APPENDIX A

METHODOLOGY FOR THE 2009 GENERAL AVIATION AND PART 135 ACTIVITY SURVEY

Purpose of Survey

The General Aviation and Part 135 Activity (GA) Survey provides the Federal Aviation Administration (FAA) with information on general aviation and on-demand Part 135 aircraft activity. The survey enables the FAA to monitor the general aviation fleet so that it 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 all aircraft in the NAS. The data are also used by other government agencies, the general aviation industry, trade associations, and private businesses to identify safety problems and to form the basis for research and analysis of general aviation issues.

Background and History

Prior to the first implementation of the annual GA Survey in 1978, the FAA used the Aircraft Registration Eligibility, Identification, and Activity Report (AC Form 8050-73) to collect data on general aviation activity. The form was sent annually to all owners of civil aircraft in the United States and served two purposes: a) Part 1 was the mandatory aircraft registration revalidation form; and b) Part 2 was voluntary and applied to general aviation aircraft only, asking questions on the owner-discretionary characteristics of the aircraft such as flight hours, avionics equipment, base location, and use. The FAA used this information to estimate aircraft activity.

In 1978, the FAA replaced AC Form 8050-73 with a new system. Part 1 was replaced by a triennial registration program. In January 1978, the FAA implemented a new procedure, known as triennial revalidation, for maintaining its master file. Instead of requiring all aircraft owners to revalidate and update their aircraft registration annually, the FAA only required revalidation for those aircraft owners who had not contacted the FAA Registry for three years. This less frequent updating affected the accuracy and representation in the master file: a) the accuracy of information about current owners and their addresses deteriorated; and, b) the master file retained information on aircraft that would have been re-registered or purged from the file under the previous revalidation system.

Part 2 of AC Form 8050-73 was replaced by the General Aviation Activity Survey. Conducted annually, the survey was based on a statistically selected sample of aircraft, and it requested the same type of information as Part 2 of AC Form 8050-73. The first survey took place in 1978 and collected data on the 1977 general aviation fleet.

In 1993, the name of the survey was changed to the General Aviation and Air Taxi Activity Survey to reflect that the survey included air taxi (that is, on-demand Part 135) aircraft. Starting in 1999, information about avionics equipment, which had been collected only every other year, was requested every year. As a result, the survey's name was changed to the General Aviation and Air Taxi Activity and Avionics Survey. In 2006, "Part 135" replaced the term "Air Taxi" in the survey title, the word "Avionics" was removed (though avionics data were still collected annually), and the survey was named the General Aviation and Part 135 Activity Survey. This is

the name under which the 2009 survey was conducted. The 2009 statistics in this report were derived from the thirty-second GA Survey, which was implemented in 2010.

The GA Survey has undergone periodic revisions to content, implementation, and definition of the GA population in order to remain current with regulations, activity patterns, and aviation technology. Tables A.1 through A.3 summarize changes in the form or content of the survey, the protocol for collecting data, and the sample design, including changes in how the survey population is defined.

Table A.1: Changes in Form or Content of Survey Questionnaire, by Survey Year

Year	Change in form or content of survey questionnaire
1993	Added sightseeing and external load to use categories
1996	Added public use (i.e., flights for the purpose of fulfilling a government function) to use categories
1999	Significant re-design of the entire survey form to reduce item non-response, add new content, and be compatible with optical scanning Added air medical services to use categories Discontinued the use of a catch-all “other” category as used in previous years Began collecting avionics data every year, rather than every other year
2000	“Public use” asked as a separate question, independent of other use categories (e.g., business transportation), because it was not mutually exclusive with respect to other flight activity
2002	Use categories refined to be mutually exclusive and exhaustive and match definitions used by National Transportation Safety Board (NTSB) for accident reporting
2004	Air medical services was divided into two separate types to capture air medical flights under Part 135 and air medical flights not covered by Part 135 A more clearly defined “other” category was reintroduced
2005	Fractional ownership question was changed from yes/no to a percentage Reduced the number of fuel type response categories by removing obsolete options Average fuel consumption (in gallons per hour) was added Revised questions about avionics equipment by adding and rearranging items
2007	Location of aircraft revised to ask the state or territory in which the aircraft was “primarily flown” during the survey year rather than where it was "based" as of December 31st of the survey year. Percentage of hours flown in Alaska was added Questions on percentage of hours flown under different flight plans, flight conditions, and day/night were revised into a single tabular format Number of types of landing gear systems was expanded Ice protection equipment was revised and prohibition from flight in icing conditions was added Questions about avionics equipment were revised to reflect changes in technology
2009	Two questions about avionics equipment were revised: “Air Bag/Ballistic Parachute” was asked as two items–“Air Bag” and “Ballistic Parachute” “ADS-B (Mode S)” was separated into two questions–“ADS-B (Mode S) Transmit Only (Out)” and “ADS-B (Mode S) Transmit and Receive (In)”

Table A.2: Changes in Data Collection Methodology, by Survey Year

Year	Change in data collection methodology
1999	Non-respondent telephone survey conducted to adjust active aircraft and hours flown estimates[1]
2000	Discontinued non-respondent telephone survey because of the variability of telephone non-respondent factors Added Internet response option
2003	Added a reminder/thank-you postcard between the first and second mailings
2004	Introduced "large fleet" summary form to allow owners/operators of multiple aircraft to report aggregate data for their entire fleet on a single form Initiated telephone follow-up effort to contact owners/operators of multiple aircraft who had not responded. (Protocol encourages and facilitates participation by providing alternate forms and offering technical assistance but survey is not conducted by telephone.)
2009	Initiated telephone follow-up effort to contact owners/operators of individual aircraft who completed partial survey. (Protocol encourages and facilitates participation by offering technical assistance but survey is not conducted by telephone.)

