Current Procedures for Collecting and Reporting U.S. General Aviation Accident and Activity Data

Safety Report

NTSB/SR-05/02

PB2005-917002
Notation 7573A

National Transportation Safety Board
Washington, D.C.

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Adopted April 29, 2005

National Transportation Safety Board
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

National Transportation Safety Board. 2005. ***Current Procedures for Collecting and Reporting U.S. General Aviation Accident and Activity Data Safety Report.*** **NTSB/SR-05/02. Washington, DC.**

Abstract: Unlike Part 121 and scheduled Part 135 air carriers, general aviation operators and on-demand Part 135 operators (air taxis) are not required to report actual flight activity data to DOT. Instead, the Federal Aviation Administration (FAA) uses its annual *General Aviation and Air Taxi Activity* (*GAATA*) *Survey* to query a sample of registered aircraft owners, either through the Internet or by mail. The National Transportation Safety Board and others rely on *GAATA Survey* activity estimates to calculate accident rates and statistics that form the basis for assessing general aviation safety in the United States. Congress, government agencies, the aviation industry, and other researchers frequently cite accident rates when evaluating the need for safety initiatives. Valid activity data are necessary to compare the accident rates for different aircraft types and types of operations, to establish baseline measures that can be used to identify and track accident trends, and to assess the effectiveness of safety improvement efforts. Because of a critical need for accurate activity measures, and the perception of possible problems with current general aviation activity estimates, the Safety Board analyzed several general aviation exposure measures to determine the relationship of trends over time. The results of that analysis are included in this report. One existing recommendation to the FAA is superseded in this report, two new recommendations are issued, and two existing recommendations are reiterated.

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Executive Summary

Unlike Part 121 and scheduled Part 135 air carriers, general aviation operators and on-demand Part 135 operators (air taxis) are not required to report actual flight activity data to DOT. Instead, the Federal Aviation Administration (FAA) uses its annual *General Aviation and Air Taxi Activity* (*GAATA*) *Survey* to query a sample of registered aircraft owners, either through the Internet or by mail. The National Transportation Safety Board and others rely on *GAATA Survey* activity estimates to calculate accident rates and statistics that form the basis for assessing general aviation safety in the United States. Congress, government agencies, the aviation industry, and other researchers frequently cite accident rates when evaluating the need for safety initiatives. Valid activity data are necessary to compare the accident rates for different aircraft types and types of operations, to establish baseline measures that can be used to identify and track accident trends, and to assess the effectiveness of safety improvement efforts. Because of a critical need for accurate activity measures, and the perception of possible problems with current general aviation activity estimates, the Safety Board analyzed several general aviation exposure measures to determine the relationship of trends over time. The results of that analysis are included in this report. One existing recommendation to the FAA is superseded in this report, two new recommendations are issued, and two existing recommendations are reiterated.

Introduction

To accurately characterize aviation accident risk, it is necessary to compare the number of accidents with some measure of activity. Depending on the safety issue in question, activity measures that can be used to determine aviation risks include the number of flight hours, the number of departures, and the number of miles traveled. Activity measures qualify exposure to risk and allow for comparisons across multiple years, aircraft types, and operational categories.

As part of the requirements of 14 *Code of Federal Regulations* (CFR) Part 241, all Part 121 air carriers currently must submit monthly reports of revenue flight activity, including block hours and departures, to the Department of Transportation (DOT). Scheduled Part 135 operators must submit similar reports as required by 14 CFR Part 298. Reported information is maintained by the Bureau of Transportation Statistics (BTS) and used by the Federal Aviation Administration (FAA) to produce summary reports of flight activity. Because of mandatory reporting requirements for Part 121 and scheduled Part 135 air carriers, the activity measures calculated for these segments of aviation can be considered accurate and stable.

Unlike Part 121 and scheduled Part 135 air carriers, general aviation[1] operators and on-demand Part 135 operators (air taxis)[2] are not required to report actual flight activity data to DOT. Instead, the FAA uses its annual *General Aviation and Air Taxi Activity (GAATA) Survey*[3] to query a sample of registered aircraft owners, either through the Internet or by mail. Sampled owners are surveyed about the activity of their aircraft during the previous year including total hours flown, hours flown in each of 15 purpose-of-flight categories, and percentage of total hours flown under instrument and visual flight rules for both day and night during the preceding year. About 11 percent of the registration records for general aviation aircraft were selected for the 2002 *GAATA Survey*, and approximately 52 percent of sampled owners responded.[4]

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[1] This document pertains to general aviation as defined by the National Transportation Safety Board—that is, any civil aircraft operation *not* covered under 14 *Code of Federal Regulations* (CFR) Parts 121, 129, and 135. See *Annual Review of Aircraft Accident Data: U.S. General Aviation, Calendar Year 2000* (Washington, DC: NTSB, 2004).

[2] Although general aviation operations are the primary focus of this report, most of the issues discussed also pertain to nonscheduled Part 135 (also known as air-taxi) operations. See *Annual Review of Aircraft Accident Data: U.S. Air Carrier Operations, Calendar Year 2000* (Washington, DC: NTSB, 2004).

[3] U.S. Department of Transportation, Federal Aviation Administration, *General Aviation and Air Taxi Activity Survey, Calendar Year 2002* (Washington, DC: FAA, 2004), available at <http://api.hq.faa.gov/pubs.asp>.

[4] The 2002 sample frame included 263,223 general aviation aircraft records from which 30,823 records were sampled (11.7 percent). After the records were adjusted for invalid registrations and inactive aircraft, the corrected sample size was 29,491 (11.2 percent). Of those 29,491 records selected for the sample, there were 15,254 responses (51.7 percent). This was similar to prior years.

The *GAATA Survey* is meant to represent the wide range of activities and aircraft included in general aviation using a stratified sample of aircraft owners, including 19 aircraft type categories and 9 geographical regions. Responses from the sample are extrapolated to what is believed to be the entire population of similar active aircraft in each region, and then added to estimate total activity.

Current survey methodology relies on the quality of survey responses and the accuracy of the active aircraft fleet enumeration to develop accurate and unbiased activity estimates. However, the survey is based on a relatively small sample of diverse aircraft operations, and the aircraft registry is believed to contain many outdated and inaccurate records. For example, a *GAATA Survey* contractor estimated in 2000 that as many as 25 percent of the registry records were inaccurate,[5] and the appendix to the 2002 *GAATA Survey* includes a statement that 20 percent of sampled owners could not be contacted because of registry errors.

The Safety Board and others rely on *GAATA Survey* activity estimates to calculate accident rates and statistics that form the basis for assessing general aviation safety in the United States. Congress, government agencies, the aviation industry, and other researchers frequently cite accident rates when evaluating the need for safety initiatives. Valid activity data are necessary to compare the accident rates for different aircraft types and types of operations, to establish baseline measures that can be used to identify and track accident trends, and to assess the effectiveness of safety improvement efforts. Because of a critical need for accurate activity measures, and the perception of possible problems with current general aviation activity estimates, the Safety Board analyzed the methods currently used to produce those estimates. The results of that analysis are included in this report.

[5] National Transportation Safety Board, *Public Aircraft Safety*, Safety Study NTSB/SS-01/01 (Washington, DC: NTSB, 2001).

History

The stated purpose of the *GAATA Survey* is to "monitor the general aviation fleet" so that the FAA can "anticipate and meet demand for National Airspace System (NAS) facilities and services, assess the impact of regulatory changes on the fleet, and implement measures to assure the safe operation of aircraft."[6] However, two Safety Board reports cited problems with the current *GAATA Survey* and the resulting activity estimates that may limit FAA's ability to carry out these monitoring tasks.

In the first of these reports, *Public Aircraft Safety*,[7] the Safety Board identified several *GAATA Survey* data tracking problems and issued eight recommendations to the FAA and the General Services Administration to improve data collection methods and to record additional details about the purpose of flight. Several of those recommendations were specific to public aircraft operations, while others targeted survey reporting categories. However, two of those recommendations would improve the accuracy of all general aviation activity data if implemented.

One of these recommendations to the FAA was to improve the accuracy of flight activity data through independent verification:

> Identify and implement methods independent of the General Aviation and Air Taxi Activity Survey that can be used to check the accuracy of nonairline flight hour estimates. (A-01-74)

In its response, the FAA stated that it "agrees that improvements should be made to the General Aviation, Air Taxi and Avionics Survey" and noted that as of January 2002, it had already spent a year working to identify and prioritize specific improvements as part of the *Safer Skies* initiative. A published implementation plan was promised pending resource commitments for the implementation process from the FAA, other government, and industry representatives. The current status of this recommendation is "Open—Acceptable Response."

