia of World Aircraft. Edited by Paul Eden and Soph Moeng. New York: Barnes and Noble, 2002.

Congress. House. Committee on Transportation & Infrastructure. Subcommittee on Aviation. *Hearing on the DOT Inspector General's September 4th Report on the Safety of the FAA's Contract Tower Program*. Washington, DC, September 18, 2003.

Conklin & de Decker Associates. *Aircraft Cost Evaluator*. Orleans, MA, Spring 2003.

Database Products. *Form 41 Data*. Year End 2002.

de Blaeij, Arianne et al. "The Value of Statistical Life in Road Safety: a Meta-Analysis," *Accident Analysis and Prevention* 35(6): 973-986, 2003.

Department of the Army. *Accident Reporting and Records*. Washington, DC, November 1994. (Army Regulation 385-40)

_____. *Maintenance Expenditure Limits for Army Aircraft*. Washington, DC, August 1998. (Technical Bulletin 43-0002-3)

Department of the Navy. "Aircraft Models and Associated Average Aircraft Costs." Memo from Commander, Naval Air Systems Command, October 21, 2002.

Department of Transportation. *Air Travel Consumer Report*. Washington, DC, 2003. http://airconsumer.ost.dot.gov/reports/index.htm

_____. "Part 250 – Oversales," *Code of Federal Regulations, Title 14*, January 1, 2000, p. 208-212.

_____. "Revised Departmental Guidance – Treatment of Value of Life and Injuries in Preparing Economic Valuations." Memorandum, January 29, 2002. http://ostpxweb.dot.gov/policy/Data/VSL02guid.pdf

_____. "Revised Departmental Guidance – Valuation of Travel Time in Economic Analysis." Memorandum, February 11, 2003. http://ostpxweb.dot.gov

_____. "Revision of Departmental Guidance on Treatment of the Value of Life and Injuries." January 23, 2004. http://ostpxweb.dot.gov/policy/EconStrat/treatmentoflife.htm#1

_____. "Treatment of Value of Life and Injuries in Preparing Economic Evaluations." Memorandum, January 8, 1993. http://ostpxweb.dot.gov/policy/Data/VSL93guid.pdf

_____. "Update of Value of Life and Injuries for Use in Preparing Economic Evaluations," Memorandum, March 15, 1994.

_____. "Update of Value of Life and Injuries for Use in Preparing Economic Evaluations," Memorandum, March 14, 1995.

_____. "Update of Value of Life and Injuries for Use in Preparing Economic Evaluations," Memorandum, 1996.

Department of Transportation. Office of Inspector General. *Safety, Cost, and Operational Metrics of the Federal Aviation Administration's Visual Flight Rule Towers*. Washington, DC, September 2003. (AV-2003-057)

Donohue, George I. et al. "Potential Net Present Value for a Cargo Airline Investment in ADS-B Avionics Equipment: A Preliminary Analysis." Fairfax, VA: George Mason University, March 2000.

"Draft Report to Congress on the Costs and Benefits of Federal Regulations; Notice." *Federal Register*, 68(22): 5492-5527, February 3, 2003.

Economic Analysis of Federal Regulations Under Executive Order 12866. Washington, DC: Executive Office of the President, Office of Management and Budget, January 11, 1996. http://www.whitehouse.gov/omb/inforeg/riaguide.html

Eurocontrol. Performance Review Unit. KPI Drafting Group. *Cost Effectiveness and Productivity KPIs*. Brussels, BE, October 2001.

European Organisation for the Safety of Air Navigation and International Air Transport Association. *Guidelines for the Economic Appraisal of EATCHIP Projects – The Effective Use of Cost-Benefit Studies*. Brussels, BE: Eurocontrol, June 1996.

Executive Office of the President. Office of Management and Budget. "Guidelines to Standardize Measures of Costs and Benefits and the Format of Accounting Statements." Memorandum for the Heads of Departments and Agencies, March 22, 2000. (M-00-08) http://www.whitehouse.gov/omb/memoranda/m00-08.pdf

_____. "Presidential Review of Agency Rulemaking by OIRA." Memorandum for the President's Management Council, September 20, 2001. http://www.whitehouse.gov/omb/inforeg/oira_review-process.html.