Table A.3: Changes in Sample Design or Definition of Survey Population, by Survey Year

Year	Change in sample design or survey population
1993	Number of aircraft types classified by the sample was expanded from 13 to 19
1999	Sample design revised to stratify by aircraft type (19 categories) and FAA region (9 categories)[2]
2003	Aircraft with known incorrect addresses and identified as "Postmaster Return" status on the Registry were retained in the definition of the survey population and were eligible for selection into the survey sample
2004	Aircraft reported as "registration pending" or "sold" (if sold status less than 5 years ago) on the Registry were retained in the definition of the survey population and were eligible for selection into the survey sample Sample design revised to stratify by aircraft type (19 categories), FAA region (9 categories), and whether the aircraft is owned by an entity certified to fly Part 135 (2 categories) Introduced 100 percent sample of the following groups: turbine aircraft, rotorcraft, on-demand Part 135 aircraft, and Alaska-based aircraft
2005	Sample design and reporting revised by introducing light-sport aircraft as a 20th aircraft type sampled at 100 percent. For purposes of sampling and reporting, "light-sport" included aircraft with Special or Experimental airworthiness certification as well as light-sport aircraft for which airworthiness certificates are not yet final.
2006	Sample design simplified by reducing the number of aircraft types to 14 (removed distinctions based on number of seats and eliminated "Other" subcategories of piston, turboprop, and turbojet aircraft)[3] Sample design included 100 percent sample of aircraft manufactured in the past five years

[1] Telephone surveys of non-respondents also were conducted in 1977, 1978, 1979, 1997, and 1998. Please refer to the 1999 GA Survey report for a full discussion of the telephone survey of non-respondents.
[2] Before 1999, the sample was stratified by aircraft type (19 categories) and state/territory (54 categories).
[3] Published estimates continue to distinguish aircraft categories by engine type, number of engines, and number of seats.

Year	Change in sample design or survey population
2008	The 100 percent sample of light-sport aircraft was limited to light-sport aircraft with Special airworthiness certification. All other light-sport aircraft—those with experimental airworthiness and those with airworthiness certificates that are not final—were sampled at a rate of less than 1.0 but in sufficient numbers to support statistical estimation.

Survey Population and Survey Sample

The survey population for the 2009 General Aviation and Part 135 Activity Survey includes all civil aircraft registered with the FAA that are based in the US or US territories and that were in existence and potentially active between January 1 and December 31, 2009. This includes aircraft operating under:

- Part 91: General operating and flight rules
- Part 125: Certification and operations: Airplanes having a seating capacity of 20 or more passengers or a maximum payload capacity of 6,000 pounds or more (but not for hire)
- Part 133: Rotorcraft external load operations
- Part 135: On-demand (air taxi) and commuter operations not covered by Part 121
- Part 137: Agricultural aircraft operations.

Aircraft operating under Part 121 as defined in Part 119 are excluded from the survey population. Foreign air carriers, which operate under Part 129, are also not part of the survey population. Civil aircraft that are known not to be potentially active during the survey year are also excluded from the population (i.e., aircraft displayed in museums, aircraft destroyed prior to January 1, 2009).

The Aircraft Registration Master File, maintained by the FAA's Mike Monroney Aeronautical Center in Oklahoma City, Oklahoma, serves as the sample frame or list of cases from which a sample of civil aircraft is selected. The Registration Master File ("Registry") is the official record of registered civil aircraft in the United States. For the purpose of defining the 2009 survey population, we used the Registry's list of aircraft as of December 31, 2009.

The Registry, like many sample frames, is an imperfect representation of the survey population. While it may exclude a small number of aircraft that operate under the FAA regulations governing the operation of general aviation and on-demand Part 135 aircraft, it also includes aircraft that are not part of the survey population. Prior to sample selection, several steps are taken to remove ineligible aircraft from the sample frame. Specifically, this includes removing the following:

- aircraft whose registration has been cancelled or revoked
- aircraft based in Europe or registered to a foreign company that have not returned flight hour reports
- aircraft that operate under Part 121

- aircraft destroyed or moved to museums prior to January 1, 2009
- aircraft reported sold before 2004 (5 years prior to survey year)[4]
- aircraft that are flagged Postmaster Return (known to have incorrect address information) since before 1999 (10 years prior to survey year)
- aircraft that lack information necessary to execute the sample design (i.e., aircraft type, FAA region)[5]

The Registry included 374,373 aircraft as of December 31, 2009. This represents a decrease of less than 1 percent (0.47 percent) over the Registry file from 2008 (376,124 records). After excluding the aircraft described above, 309,811 records remain, which is 82.8 percent of the Registry as of December 31, 2009. The 2009 survey population of 309,811 represents a decrease of less than 1 percent (0.6 percent) from 2008 (311,531). The 2009 survey population as a percentage of all records on the Registry master file is slightly less than the previous year (82.7 percent compared with 82.8 percent in 2008).