The other recommendation to the FAA was to improve the accuracy of the aircraft registry used to determine the size and makeup of the general aviation fleet:

> Implement a program that will (a) measure and track the currency of aircraft owner contact information in the Civil Aircraft Registry and (b) systematically improve the currency of this information in a measurable way. (A-01-75)

The FAA responded that it was aware of problems with the accuracy of registry information. In January 2002, the FAA stated that it was establishing a team of legal examiners charged with improving the currency of its Civil Aircraft Registry by reviewing

[6] *General Aviation and Air Taxi Activity Survey, Calendar Year 2002*, Appendix A.

[7] *Public Aircraft Safety*, NTSB/SS-01/01.

records of aircraft noting a sale, pending registration, or undeliverable address. The current status of this recommendation is "Open—Acceptable Response."

In *Transportation Safety Databases*,[8] its report on databases maintained by the various transportation modal agencies, the Safety Board identified similar issues with the accuracy of safety data sources and made the following recommendation to the BTS:

> Develop a long-term program to improve the collection of data describing exposure to transportation risk in the United States. Within each mode, representative exposure data should be maintained for distinct transportation sectors, industry segments, and travel purposes. (I-02-05)

In its initial response in February 2003, BTS stated that it concurred with the recommendation and would pursue it as a high-priority concern. The response also noted that BTS had been working with operating administrations in the DOT and outside organizations to improve exposure data, and a report of those efforts was promised. The current status of this recommendation is "Open—Initial Response Received."

[8] National Transportation Safety Board, *Transportation Safety Databases*, Safety Report NTSB/SR-02/02 (Washington DC: NTSB, 2002).

Air Taxis and Fractional Ownerships

Although the current *GAATA Survey* includes data pertaining to general aviation and nonscheduled Part 135 operations, data specific to Part 135 operations have been excluded from the analyses presented in this report. Because of the additional operating and record-keeping requirements[9] already placed on Part 135 air carriers, issues affecting the accuracy of activity data for these operators, and methods for improving the accuracy of those data, differ from general aviation operations and are beyond the scope of this report.[10] One exception is the newly created 14 CFR Part 91, Subpart K, which establishes operational and record-keeping requirements[11] for managed fractional ownerships.[12] As Part 91 operations, the activity of managed fractional ownerships is included in general aviation accident statistics and flight hour estimates, but the additional regulatory requirements make these operations similar to nonscheduled Part 135 air carriers.

In August 2003, before 14 CFR Part 91, Subpart K, was enacted, the Safety Board issued three recommendations to the FAA pertaining to nonscheduled Part 135 flight activity reporting. In light of the similarities between the requirements for nonscheduled Part 135 and Part 91, Subpart K, operations, two of those recommendations could be expanded to include operations governed by Part 91, Subpart K, regulations. The first was a recommendation to the FAA to require annual activity reporting by all nonscheduled Part 135 operators:

> Require nonscheduled Part 135 operators to report activity data on an annual basis to include total hours flown, revenue flight hours, revenue miles flown, and number of departures by category/class of aircraft; to identify for each aircraft the proportion of flight time operations that are involved in sightseeing, air medical transport, passenger transportation, and cargo-only transportation; to report for cargo operations freight ton-miles available and freight ton-miles flown; and to report for passenger service operations seat-miles available and passenger miles flown. (A-03-37)

The second was also a recommendation to the FAA:

> Develop, validate, and document an unbiased method for generating and revising activity estimates based on nonscheduled Part 135 operator surveys or reporting. (A-03-38)

[9] For example, 14 CFR 135.63 requires that a detailed manifest be completed for each revenue flight and maintained by the operator.

[10] For a discussion of activity data reporting specific to 14 CFR Part 135 operations, see safety recommendation A-03-38, Safety Board letter to the Federal Aviation Administration, August 20, 2003.

[11] Title 14 CFR 91.1027, effective November 17, 2003, extends similar manifest and record-keeping requirements of nonscheduled Part 135 operations to managed fractional ownerships.

[12] Title 14 CFR 91.1001 identifies fractional ownership operations as those involving program management services, as opposed to simple shared ownerships.

In response, the FAA stated that it was reviewing these recommendations internally, with BTS, and with its Aviation Rulemaking Advisory Committee (ARAC) to determine the cost and benefits to the industry, and to understand the options for collecting and processing the data. The current status of both recommendations is "Open—Acceptable Response."

The Safety Board concludes that the additional operational and record-keeping requirements that already exist for nonscheduled 14 CFR Part 135 and Part 91, Subpart K, flight operations allow for more comprehensive activity reporting methods than those currently used to survey the activity of noncommercial, general aviation operations. The Board therefore believes that the FAA should develop, validate, and document an unbiased method for generating and revising activity estimates based on nonscheduled 14 CFR Part 135 *and* Part 91, Subpart K, operator surveys or reporting. The Board also believes that the FAA should require Part 91, Subpart K, fractional ownership operators to report activity on an annual basis to include total hours flown, revenue flight hours flown, revenue miles flown, and number of departures by category/class of aircraft.

Aircraft Registration

The FAA currently derives its annual estimate of general aviation activity from the number of records in the aircraft registry. However, several factors limit the potential accuracy of the registry and consequently limit the utility of the registry as a basis for estimating flight activity, including the FAA's current triennial aircraft registration requirements, the failure of many owners to report changes of address, and corporate and shared aircraft ownership.

Registration Schedule. In 1978, the FAA discontinued its prior annual census of aircraft owners in favor of statistical sampling. At the same time, it changed its annual aircraft registration requirement to require owners to update their registration information every 3 years, or whenever significant changes occurred. The expected benefits of the changes included faster processing of results, improved data quality, and a savings in time and money to the Federal Government and aircraft owners. However, recent editions of the *GAATA Survey* report[13] acknowledge that, contrary to its original intent, the change to triennial registration has likely hurt the accuracy and representativeness of the Civil Aviation Registry, leading to a deterioration of owner name and address information and resulting in a residue of invalid registrations. For example, if an owner fails to notify the FAA when an aircraft becomes inactive due to irreparable damage or lack of maintenance, the aircraft remains on the registry. As will be discussed later in this report, these aircraft are included among the numbers of active aircraft within the *GAATA Survey.*

Change of Address. Although required by Federal regulations to notify the FAA within 30 days of a change of address[14] or other information that may invalidate an aircraft registration,[15] aircraft owners do not always comply. To rectify this problem, the FAA has, since 1999, compared the Civil Aviation Registry database with U.S. Postal Service change-of-address submissions and contacted aircraft owners who report a change of address but fail to notify the registry. Although this effort may eventually improve the overall accuracy of *GAATA Survey* address information, the benefits may be limited because many aircraft are not registered to the home address of a single owner, as discussed below.

[13] See *GAATA Survey, Calendar Year 2002,* Appendix A.

[14] Title 14 CFR 47.41.

[15] Title 14 CFR 47.45.

Corporate and Shared Ownership. The task of maintaining accurate aircraft owner information is complicated by corporate and shared ownerships, which are common due to liability concerns and the high costs associated with owning and operating an aircraft. For example, the popular practice of establishing a corporation (often in another state) for the sole purpose of registering a personal aircraft can hinder FAA attempts to identify and contact aircraft owners who move or whose registrations have expired because the listed address is that of an incorporating service rather than the owner.[16]

In its January 2002 response letter to Safety Board recommendation A-01-75, the FAA disputed estimates made by the survey contractor that 20 to 25 percent of registry records contain errors,[17] but acknowledged that it was aware of accuracy problems with registry data and was taking steps to remedy those problems. In June 2004, the FAA began notifying owners with out-of-date or inaccurate registrations by posting on its Web site details about aircraft registrations in danger of being canceled. The FAA also started requiring owners to include typed or printed contact information on their registrations in addition to any handwritten information, which could be illegible. The Safety Board applauds these efforts to improve the accuracy of the registry.

[16] As an example of the popularity of this practice, a review of the aircraft registry by Safety Board staff identified approximately 4,500 aircraft—nearly 2 percent of all U.S. civil aircraft—that are currently registered to a single office suite address in Delaware belonging to a registry services company.

[17] In its January 29, 2002, response letter to Safety Board recommendation A-01-75, the FAA stated that approximately 12 percent of aircraft were assigned a nonregistered status for reasons such as a reported sale or pending registration, and approximately 9 percent were registered to an undeliverable address.

