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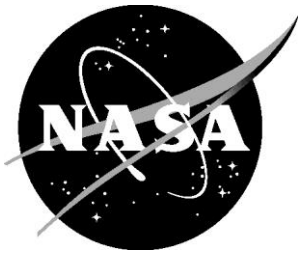

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February 2016

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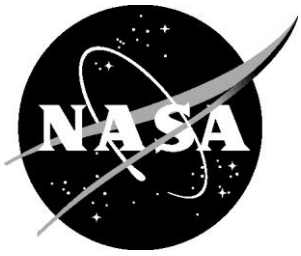

Differences in Characteristics of Aviation Accidents during 1993-2012 Based on Flight Purpose

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Introduction

Usually aviation accidents are categorized and analyzed within flight conduct rules (Part 121, Part 135, Part 91) because differences in accident rates within flight rules have been demonstrated. Even within a particular flight rule the flights have different purposes. For many, Part 121 flights are synonymous with scheduled passenger transport, and indeed this is the largest group of Part 121 accidents. But there are also non-scheduled (charter) passenger transport and cargo flights. The primary purpose of the analysis reported here is to examine the differences in aviation accidents based on the purpose of the flight. Some of the factors examined are the accident severity, aircraft characteristics and accident occurrence categories. Twenty consecutive years of data were available and utilized to complete this analysis.

Data Source

The National Transportation Safety Board is an independent Federal agency that investigates every civil aviation accident in the United States and significant accidents in the other modes of transportation, conducts special investigations and safety studies, and issues safety recommendations to prevent future accidents. The information collected by the NTSB investigators during their investigations of these aviation events resides in the NTSB Aviation Accident and Incident Data System. A copy of this database in Microsoft Access format was obtained from the Aviation Safety Information Analysis and Sharing (ASIAS) department of the FAA Office of Aviation Safety[1] in September 2014. At that point in time, the NTSB investigation was not complete for a substantial number of 2013 accidents, particularly those which occurred toward the end of the year. For this reason, all work on the database was restricted to the period 1986-2012, which resulted in an update of two years beyond the previous working version of the data. The update process requires several months of cross-checking various data elements and attempting to fill in any missing data, followed by the assignment of occurrence categories to each accident.

The NTSB database includes events involving a wide variety of aircraft (airplanes, helicopters, hot air balloons, gliders, ultra-lights, etc.) with operations conducted under various Federal Aviation Regulations (Part 91: General Aviation, Part 121: Commercial Air Carriers, Part 129: Foreign Air Carriers, Part 135: Commuters and On-Demand Air Taxis, Part 137: Agricultural Operations, etc.). In March 1997 a change was made in the Federal Aviation Regulations defining the requirements for Part 121 versus Part 135 operations. As a result, Part 121 regulations were applied to commuter operations with 10 or more passengers[2].

The NTSB considers each event to be either an accident or an incident, under the following definitions:[3]

Accident - an occurrence associated with the operation of an aircraft, which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage

Incident - an occurrence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations

Any injury or aircraft damage which occurs when there was no intent for flight (high speed taxi tests, movement of the aircraft around the airfield, maintenance run-ups, etc.) is, by definition, an incident.

All recorded accidents involving commercially built fixed-wing airplanes operating under FAR Part 121, Part 135 or Part 91 were included in this working dataset, regardless of whether the

[1] http://www.asias.faa.gov/portal/page/portal/asias_pages/asias_home/

[2] National Transportation Safety Board. *Annual Review of Aircraft Accident Data US Air Carrier Operations, Calendar Year 1999, NTSB/ARC-02/03, PB2002-109241,* November 13, 2002, page 1.

[3] National Transportation Safety Board, "Government Information Locator Service (GILS): Aviation Accident Synopses"' http://www.ntsb.gov/GILS/Pages/Synopses.aspx

investigation is in a preliminary stage or finalized, and whether or not the event occurred within the United States. Amateur built or experimental aircraft were excluded, as were helicopters, ultra light aircraft, gliders and balloons.

Flight Purpose

Aircraft accidents and incidents are reported to the NTSB using Form 6120.1 *Pilot/Operator Aircraft Accident/Incident Report*. Those completing this form are asked to specify the purpose of the flight, using the following categories (descriptions taken directly from the instructions for Form 6120.1)[4].

- ***Aerial Application***: Operations using an aircraft to perform aerial application or dispersion of any substance. Examples include agricultural, health, forestry, cloud seeding, firefighting, insect control, etc.
- ***Aerial Observation***: These flights include aerial mapping or photography, patrol, search and rescue, hunting, highway traffic advisory, ranching, surveillance, oil and mineral exploration, criminal pursuit, fish spotting, etc.
- ***Air Drop***: Aerial operations, other than aerial application, that are intended to release items from the aircraft while in flight.
- ***Air Race or Air Show***: Includes any flight operations conducted as part of an organized air race or public demonstration.
- ***Business***: Includes all personal flying without a paid professional crew for reasons associated with furthering a business, including transportation to and from business meetings or work. This does not include corporate/executive operations, air taxi, or commuter operations.
- ***Executive/Corporate***: Company flying with a paid, professional crew.
- ***Ferry***: Non-revenue flight under a special flight or "ferry" permit.
- ***Flight Test***: Flight for the purpose of investigating the flight characteristics or an aircraft or aircraft component or evaluating an applicant for a pilot certificate or rating.
- ***Instructional***: Flying while under the supervision of a flight instructor or receiving air carrier training. Personal proficiency flight operations and personal flight reviews, as required by federal air regulations, are excluded.
- ***Other Work Use***: Miscellaneous flight operations conducted for compensation or hire such as construction work, parachuting, aerial advertising, towing gliders, etc.
- ***Personal***: Flying for personal reasons (excludes business transportation) including pleasure or personal transportation. This also includes practice or proficiency flights performed under flight instructor supervision and not as part of an approved flight training program.
- ***Positioning***: Non-revenue flight conducted for the primary purpose of relocating the aircraft. Examples include moving the aircraft to a maintenance facility or to another location to load passengers or cargo.
- ***Unknown***: Use only if the primary purpose of the flight in not known.

These categories are not used for Part 121 or Part 135 flights, for which the purpose is primarily either passenger transportation or cargo operations (94% of flights in 1993-2012). Additionally,

[4] http://www.ntsb.gov/Documents/6120_1web_Reader.pdf

Form 6120.1 includes a check box for medical transportation flights and for revenue sightseeing operations.

In the view of this author, the general purpose of most non-personal flights can be described as either moving people from one location to another, moving cargo from one location to another, moving the aircraft from one location to another or flight instruction. For this analysis, flight purpose was classified under the following general regimes:

1. Scheduled passenger service (including both Part 121 and Part 135)
2. Nonscheduled passenger transportation, either using a paid, professional crew or in support of some type of business operation.
3. Cargo operations
4. Aircraft movement (includes positioning, ferry under a special permit, or delivery of the aircraft to a new owner, for which the primary purpose was to move the aircraft itself, not passengers or cargo)
5. Flight instruction
6. Intentional low-level flight operations (to include aerial application, aerial observation, photography, pipeline patrol, fish or game spotting, sightseeing, etc.)
7. Personal or pleasure flights
8. Work related operations (to include aerial advertising, glider towing, parachute jumping, medical transportation, sales demonstrations, etc.)
9. Other or Unclear (to include illegal activities and those with insufficient information to classify using the definitions above)

These regimes combine some of the NTSB categories, and also split some of the categories. The nine regimes listed above evolved from thirty-three more specific groupings. Each accident was assigned to one of those groupings using a combination of the NTSB flight purpose and the narrative report. Many of the narratives did not include specific details about the purpose of the flight, so it was necessary to rely on the recorded flight purpose. But when more detail was available, it was used. Part 121 and Part 135 flights were relatively easy to classify; as mentioned above, 94% of these flights were either scheduled passenger flights, charter passenger flights or cargo flights. The discussion below provides some detail about the other flight purpose regimes that were represented in the 1993-2012 accidents. Scheduled passenger transport and cargo operations should require no additional explanation; “aircraft movement” was defined above.

Non-scheduled passenger transportation includes four groupings:

- Charter passenger flights in Part 135 – represents roughly 28% of this regime

- Corporate/Executive flights – represents roughly 10% of this regime; nearly all were included in this grouping based on the NTSB classification
- Passenger transport as part of business flights – Not all flights classified as business flights were for passenger transport. Some were dropping off supplies at a ranch or lodge, others were picking up parts or equipment for business-related repairs, others were scouting possible landing sites for hunting or fishing operations. Each business flight with less than two passengers was reviewed, and those which clearly were not passenger transports were reclassified, mostly under "other work" (defined below). More than 75% of the business flights were confirmed or assumed to be associated with transporting passengers, or sometimes just the pilot, to or from a business-related meeting; these represent nearly 60% of this regime.
- Commuting – Occasionally pilots travel to their place of work using their aircraft rather than an automobile.

The NTSB's "instructional" category was made very restrictive, and requires the presence of a certified flight instructor. This definition excludes numerous other situations, that for the purposes of this analysis, were also considered instructional: solo work by student pilots (pattern work or cross country flights); solo and dual-instruction flights by licensed pilots receiving instruction for additional ratings (instrument, multi-engine, etc.) or advanced licenses; re-currency training or to gain experience in a new aircraft; flight tests with a designated pilot examiner for initial licensing or add-on ratings; biennial flight reviews and proficiency check rides to meet the requirements of insurance carriers, aircraft rental clubs or new employers. Additionally, maintaining pilot proficiency requires practicing pattern work, instrument approaches, stall recovery, etc. These flight practice activities were included with more traditional flight instruction in the instruction regime.

The intentional low-level flight operations regime consisted of the largest number of individual groupings, which are listed below:

- Aerial application: Operations using an aircraft to perform aerial application or dispersion of any substance. Includes practice flights or training in aerial application.
- Aerobatics: Includes both practice and performance of aerobatic maneuvers. At times these maneuvers were performed in a flight with another original purpose, but if the aerobatics contributed to the accident, the purpose was considered to be aerobatics.
- Aerial law enforcement: Operations using an aircraft to perform criminal pursuit, prisoner transport, border patrol or search for stolen property.
- Aerial observation, aerial photography or aerial survey: Included here were flights with often non-specific observation of ground features from the air, sometimes including photography or videography.
- Aerial traffic report: Operating an aircraft for media reports on traffic or road conditions.