"Executive Order 12866 – Regulatory Planning and Review." *Federal Register*, 58(190): 51735-51744, October 4, 1993.

Federal Aviation Administration. *Aircraft Registration Master File*. August 8, 2001.

_____. "Charter of the Aviation Rulemaking Cost Committee." FAA Order 1110.132, September 13, 2002.

_____. "Civil Aircraft Registry." http://registry.faa.gov/aircraft.asp

_____. *Economic Analysis of Investment and Regulatory Decisions – Revised Guide*. Washington, DC, 1998. (FAA-APO-98-4)

_____. *Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs*. Washington, DC, October 1989. (FAA-APO-89-10)

_____. *Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs*. Washington, DC, June 1998. (FAA-APO-98-8)

_____. "FAA General Aviation and Air Taxi Activity and Avionics Codebook." Washington, DC, 2001.

_____. "FAA Standard Work Breakdown Structure (WBS) WBS Element Definitions." Version 1.0. Washington, DC. http://fast.faa.gov/wbs/wbssec.htm

_____. *General Aviation and Air Taxi Activity Survey*. Calendar Year 2001. Washington, DC, 2003.

_____. *General Aviation and Air Taxi Activity Survey.* Calendar Year 2002. Washington, DC, 2004.

_____. *Next-Generation Air/Ground Communications System, Investment Analysis Report*. Washington, DC, September 1998.

_____. Operating Specification Subsystem. (Data as of July 2001)

_____. *Report to Congress Under Section 735 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century; Part 135 Air Taxi Operators (ATO) Study*. Draft. Washington, DC, December 6, 2001.

Federal Aviation Administration. Investment Cost Analysis Branch. *AMS Investment Analysis Process Guidelines*. Washington, DC, July 1998. http://fast.faa.gov/investment/index.htm

Federal Aviation Administration. Office of Aviation Policy and Plans. *FAA Aerospace Forecasts*. Washington, DC, various years.

_____.*Final Regulatory Evaluation, Regulatory Flexibility Analysis, Trade Impact Assessment, and Unfunded Mandates Reform Act Analysis; Revised Standards for Cargo or Baggage Compartments in Transport Category Airplanes*. Final Rule. Washington, DC, December 1997.

_____. *Initial Regulatory Evaluation, Initial Regulatory Flexibility Determination, Trade Impact Assessment, and Unfunded Mandates Assessment; Supplement to Notice of Proposed Rulemaking; Licensing and Safety Requirements for Launch*. Washington, DC, January 2002.

_____. "Interim Guidance for Conducting Regulatory Flexibility Reviews and Analyses of Federal Aviation Regulations." Memorandum from APO-300. Washington, DC, March 31, 1998.

_____. *Preliminary Regulatory Evaluation, Initial Regulatory Flexibility Determination, Trade Impact Assessment, and Unfunded Mandates Assessment for Supplemental Notice of Proposed Rulemaking: Improved Seats in Air Carrier Transport Category Airplanes*. Washington, DC, April 2002.

_____. *Preliminary Regulatory Evaluation, Initial Regulatory Flexibility Determination, International Trade Impact Assessment, and Unfunded Mandates; Proposed Rule: Corrosion Prevention and Control Program*. Washington, DC, July 2001.

_____. *Regulatory Evaluation, Regulatory Flexibility Determination, Trade Impact Assessment, and Unfunded Mandates Determination*; *Certification of Screening Companies*. Final Rule. Washington, DC, January 2001.

_____. *Regulatory Evaluation, Regulatory Flexibility Determination, Unfunded Mandates and Trade Impact Assessment: Reduced Vertical Separation Minimum Operations in the West Atlantic Route System*. NPRM. Washington, DC, July 27, 2000.

_____. "Treatment of Values of Passenger Time in Economic Analysis." APO Bulletin, APO-03-1. Washington, DC, March 2003.

Feldman, Allan M. *The Value of Life, Value of Time, and Constant Relative Risk Aversion Utility*. Providence, RI: Brown University, Department of Economics, July 24, 1998. (Working Paper 98-13) http://www.brown.edu/Departments/Economics/Papers/1998/1998-13.pdf

"Fractional Market," *UBS Investment Research – June Business Jet Monthly*, June 2003, p. 38-48.