Activity Survey Sample

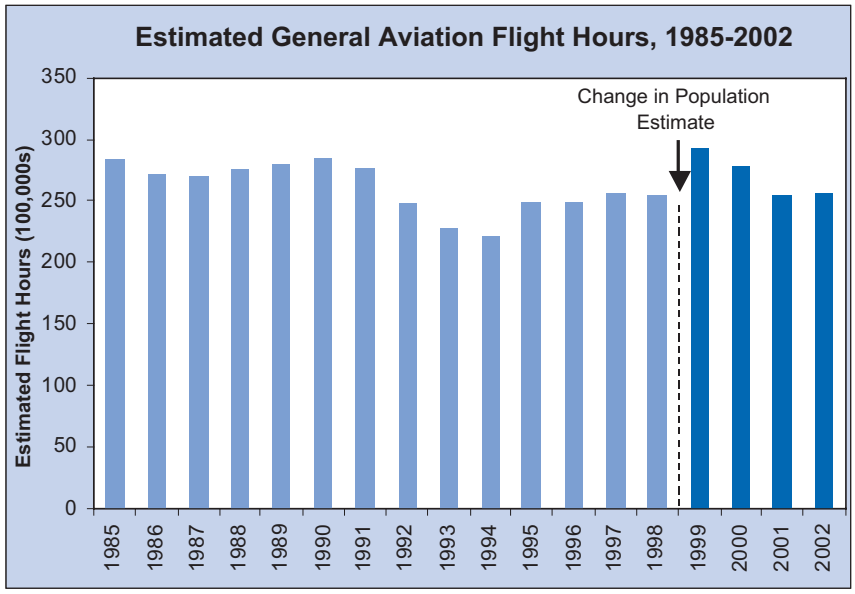
Historically, the *GAATA Survey* has excluded all aircraft reported as destroyed, registered to dealers with sale reported or registration pending, with known inaccurate owner address information, or with missing make or model information. However, in 1999, the FAA expanded the assumed population of active aircraft to include all aircraft registrations that had become invalid within the last 10 years due to inaccurate address information, a reported sale, or a pending registration. According to the methodology described in an appendix to the survey report, this change was based on the assumption that many aircraft owners continue to operate aircraft with invalid registrations. Because of this change, the *GAATA Survey* now extrapolates data from a sample of aircraft known to be active to represent an assumed population that cannot be verified. As a result of this change, the total number of aircraft used to estimate flight activity increased considerably. In 1999, the aircraft fleet increased by 20,233 records—or 8 percent—as a result of this change.[18]

The Safety Board concludes that the accuracy of civil aircraft flight-hour estimates currently depends on the accuracy and currency of the FAA Civil Aviation Registry. However, a triennial registration schedule and certain owner registration practices have resulted in a substantial percentage of registry records that are likely to be inaccurate. The Board therefore reiterates recommendation A-01-75 that the FAA implement a program that will (a) measure and track the currency of aircraft owner contact information in the Civil Aircraft Registry and (b) systematically improve the currency of this information in a measurable way.

[18] U.S. Department of Transportation, Federal Aviation Administration, *General Aviation and Air Taxi Activity Survey, Calendar Year 1999,* Appendix A (Washington, DC: FAA, 2001).

General Aviation Activity Trends

Any large change in the estimated number of active aircraft has a noticeable effect on the annual general aviation activity totals, as shown in the following table. For example, the jump in total estimated hours between 1998 and 1999 was due in large part to the change in survey methodology, described above, rather than a known surge in activity.



Although changes in survey methodology may occasionally be required to maintain or improve data integrity or to correct specific errors, each significant change limits the survey's usefulness for accurately tracking accident rates over time. Meaningful comparisons of accident risk across multiple years require yearly accident totals to be converted to an accident rate by dividing the number of accidents by a measure of the total exposure to accident risk (in this case, total flight hours). When the FAA expanded the aircraft population, the estimated number of hours increased, and the accident rate for 1999 was the lowest on record. However, the rate decrease is questionable given that the definition of the active aircraft population was substantially different than during previous years.

Comparative Data Analyses

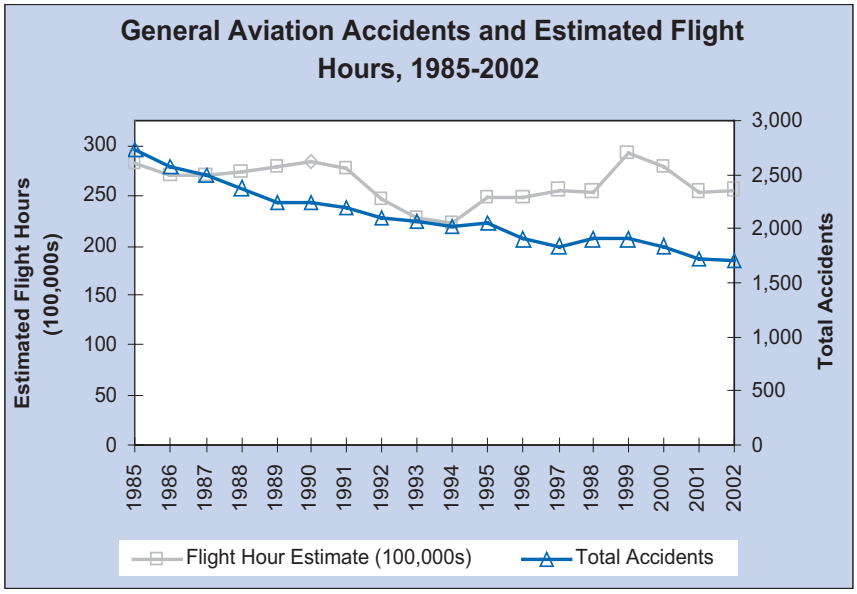
Given the limitations and known inaccuracies in the aircraft registry information, it follows that estimates of general aviation activity based solely on these records are likely to exhibit similar accuracy problems. For that reason, the Safety Board attempted to independently verify general aviation activity estimates by comparing FAA aircraft registry and annual flight-hour estimates with other indicators of flight activity. These comparisons included the number of general aviation accidents and fatal accidents, the active pilot population, and aviation fuel consumption for the years 1985 through 2002.

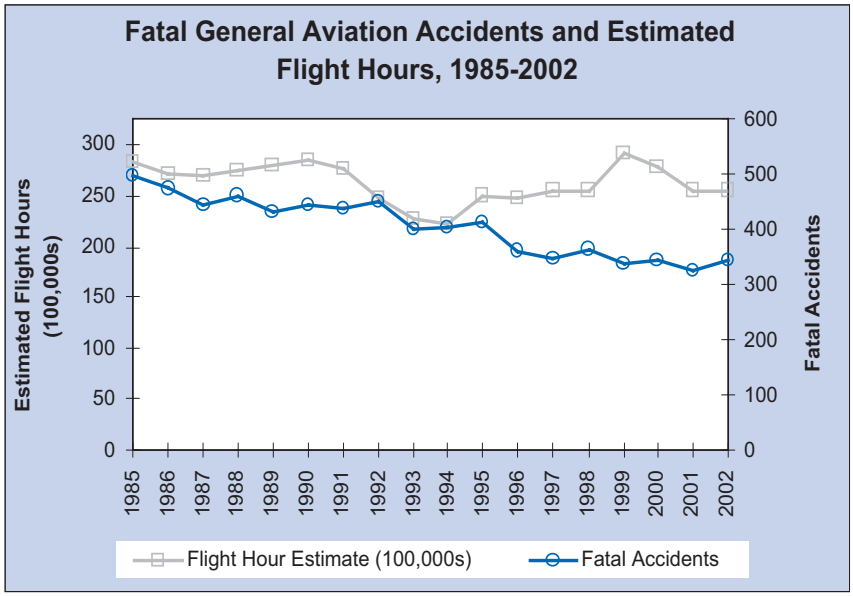
Activity and Accident Trends

The first indication of potential problems with general aviation activity estimates can be observed in the limited relationship between flight hours and general aviation accident data from 1985 through 2002.[19] In contrast to the steady decline in accidents, activity estimates fluctuated by millions of hours annually. It is important to note that the Safety Board does not suggest that accidents are a direct indicator of activity. However, the relationship between activity and accidents is such that unless the hazards associated with a particular operation change considerably, the number of mishaps will track closely with activity. The exact relationship between activity and accidents may change over time, but the number of accidents or mishaps will always be dependant on the amount of activity.

The following two charts show that, although FAA's annual estimates of general aviation flight hours fluctuated annually with no discernible trend, the numbers of total and fatal general aviation accidents occurring annually fluctuated less and declined overall.

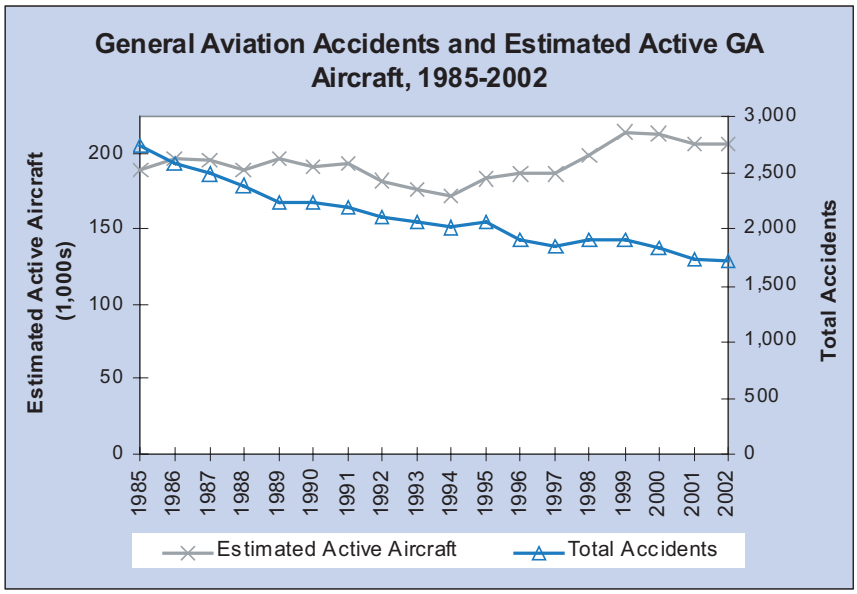
[19] Raw values are included in appendix A to this document.