- Air show or air race: Includes any flight operation conducted as part of an organized air race or public demonstration. Often includes aerobatic flight.
- Fire spotting or fire suppression: Operations using an aircraft to look for fires, to apply fire suppression material or to monitor the progress of fire suppression.
- Game or fish spotting: Operations using an aircraft to look for animals (mostly game for hunting) or fish.
- Pipeline or power line patrol: Operations using an aircraft to inspect either a pipeline or power line.
- Search and rescue: Operations using an aircraft to search for lost or injured people.
- Sightseeing: Operations, both revenue and non-revenue, for the purpose of viewing geologic or biologic features of a landmass or water feature.

More than sixty percent of Part 91 operations were classified as personal or pleasure flights. Many of these flights had no actual purpose other than the pleasure of flying. Many others may have had a purpose that would qualify them for another regime, but insufficient detail was provided in the accident report. Due to the size of this regime, the flights were split into personal local flights versus personal cross-country flights, based on the distance between the departure and destination airports. The distance chosen was the same as that used for the purpose of meeting aeronautical requirements for a private pilot license: a straight-line distance exceeding fifty nautical miles.[5] By definition, any flight intending to return to the departure airport, regardless of time spent in the air, is a local flight.

Work related operations include the following:

- Aerial advertising (also known as banner towing)
- Glider tow operations
- Hunt/Guide business operations (not including actual game spotting)
- Medical transport (includes the opposite leg of flight with no patient on board)
- Maintenance test flights (performed immediately after maintenance work)
- Sales demonstration flight (to demonstrate aircraft characteristics before finalizing the sale of that aircraft)
- Sky-diving operations
- Other work related activities (see discussion of business flights above)

[5] 14 CFR 61.1(b)(3)(ii); FAA Certification: Pilots, Flight Instructors and Ground Instructors. http://www.gpo.gov/fdsys/pkg/CFR-2011-title14-vol2/pdf/CFR-2011-title14-vol2-part61.pdf

The final regime, "Other or Unclear," includes illegal activities because those flights seldom have a known departure point, which makes it impossible to know if the flight was local or cross-country. Similarly, there are other personal flights for which either the departure or destination point was unknown. And, unfortunately, several accidents have no narrative report; this lack of information makes it difficult to assign any flight purpose.

Other Derived Variables

Accident Occurrence Category

All of the accidents included in this report have been assigned occurrence categories based on the taxonomy developed by the Commercial Aviation Safety Team/International Civil Aviation Organization (CAST/ICAO) Common Taxonomy Team (CICTT)[6]. A few categories were added to this taxonomy for non-transport accidents, and details of all categories can be found in Appendix A. The assignment of categories was performed by means of a computer program, based on the occurrence codes and causal factor codes in the NTSB database. During the assignment process, many of the more complicated accidents were reviewed by the author, and all of the fatal accidents for Part 121 and scheduled Part 135 were reviewed by other systems analysis staff within the Aeronautics Research Mission Directorate. Note that a particular accident might have been assigned multiple occurrence categories.

One CICTT specification was not followed; this was regarding loss of control when a system/component failure/malfunction rendered the aircraft uncontrollable. The CICTT taxonomy states that the loss of control should not be considered as a separate category in these cases. However, this analysis retained the loss of control category in all circumstances, regardless of malfunctions, in order to capture all of the loss of control including those that followed system/component failure/malfunction or other circumstances (e.g., incapacitation, weather, etc.) that might have rendered the aircraft uncontrollable.

Accident Severity

In 1997 the NTSB developed a classification system in order to combine injury and aircraft damage into one rating of accident severity. The classification was developed for Part 121 aircraft only, but has been expanded in this report to apply to all aircraft. When multiple aircraft were involved in the accident, the most severe injury and damage was used to classify the accident. The definitions for these classifications are as follows:

Major: the aircraft was destroyed
OR there were multiple fatalities
OR there was one fatality and the aircraft was substantially damaged

[6] CAST/ICAO Common Taxonomy Team, "Aviation Occurrence Categories Definitions and Usage Notes, April 2011 (4.1.5) http://www.intlaviationstandards.org/Documents/CICTTOccurrenceCategoryDefinitions.pdf.

Serious: there was one fatality without substantial aircraft damage
OR there was at least one serious injury and the aircraft was substantially damaged

Injury: no fatalities but at least one serious injury
(with less than substantial damage to the aircraft)

Damage: no fatalities or serious injuries, but the aircraft was substantially damaged

Aircraft Grouping

In order to describe the types of aircraft involved in these accidents, the specific aircraft make and model (and in many cases, aircraft series) was determined for each accident. For the vast majority of events, this information could be easily found in the data record. For some events it was necessary to consult the FAA's aircraft registry database, and to assume that the correct aircraft registration number was recorded in the data system.

All aircraft in the data system for the chosen time period (1993-2012) were divided into thirteen groups based on some combination of engine type, aircraft use, aircraft size and aircraft complexity. The aircraft categories are as follows, and a list of the particular aircraft models (sometimes including series information) within each category can be found in Appendix B.

- Wide Body Jet Airliners
- Narrow Body Jet Airliners
- Regional Jets
- Medium Sized Business Jets
- Small Business Jets (maximum takeoff weight <= 12,500 lb)

- Large Turbo-props (maximum takeoff weight >= 32,000 lb and more than 30 seats)
- Medium Turbo-props (12,500< maximum takeoff weight <32,000 lb or 15-30 seats)
- Small Turbo-props (maximum takeoff weight <12,500 lb and less than 15 seats)

- Heavier multiple reciprocating engines (maximum takeoff weight >15,000 lb)
- Lighter multiple reciprocating engines (maximum takeoff weight < 15,000 lb)

- Single reciprocating engine, retractable landing gear
- Single reciprocating engine, fixed landing gear

- Light Sport Aircraft (maximum takeoff weight <= 1320 lb)

Results and Discussion

Table 1 shows the distribution of flight purpose regimes among flight operation categories. Part 135 regulations specify that commuter operations are limited to nine or fewer passenger seats, and on-demand operations are limited to 30 passenger seats.[7] Among the non-scheduled passenger flights, all of the Part 121 flights carried at least 30 passengers, and none of the Part 135 flights carried more than 20 passengers; more than 96% of the Part 91 flights had no more than six passengers on board. All of the Part 121 and Part 135 flights in the intentional low level flight regime were sightseeing flights. The Non-Scheduled Part 135 flights in the Other Work Related regime were all medical transport flights. More than 80% of Part 91 flights were either personal or instructional in nature.

Table 1. Summary of Accidents by Flight Operation (1993-2012)

Flight Purpose Regime	Part 121	Scheduled Part 135	Non-Scheduled Part 135	Part 91	Total
Scheduled Passenger	664	155	0	0	819
Non-Scheduled Passenger	8	0	441	1129	1578
Cargo Operations	99	21	532	21	673
Aircraft Movement	1	0	1	994	996
Flight Instruction	0	0	0	5099	5099
Intentional Low Level	2	0	71	1335	1408
Personal Local	0	0	0	7405	7405
Personal Cross Country	0	0	0	8349	8349
Other Work Related	0	0	40	1005	1045
Unclear	0	0	2	218	220
Total	774	176	1087	25555	27592

Table 2 summarizes the number of accidents and fatal accidents, and also the number of total injuries out of all persons on board in these accidents, for each of the ten flight purpose regimes. In both scheduled passenger flights and instructional flights, less than nine percent of the accidents included a fatality. Forty-seven percent of intentional low-level flight accidents resulted in a fatality, as did 47% of accidents for which the flight purpose was unclear. Personal cross-country accidents were twice as likely to result in a fatality as personal local flight accidents. In the other four flight purpose regimes, between 20% and 27% of the accidents were fatal. Overall, 19% of accidents were fatal.

[7] eCFR Title 14, Chapter I, Subchapter G, Part 110; http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=f8cb6514ecdf523e97d3a90c45bef6c6&rgn=div8&view=text&node=14:3.0.1.1.1.0.1.2&idno=14

Less than six percent of all persons on board (passenger and crew) in scheduled passenger flight accidents sustained an injury. Next in terms of least injuries were flight instruction (29%), non-scheduled passenger flights (32%) and personal local flights (35%). Almost 66% of persons on board intentional low-level flight accidents were injured, followed by those accidents for which the purpose was unclear (56%) and aircraft movement accidents (54%). In the remaining three regimes, between 42% and 47% of persons on board were injured. Overall, 21% of all persons on board accident flights were injured, although that number rises to 41% if scheduled passenger flights are excluded.

Table 2. Summary of Accidents and Injuries (1993-2012)

Flight Purpose Regime	Total Accidents	Fatal Accidents	Total Persons on Board	Total Injuries
Scheduled Passenger	819	63 (7.7%)	70216	3857 (5.5%)
Non-Scheduled Passenger	1578	423 (26.8%)	6508	2062 (31.7%)
Cargo Operations	673	174 (25.8%)	1043	495 (47.4%)
Aircraft Movement	996	232 (23.3%)	1429	778 (54.4%)
Flight Instruction	5099	446 (8.7%)	8036	2343 (29.2%)
Intentional Low Level	1408	656 (46.6%)	3020	1983 (65.7%)
Personal Local	7405	846 (11.4%)	12812	4513 (35.2%)
Personal Cross Country	8349	2009 (24.1%)	17966	8385 (46.7%)
Other Work Related	1045	212 (20.3%)	2288	972 (42.5%)
Unclear	220	103 (46.8%)	422	234 (55.5%)
All	27592	5164 (18.7%)	123740	25622 (20.7%)

Table 3 displays several summary statistics related to injuries and fatal injuries. Personal cross-country flights resulted in the most injuries and fatalities, followed by personal local flights (2nd in injuries and 3rd in fatalities) and scheduled passenger flights (3rd in injuries and 2nd in fatalities). However, due to the greater number of persons on board scheduled passenger flights relative to other flight purpose regimes, by far the largest number of injuries per accident, fatal injuries per accident, and fatal injuries per fatal accident were seen in scheduled passenger flights. The next highest number of injuries and fatal injuries per accident were in intentional low level flights (1.4 and 0.8) and non-scheduled passenger flights (1.3 and 0.7). The lowest number of injuries and fatal injuries per accident were in instructional flights (0.46 and 0.15) and local personal flights (0.61 and 0.18). The second highest number of fatal injuries per fatal accident was in non-scheduled passenger flights (2.7) and the lowest number of fatal injuries per fatal accident was in cargo flights (1.5).