The 2009 GA Survey Sample

The 2009 survey sample design is the same as that for the 2008 survey year.[6] The sample is stratified by aircraft type (15 categories), FAA region in which the aircraft is registered (9 categories), whether the aircraft operates under a Part 135 certificate (2 categories), and whether the aircraft was manufactured in the past 5 years (2 categories). Aircraft operated under a Part 135 certificate were identified using the FAA's Operations Specifications Subsystem (OPSS) database that was merged with the Registry by N-number. The four stratifying variables yield a matrix of 540 cells.

We define 15 aircraft types to execute the sample design as shown in Table A.4. The classification distinguishes among fixed wing aircraft, rotorcraft, experimental aircraft, light-sport, and other aircraft. Within the major categories of fixed wing and rotorcraft, we differentiate aircraft by type and number of engines (e.g., piston, turboprop, turbojet, turbine, single- and two-engines). Experimental aircraft are subdivided by amateur-built status and airworthiness certification, and we classify "other" aircraft as gliders or lighter-than-air. Light-sport is subdivided into special and experimental based on airworthiness certification. Light-sport aircraft for which airworthiness certificates are not yet final are included with experimental light-sport.

Prior to the 2006 survey year, we defined 20 aircraft types and distinguished aircraft by size (number of seats) as well as by type and number of engines and airworthiness. We eliminated subcategories based on number of seats to increase the efficiency of the sample. We also eliminated three "other" categories. Improvements in the Registry over the years have left relatively few aircraft assigned to three residual categories: Fixed wing piston–other, fixed wing turboprop–other, and fixed wing turbojet–other. Because these categories are relatively small and unable to support reliable statistical estimates, the aircraft are reassigned to the modal category in the corresponding larger group. Since 2006, the modal categories have resulted in the following reassignments: a) *from* fixed wing piston–other *to* fixed wing piston–1 engine, 4 or

[4] Prior to 2004, aircraft were excluded if reported sold more than one year prior to the survey year.
[5] The number of aircraft missing this information is typically very small.
[6] The 2006 survey year initiated changes in the sample design that are retained in 2009. For a discussion, see "Appendix A: Methodology for the 2006 General Aviation and Part 135 Activity Survey."

more seats; b) *from* fixed wing turboprop–other *to* fixed wing turboprop–2 engines, 1-12 seats; and c) *from* fixed wing turbojet–other *to* fixed wing turbojet.

Table A.4 also identifies the aircraft types that are used in reporting survey results. Although we define 15 aircraft types for the purpose of sampling, statistical estimates are reported for 18 aircraft types that elaborate aggregate groups (e.g., fixed wing piston) by number of engines and number of seats (e.g., fixed wing piston–2 engines, 1-6 seats). Starting with the 2009 GA Survey, estimates are reported separately for experimental light-sport and special light-sport aircraft. Prior to 2009, there were too few light-sport aircraft to support reliable estimates by experimental and special airworthiness within the light-sport group.

Table A.4: Aircraft Types Used for Sample Design and for Reporting Survey Results

Aircraft Types in the Sample Design	Aircraft Types for Reporting Results
Fixed wing piston (1 engine)	Fixed wing piston (1 engine, 1-3 seats)
Fixed wing piston (2 engines)	Fixed wing piston (1 engine, 4 or more seats)
Fixed wing turboprop (1 engine)	Fixed wing piston (2 engines, 1-6 seats)
Fixed wing turboprop (2 engines)	Fixed wing piston (2 engines, 7 or more seats)
Fixed wing turbojet	Fixed wing turboprop (1 engine)
Rotorcraft (Piston)	Fixed wing turboprop (2 engines, 1-12 seats)
Rotorcraft (Turbine, 1 engine)	Fixed wing turboprop (2 engine, 13 or more seats)
Rotorcraft (Turbine, multi-engine)	Fixed wing turbojet
Glider	Rotorcraft (Piston)
Lighter-than-air	Rotorcraft (Turbine, 1 engine)
Experimental (Amateur)	Rotorcraft (Turbine, multi-engine)
Experimental (Exhibition)	Glider
Experimental (Other)	Lighter-than-air
Light-sport (Experimental)	Experimental (Amateur)
Light-sport (Special)	Experimental (Exhibition)
	Experimental (Other)
	Light-sport (Experimental)
	Light-sport (Special)

Aircraft Sampled at 100 Percent

The 2009 survey sample included several types of aircraft that were sampled at a rate of 1.0. Because of the FAA's interest in better understanding the operation of these aircraft, all such aircraft listed in the Registry were included in the survey sample to ensure a sufficient number of responses to support analysis and provide more precise estimates of fleet size and aircraft activity. These include:

- 100 percent sample of turbine aircraft (turboprops and turbojets)
- 100 percent sample of rotorcraft
- 100 percent sample of special light-sport aircraft
- 100 percent sample of aircraft operating on-demand Part 135
- 100 percent sample of aircraft based in Alaska[7]
- 100 percent sample of aircraft manufactured within the past 5 years (since 2004).