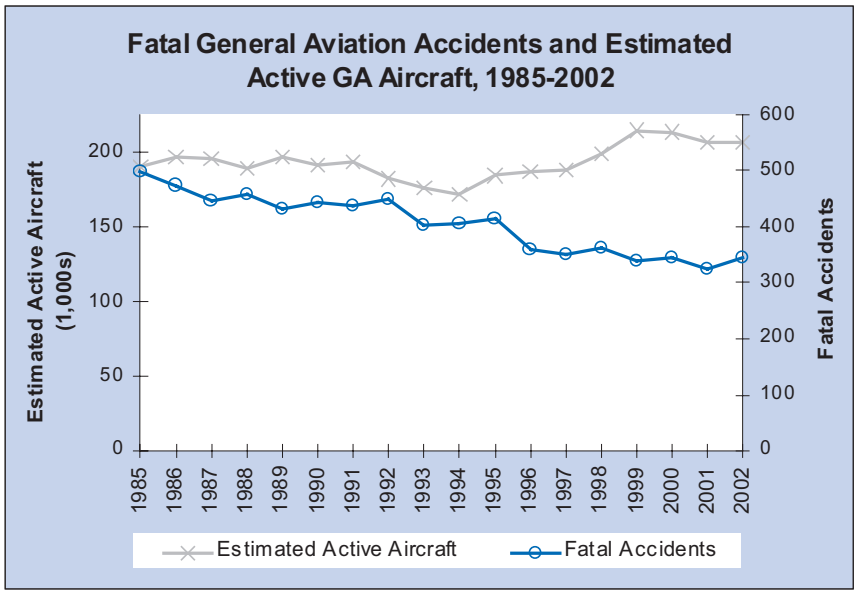




Much like their annual estimates for flight hours, FAA's annual estimates of active general aviation aircraft fluctuated and deviated from annual accident totals, particularly

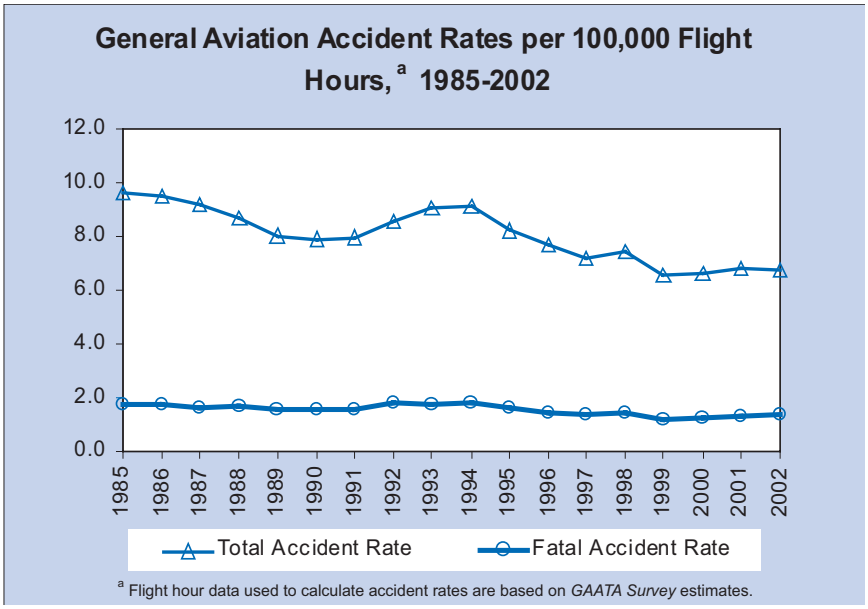
after the mid-1990s.[20] The fact that flight-hour estimates and estimated number of active aircraft were derived from the number of registered aircraft is evident in the similarity of the plots for both sets of data.





[20] The 1995 increase in general aviation aircraft registrations coincides with passage of the *General Aviation Revitalization Act*, signed into law August 17, 1994, limiting the liability of general aviation manufacturers to 18 years. Production of several U.S.-manufactured light aircraft began to increase following passage of this act.

The steady decline in general aviation accidents, combined with fluctuating/increasing annual flight-hour estimates, resulted in calculated annual accident rates that decreased from 9.6 accidents per 100,000 flight hours in 1985 to 6.7 accidents per 100,000 flight hours in 2002. In light of the cited concerns about the accuracy of current activity estimates, it is necessary to determine if variability in the source data has affected the calculated accident rates.



Changes in general aviation accident rates can also be associated with changes in pilot population and aircraft design. New pilot training standards and new aircraft both provide a way to improve safety through implementation of the latest safety innovations. However, new training standards historically affect only a small percentage of the population each year, and the number of new aircraft added to the general aviation fleet during recent years is still too small to have an observable impact on the accident rate.[21] As discussed below, the gradual rate of change in the general aviation pilot population and aircraft fleet may have limited the pace at which improvements have been realized, but it also provides a means for validating activity estimates.

General Aviation Pilots

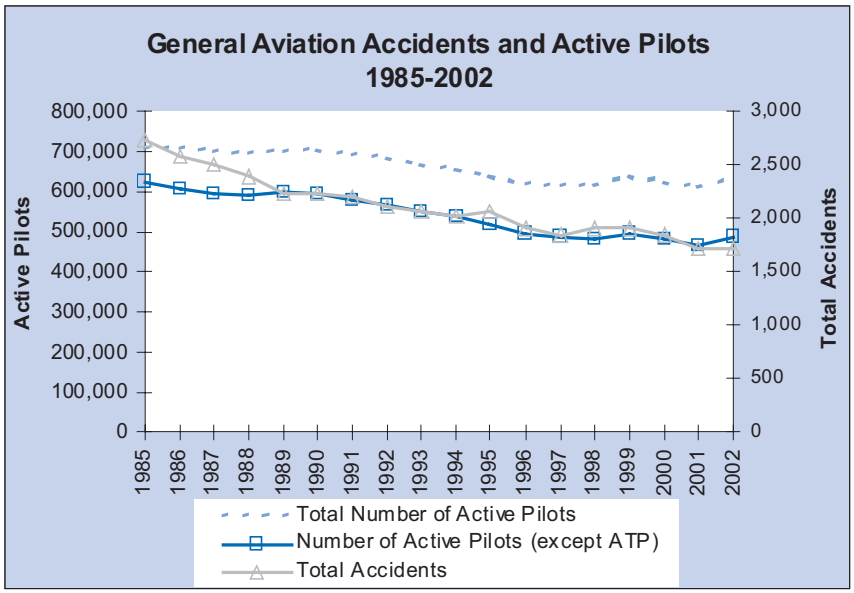
In an attempt to verify the accuracy of the FAA's general aviation activity data, the Safety Board compared the general aviation pilot population with *GAATA Survey* estimates for the years 1985 through 2002. With regard to numbers and training, the pilot

[21] Advances in aircraft equipment and avionics available as upgrades to existing aircraft, such as satellite navigation, have also evolved gradually and any changes in accident risk resulting from those upgrades would happen at a similar, gradual pace.

population decreased gradually during that time. After 1985, the total number of active pilots decreased by about 11 percent, and the number of student pilot certificates issued annually decreased about 25 percent overall. Each year, newly certificated[22] pilots accounted for approximately 5 to 7 percent of the total pilot population.

Recently trained pilots can contribute to changes in aviation safety because they are most affected by new safety initiatives and regulatory changes. Of the numerous changes to practical test standards and training requirements between 1985 and 2002, the most notable occurred in 1997 when 14 CFR Part 61, governing pilot training operations, was extensively rewritten. However, because the percentage of new pilots certified each year after that was small, the accident record may not reflect the impact of those changes for several more years.