Table 3. Summary of Injuries and Fatal Injuries (1993-2012)

Flight Purpose Regime	Total Injuries	Injuries per Accident	Fatal Injuries	Fatal Injuries per Accident	Fatal Injuries per Fatal Accident
Scheduled Passenger	3857	4.71	1733	2.12	27.51
Non-Scheduled Passenger	2062	1.31	1161	0.74	2.74
Cargo Operations	495	0.73	258	0.38	1.48
Aircraft Movement	778	0.78	456	0.46	1.97
Flight Instruction	2343	0.46	771	0.15	1.73
Intentional Low Level	1983	1.41	1164	0.83	1.77
Personal Local	4513	0.61	1356	0.18	1.60
Personal Cross Country	8385	1.00	4183	0.50	2.08
Other Work Related	972	0.93	449	0.43	2.12
Unclear	234	1.06	164	0.74	1.59
All	25622	0.93	11695	0.42	2.26

Table 4 shows the four levels of aircraft damage associated with each flight purpose regime. Overall, eighty percent of accidents result in substantial damage to the aircraft. But 35% of scheduled passenger flight accidents had no aircraft damage; this regime has the highest rates of no damage and minor damage, and the lowest rates of substantial damage and aircraft destruction. Conversely, nearly 40% of the intentional low level flight accidents resulted in aircraft destruction; this regime had the second lowest rate of substantial damage.

Table 4. Summary of Aircraft Damage (1993-2012)

Flight Purpose Regime	No Damage	Minor Damage	Substantial Damage	Aircraft Destruction
Scheduled Passenger	288 (35.2%)	63 (7.7%)	418 (51.0%)	50 (6.1%)
Non-Scheduled Passenger	20 (1.3%)	7 (0.4%)	1151 (72.9%)	400 (25.3%)
Cargo Operations	3 (0.4%)	10 (1.5%)	479 (71.2%)	181 (26.9%)
Aircraft Movement	5 (0.5%)	8 (0.8%)	732 (73.5%)	251 (25.2%)
Flight Instruction	8 (0.2%)	24 (0.5%)	4568 (89.6%)	499 (9.8%)
Intentional Low Level	5 (0.4%)	13 (0.9%)	843 (59.9%)	547 (38.8%)
Personal Local	30 (0.4%)	60 (0.8%)	6476 (87.5%)	839 (11.3%)
Personal Cross Country	20 (0.2%)	21 (0.3%)	6459 (77.4%)	1849 (22.1%)
Other Work Related	9 (0.9%)	12 (1.1%)	827 (79.1%)	197 (18.9%)
Unclear	3 (1.4%)	1 (0.5%)	133 (60.5%)	83 (37.7%)
All	391 (1.4%)	219 (0.8%)	22086 (80.0%)	4896 (17.7%)

Table 5 shows the four levels of aircraft severity (according to the NTSB severity classification system) associated with each flight purpose regime. Nearly 70% of all accidents in this time period were considered "damage" accidents, the lowest severity classification; only 23% were major accidents. Scheduled passenger transport accidents had the lowest rate of major accidents (7%) and the highest rate of injury accidents (39%). This result is consistent with this regime's low rate of fatalities and high rate of accidents with no damage. The only other regimes below 23% in terms of major accidents were flight instruction (13%) and personal local flights (16%); these two regimes had the highest percentages of "damage" accidents (82% and 76%, respectively). Intentional low-level flights and those for which the purpose was unclear had the lowest percentage of "damage" accidents (37% and 44%) and the highest percentage of major accidents (53% and 51%).

Table 5. Summary of Accident Severity (1993-2012)

Flight Purpose Regime	Damage	Injury	Serious	Major
Scheduled Passenger	403 (49.2%)	316 (38.6%)	44 (5.4%)	56 (6.8%)
Non-Scheduled Passenger	970 (61.5%)	18 (1.1%)	86 (5.4%)	504 (31.9%)
Cargo Operations	433 (64.3%)	5 (0.7%)	28 (4.2%)	207 (30.8%)
Aircraft Movement	634 (63.7%)	7 (0.7%)	55 (5.5%)	300 (30.1%)
Flight Instruction	4179 (82.0%)	10 (0.2%)	261 (5.1%)	649 (12.7%)
Intentional Low Level	527 (37.4%)	4 (0.3%)	129 (9.2%)	748 (53.1%)
Personal Local	5621 (75.9%)	31 (0.4%)	589 (8.0%)	1164 (15.7%)
Personal Cross Country	5316 (63.7%)	14 (0.2%)	615 (7.4%)	2404 (28.8%)
Other Work Related	687 (65.7%)	8 (0.8%)	86 (8.2%)	264 (25.3%)
Unclear	97 (44.1%)	1 (0.5%)	11 (5.0%)	111 (50.5%)
All	18867 (68.4%)	414 (1.5%)	1904 (6.9%)	6407 (23.2%)

Table 6 presents various summary statistics related to the age of the primary pilot. In general, the pilots in cargo flight accidents and those participating in flight instruction were somewhat younger than other pilots, while those in personal local flights, personal cross-country flights and those flights for which the purpose was unclear were somewhat older. It is somewhat disturbing that nine percent of scheduled passenger transport accidents did not record the age of the primary pilot. These 76 accidents were reviewed, and 48 of the accidents were international flights, for which less information in general is recorded; nine accident investigations are in the preliminary stage, so not all information was available; twelve accidents were ground handling accidents, for which less information is sometimes provided, particularly if the aircraft was still at the gate. That left seven accidents (less than 1%) for which age should have been recorded, but for some reason was not.

Table 6. Summary of Pilot Age (1993-2012)

Flight Purpose Regime	Mean	Median	Range	Number Missing
Scheduled Passenger	44.6	46	20-69	76 (9.3%)
Non-Scheduled Passenger	47.6	48	19-82	49 (3.1%)
Cargo Operations	40.3	38	20-77	42 (6.2%)
Aircraft Movement	45.6	45	20-88	34 (3.4%)
Flight Instruction	40.8	39	15-92	55 (1.1%)
Intentional Low Level	45.3	45	17-88	25 (1.8%)
Personal Local Flight	51.5	52	16-94	97 (1.3%)
Personal Cross Country	50.3	51	17-91	183 (2.2%)
Other Work Related	44.9	45	18-84	37 (3.5%)
Unclear	49.2	50	14-78	56 (25.5%)
All	47.7	48	14-94	654 (2.4%)

Table 7. Summary of Pilot Certification (1993-2012)

Flight Purpose Regime	Air Transport	CFI or Commercial	Private	Student or Recreation	Other or Unknown
Scheduled Passenger	723 (88.3%)	46 (5.6%)	0 (0.0%)	0 (0.0%)	50 (6.1%)
Non-Scheduled Passenger	553 (35.0%)	586 (37.1%)	420 (26.6%)	3 (0.2%)	16 (1.0%)
Cargo Operations	344 (51.1%)	303 (45.0%)	2 (0.3%)	0 (0.0%)	24 (3.6%)
Aircraft Movement	405 (40.7%)	457 (45.9%)	119 (12.0%)	1 (0.1%)	14 (1.4%)
Flight Instruction	534 (10.5%)	1806 (35.4%)	770 (15.1%)	1979 (38.8%)	10 (0.2%)
Intentional Low Level	226 (16.1%)	579 (41.1%)	556 (39.5%)	24 (1.7%)	23 (1.6%)
Personal Local	618 (8.4%)	1670 (22.6%)	4832 (65.3%)	210 (2.8%)	75 (1.0%)
Personal Cross Country	680 (8.1%)	1803 (21.6%)	5692 (68.2%)	97 (1.1%)	77 (0.9%)
Other Work Related	243 (23.3%)	590 (56.5%)	184 (17.6%)	3 (0.3%)	25 (2.4%)
Unclear	16 (7.3%)	45 (20.5%)	91 (41.4%)	8 (3.6%)	60 (27.3%)
All	4342 (16%)	7885 (29%)	12666 (46%)	2325 (8.4%)	374 (1.4%)

Table 7 shows the distribution of certification for the primary pilot. Based on highest frequency, Air Transport pilots are associated with scheduled passenger transport flights, commercial pilots with other work related flights, private pilots with personal local and personal cross-country flights, student pilots with flight instruction and an unknown license with the unclear flight purpose.

Tables 8, 9 and 10 show the number of accidents in a specific category of aircraft type within each of the flight purpose regimes. All of the percentages are based on the total number of accidents in each regime.

More than half of scheduled passenger transport accidents were in either wide-body or narrow-body jet airliners, with about 22% in turbo-props and 11% in piston-engine aircraft. Conversely, more than three-quarters of non-scheduled passenger transport accidents were in piston-engine aircraft, with only ten percent in jet aircraft and the remaining 12% in turbo-props. Fifteen percent of cargo accidents were in jet aircraft, with 23% in turbo-props and 62% in piston-engine aircraft. Cargo accidents had by far the largest usage of twin-engine (piston) aircraft (34%).

Table 8. Accidents by Aircraft Type (1993-2012)

Aircraft Type	Scheduled Passenger	Non-Scheduled Passenger	Cargo Operations
Total Events	819	1578	673
Wide Body Jet Airliner	118 (14.4%)	3 (0.2%)	51 (7.6%)
Narrow Body Jet Airliner	326 (39.8%)	5 (0.3%)	32 (4.8%)
Regional Jets	99 (12.1%)	1 (0.1%)	0 (0.0%)
Business Jets	0 (0.0%)	158 (10.0%)	20 (3.0%)
Large Turbo-Props	50 (6.1%)	1 (0.1%)	10 (1.5%)
Medium Turbo-Props	108 (13.2%)	62 (3.9%)	63 (9.4%)
Small Turbo-Props	24 (2.9%)	129 (8.2%)	78 (11.6%)
Heavy Multi-Engine (Piston)	0 (0.0%)	3 (0.2%)	26 (3.9%)
Lighter Multi-Engine (Piston)	42 (5.1%)	356 (22.6%)	202 (30.0%)
Single Engine (Piston) Retractable Gear	1 (0.1%)	295 (18.7%)	70 (10.4%)
Single Engine (Piston) Fixed Gear	51 (6.2%)	565 (35.8%)	121 (18.0%)
Very Light Sport Aircraft	0 (0.0%)	0 (0.0%)	0 (0.0%)

More than ninety percent of flight instruction accidents (reminder: this category includes flight practice as well as training for multi-engine ratings) were in single-engine (piston) aircraft. Over 85% of accidents during personal local flights and personal cross-country flights were in single-engine (piston) aircraft, although cross-country flight accidents tended toward retractable gear aircraft while local flights tended toward fixed gear aircraft.