Since 2004, the survey design has included 100 percent samples of turbine aircraft, rotorcraft, aircraft certificated to operate under Part 135, and Alaska-based aircraft. In 2005, we added the 100 percent sample of light-sport aircraft. In 2006, we added the 100 percent sample of recently-manufactured aircraft. In 2008, we revised the 100 percent sample of light-sport aircraft to include only special light-sport aircraft. Experimental light-sport and those without final airworthiness documentation are sampled at less than 100 percent but in sufficient numbers to support statistical estimates of flight activity. Altogether the aircraft sampled at 100 percent contributed 62,983 observations to the 2009 survey sample.

Aircraft Sampled at Less than 100 Percent

Aircraft that are not part of a 100 percent sample are subject to selection based on sampling fractions defined for each cell in the sample design matrix. "Average annual flight hours" is the primary measure needed by the FAA to address survey goals. Sample fractions for each sample strata are defined to optimize sample size to obtain a desired level of precision for an estimate of flight activity. Data from the previous survey year on average hours flown, variability in hours flown by region and aircraft type, and response rates are used to set precision levels and identify the optimal sample size for each strata. Aircraft are randomly selected from each cell in the matrix, subject to the desired sample size. Strata that yield a very small sample size are examined and adjusted to include all observations in the strata if necessary.

In 2009, an additional 22,103 aircraft were sampled at a rate of less than 1.0. The number of aircraft sampled at a rate of less than 1.0 is 22 percent greater than the 2008 survey when 18,086 such aircraft were included in the sample. Limiting the 100 percent sample of light-sport aircraft to those with special airworthiness certificates made it possible to sample other categories of aircraft at slightly higher rates without exceeding a maximum sample size feasible within the constraints of the data collection protocol, timeframe, and resources. However, the

[7] Alaska-based aircraft are identified by the state listed in the Registry file, not survey data on where the aircraft is operated.

number of aircraft selected at a rate of less than 1.0 is still lower than it was before the introduction of multiple 100 percent samples. In 2006, an additional 25,494 aircraft were sampled at a rate of 1.0, and in the 2005 survey year, an additional 34,667 aircraft were sampled. The increase in the 100 percent samples has had the greatest impact on fixed wing piston aircraft, where sampling fractions are small relative to population size. Other categories, such as “other aircraft” and experimental aircraft may have a smaller absolute number of aircraft selected into the sample, but the sampling fractions are relatively high because almost all available aircraft are needed to populate the sample design.

The 2009 GA Survey sample included 85,086 aircraft. Table A.5 summarizes the population counts and sample sizes by aircraft type.

Table A.5: Population and Survey Sample Counts by Aircraft Type

Aircraft Type	Population	Sample Size	Sample as Percent of Population
Fixed Wing - Piston	**211,932**	**28,962**	**13.7**
1 engine, 1-3 seats	62,067	6,070	9.8
1 engine, 4+ seats	127,780	14,970	11.7
2 engines, 1-6 seats	14,953	5,060	33.8
2 engines, 7+ seats	7,132	2,862	40.1
Fixed Wing - Turboprop	**9,965**	**9,965**	**100.0**
1 engine	4,293	4,293	100.0
2 engines, 1-12 seats	4,653	4,653	100.0
2 engines, 13+ seats	1,019	1,019	100.0
Fixed Wing - Turbojet	**12,586**	**12,586**	**100.0**
2 engines	12,586	12,586	100.0
Rotorcraft	**12,723**	**12,723**	**100.0**
Piston	5,246	5,246	100.0
Turbine (1 engine)	5,819	5,819	100.0
Turbine (multi-engine)	1,658	1,658	100.0
Other Aircraft	**9,802**	**5,105**	**52.1**
Glider	3,121	1,922	61.6
Lighter-than-air	6,681	3,183	47.6
Experimental	**42,666**	**10,723**	**25.1**
Amateur	37,279	6,612	17.7
Exhibition	3,140	1,978	63.0
Other	2,247	2,133	94.9
Light-sport	**10,137**	**5,022**	**49.5**
Experimental light-sport*	8,570	3,455	40.3
Special light-sport	1,567	1,567	100.0
Total	**309,811**	**85,086**	**27.5**

*Experimental light-sport includes light-sport aircraft with experimental airworthiness certificates as well as light-sport aircraft for which airworthiness certification is not final.

Weighting the Survey Data

Data from completed surveys are weighted to reflect population characteristics. The weights reflect the proportion of aircraft sampled from the population in each sample strata and

differential response as well as a small adjustment for aircraft that are not part of the survey population.

Initially, each aircraft for which we receive a completed survey is given a weight that reflects sampling fraction and differential response. That is:

WEIGHT = (Population N_{ijkl}/Sample N_{ijkl}) * (N Respondents$_{ijkl}$/Sample N_{ijkl})

where i, j, k, and l represent the four sample strata of aircraft type, FAA region, Part 135 status, and whether an aircraft was manufactured in the past 5 years.

The weight is subsequently adjusted to reflect new information about non-general aviation aircraft. That is, survey responses that identify an aircraft as not being part of the survey population—destroyed prior to January 1, 2009; displayed in a museum; operated primarily as an air carrier under Part 121 or 129; or a military aircraft—are used to remove aircraft proportionally from the sample and from the population. This adjustment is done at the level of the 15 aircraft types. The procedure assumes that non-GA aircraft occur in the same proportion among survey respondents and non-respondents. To the extent that non-GA aircraft are less likely to receive and complete a survey, this approach will underestimate the adjustment for aircraft that are not part of the general aviation population.