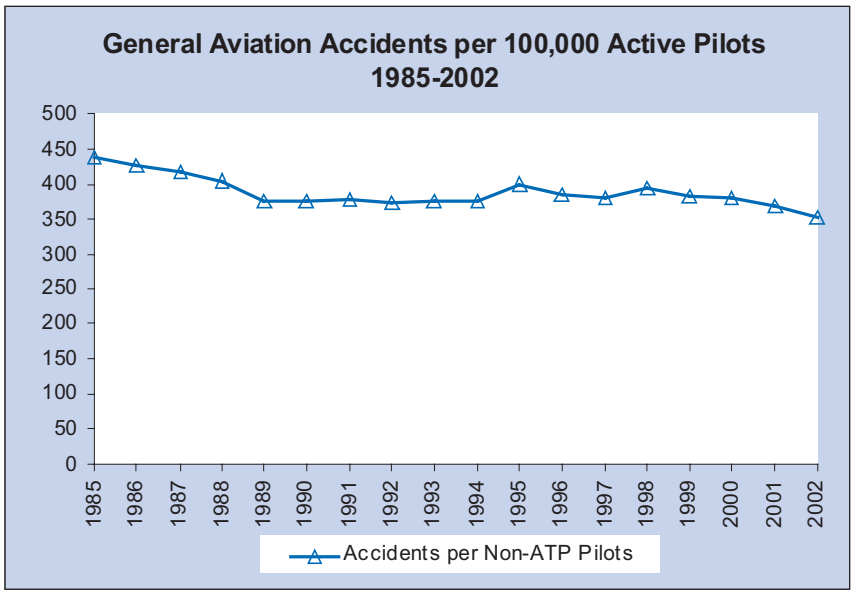
When compared with the annual general aviation accident total, the number of active pilots[23] provides indirect support for an accident rate more stable than that suggested by *GAATA Survey* estimates. To best represent those pilots likely to engage in general aviation operations, the graph below presents the number of active pilots minus the number of Airline Transport Pilot (ATP) certificate holders from 1985 through 2002. Because ATP-rated pilots are not exempt from general aviation activity, the total number of active pilots, represented as the dashed line, is also included for comparison.



[22] These certificates include original issuances of private-pilot fixed-wing and rotorcraft, as well as recreational pilot and glider-only certificates.

[23] FAA estimates of active pilots are based on the number of aviation medical certificates issued in the previous 24 calendar months.

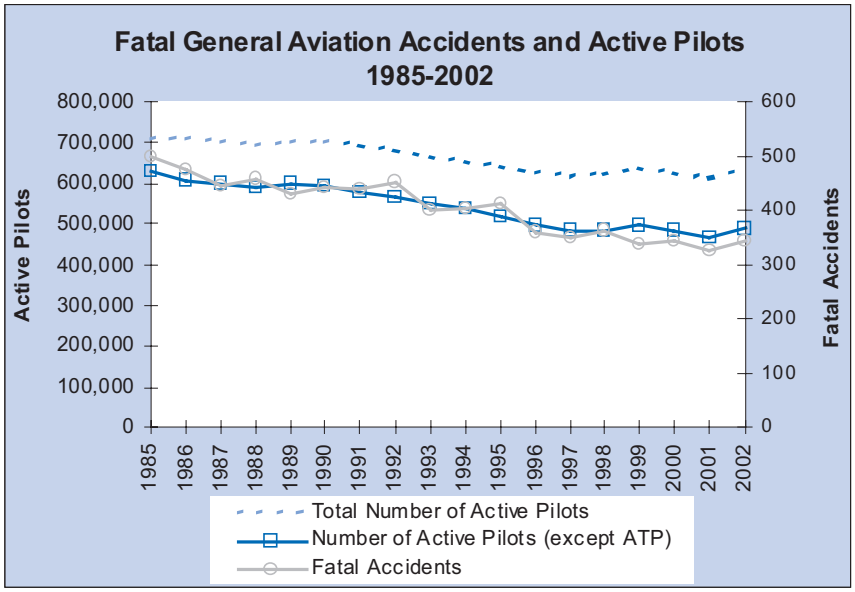
This graph shows that the number of active pilots closely tracked annual accident totals from 1985 through 2002. Pearson's Correlation Coefficient[24] for these arrays of values is $r = .937$, $p < .001$,[25] meaning that about 88 percent of the variance associated with the annual general aviation accident total can be accounted for in the number of active, non-ATP-rated, general aviation pilots. Based on these values, the number of general aviation accidents per pilot has decreased only slightly overall during the studied period.



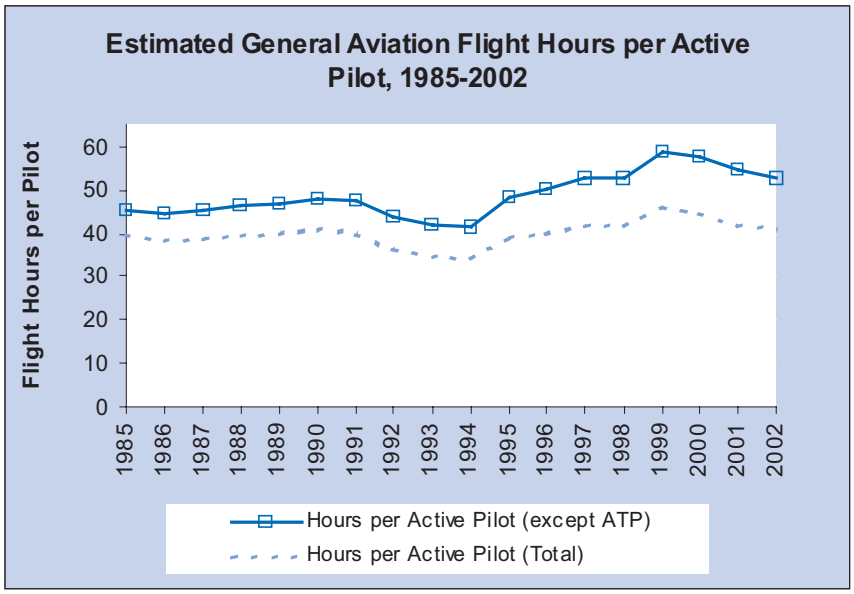
The following chart shows that the relationship between accident risk and the number of active pilots is even stronger when limited to fatal general aviation accidents. Pearson's Correlation Coefficient for these arrays of values is $r = .959$, $p < .001$, meaning that about 92 percent of the variance associated with the number of fatal general aviation accidents occurring annually from 1985 through 2002 can be accounted for by the number of active, non-ATP-rated, general aviation pilots.

[24] Pearson's Correlation Coefficient is a statistical measure of the strength of the linear relationship between two variable arrays. Correlation results are reported as an r value, ranging from -1 to 1, where 1 indicates a perfect positive correlation, -1 signifies a perfect inverse relationship, and 0 represents no relationship. The effect size of the correlation is typically represented as r^2 (r squared), indicating the proportion of variance in one variable contained in the second variable. The statistical significance of r is reported as a p-value that can be interpreted as roughly the percent likelihood of finding the same relationship between unrelated variables.

[25] Although the presented statistical analyses are based on the number of non-ATP-rated pilots so as to not include pilots active only in 14 CFR Part 121 operations, the relationship between general aviation accidents and the total pilot population is similar. Pearson's Correlation Coefficient for all active pilots and general aviation accidents between 1985 and 2002 is $r = .902$, $p < .001$.



With an active pilot population between 600,000 and 700,000, the average number of hours flown per pilot would not be expected to change drastically over a short period of time. However, the average number of hours flown annually per pilot would have had to increase significantly between 1994 and 1999 without a corresponding effect on the total number of accidents if the *GAATA Survey* results are to be considered accurate.



General Aviation Aircraft Fleet and Fuel Consumption

The Safety Board also used general aviation fleet data and general aviation gasoline consumption rates to verify FAA activity estimates. The general aviation fleet changed little overall from 1985 through 2002 due to the large number of older aircraft that remained in service. Aircraft used in general aviation operations during 2002 were an average of 31 years old,[26] and the total number of all general aviation aircraft shipped by U.S. manufacturers after 1985 accounted for only about 13 percent of the 207,000 aircraft estimated to be active during 2002.

There is no evidence to suggest that general aviation aircraft already in service were modified enough to affect observed relationships in the data. The structures and powerplant of the "average" general aviation aircraft were much the same in 2002 as they were in 1985. Given the absence of significant changes in the general aviation fleet, flight activity appears to be the most likely determinant of annual aviation fuel consumption after 1985. Therefore, the Safety Board chose the annual consumption of aviation gasoline,[27] as reported by the Department of Energy (DOE), as its second measure for verifying *GAATA Survey* estimates. A graph of the DOE data shows that, aside from a few minor fluctuations, annual fuel consumption decreased gradually from 1985 through 2002,[28] suggesting that the number of general aviation hours flown annually, specifically in piston-powered aircraft, also decreased gradually during that time.

The decreasing annual aviation gasoline consumption figures track closely with the annual general aviation accident totals ($r = .900$, $p < .001$). Although these fuel consumption figures exclude aircraft that do not use aviation gasoline,[29] most general aviation operations involve piston-powered aircraft that are represented in these figures.[30] A graph of the number of accidents per barrels of fuel consumed illustrates that, despite minor fluctuations, the ratio has remained steady overall since 1985.