Table 9. Accidents by Aircraft Type (1993-2012)

Aircraft Type	Flight Instruction	Personal Local	Personal Cross Country
Total Events	5099	7405	8349
Wide Body Jet Airliner	0 (0.0%)	0 (0.0%)	0 (0.0%)
Narrow Body Jet Airliner	1 (0.1%)	0 (0.0%)	0 (0.0%)
Regional Jets	1 (0.1%)	1 (0.1%)	0 (0.0%)
Business Jets	8 (0.2%)	4 (0.1%)	43 (0.5%)
Large Turbo-Props	0 (0.0%)	0 (0.0%)	0 (0.0%)
Medium Turbo-Props	12 (0.2%)	2 (0.1%)	26 (0.3%)
Small Turbo-Props	34 (0.7%)	26 (0.4%)	164 (2.0%)
Heavy Multi-Engine (Piston)	3 (0.1%)	4 (0.1%)	1 (0.1%)
Lighter Multi-Engine (Piston)	312 (6.1%)	364 (4.9%)	959 (11.5%)
Single Engine (Piston) Retractable Gear	534 (10.5%)	1061 (14.3%)	2526 (30.3%)
Single Engine (Piston) Fixed Gear	4122 (80.8%)	5871 (79.3%)	4599 (55.1%)
Very Light Sport Aircraft	72 (1.4%)	72 (1.0%)	31 (0.4%)

Just over half of the aircraft involved in accidents while moving the aircraft were single-engine (piston) aircraft and nearly one quarter were twin-engine (piston) aircraft. Roughly fifteen percent were turbo-props and seven percent were business jets. Both of those percentages are second highest of all other flight purpose regimes, second to non-scheduled passenger transport (for business jets) and cargo flights (for turbo-props).

Table 10. Accidents by Aircraft Type (1993-2012)

Aircraft Type	Aircraft Movement	Intentional Low-Level	Other Work Related	Unclear
Total Events	996	1408	1045	220
Wide Body Jet Airliner	2 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Narrow Body Jet Airliner	6 (0.6%)	0 (0.0%)	1 (0.1%)	2 (0.9%)
Regional Jets	6 (0.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Business Jets	71 (7.1%)	2 (0.1%)	35 (3.3%)	2 (0.9%)
Large Turbo-Props	3 (0.3%)	0 (0.0%)	3 (0.3%)	0 (0.0%)
Medium Turbo-Props	49 (4.9%)	17 (1.2%)	30 (2.9%)	4 (1.8%)
Small Turbo-Props	96 (9.6%)	20 (1.4%)	70 (6.7%)	5 (2.3%)
Heavy Multi-Engine (Piston)	22 (2.2%)	5 (0.4%)	4 (0.4%)	2 (0.9%)
Lighter Multi-Engine (Piston)	215 (21.6%)	70 (5.0%)	87 (8.3%)	29 (13.2%)
Single Engine (Piston) Retractable Gear	119 (11.9%)	176 (12.5%)	111 (10.6%)	37 (16.8%)
Single Engine (Piston) Fixed Gear	402 (40.4%)	1112 (79.0%)	704 (67.4%)	139 (63.2%)
Very Light Sport Aircraft	5 (0.5%)	6 (0.4%)	0 (0.0%)	0 (0.0%)

Almost 92% of accidents during intentional low-level flight were in were single-engine (piston) aircraft. Roughly 87% of other work related accidents and 94% of those accidents with an unclear flight purpose were in piston-engine aircraft.

Tables 11, 12 and 13 show the number of accidents assigned to each CICTT occurrence category within each of the flight purpose regimes. All of the percentages are based on the total number of accidents in each regime. The reader is reminded that a particular accident might be assigned multiple occurrence categories. The additional categories that are not part of the official CICTT taxonomy are denoted with an asterisk (*). These data are presented but not discussed below. (Aside: In the four regimes with a high percentage of accidents that include fuel-related loss of engine power, many of the accident sequences also include collision with an object during the precautionary landing.)

Roughly half of scheduled passenger flight accidents fall into one of two categories: Turbulence Encounters (27%) or Ground Handling (22%). The next most frequent occurrence category is non-powerplant system/component failure (9%). Turbulence encounters tend to result in serious injuries rather than aircraft damage, while ground handling events tend to result in substantial damage and either minor or no injury; this explains the low percentage of major accidents in Table 5. Turbulence Encounters account for no more than two percent of the accidents in any other flight purpose regime, while Ground Handling events account for no more than seven percent of other flight purpose accidents.

Seven occurrence categories each accounted for at least ten percent of accidents among non-scheduled passenger transport flights: loss of control – in flight (20%), runway excursion (18%), post-impact fire (14%), non-powerplant system/component failure (12%), abnormal runway contact (11%), loss of control – on ground (10%) and fuel related loss of engine power (10%). Collectively, these seven categories accounted for 71% of accidents in this regime.

Five of those same categories are among the six most frequently seen in cargo operations accidents: loss of control – in flight (18%), post-impact fire (14%), abnormal runway contact (13%), runway excursion (13%), non-powerplant system/component failure (12%), and controlled flight into terrain (10%). Collectively, these six categories account for 61% of cargo flight accidents.

Roughly half of flight instruction accidents involved runway excursion (29%) or abnormal runway contact (23%). Loss of control – on ground (19%) and loss of control – in flight (15%) are the only other categories assigned to more than ten percent of the accidents. Collectively, these four categories account for 72% of flight instruction accidents.

Table 11. Accidents by CICTT Occurrence Category (1993-2012)

CICTT Occurrence Category	Scheduled Passenger	Non-Scheduled Passenger	Cargo Operations
Total Events	819	1578	673
Abrupt Maneuver	18 (2.2%)	2 (0.1%)	5 (0.7%)
Abnormal Runway Contact	65 (7.9%)	166 (10.5%)	86 (12.8%)
Aerodrome	20 (2.4%)	43 (2.7%)	22 (3.3%)
Air Traffic Management	17 (2.1%)	12 (0.8%)	11 (1.6%)
Bird Strikes	29 (3.5%)	14 (0.9%)	8 (1.2%)
Cabin Safety or Pilot Incapacitation	15 (1.8%)	12 (0.8%)	7 (1.0%)
Controlled Flight Into Terrain	23 (2.8%)	110 (7.0%)	68 (10.1%)
Collision with Object – Takeoff or Landing	4 (0.5%)	53 (3.4%)	12 (1.8%)
Collision with Object – Prec Landing *	1 (0.1%)	119 (7.5%)	35 (5.2%)
Collision with Terrain – Prec Landing *	3 (0.4%)	71 (4.5%)	31 (4.6%)
Encounter with Terrain – Prec Landing *	8 (1.0%)	77 (4.9%)	23 (3.4%)
Evacuation	47 (5.7%)	0 (0.0%)	3 (0.5%)
Fire – Non-Impact	27 (3.3%)	29 (1.8%)	21 (3.1%)
Fire – Post Impact	24 (2.9%)	219 (13.9%)	94 (14.0%)
Ground Collision	65 (7.9%)	47 (3.0%)	37 (5.5%)
Ground Handling or Inadequate Pre-Flight	177 (21.6%)	73 (4.6%)	47 (7.0%)
Icing	20 (2.4%)	79 (5.0%)	45 (6.7%)
Low Altitude Operations	2 (0.2%)	38 (2.4%)	14 (2.1%)
Loss of Control – In Flight	42 (5.1%)	316 (20.0%)	124 (18.4%)
Loss of Control – On Ground	10 (1.2%)	154 (9.8%)	40 (5.9%)
Mid Air Collision	5 (0.6%)	15 (1.0%)	4 (0.6%)
Power Loss – Fuel	1 (0.1%)	153 (9.7%)	46 (6.8%)
Power Loss – Other Reasons *	5 (0.6%)	14 (0.9%)	1 (0.2%)
Power Loss – Unknown Reason *	0 (0.0%)	71 (4.5%)	34 (5.1%)
Runway Excursion	68 (8.3%)	287 (18.2%)	86 (12.8%)
Runway Incursion (Vehicle, Aircraft or Person)	2 (0.2%)	4 (0.3%)	2 (0.3%)
SCF – Powerplant	25 (3.1%)	123 (7.8%)	59 (8.8%)
SCF – Non Powerplant	73 (8.9%)	181 (11.5%)	82 (12.2%)
SCF – Stress Limits Exceeded *	2 (0.2%)	28 (1.8%)	8 (1.2%)
Security Related	5 (0.6%)	1 (0.1%)	1 (0.2%)
Turbulence Encounter	221 (27.0%)	24 (1.5%)	8 (1.2%)
Thunderstorm or Windshear	9 (1.1%)	31 (2.0%)	10 (1.5%)
Undershoot or Overshoot	4 (0.5%)	43 (2.7%)	17 (2.5%)
Unintended Flight in IMC	15 (1.8%)	56 (3.6%)	18 (2.7%)
Wildlife	5 (0.6%)	16 (1.0%)	0 (0.0%)
Other	7 (0.9%)	22 (1.4%)	7 (1.0%)
Unknown or Undetermined	2 (0.2%)	24 (1.5%)	14 (2.1%)

* Denotes occurrence categories not in the official CAST/ICAO taxonomy.