Errors in Survey Data

Errors associated with survey data can be classified into two types—sampling and non-sampling errors. Sampling errors occur because the estimates are based on a sample of aircraft rather than the entire population and we can expect, by chance alone, that some aircraft selected into the sample differ from aircraft that were not selected.

Non-sampling errors can be further subdivided into a) errors that arise from difficulties in the execution of the sample (e.g., failing to obtain completed interviews with all sample units), and b) errors caused by other factors, such as misinterpretation of questions, inability or unwillingness to provide accurate answers, or mistakes in recording or coding data.

Sampling Error

The true sampling error is never known, but in a designed survey we can estimate the potential magnitude of error due to sampling. This estimate is the standard error. The standard error measures the variation that would occur among the estimates from all possible samples of the same design from the same population.

This publication reports a standard error for each estimate based on survey sample data. An estimate and its standard error can be used to construct an interval estimate ("confidence interval") with a prescribed level of confidence that the interval contains the true population figure. In general, as standard errors decrease in size we say the estimate has greater precision (the confidence interval is narrower), while as standard errors increase in size the estimate is less precise (the confidence interval is wider). Table A.6 shows selected interval widths and their corresponding confidence.

Table A.6: Confidence Interval Estimates

Width of interval	Approximate confidence that interval includes true population value
1 Standard error	68%
2 Standard error	95%
3 Standard error	99%

This report presents a “percent standard error” for each estimate, which is the standard error relative to the mean. The percent standard error is the ratio of the standard error to its estimate multiplied by 100. For example, if the estimate is 4,376 and the standard error is 30.632, then the percent standard error is (30.632/4,376) x 100 = 0.7. Reporting percent standard errors makes it possible to compare the precision of estimates across categories.

Estimates and percent standard errors reported in Table 2.1 in Chapter 2 ("Population Size, Active Aircraft, Total Flight Hours, and Average Flight Hours by Aircraft Type") provide an example of how to compute and interpret confidence intervals. To obtain a 95 percent confidence interval for the estimated number of total hours flown for twin-engine turboprops in 2009, where the total hours flown is estimated to be 1,148,663 and the percent standard error of the estimate is 2.1, the following computation applies:

Lower confidence limit: 1,148,663 – 1.96(2.1/100)(1,148,663) = 1,101,384

Upper confidence limit: 1,148,663 + 1.96(2.1/100)(1,148,663) = 1,195,942

In other words, if we drew repeated samples of the same design, 95 percent of the estimates of the total hours flown by twin-engine turboprops would fall between 1,101,384 and 1,195,942.

Non-sampling Error

Sampling error is estimable and can be reduced through survey design (e.g., by increasing sample size), but it is difficult, if not impossible, to quantify the amount of non-sampling error. Although extensive efforts are undertaken to minimize non-sampling error, the success of these measures cannot be quantified.

Steps taken to reduce non-sampling error include strategies to reduce non-response and efforts to minimize measurement and coding errors. To this end, implementation and design of the 2009 GA Survey incorporated the following steps to maximize cooperation among sample members:

- Two modes of administration to facilitate access to the survey—a postcard invitation to complete the survey on the Internet followed by a mail survey to be completed by pen or pencil.

- Three mailings of the survey to individuals who had not yet responded, as well as a reminder/thank-you postcard.

- Cover letters accompanying each survey mailing clearly explained the purpose of the survey as well as the endorsement (organizational logos) of several aviation associations.[8]

- Cover letters assured owners of the confidentiality of their responses and informed them: "Names of individuals are never associated with responses. There is an identification number on your survey only so [survey contractor] knows who should receive the survey."

- Use of additional sources to obtain updated contact information and help ensure the mail survey reaches the sample member (e.g., National Change of Address, updates from aviation associations).

- Use of a toll-free telephone number and e-mail address to respond to questions.

- Collaboration with aviation organizations and industry groups to encourage cooperation of owners or operators of multiple aircraft.

- Telephone follow-up to owners/operators of multiple aircraft who had not yet responded as well as telephone follow-up to owners/operators of single aircraft that started, but did not complete, the survey.

The survey efforts also minimize measurement error by increasing the likelihood that respondents share a common understanding of survey questions and reducing errors in data coding. These efforts include:

- Close collaboration with the FAA, other federal agencies, and aviation groups to refine and clarify question wording as well as definitions to questions. The questionnaire is re-examined each year to identify ambiguities or revisions necessary to remain consistent with aviation regulations and definitions.

- Significant reviews and re-designs of the questionnaire have been undertaken periodically (see "Background" section of this report). Significant revisions are thoroughly pre-tested with a sample of aircraft owners or operators and, if necessary, modified on the basis of the pre-test results.

- Comprehensive editing and verification procedures to ensure the accuracy of data transcription to machine-readable form as well as internal consistency of responses.