Gabler, Eric. "Update of FAA Values of Avoided Injury," Draft Working Paper. Federal Aviation Administration, Office of Aviation Policy and Plans, February 1994.

"General Aviation Engineering/Production Labor Rates," Memorandum. Washington, DC: General Aviation Manufacturers Association, June 1, 2003.

General Aviation Manufacturers Association. "Memorandum: General Aviation Engineering Production Labor Rates," Washington, DC, June 1, 2003.

Gollier, Christian. "Discounting an Uncertain Future," J*ournal of Public Economics*, 85:149-166, 2002.

GRA, Inc. *A Cost Allocation Study of FAA's 1995 Costs*. Jenkintown, PA, March 1997. (Prepared for FAA Office of Aviation Policy and Plans)

_____. *FAA FY 1995 Accident Investigation Costs*. Jenkintown, PA, April 28, 1997

_____. *The Social Costs of Transportation Accidents, Task I, A Review of the Literature*. Final Report. Jenkintown, PA, April 2002. (Subcontract to National Safety Council, for Bureau of Transportation Statistics)

Great Britain. Department of Transport. *Aviation and the Environment; Using Economic Instruments*. London, UK, March 2003.

Gunn, Hugh. "Spatial and Temporal Transferability of Relationships Between Travel Demand, Trip Cost and Travel Time," *Transportation Research, Part E*, 37:163-189, 2001.

Hansen, Mark M., David Gillen and Reza Djafarian-Tehrani. *Aviation Infrastructure Performance and Airline Cost: A Statistical Cost Estimation Approach*, Berkeley, CA: Institute of Transportation Studies, University of California, March 2000.

Henderson, James M. and Richard E. Quandt. *Microeconomic Theory - a Mathematical Approach*. New York: McGraw-Hill, 1958.

Hickling Lewis Brod, Inc. *Impact of Weight Changes on Aircraft Fuel Consumption*. Silver Spring, MD, July 1998.

Hultkrantz, Lars and Reza Mortazavi. "Anomalies in the Value of Travel-Time Changes," *Journal of Transport Economics and Policy*, 35(2): 285-300, 2001.

Hustache, Jean-Claude, Marco Gibellini and Paula Leal De Matos. "A System Dynamics Tool for Economic Performance Assessment in Air Traffic Management," *4th USA/Europe Air Traffic Management R&D Seminar*, Santa Fe, NM, December 2001.

IBM. *Navy Visibility and Management of Operating and Support Cost (VAMOSC), Aviation Type/Model/Series Report, User Manual, Fiscal Years 1997 Through 2002.* February 2003.

Interagency Aviation Training. "Aircraft Identification Library."

Jane's Aircraft Upgrades, 2003-2004. Alexandria, VA: Jane's Information Group, 2003.

Jane's All the World's Aircraft. Alexandria, VA: Jane's Information Group, various years.

Kocks, Kathleen. "2002 Aviation Maintenance U.S. Salary Survey." *Aviation Maintenance,* July 2002. http://www.aviationtoday.com/cgi/am/show_mag.cgi?pub=am&mon=0702&file=0702salary_survey.htm

Krupnick, Alan. "Commentary on: What Determines the Value of Life?: A Meta-Analysis," *Journal of Policy Analysis and Management*, 21(2): 275-282, 2002.

Lam, Terence C. and Kenneth A. Small. "The Value of Time and Reliability: Measurement From a Value Pricing Experiment," *Transportation Research, Part E*, 37:231-251, 2001.

Litman, Todd. *Transportation Cost Analysis: Techniques, Estimates and Implications*. Victoria, BC: Victoria Transport Policy Institute, June 2002. http://www.vtpi.org/tca/

Lombardo, David A. "FAA Grounds Learjet 45 Fleet, Demands Tail Jackscrew Fix," *Aviation International News*, September 2003.

"Maintenance Repair & Overhaul Yearbook, 2002/2003," *Aircraft Economics*, 2002.