Table 12. Accidents by CICTT Occurrence Category (1993-2012)

CICTT Occurrence Category	Flight Instruction	Personal Local	Personal Cross Country
Total Events	5099	7405	8349
Abrupt Maneuver	19 (0.4%)	34 (0.5%)	24 (0.3%)
Abnormal Runway Contact	1183 (23.2%)	931 (12.6%)	875 (10.5%)
Aerodrome	51 (1.0%)	99 (1.3%)	99 (1.2%)
Air Traffic Management	40 (0.8%)	15 (0.2%)	63 (0.8%)
Bird Strikes	22 (0.4%)	16 (0.2%)	10 (0.1%)
Cabin Safety or Pilot Incapacitation	23 (0.5%)	100 (1.4%)	116 (1.4%)
Controlled Flight Into Terrain	53 (1.0%)	105 (1.4%)	516 (6.2%)
Collision with Object – Takeoff or Landing	125 (2.5%)	407 (5.5%)	278 (3.3%)
Collision with Object – Prec Landing *	379 (7.4%)	718 (9.7%)	984 (11.8%)
Collision with Terrain – Prec Landing *	107 (2.1%)	244 (3.3%)	410 (4.9%)
Encounter with Terrain – Prec Landing *	243 (4.8%)	451 (6.1%)	676 (8.1%)
Evacuation	0 (0.0%)	0 (0.0%)	0 (0.0%)
Fire – Non-Impact	33 (0.7%)	72 (1.0%)	100 (1.2%)
Fire – Post Impact	235 (4.6%)	434 (5.9%)	938 (11.2%)
Ground Collision	111 (2.2%)	212 (2.9%)	96 (1.2%)
Ground Handling or Inadequate Pre-Flight	48 (0.9%)	239 (3.2%)	233 (2.8%)
Icing	16 (0.3%)	29 (0.4%)	185 (2.2%)
Low Altitude Operations	162 (3.2%)	125 (1.7%)	192 (2.3%)
Loss of Control – In Flight	783 (15.4%)	1269 (17.1%)	1800 (21.6%)
Loss of Control – On Ground	962 (18.9%)	1671 (22.6%)	1005 (12.0%)
Mid Air Collision	88 (1.7%)	92 (1.2%)	56 (0.7%)
Power Loss – Fuel	463 (9.1%)	894 (12.1%)	1320 (15.8%)
Power Loss – Other Reasons *	62 (1.2%)	56 (0.8%)	72 (0.9%)
Power Loss – Unknown Reason *	236 (4.6%)	501 (6.8%)	477 (5.7%)
Runway Excursion	1453 (28.5%)	1615 (21.8%)	1539 (18.4%)
Runway Incursion (Vehicle, Aircraft or Person)	33 (0.7%)	38 (0.5%)	31 (0.4%)
SCF – Powerplant	222 (4.4%)	400 (5.4%)	674 (8.7%)
SCF – Non Powerplant	266 (5.2%)	520 (7.0%)	584 (7.0%)
SCF – Stress Limits Exceeded *	12 (0.2%)	9 (0.1%)	158 (1.9%)
Security Related	3 (0.1%)	8 (0.1%)	2 (0.1%)
Turbulence Encounter	23 (0.5%)	33 (0.5%)	94 (1.1%)
Thunderstorm or Windshear	30 (0.6%)	38 (0.5%)	170 (2.0%)
Undershoot or Overshoot	144 (2.8%)	164 (2.2%)	170 (2.0%)
Unintended Flight in IMC	24 (0.5%)	100 (1.4%)	462 (5.5%)
Wildlife	24 (0.5%)	54 (0.7%)	45 (0.5%)
Other	23 (0.5%)	62 (0.8%)	42 (0.5%)
Unknown or Undetermined	9 (0.2%)	46 (0.6%)	95 (1.1%)

* Denotes occurrence categories not in the official CAST/ICAO taxonomy.

Table 13. Accidents by CICTT Occurrence Category (1993-2012)

CICTT Occurrence Category	Aircraft Movement	Intentional Low-Level	Other Work Related	Unclear
Total Events	996	1408	1045	220
Abrupt Maneuver	5 (0.5%)	51 (3.6%)	3 (0.3%)	0 (0.0%)
Abnormal Runway Contact	93 (9.3%)	31 (2.2%)	78 (7.5%)	18 (8.2%)
Aerodrome	16 (1.6%)	6 (0.4%)	13 (1.2%)	2 (0.9%)
Air Traffic Management	9 (0.9%)	5 (0.4%)	3 (0.3%)	0 (0.0%)
Bird Strikes	9 (0.9%)	2 (0.1%)	6 (0.6%)	0 (0.0%)
Cabin Safety or Pilot Incapacitation	16 (1.6%)	87 (6.2%)	11 (1.1%)	12 (5.5%)
Controlled Flight Into Terrain	70 (7.0%)	13 (0.9%)	20 (1.9%)	6 (2.7%)
Collision with Object – Takeoff or Landing	27 (2.7%)	15 (1.1%)	35 (3.4%)	5 (2.3%)
Collision with Object – Prec Landing *	116 (11.7%)	67 (4.8%)	116 (11.1%)	9 (4.1%)
Collision with Terrain – Prec Landing *	73 (7.3%)	56 (4.0%)	62 (5.9%)	5 (2.3%)
Encounter with Terrain – Prec Landing *	80 (8.0%)	50 (3.6%)	84 (8.1%)	3 (1.4%)
Evacuation	0 (0.0%)	1 (0.1%)	0 (0.0%)	0 (0.0%)
Fire – Non-Impact	29 (2.9%)	8 (0.6%)	16 (1.5%)	1 (0.5%)
Fire – Post Impact	139 (14.0%)	236 (16.8%)	123 (11.8%)	19 (8.6%)
Ground Collision	20 (1.0%)	16 (1.1%)	15 (1.4%)	3 (1.4%)
Ground Handling or Inadequate Pre-Flight	35 (2.5%)	28 (2.0%)	36 (3.4%)	11 (5.0%)
Icing	15 (1.5%)	2 (0.1%)	8 (0.8%)	0 (0.0%)
Low Altitude Operations	32 (3.2%)	844 (59.9%)	81 (7.8%)	13 (5.9%)
Loss of Control – In Flight	185 (18.6%)	489 (34.7%)	265 (25.4%)	47 (21.4%)
Loss of Control – On Ground	132 (13.3%)	83 (5.9%)	156 (14.9%)	22 (10.0%)
Mid Air Collision	12 (1.2%)	52 (3.7%)	12 (1.2%)	1 (0.5%)
Power Loss – Fuel	161 (16.2%)	109 (7.7%)	174 (16.7%)	13 (5.9%)
Power Loss – Other Reasons *	9 (0.9%)	9 (0.6%)	11 (1.1%)	0 (0.0%)
Power Loss – Unknown Reason *	95 (9.5%)	59 (4.2%)	92 (8.8%)	5 (2.3%)
Runway Excursion	127 (12.8%)	53 (3.8%)	128 (12.3%)	16 (7.3%)
Runway Incursion (Vehicle, Aircraft or Person)	4 (0.4%)	5 (0.4%)	6 (0.6%)	0 (0.0%)
SCF – Powerplant	85 (8.5%)	69 (4.9%)	76 (7.3%)	9 (4.1%)
SCF – Non Powerplant	90 (9.0%)	47 (3.3%)	124 (11.9%)	9 (4.1%)
SCF – Stress Limits Exceeded *	6 (0.6%)	16 (1.1%)	3 (0.3%)	2 (0.9%)
Security Related	0 (0.0%)	8 (0.6%)	2 (0.2%)	53 (24.1%)
Turbulence Encounter	15 (1.5%)	17 (1.2%)	9 (0.9%)	1 (0.5%)
Thunderstorm or Windshear	14 (1.4%)	11 (0.8%)	8 (0.8%)	4 (1.8%)
Undershoot or Overshoot	9 (0.9%)	4 (0.3%)	19 (1.8%)	4 (1.8%)
Unintended Flight in IMC	37 (3.7%)	41 (2.9%)	9 (0.9%)	6 (2.7%)
Wildlife	7 (0.7%)	2 (0.1%)	4 (0.4%)	0 (0.0%)
Other	5 (0.5%)	5 (0.4%)	50 (4.8%)	3 (1.4%)
Unknown or Undetermined	16 (1.6%)	12 (0.9%)	18 (1.7%)	40 (18.2%)

* Denotes occurrence categories not in the official CAST/ICAO taxonomy

The accident categories associated with personal local flights and personal cross-country flights are very similar. Personal local flight accidents consisted of loss of control – on ground (23%), runway excursion (22%), loss of control – in flight (17%), abnormal runway contact (13%) and fuel related loss of engine power (12%). Accidents during personal cross-country flights consisted of loss of control – in flight (22%), runway excursion (18%), fuel related loss of engine power (16%), loss of control – on ground (12%), post-impact fire (11%) and abnormal runway contact (11%). In addition to post-impact fire in cross-country flights, the main difference is that local flights have more loss of control – on ground and cross-country flights have more loss of control – in flight. Collectively, the sets of five and six, respectively, accidents categories account for 73% of local flight accidents and 73% of cross-country flight accidents.

The accident categories associated with the aircraft movement regime are very similar to personal cross-country flights, which is not surprising since many of these were cross-country flights. The top five categories are loss of control – in flight (19%), fuel related loss of engine power (16%), runway excursion (13%), loss of control – on ground (13%), and post-impact fire (12%); collectively they account for 62% of aircraft movement accidents.

Not surprisingly, sixty percent of the accidents in the intentional low-level flight regime included the category Low Altitude Operations. This category consists mainly of collisions with objects or terrain while flying at low altitude not associated with takeoff or landing. Thirty-five percent of this regime experienced loss of control – in flight, and seventeen percent resulted in post-impact fire. These three categories, collectively, accounted for 71% of the accidents in this regime.

The largest accident category in the other work related flight purpose regime is loss of control – in flight (25%). Other frequently occurring categories include fuel related loss of engine power (17%), loss of control – on ground/water (15%), runway excursion (12%), non-powerplant system component failure (12%) and post-impact fire (12%). Collectively, these six categories accounted for 72% of the work related accidents.

Not surprisingly, eighteen percent of the accidents with an unclear flight purpose also have an undetermined accident category. Some of these simply have no narrative in the report, and little factual data, others are accidents in which the aircraft wreckage was discovered months or years after the fact, and little was known of the flight's origin. Twenty-four percent of the accidents were security related, with evidence of illegal activity including stolen aircraft. Another twenty-one percent of the accidents were due to loss of control – in flight. These three categories, collectively, account for 61% of the accidents in this regime.

Thirteen accident categories were among the most frequently observed in at least one of the flight purpose regimes. Figure 1 shows the percentage of each regime that was assigned to each of these thirteen accident categories. The bubbles are proportional to the percentage, and a ring circles each category that was among the most frequent for that particular regime.