We undertake extensive effort to reduce measurement error, particularly where we can anticipate systematic or repeated error on the part of survey respondents, but it is impossible to eliminate all measurement error. Survey participants may misunderstand questions or misreport

[8] The following associations' logos appear on the 2009 cover letter and the introduction page of the Internet survey: Aircraft Owners and Pilots Association (AOPA), Experimental Aircraft Association (EAA), General Aviation Manufacturers Association (GAMA), Helicopter Association International (HAI), Light Aircraft Manufacturers Association (LAMA), National Agricultural Aviation Association (NAAA), National Air Transportation Association (NATA), National Business Aviation Association (NBAA), and Regional Air Cargo Carriers Association (RACCA). Surveys mailed to Alaska addresses included an insert in which the directors of three Alaska-based associations encouraged recipients to respond (Alaska Airmen's Association, Alaska Air Carriers Association, and the Medallion Foundation).

flight activity in ways that cannot be anticipated or prevented through survey or questionnaire design. Where survey reports appear nonsensical or contradict FAA regulations (e.g., lighter-than-air aircraft providing air medical services), we manually verify that the data were processed accurately. Instances in which a small number of illogical reports occur may be suppressed and are indicated in table notes. No additional steps are taken to "cleanse" the data of apparently illogical reports or assign them to other categories. To do so would introduce additional and systematic error that would be misleading and would affect other uses of the data.

Imputation of Missing Data

Since the 2000 survey year, the survey questionnaire has undergone re-design efforts and data collection methods have been developed to reduce item non-response. In 2009, less than five percent of survey responses are missing data on the main reporting variables and the rate is less than two percent for sampled aircraft administered the full survey form. Imputation rates are higher on some variables, because the questions are not asked on the abbreviated survey form that is used for owners/operators of multiple aircraft. Other variables with relatively high rates of imputation are "Year of manufacture," which is drawn from Registry files, and "state primarily flown." While "state primarily flown" is rarely missing, many answers cannot be coded to a single state; for example, respondents list more than one state, identify a region of the country, or simply indicate "US."

Values are imputed for selected variables if the survey response is incomplete, the survey form did not include the question, or the Registry data field is blank. For most variables, a nearest-neighbor imputation procedure is used so that missing data are replaced with values based on an aircraft with otherwise similar characteristics. Data are sorted by aircraft characteristics and starting values are selected randomly within that sorted sequence.

Table A.7 lists the variables for which values are imputed, describes the imputation procedure, and shows the percentage of cases with imputed data. The last column shows the percentage of cases with imputed values excluding owners/operators that completed an abbreviated survey form. Percentages are based on unweighted number of survey responses (total 36,222).

Table A.7: Variables with Imputed Values, Imputation Procedure, and Percentage Imputed

Variable	Imputation Procedure	Percent Imputed	Percent Imputed (exclude large fleet)
Year of manufacture (Registry data field)	Nearest neighbor by aircraft type by engine manufacture model	11.0	9.8
State primarily flown	Assign state of registration from Registry Master	25.1	23.5
Airframe hours *	Nearest neighbor by aircraft type by age	22.2	1.8
Percentage of hours by use (e.g., personal, business transport)	Mean values by aircraft type	2.7	0.7
Percentage of hours rented/leased *	Nearest neighbor by aircraft type by engine manufacture model	21.9	1.5
Percentage of hours public use	Nearest neighbor by aircraft type by engine manufacture model	2.2	1.6

Variable	Imputation Procedure	Percent Imputed	Percent Imputed (exclude large fleet)
Percentage of hours fractional ownership	Nearest neighbor by aircraft type by engine manufacture model	0.3	0.4
Percent of hours by flight plans/flight conditions *	Mean values by aircraft type	21.9	1.5
Number of landings	Nearest neighbor by aircraft type by engine manufacture model by age	4.3	2.8
Landing gear *	Nearest neighbor by aircraft type by engine manufacture model	22.1	1.8
Fuel type *	Nearest neighbor by aircraft type by engine manufacture model	22.3	2.0
Fuel burn rate	Nearest neighbor by aircraft type by engine manufacture model	3.7	1.8
Avionics equipment *	Nearest neighbor by aircraft type by engine manufacture model by age	27.5	3.2

Percentages are based on unweighted survey responses (total 36,222).
* Question not asked on the abbreviated survey form administered to owners/operators of multiple aircraft.

Survey Content

The 2009 GA Survey questionnaire requests the aircraft owner or operator to provide information on flight activity, flight conditions, where the aircraft was flown, and aircraft characteristics. Key variables derived from the survey responses include:

- number of total hours flown in 2009, hours flown by use, and total lifetime airframe hours
- the state in which the aircraft was flown most of the survey year and hours flown in the state of Alaska
- hours flown by flight plan and flight conditions, including flight under Instrumental Meteorological Conditions (IMC) and Visual Meteorological Conditions (VMC) during the day and night
- hours flown as part of a fractional ownership program, rented or leased, or used to fulfill a government function
- type of landing gear and number of landings in 2009
- fuel type and average fuel burn rate
- avionics equipment installed in the aircraft, including ice protection systems.

Two changes were made to the 2009 survey questionnaire to improve the quality of data on avionics equipment. As described in Table A.2, two items about installed general equipment

(Air Bag/Ballistic Parachute) and installed transponder equipment (ADS-B (Mode S)) were refined to collect more detail.

Data Collection Methods

Collecting Data from Owners/Operators of a Single Aircraft

Appendix B presents the materials used to conduct the 2009 survey. The survey form administered to owners/operators of a single aircraft is shown in Figure B.1. The postcard invitation to the Internet component and the reminder/thank-you postcard are shown in Figure B.2. Surveys sent to aircraft owners who started, but did not complete, an Internet survey included a special insert (Figure B.3). Surveys mailed to Alaskan addresses included an insert with the endorsement of Alaska aviation associations encouraging owners to participate (see Figure B.4). Each of the three mailings for the survey was accompanied by a cover letter, shown respectively in Figures B.5, B.6, and B.7.