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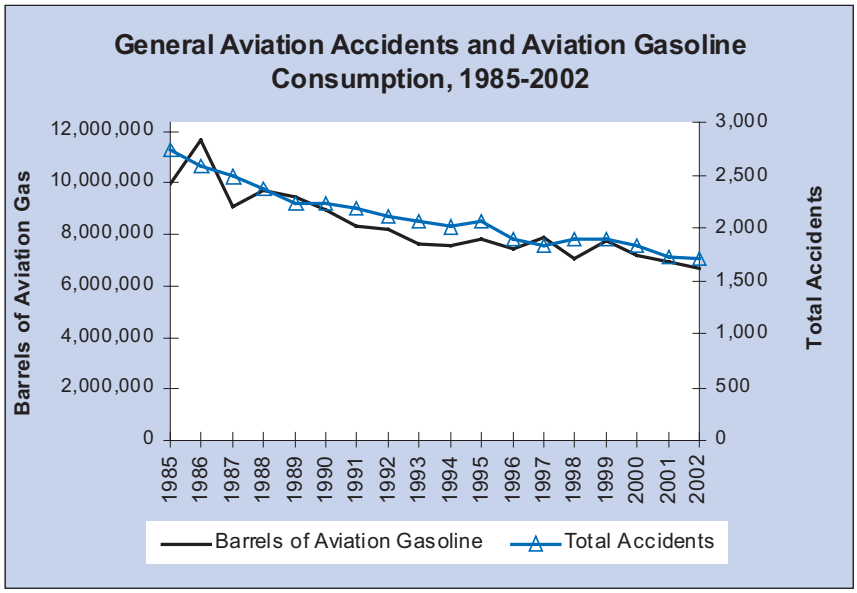
[26] General Aviation Manufacturers Association, *General Aviation Statistical Databook, 2002* (Washington, DC: 2002).

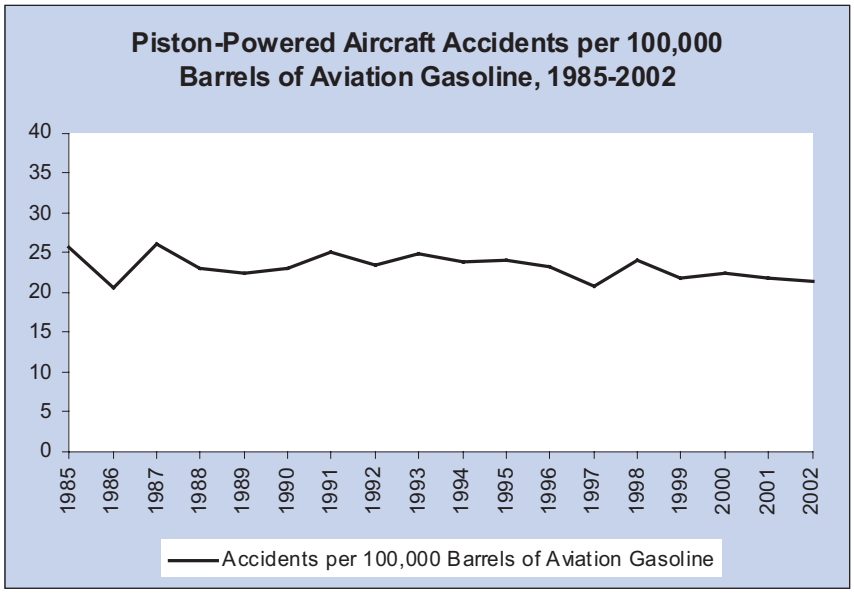
[27] Aviation gasoline is distinctly different from automotive gasoline in octane rating(s) and additives. The gasoline currently used by most piston aircraft is distinctive because it is the only leaded gasoline still available for widespread use in the United States. Supplemental Type Certification is available for certain aircraft/engines to allow the substitution of automobile gasoline for aviation gasoline and the flight activity of those aircraft would not be represented in the graphed data.

[28] The *GAATA Survey* also includes estimates of fuel consumption that, although also based on registry data and survey responses, also indicate a gradual decrease from approximately 412,460,000 gallons consumed in 1985 to 261,500,000 gallons in 2002.

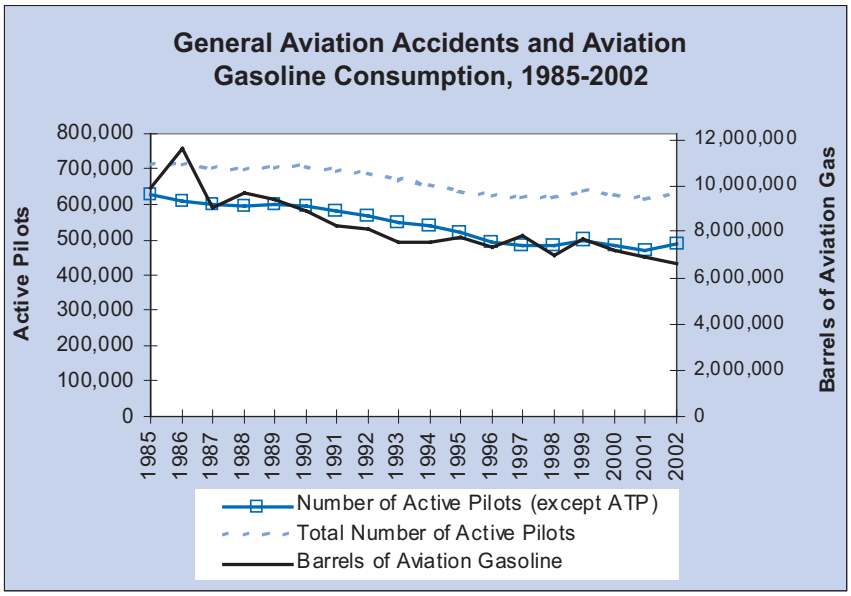
[29] Examples of general aviation aircraft that do not use aviation gasoline include turboprop-, turboshaft-, turbojet-, and fanjet-powered airplanes and helicopters, as well as nonpowered gliders and lighter-than-air aircraft.

[30] About 76 percent of estimated general aviation flight hours, 85 percent of estimated active aircraft registrations, and 85 percent of Safety Board general aviation accident investigations during 2002 were attributed to piston-powered aircraft.





It should be noted that annual aviation gasoline consumption data are also highly correlated with the previously presented numbers of active, non-ATP pilots: $r = .850$, $p < .001$. These data are completely independent indicators of activity, and the similar trends reflected in both measures are consistent with a steady decrease in annual activity between 1985 and 2002.



Unlike the strong relationships observed between pilots, aviation fuel consumption, and accidents, no significant correlations were observed between the annual general aviation flight hour estimates reported in the *GAATA Survey* and the number of active pilots ($r = .381$, $p = .119$), barrels of aviation gasoline consumed ($r = .451$, $p = .060$), or general aviation accidents ($r = .377$, $p = .123$).[31] In sum, the FAA's interdependent estimates of active aircraft and flight hours show similarity with each other, but little or no similarity to the independent measures of the active pilot population, fuel consumption, and accident totals that all display remarkably similar downward trends.

Interpreting the Results

The analysis results indicate that active pilot population totals, aviation fuel consumption, and general aviation accidents have all followed similar patterns of change annually while decreasing overall between 1985 and 2002. General aviation flight hour estimates have also decreased overall, from 28.3 million hours in 1985 to 25.5 million hours in 2002, but the pattern of annual changes in flight hour estimates has been very different than the other three measures. The differences between these patterns have been most apparent since the mid 1990s, when activity estimates began to increase while all other indicators continued to decline. In light of the declining pilot population, decreased fuel consumption, and decreasing annual accident totals, there is little evidence to suggest a large increase in general aviation activity during this period.

[31] In comparison, the correlation coefficient for accidents and flight hours involving 14 CFR Part 121 air carrier operations from 1985 to 2002 is $r = .841$, $p < .001$, and the correlation between 14 CFR Part 121 air carrier departures and accidents is $r = .884$, $p < .001$.

The principle of parsimony[32] suggests (1) that the number of accidents continues to be related to activity and (2) that a shrinking pilot population and decreasing fuel consumption are good indications that activity is decreasing. The strong correlations between the number of active pilots, the amount of aviation fuel consumed, and the number of general aviation accidents contrast clearly with the lack of correlation between the *GAATA Survey* figures for general aviation activity and the number of accidents. These results strongly suggest that activity data derived from the *GAATA Survey* have not accurately portrayed the changes in general aviation activity during the studied period.[33]

The easiest explanation for the lack of correlation between indirect measures of general aviation activity and the *GAATA Survey* data is that changes to survey methodology and calculation over time have resulted in data that lack the continuity necessary to make accurate year-to-year comparisons. Correlation statistics provide no indication of the accuracy of the results for a specific year, but the lack of consistency with more stable measures suggests that the periodic changes to the survey have limited its usefulness for identifying trends over time.