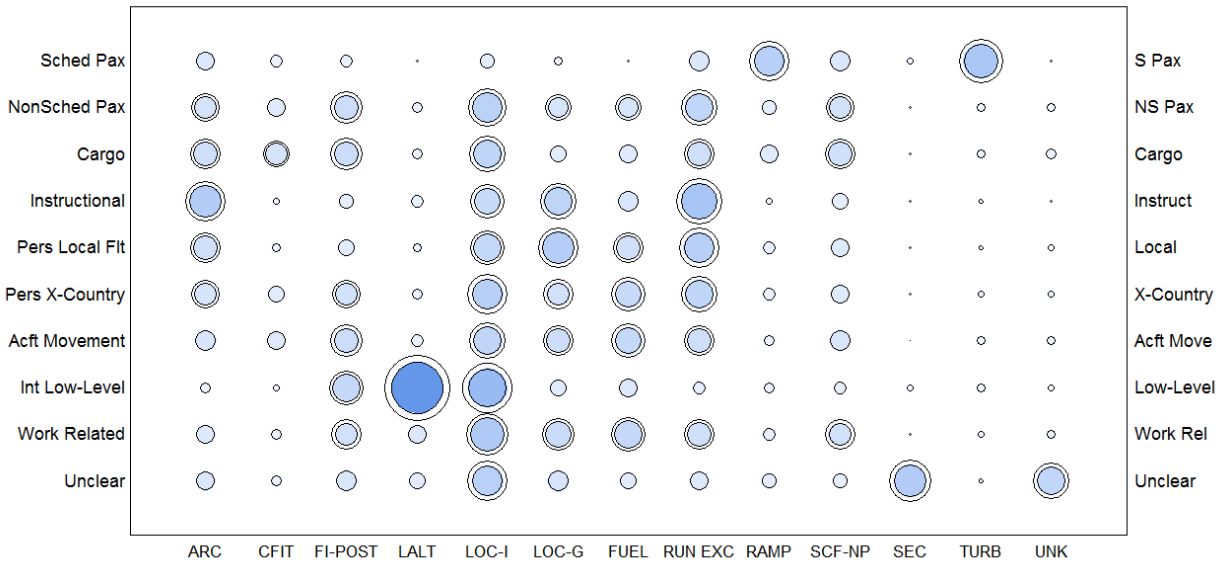

Figure 1. Most Frequent Accident Categories in any Flight Purpose Regime.

In order to summarize the risk associated with each flight purpose regime, seven measures of adverse outcome were selected, and scores were assigned to ranges of those outcomes. The score definitions (with abbreviations used in Table 15) are in Table 14, and the actual scores, as well as an average score, are presented in Table 15.

Table 14. Adverse Outcome Scoring

Adverse Outcome	1	2	3	4	5
Total Number of Accidents (TA)	<1000	1000-2000	2000-4000	4000-6000	>6000
Percentage of Accidents with a Fatality (FAP)	<10%	10-20%	20-30%	30-40%	>40%
Total Number of Injuries (TI)	<500	500-1000	1000-2000	2000-3000	>3000
Percentage Injured out of All Persons On Board (TIP)	<15%	15-30%	30-40%	40-50%	>50%
Injuries per Accident (I/A)	<0.5	0.5-1	1-1.5	1.5-2	>2
Percentage of Aircraft Destruction (PD)	<10%	10-20%	20-25%	25-30%	>30%
Percentage of Major Accidents (MA)	<10%	10-20%	20-30%	30-40%	>40%

Table 15. Summary of Adverse Outcomes (1993-2012)

Flight Purpose Regime	TA	FAP	TI	TIP	I/A	PD	MA	Avg
Scheduled Passenger	1	1	5	1	5	1	1	2.14
Non-Scheduled Pax	2	3	4	3	3	4	4	3.29
Cargo Operations	1	3	1	4	2	4	4	2.71
Aircraft Movement	1	3	2	5	2	4	4	3
Flight Instruction	4	1	4	2	1	1	2	2.14
Intention. Low Level	2	5	3	5	3	5	5	4
Personal Local	5	2	5	3	2	2	2	3
Pers Cross Country	5	3	5	4	3	3	3	3.71
Other Work Related	2	3	2	4	2	2	3	2.57
Unclear	1	5	1	5	3	5	5	3.57

Summary

Scheduled Passenger Transport

Less than three percent of all civilian, commercially built, fixed wing accidents (Part 121, Part 135 and Part 91) were associated with scheduled passenger transport, as were barely more than one percent of the fatal accidents. Nearly eight percent of accidents in this regime were fatal, and just over five percent of all persons on board the aircraft suffered an injury. These are, by far, the lowest percentages of any of the ten flight purpose regimes. However, due to the greater number of persons on board scheduled passenger flights relative to other flight purpose regimes, these accidents had by far the largest number of injuries per accident (4.7), fatal injuries per accident (2.1), and fatal injuries per fatal accident (27.5). Only six percent of the aircraft flown in these accidents were destroyed, and there was no damage to 35% of the aircraft. Nearly half of the accidents were considered “damage” accidents, which is the least severe category in the NTSB classification. Another 39% were considered “injury” accidents, and less than seven percent were major accidents. All of this led to the lowest average score of the seven adverse outcomes.

At least eighty-eight percent of the primary pilots in these accidents held an air transport license (pilot certification was unknown for six percent of the accidents). Roughly forty percent of the scheduled passenger transport flights used narrow body jet airliners; another forty percent used either wide-body jets, regional jets or medium-sized turbo-props. Roughly half of scheduled passenger transport accidents were either encounters with turbulence or ground handling events; these types of accidents were seldom experienced in other flight purpose regimes. Turbulence encounters tend to result in serious injuries but little to no aircraft damage, while ground handling events tend to result in substantial damage and either minor or no injury. This result is consistent with the vast majority of accidents being classified as either “injury” or “damage,” and so few major accidents.

Non-Scheduled Passenger Transport

Nearly twice the number of accidents occurred in non-scheduled passenger transport relative to scheduled passenger transport. Twenty-seven percent of these accidents were fatal, and more than 30% of persons on board the aircraft were injured. The aircraft was destroyed in one out of four accidents; as a result, 32% of the accidents were classified as a major accidents. This regime was seventh out of ten in the average adverse outcomes score, which might be a concern to anyone thinking of chartering a flight. Seventy-two percent of the primary pilots held either an air transport or commercial license. Ten percent of these accidents used business jets, but more than half used single-engine (piston) aircraft. Seven occurrence categories accounted for 71% of the accidents; six of these were common in six other flight purpose regimes.

The NTSB separates execute/corporate flights from business flights based on the presence of a paid, professional flight crew, which is also required for Part 121 and Part 135 charter passenger flights. An ancillary analysis divided the non-scheduled passenger regime into two groups based on the flight crew. Nearly 40% of the regime used a paid, professional crew (charter passenger flights under Part 121 or Part 135 or executive/corporate flights under Part 91; this group will be referred to a PPC) while just over 60% did not (business or commuting under Part 91; this group will be referred to as NPPC). More than 60% of the total persons on board the aircraft in this regime were in PPC. Twice as many of the people on board NPPC flights were injured, relative to PPC flights (45% vs 23%). Roughly 50% more of the NPPC accidents (relative to PPC) included a fatality (31% vs 20%), resulted in aircraft destruction (29% vs 20%) and were classified as major accidents (36% vs 25%). The PPC group has an average adverse outcome score of 2.29, which is third best, while the NPPC score is 3.29.

Cargo Operations

Cargo flights comprised the smallest regime for which the flight purpose was known, but nearly half of the persons on board were injured in the accident. The aircraft was destroyed in 27% of the accidents, which was the third highest percentage, but the general distribution of damage was similar to non-scheduled passenger flights. The average score of seven adverse outcomes was the fourth best among the ten regimes. The pilots tended to be the youngest of any flight purpose regime (40.2 years on average), although 96% held either an air transport or commercial license. Thirty-four percent of cargo accidents were flown in twin-engine (piston) aircraft, which was the largest percentage for this type of aircraft in any of the flight purpose regimes. Six occurrence categories accounted for 61% of the accidents; none of these categories were unusual. Seventy-nine percent of the cargo flight accidents were flown under the rules of Non-Scheduled Part 135.

Aircraft Movement

Aircraft movement flights were similar to cargo flights in that roughly 1.5 people were on board each accident flight. However, a larger percentage of those on board were injured (54%) compared with cargo flights. The distribution of aircraft damage and accident severity was also similar to cargo flights, and the average adverse outcome score was slightly worse than that of

cargo operations (tied for fifth). There were some differences: twelve percent of the primary pilots had only a private license, and 76% of the aircraft had piston engines (compared with 62% in cargo). Also the most frequent accidents categories were more similar to those in personal cross-country flights rather than cargo flights. The top five categories accounted for 62% of accidents in this regime.

Instructional Flights

More than eighteen percent of all accidents between 1993 and 2012 occurred during flights that were somehow instructional in nature (including flight practice). Yet these instructional flights, which by nature are piloted by those with less experience (39% of primary pilots held either a student or recreational license), account for only nine percent of all injuries and seven percent of all fatalities. Flight instruction was second to scheduled passenger flights in the percentage of persons injured (29%), the percentage of aircraft destroyed (10%) and the percentage of major accidents (13%), and also boasts the lowest average number of injuries per accident (0.46) and fatal injuries per accident (0.15). As a result, instructional flights tied with scheduled passenger flights for the lowest average adverse outcome score. Eighty-one percent of accidents in this regime were flown in single-engine (piston) aircraft with fixed landing gear. Roughly half of these accidents involved runway excursion (29%) or abnormal runway contact (23%). Together with loss of control (both in flight and on ground) these four categories accounted for 72% of flight instruction accidents.

Intentional Low-Level Flights

Intentional low-level flights comprise only five percent of the accidents, but they represent the highest percentage of injuries (66%) and fatal accidents (47%), and the second highest number of injuries per accident (1.4) and fatal injuries per accident (0.8). More of the aircraft were destroyed (39%) than in any other regime and more than half of the accidents were classified as major. As a result, this regime had the highest average score of the seven adverse outcomes, indicating the highest level of risk. Forty percent of the pilots held only a private license. Ninety-two percent of the aircraft had single piston engines. Not surprisingly, sixty percent of these accidents were assigned to the accident category Low Altitude Operations. Thirty-five percent of this regime experienced loss of control – in flight, and seventeen percent resulted in post-impact fire. Twenty-five percent experienced both low altitude operations and loss of control – in flight. These three categories, collectively, accounted for 71% of the accidents in this regime.