The protocol used for the 2009 survey is similar to that used since the 2000 survey. The survey data were collected from owners and operators of the sampled aircraft through two venues—the Internet and mailings of the questionnaire. We implemented the Internet component before the mailing portion to maximize the number of responses collected electronically. We first sent the owners/operators of sampled aircraft a postcard inviting them to complete the survey on the Internet (mailed on April 30, 2010). The Internet survey site remained open through August 31, 2010.

We mailed survey questionnaires to owners/operators of sampled aircraft three times during the field period as well as a reminder/thank you postcard between the first and second mailings. Each mailing was sent to owners/operators that had not yet responded to the survey at that time and had not been assigned a final disposition (e.g., refused, respondent deceased, undeliverable with no new address). We mailed the first questionnaire on May 27, 2010, followed by the reminder/thank you postcard on June 11, 2010. The second and third mailings were sent July 1, 2010 and July 23, 2010, respectively.

Starting with the 2009 survey, we also placed telephone follow-up calls to owners/operators of individual aircraft that started but did not complete the Internet survey or returned an incomplete mail survey. Telephone staff encouraged owners/operators to complete the survey and offered technical assistance, but the survey itself was not conducted by telephone.

Collecting Data from Owners/Operators of Multiple Aircraft

The 2009 GA Survey continued the effort initiated in 2004 to increase cooperation among respondents who own or operate multiple aircraft. The 2009 survey employed data collection tools and methods similar to those introduced in 2004, including extensive effort to contact owners/operators of multiple aircraft by telephone to encourage participation among non-responders after the first mailing. The survey forms, cover letters, and reminder letter are presented in Appendix B, Figures B.8–B.12.

The responses of multiple-aircraft owners/operators are important for accurately estimating general aviation activity. Because of the increased burden of reporting for multiple aircraft, there was a concern that these operators were less likely to respond to the survey. After selecting the sample, we identify groups of aircraft belonging to the same operator using three resources: FAA's Operations Specifications Subsystem (OPSS), databases available from aviation

associations, and the Civil Aviation Registry's Master file. Operators or owners with three or more aircraft are classified as "multiple owners/operators" or "fleets" for survey purposes.

Owners/operators of multiple aircraft receive an abbreviated survey form to minimize the reporting burden. The form, developed in cooperation with several aircraft operators and aviation associations, allows an operator to report a summary of activity for a group of aircraft of a similar type instead of requiring the operator to complete a separate and longer questionnaire for each individual aircraft. This survey form (Appendix B, Figure B.8) collects data on key variables for major classes of aircraft (e.g., hours flown, how flown, fuel consumption, fractional ownership, and number of landings). The form does not collect data on flight conditions, fuel type, landing gear, or avionics.

Data collection for multiple-aircraft owners/operators followed the same timing as that for owners/operators of single aircraft. Like the standard survey protocol, we programmed an Internet survey that matched the hard-copy survey form and the on-line survey remained open throughout the field period. We mailed survey questionnaires three times during the field period as well as a reminder letter between the first and second mailings. Each mailing was sent to owners/operators of multiple aircraft that had not yet responded to the survey at that time and had not been assigned a final disposition. The first survey mailing was sent May 10, 2010 followed by a reminder letter on May 28, 2010. The second and third mailings were sent June 11, 2010 and July 23, 2010, respectively.

To maximize survey response, we placed follow-up telephone calls to all multiple-aircraft owners/operators who had not responded. The telephone effort, which was prioritized by fleet size, began June 7, 2010 and continued through the field period. The calling effort focused on encouraging survey participation as well as ensuring that survey mailings were reaching the appropriate person in the operator's organization.

The alternate survey form for owners/operators of multiple aircraft has reduced respondent burden and improved representation of activity among high-end and high-use aircraft. The alternate data collection track for owners/operators of multiple aircraft consistently accounts for approximately 20 percent or more of all aircraft responding to the survey (21.1 percent of all survey completes in 2009, 24.8 percent of all survey completes in 2008, 20.5 percent in 2007, and 22.8 percent in 2006).

Response Rate

The response rate is calculated conservatively following guidelines published by the American Association for Public Opinion Research (AAPOR), a professional association that establishes standards, "best practice" guidelines, and a code of ethics for professional survey researchers and research firms.[9] Specifically, the response rate is computed as the number of completed and partial surveys returned divided by the total number of eligible aircraft in the sample using the following formula.

$$RR = (C + P) / (C + P) + (NR + INS + REF + PMR + UNK)$$

[9] The American Association for Public Opinion Research. 2000. *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*. Ann Arbor, MI: AAPOR.

Where

RR = Response Rate

C = Completed survey

P = Partial survey

NR = No response

INS = Insufficient complete; a partial survey that is not sufficient to count as a complete

REF = Refused

PMR = Post Master Returned, no new address

UNK = Unknown eligibility

The numerator is comprised of completed surveys and partial surveys that provide enough information to be used for analysis. Partial surveys must include information on hours flown to be included in the numerator.