The decision to include noncurrent registrations in the active aircraft count beginning in 1999 is an example of how susceptible the current activity estimates are to change. Although *GAATA Survey* tables include footnotes stating that, due to changes in methodology and changes in the adjustments made to correct for response biases,[34] estimates may not be comparable over multiple years, the same warnings are rarely extended to discussions of the apparent improvement in the general aviation accident rate calculated across those years.

An undeniable implication of these results is that, because it appears likely that activity has decreased overall after 1985, the true accident risk for domestic general aviation operations has likely changed less during the studied years than *GAATA Survey* data suggest. A reduction in accidents that results from a decrease in general aviation activity cannot be counted as a safety improvement. The task of maintaining an accurate and consistent activity measure is fundamental to future attempts at identifying and reducing general aviation accident risk. The Safety Board concludes that an accurate and stable activity measure is needed to guide future attempts to portray the accident rate accurately, which is critical to formulating and evaluating general aviation safety initiatives. Therefore, the Safety Board believes that the FAA should develop, validate, and document an unbiased method for generating and revising activity estimates based on surveys or reporting of general aviation operations. The Safety Board also reiterates recommendation A-01-74 that the FAA identify measures independent of the General Aviation and Air Taxi Survey that can be used to check the accuracy of nonairline flight hour estimates.

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[32] The principle of parsimony is a basic underlying tenet of all scientific modeling and theory building. It states that when given a choice, one must always choose the simplest of all possible explanations for a phenomenon, the model that requires the fewest leaps of logic.

[33] In fact, the only measure used in the *GAATA Survey* that correlates closely with annual flight-hour estimates is the number of active aircraft ($r = .696$, $p = .002$) used in the activity calculation.

[34] The footnote citing response bias refers specifically to 1996 telephone survey factors. Survey data are no longer collected via telephone. However, some survey data have been collected via the Internet since 2000.

Additional Issues

Government Accountability Office Report

Problems associated with currently available general aviation activity measures are not confined to the work of the Safety Board. For example, the U.S. Government Accountability Office (GAO, formerly the General Accounting Office) noted that it cannot adequately monitor the effectiveness of FAA safety initiatives because of insufficient activity data. In a June 2000 report[35] to the House of Representatives, Committee on Transportation and Infrastructure, Subcommittee on Aviation, about the FAA's *Safer Skies* initiative, the GAO cited the FAA's failure to provide any baseline information about past accidents from which to evaluate the effectiveness of new programs. The reports warned that,

> without more specific baseline information on these performance measures prior to the implementation of the interventions and interim and long-term goals for progress, the initiative will not be able to evaluate the impact of these interventions.

The report went on to include the FAA response to the GAO findings, which acknowledged that "the problems with general aviation data make it difficult to measure the effectiveness of intervention strategies by the traditional approach of how they affect accident rates." To address data tracking problems, the *Safer Skies* General Aviation Joint Steering Committee launched the General Aviation Data Improvement Team (GADIT) in August 2000. GADIT's June 15, 2001, activity data report included 32 recommendations, but no implementation plan has been developed for those recommendations.

In response to the perceived problems with the accuracy of general aviation activity data, the FAA and industry participants have stopped using accident rates as a performance measure for the *Safer Skies* initiative and have reverted to using raw accident numbers. However, using raw numbers to evaluate safety is directly counter to the philosophy that motivated the FAA to pursue development of "a single, comprehensive index that provides a meaningful measure of the safety performance of the U.S. civil aviation system," as first stated in its *Flight Plan 2004–2008*[36] initiative.[37]

Providing a meaningful measure of safety based on raw accident numbers is only possible if safety-related changes are distinguishable from activity-related changes. For

[35] U.S. General Accounting Office, *Aviation Safety; Safer Skies Initiative Has Taken Initial Steps to Reduce Accident Rates by 2007*, GAO/RCED-00-111 (Washington, DC: GAO, 2000), available at <http://www.gao.gov>.

[36] The goal of creating a composite safety index is repeated in the 2005–2009 flight plan document with a target implementation of 2006.

[37] Because general aviation activity data are an integral part of the proposed index calculations, inaccuracies in the data limit the usefulness of the index as a meaningful measure of safety.

example, Safety Board records indicate that the annual general aviation accident total dropped from 1,906 to 1,726 between 1999 and 2001. At the same time, all direct and indirect indicators of flight activity, including *GAATA Survey* estimates, DOE aviation fuel consumption figures, number of registered aircraft, and number of active pilots, suggested a decrease in general aviation activity. In this case, an evaluation of general aviation safety based on raw accident numbers would mask what was actually an increase in accident risk given the decrease in activity. Even using the most optimistic estimate, one based on the *GAATA Survey*, the general aviation accident rate *increased* from 6.52 accidents per 100,000 flight hours in 1999 to 6.79 in 2001.

Conversely, raw numbers can just as easily mask the positive influence of safety improvement initiatives if accident totals remain steady or increase during a period when activity increases. The *Safer Skies* performance goal of no more than 319 fatal accidents by 2009 could be jeopardized by this effect if general aviation activity increases as predicted in FAA forecasts.[38]

Managing the Activity Survey

Considering the importance of accurate activity data for making scientifically and fiscally responsible decisions about aviation safety programs, the Safety Board is concerned that the FAA may not be placing a high enough priority on the task of collecting those data. Responsibility for funding the *GAATA Survey*[39] has been disputed for several years, with various FAA offices contributing funds but none taking full responsibility. Distribution of the survey has been delayed repeatedly in recent years because of funding problems. For example, 2002 surveys were not mailed until August 2003 because of a lack of funding, and the 2003 survey went without funding until the summer of 2004. Once funding was finally secured, the survey contract had expired and had to be recompeted. The first mailing of the 2003 activity survey finally began at the end of September 2004, with the completion of survey data collection scheduled for mid-January 2005. The accuracy of survey responses depends on the record-keeping habits and memories of aircraft owners, and in some cases, their ability to obtain needed information from pilots who fly their aircraft. With such long delays, owners are asked to report on activities that occurred more than a year earlier, a situation that is likely to further degrade the quality and accuracy of the resulting information.

[38] U.S. Department of Transportation, Federal Aviation Administration, *FAA Aerospace Forecasts: Fiscal Years 2004–2015* (Washington, DC: FAA, 2004).

[39] According to correspondence with the FAA, Office of Aviation Policy and Plans, the most recently completed *GAATA Survey* (2002) cost approximately $305,000.

Funding of the annual activity survey is notable when safety programs that cost many times more than the survey *are* funded but may lack the data necessary to be effectively evaluated.[40] Responsible attempts to measure accident risk require the identification and monitoring of accident trends, as well as exposure to accident risk—efforts that all depend on accurate measures of aviation activity.

Improving Activity Estimates

Although the observed relationships between the number of active pilots and annual aviation gasoline consumption point to problems with current general aviation flight-hour estimates, the limited applicability of these measures preclude their use as a replacement for the *GAATA Survey*. Despite problems with the current implementation, a user survey has the benefit of collecting information that can be used for more than estimating flight activity, such as purpose of flight and aircraft equipment.

Once registry accuracy is improved, a possible strategy for improving the accuracy of activity data would be to expand the survey to include a larger sample of the population. The timeliness of the data could also be improved by collecting data for periods shorter than 1 year. Survey estimates should also account for other indicators of activity data, either as part of the activity calculations or as separate measures of validity. In addition to the examples of fuel consumption and active pilot certificates presented here, possible comparative data sources might include annual inspection records already required for all registered aircraft or an expansion of the flight-hour information already collected as part of required pilot medical examinations.[41]

In order to ensure the long-term usefulness of the data, the process of collecting and reporting general aviation activity must be well documented, performed in a timely manner, and allocated the resources necessary to maintain consistency year after year. Whether through a comparison of multiple data sources or through the use of different data collection methods, improving the accuracy and consistency of general aviation activity data will admittedly require more resources than are currently being allocated to the *GAATA Survey*. Although collecting and processing additional activity data and/or expanding the current survey would incur both direct and indirect burdens, those costs should be evaluated against the fiscal and safety benefits associated with more accurately identifying accident risks, targeting safety initiatives to identified risk areas, and tracking the effectiveness of funded safety initiatives.

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[40] For example, the 2005 FAA budget request included $117 million for research, engineering, and development, including $93 million for continued research on aviation safety issues. Another $343 million are requested for facilities and equipment projects that support safety performance goals to reduce aviation fatalities, such as improvements to weather sensing and reporting systems, safety information databases and computer systems to assist safety inspections, improvements to flight services for general aviation, and runway incursion research and new technology. See <http://www.dot.gov/bib2005/admins.html>.

[41] These records may not capture the activity of pilots engaging in flight operations that do not require an FAA medical certificate.

Conclusions

As a result of this review, the National Transportation Safety Board concludes the following:

1. The additional operational and record-keeping requirements that already exist for nonscheduled 14 CFR Part 135 and Part 91, Subpart K, flight operations allow for more comprehensive activity reporting methods than those currently used to survey the activity of noncommercial, general aviation operations.