Personal Local Flights

Personal local flights comprise the second largest accident regime, but only 11% of the accidents were fatal, 11% of the aircraft were destroyed and one third of those on board were injured. In terms of accident severity, personal local flights were third lowest in the percentage of major accidents. Personal local flights tied with aircraft movement flights for middle of the pack with regard to safety. The pilots were the oldest of any regime, although 65% held only a private

license. Less than half of one percent of the accidents were flown in an aircraft with other than a piston engine. Five accident categories accounted for 73% of the accidents, with loss of control – on ground and runway excursion leading the way.

Personal Cross-Country Flights

Personal cross-country flights comprise the largest accident regime, and pilot age and certification were very similar to those in personal local flights. However, nearly half of the persons on board were injured, nearly one quarter of the aircraft were destroyed, and 24% of the accidents were fatal. Personal cross-country flights had the second highest average adverse outcome score. Slightly fewer of the aircraft flown had piston engines, compared with local flights, but of those that did, more had multiple engines and/or retractable landing gear. The accident categories associated with cross-country flights are similar to the local flights, except that local flights tend to have more loss of control – on ground, and cross-country flights tend to have more loss of control – in flight, as well as more post-impact fire. Six accident categories, the same five as in local flights, plus post-impact fire, accounted for 73% of the accidents.

Other Work Related Flights

Compared with the statistics for all accidents in this time period, more than twice as many persons on board work-related flights were injured, but the average number of injuries and fatal injuries were similar, and the percentages of fatal accidents, aircraft damage and accident severity were similar. The average adverse outcome score was third lowest among the ten regimes, which makes this regime above average in terms of safety risk. Pilot age is a little lower than the overall average, and nearly twice as many of the pilots in this regime held a commercial license. Seventy-eight percent of the accident aircraft had a single piston engine, while three percent were business jets and ten percent were turbo-props. There were no unusual accident categories, and six categories accounted for 72% of the accidents in this regime.

Unclear Flight Purpose

This flight purpose regime is the smallest of the ten regimes, but forty-seven percent (the highest percentage) of these accident were fatal. In many cases, the fatality contributed to being placed in this regime, because many of the flight details were unknown, and there were no survivors to interview. More than half of those on board were injured, thirty-eight percent of the aircraft were destroyed, and half of the accidents were classified as major. All of this combined to give this regime the third highest adverse outcome average score. Eighty percent of the accidents were in aircraft with a single piston engine. Twenty-four percent of these accidents were security-related, with some evidence of illegal activity including stolen aircraft. Twenty-one percent were categorized as loss of control – in flight, and for eighteen percent the accident category could not be determined. There was very little overlap in those categories, as the three accounted for 61% of the accidents in this regime.

Conclusions

Despite the high number of injuries per accident, scheduled passenger flights carried the lowest overall risk of adverse outcomes (injuries, fatal accidents, aircraft destruction, major accidents). What might be surprising is that, despite the much lower degree of pilot certification, instructional flights earned the same average score as scheduled passenger flights. Roughly half of scheduled passenger flight accidents were either encounters with turbulence or ground handling accidents, while roughly half of instructional flight accidents were abnormal runway contact (mostly hard or bounced landings) or runway excursions. Accidents in these four categories have much lower rates of aircraft destruction (5.5% combined) and fatality (4.8% combined) than was seen among all accidents combined.

The two regimes with the highest risk of adverse outcome are intentional low-level flight and personal cross-country flights. These regimes have two of the three highest percentages of loss of control – in flight. It is not surprising that intentional low-level flight tops the list, since the nature of the flight path makes it more difficult to recover from issues such as system/component failure or loss of engine power, temporary distractions or prolonged lack of visual lookout. Personal cross-country flights represent the largest group of accidents in this time period and the most injuries, with nearly half of persons on board being injured. Otherwise, the rates of various adverse outcomes were not unusually large. It is clear, however, that personal cross-country flights carry more risk than personal local flights.

The results of this study contained many surprises for this author, the greatest of which was the high adverse outcome scores associated with non-scheduled passenger flights. However, the ancillary analysis shows the flights with a paid, professional crew are much safer than the others, with the third best score in that subgroup. Also expected was a higher rate of adverse outcome among other work related flights, given the opportunities for problems on skydiving flights, banner tow or glider tow flights, yet this regime had the third best average score (fourth if one considers two scores for non-scheduled passenger flights).

Regardless of the purpose of the flight, certain accident categories were more commonly assigned than others. In particular, loss of control – in flight occurs frequently in every regime except scheduled passenger flight. Additionally, runway excursion, loss of control – on ground, abnormal runway contact and fuel-related loss of engine power are a major part of all but three regimes (scheduled passenger flight, intentional low-level flight, and other or unclear).

Despite the many similarities between various flight purpose regimes, it is clear that not all flights carry the same risk of adverse outcome.

Appendix A

Aviation Occurrence Categories

The CAST/ICAO Common Taxonomy Team (CICTT) was jointly chartered by the International Civil Aviation Organization (ICAO) and the Commercial Aviation Safety Team (CAST), and was charged with developing common taxonomies and definitions for aviation accident and incident reporting systems (for additional information see http://www.intlaviationstandards.org/). The occurrence categories are listed below, with brief descriptions of each. The information is taken from a document dated October 2008.

CICTT Categories

Abnormal Runway Contact (ARC): Any takeoff or landing involving abnormal contact with the runway or landing surface. Included are hard/heavy landings, long/fast landings, crabbed landings, nose wheel first touchdowns, tail strikes, wing/nacelle strikes and gear up landings.

Abrupt Maneuver (AMAN): The intentional abrupt maneuvering of the aircraft (in-flight or on-ground) by the flight crew to avoid a collision with terrain, objects, weather or other aircraft.

Aerodrome (ADRM): Occurrences involved aerodrome design, service or functionality issues. The aerodrome includes runways, taxiways, ramp areas, parking areas, buildings and structures, lighting, signage Crash/Fire/Rescue (CFR) services.

ATM/CNS (ATM): Occurrences involving air traffic management (ATM) or communication, navigation or surveillance (CNS) service issues.

Bird Strike (BIRD): Occurrences involving collisions or near collisions with bird(s) or wildlife.

Cabin Safety Events (CABIN): Includes significant events in the passenger cabin, related to carry-on baggage, supplemental oxygen, missing/non-operational emergency equipment, the inadvertent deployment of emergency equipment, and the medical emergency (not caused by turbulence encounters) of persons other than the flight crew or medical evacuation patients.

Collision with Obstacle(s) During Takeoff and Landing (CTOL): A collision with an object or obstacle during airborne phases of take-off or landing.

Controlled Flight into or toward Terrain (CFIT): In-flight collision or near collision with terrain, water or obstacle without indication of loss of control. Excludes intentional low altitude operations, intentional flight into terrain and runway undershoot/overshoot.

Evacuation (EVAC): Occurrences including one or more of the following: an unnecessary evacuation was performed, person(s) were injured during the evacuation, evacuation equipment failed to perform as required, or the evacuation was a factor in the outcome.

External Load Related Occurrences (EXTL): Occurrences during or as a result of external load or external cargo operations. Includes cases where external load or the load lifting equipment contacts terrain, water surface or objects.

Fire/Smoke Non-Impact (FI-NI): Fire or smoke in the aircraft (in-flight or on-ground), which was not the result of an impact.

Fire/Smoke Impact (FI-POST): Fire or smoke resulting from impact.

Fuel Related (FUEL): One or more powerplants experienced reduced or no power output due to fuel exhaustion (no usable fuel on board), fuel starvation (usable fuel is not available to the engine), fuel contamination (by water, sand, dirt, bugs) or wrong fuel, or carburetor and/or induction icing.

Glider Towing Related Events (GTOW): Premature release, inadvertent release or non-release during towing, entangling with towing, cable, loss of control, or impact into towing aircraft/winch.

Ground Handling (RAMP): Occurrences during (or as a result of) ground operations, including preflight configuration errors that lead to subsequent events (such as improperly latched doors, pitot tube contamination, or weight/balance issues).

Ground Collision (GCOL): Collision with an aircraft, person, animal, ground vehicle, building, etc., while taxiing to or from the runway in use.

Icing (ICE): The accumulation of snow, ice, freezing rain or frost on aircraft surfaces to the extent that aircraft control or performance is adversely affected.

Loss of Control – Ground (LOC-G): Loss of aircraft control while the aircraft is on the ground, which may result from a contaminated runway, evasive action due to a runway incursion, or the failure or malfunction of a system or component.

Loss of Control – In flight (LOC-I): Loss of aircraft control while in flight; may occur in Instrument Meteorological Conditions (IMC) or Visual Meteorological Conditions (VMC).

Loss of Lifting Conditions En-Route: (LOLI): Landing en-route due to loss of lifting conditions. Applicable only to aircraft that rely on static lift to maintain or increase flight attitude, namely sailplanes, gliders, hang gliders, and paragliders, balloons and airships.

Low Altitude Operations (LALT): Collision or near collision with terrain/objects/obstacles while intentionally operating near the surface (excludes landing and takeoff phases). Includes aerobatics, sightseeing, aerial photography, aerial application, scud running, and flying in close proximity to mountains or box canyons where the aircraft aerodynamic capability is not sufficient to avoid impact.

Airprox/TCAS Alert/Loss of Separation/Near Mid-Air Collision/Mid-Air Collision (MAC): Airprox, TCAS alerts and loss of separation, as well as near collisions or collisions between aircraft in flight. [Note: In the United Kingdom, an aviation near miss report is known as an "airprox", an air proximity hazard.]

Other (OTHER): Any occurrence not covered under another category.

Runway Excursion (RE): A veer off the side or overrun off the end of the runway.

Runway Incursion – Vehicle, Aircraft or Person (RI-VAP): The incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for takeoffs or landings.

Security Related (SEC): Criminal or security related acts such as hijacking, aircraft theft, flight control interference, sabotage or suicide.

System/Component Failure or Malfunction – Non-powerplant (SCF-NP): Failure or malfunction of an aircraft system or component other than the powerplant.

System/Component Failure or Malfunction – Powerplant (SCF-PP): Failure or malfunction of an aircraft system or component related to the powerplant.