Miller, Ted R. "Costs and Functional Consequences of U.S. Roadway Crashes," *Accident Analysis and Prevention*, 25(5): 591-607, 1993.

_____. "Variations Between Countries in Values of Statistical Life," J*ournal of Transport Economics and Policy*, 34(2): 169-188, 2000.

Miller, Ted R. et al. *The Costs of Highway Crashes*. Washington, DC: Urban Institute, 1991.

Miller, Ted R., Diane C. Lestina and Rebecca S. Spicer. "Highway Crash Costs in the United States by Driver Age, Blood Alcohol Level, Victim Age, and Restraint Use," *Accident Analysis and Prevention*, 30(2): 137-150, 1998.

Miller, Ted R., Stephen Luchter and C. Philip Brinkman. "Crash Costs and Safety Investment," *Accident Analysis and Prevention* 21(4): 303-315, 1989.

Morrison, John. "Lessors Face Black Hole," *Airfinance Journal*, December 2003/January 2004, p. 24-29.

Mrozek, Janusz R. and Laura O. Taylor. "What Determines the Value of Life? A Meta Analysis," J*ournal of Policy Analysis and Management*, 21(2): 253-270, 2002. http://www.gsu.edu/%7Eecolot/docs/meta.pdf

National Business Aviation Association. *NBAA Compensation and Benchmark Survey.* 2d ed. Washington, DC, 2002.

National Highway Traffic Safety Administration. *The Economic Impact of Motor Vehicle Crashes, 2000*. Washington, DC, 2002. (DOT HS 809 446)

National Oceanic and Atmospheric Administration. *Enhanced Traffic Management System(ETMS)*. http://www-ad.fsl.noaa.gov/asdad/projects/etms_project.html

National Transportation Safety Board. "Aviation Accident Database, 1982-2003." http://www.ntsb.gov/ntsb/query.asp

Official Airline Guide(OAG) Flight Guide - North American, February 2003.

"Operations Planning Guide," *Business & Commercial Aviation*, August 1999, 2000, 2001, 2002 and 2003 issues.

Planequest.com. "Operating Costs." http://www.planequest.com/operationcosts/default.asp

Raymer, Daniel P. *Aircraft Design: A Conceptual Approach*. Washington, DC: AIAA, 1989.

Rickey, Patricia. “Salary Survey 2002: Hard Realities,” *Rotor & Wing*, June 2002. “Salary Study 2002,” *Professional Pilot*, June 2002, p. 64-80.

Small Business Administration. *The Regulatory Flexibility Act*. Washington, DC, October 1982.

_____. *The Regulatory Flexibility Act: An Implementation Guide for Federal Agencies*. Washington, DC, 1998.

Small Business Regulatory Enforcement Fairness Act of 1996. P.L. 104-121, March 29, 1996. http://www.sba.gov/advo/laws/sbrefa.html

Small, Kenneth A. *Urban Transportation Economics*. Reading: Harwood, 1992.

Sunstein, Cass R. *Are Poor People Worth Less Than Rich People? Disaggregating the Value of Statistical Lives*. Washington, DC: AEI-Brookings Joint Center for Regulatory Studies, January 2004. (Working Paper 04-05) http://www.aei-brookings.org/admin/authorpdfs/page.php?id=326

Viscusi, W. Kip and Joseph E. Aldy. *The Value of a Statistical Life: A Critical Review of Market Estimates throughout the World*. Cambridge, MA: National Bureau of Economic Research, February 2003. (NBER Working Paper No. 9487) http://www.nber.org/papers/w9487

Wardman, Mark. ”A Review of British Evidence on Time and Service Quality Valuations,” *Transportation Research, Part E*, 37:107-128, 2001.

_____. “The Value of Travel Time, A Review of British Evidence,” *Journal of Transport Economics and Policy*, 32(3): 285-316, 1998.

Warwick, Graham. “Learjet 45 Grounding Enters Week Number Four,” *Flight International*, September 9-15, 2003, p. 26.

“What Savings Can Be Expected From Commonality Benefits?” *Aircraft Commerce*, December 2003/January 2004, p. 12-18.