In addition to completed and partial surveys, the denominator includes cases for which no response was received, insufficiently completed surveys (i.e., no data reported for hours flown), refusals, surveys returned as undeliverable by the USPS, and cases of unknown eligibility. The last category includes aircraft in which the owners cannot be identified or cannot report about aircraft activity (e.g., owner is deceased and the survivors cannot report on the aircraft activity, survey recipient does not own the aircraft listed).

The denominator includes aircraft that were sold or destroyed during the survey year. The survey collects data on flight activity for the portion of the year the aircraft was eligible to fly, and data collection efforts attempt to identify and mail surveys to new owners.

The denominator excludes aircraft known not to be part of the general aviation fleet or known not to be eligible to fly during the survey year. These are aircraft that were destroyed prior to the survey year, displayed in a museum, operated primarily as an air carrier, operated outside of the US, or exported overseas.

Table A.8 shows the final response rate by mailing and overall, along with the number of completed surveys. The number of completed surveys shown here excludes duplicate surveys after cleaning the returned survey data to retain the form with the most complete information. The overall response rate for the 2009 GA Survey was 42.9 percent. Almost 60 percent of responses were received on the Internet and slightly more than one-quarter were received from the first mailing. The second and third mailings had lower response, but these rates are calculated conservatively. For example, the Mail 3 response rate is the proportion of sampled aircraft that returned that hard-copy survey. If a third mailing was sent, but the survey was later completed on-line then the response is recorded as “Internet.”

Table A.8: Response Rate by Mailing

Mailing	Completes	Response Rate	% Total Response
Internet	20,985	24.8%	57.9%
1st Mailing	9,879	11.6%	27.3%
2nd Mailing	3,263	3.8%	9.0%
3rd Mailing	2,095	2.5%	5.8%
Overall	36,222	42.9%	100.0%

As noted above, the response rate is calculated conservatively and retains all non-responding surveys, sampled units with bad addresses, and sampled aircraft of unknown eligibility in the denominator. In the 2009 survey, 5,871 surveys were returned undeliverable and we were unable to obtain updated address information. In addition, the survey sample itself included over 5,000 aircraft that could not be contacted because their status was "Sale Reported," "Registration Pending" or the address was already known to be incorrect (i.e., Postmaster Return status on the Registry). Applying guidelines for defining the GA population developed with the FAA and Registry staff, these aircraft are deemed potentially active and therefore eligible for selection into the survey.

Table A.9 illustrates the steady increase in the Internet response as a percentage of all returned surveys from 2000 to 2009. Almost 60 percent of survey responses were received by Internet in 2009, and the share of Internet response was very similar to the previous survey year (57.9 percent of all responses). Since the survey was first made available on-line in 2000, the share of Internet responses has increased by 43 percent (from 32.6 to 57.9 percent). The growth in response via the Internet has made it possible to field an expanded GA Survey, manage larger sample sizes, and process more data efficiently and cost effectively.

Table A.9: Percentage of All Completed Surveys Responding by Internet

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total Sample Size	31,039	30,886	30,817	31,996	75,659	77,403	84,486	84,570	82,277	85,086
Total Completes	15,689	16,432	15,254	14,471	32,056	34,248	38,973	38,920	35,607	36,222
Internet Completes	5,144	5,954	5,304	6,059	13,441	14,555	17,266	19,268	20,611	20,985
Internet % of Total	32.8%	36.2%	34.8%	41.9%	41.9%	42.5%	44.3%	49.5%	57.9%	57.9%

Table A.10 shows response rates by aircraft type. Responses rates for most aircraft types are very similar to the previous survey year. Fixed wing–turbojets and rotorcraft are the exceptions; response rates among these aircraft dropped slightly compared to 2008. Light-sport aircraft continue to have a higher response rate than most other categories, probably reflecting their more recent registration dates (and therefore more accurate contact information).

Table A.10: Response Rate by Aircraft Type

Aircraft Type	Sample	Invalid Sample[10]	Completes	Response Rate
Fixed Wing - Piston				
1 engine, 1-3 seats	6,070	26	2,495	41.3%
1 engine, 4+ seats	14,970	68	6,087	40.8%
2 engines, 1-6 seats	5,060	40	2,055	40.9%
2 engines, 7+ seats	2,862	84	1,116	40.2%
Fixed Wing - Turboprop				
1 engine	4,293	54	1,966	46.4%
2 engines, 1-12 seats	4,653	28	1,696	36.7%
2 engines, 13+ seats	1,019	3	360	35.4%
Fixed Wing - Turbojet				
2 engines	12,586	173	5,245	42.3%
Rotorcraft				
Piston	5,246	23	1,538	29.4%
Turbine: 1 engine	5,819	24	2,564	44.2%
Turbine: Multi-engine	1,658	22	865	52.9%
Other Aircraft				
Glider	1,922	10	893	46.7%
Lighter-than-air	3,183	27	1,232	39.0%
Experimental				
Amateur	6,612	44	3,934	59.9%
Exhibition	1,978	18	865	44.1%
Experimental: Other	2,133	20	821	38.9%
Light-sport	5,022	11	2,490	49.7%
Total	85,086	675	36,222	42.9%

[10] Even though efforts are made to remove non-GA aircraft from the population before the sample is selected, a small number of surveys are returned indicating that the aircraft should not be part of the survey population (e.g., the aircraft was used primarily as a Part 121 air carrier, or was a museum piece the entire survey year). The Invalid Sample represents such aircraft, which are excluded from response rate calculations.