2. The accuracy of civil aircraft flight-hour estimates currently depends on the accuracy and currency of the FAA Civil Aviation Registry. However, a triennial registration schedule and certain owner registration practices have resulted in a substantial percentage of registry records that are likely to be inaccurate.

3. The strong correlations between the number of active pilots, the amount of aviation fuel consumed, and the number of general aviation accidents contrast clearly with the lack of correlation between the *GAATA Survey* figures for general aviation activity and the number of accidents. These results strongly suggest that activity data derived from the *GAATA Survey* have not accurately portrayed the changes in general aviation activity during the studied period.

4. The easiest explanation for the lack of correlation between indirect measures of general aviation activity and the *GAATA Survey* data is that changes to survey methodology and calculation over time have resulted in data that lack the continuity necessary to make accurate year-to-year comparisons.

5. Because it appears likely that activity has decreased overall after 1985, the true accident risk for domestic general aviation operations has likely changed less during the studied years than *GAATA Survey* data suggest.

6. An accurate and stable activity measure is needed to guide future attempts to portray the accident rate accurately, which is critical to formulating and evaluating general aviation safety initiatives.

7. Providing a meaningful measure of safety based on raw accident numbers is only possible if safety-related changes are distinguishable from activity-related changes.

8. Responsible attempts to measure accident risk require the identification and monitoring of accident trends, as well as exposure to accident risk—efforts that all depend on accurate data to be effective.

9. Survey estimates should also account for other indicators of activity data, either as part of the activity calculations or as separate measures of validity.

10. In order to ensure the long-term usefulness of the data, the process of collecting and reporting general aviation activity must be well documented, performed in a timely manner, and allocated the resources necessary to maintain consistency year after year.

Recommendations

The National Transportation Safety Board supersedes Safety Recommendation A-03-38 to recommend that the Federal Aviation Administration:

> Develop, validate, and document an unbiased method for generating and revising activity estimates based on nonscheduled 14 *Code of Federal Regulations* Part 135 *and* Part 91, Subpart K, operator surveys or reporting. (A-05-11)

Further, the National Transportation Safety Board also recommends that the Federal Aviation Administration:

> Require Part 91, Subpart K, fractional ownership operators to report activity on an annual basis to include total hours flown, revenue flight hours flown, revenue miles flown, and number of departures by category/class of aircraft. (A-05-12)

> Develop, validate, and document an unbiased method for generating and revising activity estimates based on surveys or reporting of general aviation operations. (A-05-13)

Finally, the National Transportation Safety Board reiterates the following recommendations to the Federal Aviation Administration:

> Identify measures independent of the *General Aviation and Air Taxi Survey* that can be used to check the accuracy of nonairline flight hour estimates. (A-01-74)

> Implement a program that will (a) measure and track the currency of aircraft owner contact information in the Civil Aircraft Registry and (b) systematically improve the currency of this information in a measurable way. (A-01-75)

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Appendix A

Raw Data Used in Analyses

General Aviation Activity Data

Year	GA Accidents	Fatal GA Accidents	GA Accidents Involving Piston Aircraft	GAATA Survey Flight Hour Estimate (100,000 hours Flown)	Accident Rate per 100,000 Flight Hours	Active Pilots--Total	Active Pilots --Except ATP	Estimated Active Aircraft (1,000s)	Aviation Gasoline Consumption (barrels)
1985	2,739	498	2,559	283.22	9.63	709,540	626,800	189.7	9,969,000
1986	2,581	474	2,410	270.73	9.49	709,118	607,031	196.6	11,673,000
1987	2,494	446	2,353	269.72	9.18	699,653	597,566	196.0	9,041,000
1988	2,388	460	2,233	274.46	8.65	694,016	591,929	189.3	9,705,000
1989	2,242	432	2,107	279.20	7.97	700,010	597,923	197.1	9,427,000
1990	2,242	444	2,047	285.10	7.85	702,659	594,927	191.0	8,910,000
1991	2,197	439	2,071	276.78	7.91	692,095	579,928	194.0	8,265,000
1992	2,111	451	1,892	247.80	8.51	682,959	567,104	182.1	8,133,000
1993	2,064	401	1,894	227.96	9.03	665,069	547,999	176.7	7,606,000
1994	2,022	404	1,792	222.35	9.08	654,088	536,654	172.4	7,555,000
1995	2,056	413	1,890	249.06	8.21	639,184	515,307	184.1	7,841,000
1996	1,908	361	1,721	248.81	7.65	622,261	494,775	186.9	7,400,000
1997	1,845	350	1,639	255.91	7.19	616,342	485,484	187.4	7,864,000
1998	1,904	364	1,683	255.18	7.44	618,298	483,686	199.5	7,032,000
1999	1,905	340	1,689	292.46	6.5	635,472	497,830	214.7	7,760,000
2000	1,837	345	1,598	278.38	6.57	625,581	483,985	213.5	7,188,000
2001	1,726	325	1,494	254.31	6.78	612,274	467,572	206.9	6,921,000
2002	1,713	345	1,412	255.45	6.69	631,762	487,054	207.0	6,640,000

Correlation Matrix. General aviation (GA) accidents, fatal GA accidents, GA accidents involving piston aircraft, annual flight hour-estimates, active pilots, active non-ATP-rated pilots, active aircraft estimates, and aviation gasoline consumption, 1985–2002

Correlations

		GA Accidents	Fatal GA Accidents	GA Accidents Involving Piston Aircraft	Annual Flight Hour Estimate	Active Pilots -- Total	Active Pilots -- Except ATP	Estimated Active Aircraft	Aviation Gasoline Consumption
GA Accidents	Pearson Correlation	1	.937**	.995**	.377	.902**	.937**	-.280	.901**
	Sig. (2-tailed)		.000	.000	.123	.000	.000	.261	.000
	N	18	18	18	18	18	18	18	18
Fatal GA Accidents	Pearson Correlation	.937**	1	.934**	.233	.937**	.959**	-.456	.828**
	Sig. (2-tailed)	.000		.000	.352	.000	.000	.057	.000
	N	18	18	18	18	18	18	18	18
GA Accidents Involving Piston Aircraft	Pearson Correlation	.995**	.934**	1	.376	.902**	.938**	-.297	.897**
	Sig. (2-tailed)	.000	.000		.124	.000	.000	.231	.000
	N	18	18	18	18	18	18	18	18
Annual Flight Hour Estimate	Pearson Correlation	.377	.233	.376	1	.381	.349	.639**	.451
	Sig. (2-tailed)	.123	.352	.124		.119	.156	.004	.060
	N	18	18	18	18	18	18	18	18
Active Pilots -- Total	Pearson Correlation	.902**	.937**	.902**	.381	1	.991**	-.276	.834**
	Sig. (2-tailed)	.000	.000	.000	.119		.000	.268	.000
	N	18	18	18	18	18	18	18	18
Active Pilots -- Except ATP	Pearson Correlation	.937**	.959**	.938**	.349	.991**	1	-.343	.850**
	Sig. (2-tailed)	.000	.000	.000	.156	.000		.163	.000
	N	18	18	18	18	18	18	18	18
Estimated Active Aircraft	Pearson Correlation	-.280	-.456	-.297	.639**	-.276	-.343	1	-.145
	Sig. (2-tailed)	.261	.057	.231	.004	.268	.163		.566
	N	18	18	18	18	18	18	18	18
Aviation Gasoline Consumption	Pearson Correlation	.901**	.828**	.897**	.451	.834**	.850**	-.145	1
	Sig. (2-tailed)	.000	.000	.000	.060	.000	.000	.566	
	N	18	18	18	18	18	18	18	18

**. Correlation is significant at the 0.01 level (2-tailed).

Correlation Matrix: GA accidents, annual flight hour estimates, active pilots, active aircraft estimates, and aviation gasoline consumption, 1985–1998 only

Correlations

		GA Accidents	Annual Flight Hour Estimate	Active Pilots -- Except ATP	Estimated Active Aircraft	Aviation Gasoline Consumption
GA Accidents	Pearson Correlation	1	.633*	.908**	.355	.867**
	Sig. (2-tailed)		.015	.000	.214	.000
	N	14	14	14	14	14
Annual Flight Hour Estimate	Pearson Correlation	.633*	1	.632*	.782**	.649*
	Sig. (2-tailed)	.015		.015	.001	.012
	N	14	14	14	14	14
Active Pilots -- Except ATP	Pearson Correlation	.908**	.632*	1	.262	.804**
	Sig. (2-tailed)	.000	.015		.365	.001
	N	14	14	14	14	14
Estimated Active Aircraft	Pearson Correlation	.355	.782**	.262	1	.437
	Sig. (2-tailed)	.214	.001	.365		.118
	N	14	14	14	14	14
Aviation Gasoline Consumption	Pearson Correlation	.867**	.649*	.804**	.437	1
	Sig. (2-tailed)	.000	.012	.001	.118	
	N	14	14	14	14	14

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

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