Turbulence Encounter (TURB): In flight encounter with turbulence; includes clear-air or cloud turbulence, mountain wave and wake vortex.

Unintended Flight in Instrument Meteorological Conditions (UIMC): Applicable if the pilot was flying according to Visual Flight Rules (VFR), and by any reason found oneself inadvertently in IMC. Only to be used if pilot not qualified to fly in IMC and/or aircraft not equipped to fly in IMC, and only in the case of a loss of visual references.

Undershoot/Overshoot (USOS): A touchdown off the runway surface but in close proximity to the runway. Excludes off-airport emergency landings.

Unknown or Undetermined (UNK): Insufficient information exists to categorize the accident; includes missing aircraft.

Wildlife (WILD): Collision with, risk of collision with, or evasive action taken by an aircraft to avoid an animal (other than birds) on the runway in use. Previously known as Runway Incursion – Animal (RI-A).

Windshear or Thunderstorm (WSTRW): Flight into windshear or thunderstorm; includes hail and heavy rain.

Additional Categories

Many of the following categories were added in order to completely capture the event sequence. An emergency landing is required in most cases of System/Component Failure/Malfunction and Loss of Engine Power, and may be performed after an encounter with adverse weather; this landing often is not without further incident. Control of the aircraft may be lost, hard or bounced landings may occur, terrain unsuitable for a proper landing may be encountered, the aircraft may collide with power lines, fences or ground vehicles during an off-airport landing, the aircraft may be unable to avoid rising terrain due to degraded performance. The single category of "Loss of Engine Power" is not sufficient to explain why the aircraft was destroyed.

Several categories (collisions with terrain or objects and loss of control) were further subdivided by general phase of flight (ground, takeoff, in flight, approach/landing) because either the root cause or the consequences of the occurrence differ by phase of flight.

Collision with Object – Precautionary Landing (CWO-PL): A collision with an object or obstacle occurred during a precautionary landing approach. CFIT is not an appropriate category in these cases because a system/component failure/malfunction or non-mechanical loss of engine power necessitated the landing.

Collision with Terrain – Precautionary Landing (CWT-PL): A collision with terrain occurred during a precautionary landing approach. CFIT is not an appropriate category in these cases because a system/component failure/malfunction or non-mechanical loss of engine power necessitated the landing. This code was also used in cases where the pilot "ditched" the aircraft in water.

Encounter with Terrain – Precautionary Landing (EWT-PL): An encounter with terrain occurred on the ground away from an airport environment during a precautionary landing, causing damage to the aircraft. The difference between this category and CWT-PL is primarily the force with which the aircraft strikes the ground at touchdown. An encounter with terrain involves a normal touchdown, with rough terrain encountered during the landing roll. Included here are intentional gear-up off-airport landings.

Pilot Incapacitation or Severe Impairment (INCAP): Pilot became incapacitated (due to illness or fatigue) or severely impaired (due to illness, alcohol or illegal drugs). Does not include minor impairment caused by fatigue or the use of unapproved prescription medications.

Loss of Engine Power – Fuel Related (PL-FUEL): Loss of engine power due to fuel exhaustion (no usable fuel on board), fuel starvation (usable fuel is not available to the engine), fuel contamination (by water, sand, dirt, bugs) or wrong fuel, or carburetor and/or induction icing (see FUEL above).

Loss of Engine Power – Other Reasons (PL-OTHER): Loss of engine power due to other non-mechanical reasons. Reasons include foreign object damage (e.g. bird strikes), ice ingestion, improper simulated engine out procedures, other improper procedures.

Loss of Engine Power – Unknown Reasons (PL-UNK): Loss of engine power occurred but the exact cause was undetermined.

System/Component Failure or Malfunction – Stress Limits Exceeded (SCF-SLE): Structural failure due to exceeding the designed stress limits of the aircraft, most often resulting from loss of control, from forces associated with severe weather or from pilot actions such as excessive airspeed or abrupt maneuvering.

Appendix B

List of Specific Aircraft Make and Model Within Each Aircraft Group

	Wide-Body Jet Airliner	Narrow Body Jet Airliner
Airbus	A300 A310 A330 A340 A380	A318 A319 A320 A321
Boeing	747 767 777 787	707 717 727 737 757
Lockheed	L-1011 TRISTAR	
McDonnell-Douglas	DC-10 MD-11	DC-8 DC-9 MD-80 MD-90
British Aerospace		BAE-146
British Aircraft Corporation		BAC One-Eleven

Regional Jet

Canadair-Bombardier	CRJ-100 CRJ-200 CRJ-700 CRJ-900 CRJ-5000
Embraer	ERJ-135 ERJ-140 ERJ-145 ERJ-170 ERJ-190
Fairchild	DO-328 (series 300)
Fokker	F-100 F-28

Medium Business Jet

Aero Commander	Jet Commander 1121
Aerospatiale	Corvette
Bombardier	Challenger BD-100
Cessna	Citation II (CE-550) Citation V (CE-560) Citation III (CE-650) Citation Sovereign Citation X (CE-750)
Dassault	Falcon 10-100 Falcon 20-200 Falcon 50 Falcon 900 Falcon 2000
Gulfstream	GA-1159 Gulfstream II Gulfstream III Gulfstream IV Gulfstream V
Hamburger Flugzeugbau	320
Beech	Hawker-800
HS-BAE Systems	125-HAWKER
Raytheon	125-HAWKER BeechJet 400
Israel Aircraft Industries	Astra Gulfstream G150 Gulfstream G200 Westwind

Medium Business Jet (continued)

Learjet	24 25 31 35 36 45 55 60
Lockheed	Jetstar
Mitsubishi	300
Rockwell	Sabreliner

Small Business Jet

Cessna	Citation I CitationJet Mustang T-37 (military)
Eclipse	500
Embraer	EMB-500
Learjet	23
Morane Saulnier	MS-760
Raytheon	390

Large Turbo-prop

ATR	42 72
Convair	CV-580 CV-600 CV-640
De Havilland	Dash 7 Dash 8
Fokker	F-27
HS-BAE Systems	BAE-ATP
Lockheed	L-188 L-382
NAMC	YS-11

Medium Turbo-prop

Aerospatiale	NORD-262
Air Tractor	602 802
Beech/Raytheon	BE-100 BE-200 BE-300 99 1900
CASA	212
De Havilland	DHC-6
Douglas	DC-3 (Turbo conversion)
Embraer	EMB-110 EMB-120

Medium Turbo-prop (continued)

Fairchild	DO-228 DO-328 (series 100)
Fairchild-Swearingen Metro	SA-226 SA-227
GAF-ASTA	Nomad
Grumman	73-T
Gulfstream	Gulfstream I
Jetstream-BAE Systems	31 41
Rockwell	OV-10
Saab	340
Short Brothers	3-60 SC.7 Skyvan

Small Turbo-prop

Ayres	Turbo Thrush
Air Tractor	AT-400 AT-402 AT-503 AT-504
Beech/Raytheon	BE-18 (conversions) BE-36 (conversions) BE-45 (T-34C) BE-60-T BE-90
De Havilland	DHC-2-MKIII DHC-3T

Small Turbo-prop (continued)

Cessna	CE-206 CE-207 CE-208 CE-210 CE-421 CE-425 CE-441
Fairchild-Swearingen	SA-26
Grumman	G-164
Gulfstream	GA-164 GA-680 GA-681 GA-690 GA-695
McKinnon	G-21
Mitsubishi	MU-2B
Partenavia	AP-68-TP
Piaggio	P180
PZL-Mielec	M-18/T-45
Pilatus	PC-6 PC-7 PC-12
Piper	PA-31T PA-42 PA-46-310TP, PA-46-350TP, PA-46-500TP
Quest	Kodiak
Reims	F406
SIAI Marchetti	SF-260-TP
Socata	TBM-700

Heavier Multi-Engine (Reciprocating)

Boeing	B-17
	B-307
Convair	CV-240
	CV-340
	CV-440
Curtiss	C-46
De Havilland	DHC-4
Douglas	DC-3
	DC-4
	DC-6
	DC-7
	DC-A20
	DC-A26
Fairchild	C-119
	C-123
Grumman	C-1
	G-111
	HU-16
	S-2F
	TS-2A
Lockheed	L-1049
	L-18
	L-49
	P-2V
	P-38
Martin	B26

Lighter Multi-Engine (Reciprocating)

Beagle	206
Beech	BE-18 BE-50, BE-55, BE-56, BE-58 BE-60, BE-65, BE-70, BE-76, BE-95
Beriev	BE-103
Britten-Norman	Islander Tri-Islander Defender
Stout Bushmaster	2000
Camair	480
Cessna	CE-303, CE-310, CE-320 CE-335, CE-336, CE-337, CE-340 CE-401, CE-402, CE-404 CE-411, CE-414, CE-421 T-50 (Military)
Champion	Lancer
De Havilland	DHC-90
Dornier	DO-28
Grumman	21, 44, 73
Gulfstream	GA-7, GA-500, GA-520, GA-560 GA-680, GA-685 GA-700, GA-720
Lockheed	L-12
Navion	D-16
Piper	PA-23 PA-30, PA-30A, PA-30B PA-31, PA-34, PA-39 PA-44, PA-60

Lighter Multi-Engine (Reciprocating) (continued)

Partenavia	P-68
STOL Aircraft Corp	UC-1
Tecnam	P2006T
Wing Aircraft	D-1

Single-Engine (Reciprocating) Retractable Gear

Beech	BE-17 BE-23 (series codes 24R, A24R, B24R, C24R) BE-33, BE-35, BE-36 BE-45 (except BE-45-T34C)
Bellanca	BL-14, BL-17, BL-260
Cavalier	Mustang
Cessna	CE-172-RG CE-177-RG CE-182-RG CE-182-TR CE-210
Colonial Aircraft	C-1, C-2
Columbia	XJL
Culver	LCA, LFA, V, TD-2, PQ-14
Curtiss-Wright	P-40
Diamond	DA-42
Globe	GC-1
Grob	G-115, G-120

Single-Engine (Reciprocating) Retractable Gear (continued)

Grumman	Avenger
Gulfstream	GA-112, GA-114
Lake	LA-4
Meyers	Aero Commander 200 MAC-145
Mooney	M-18, M-20, M-22
North American	AT-6 SNJ-2, SNJ-4, SNJ-5, SNJ-6 Harvard
Navion	NAV-1, NAV-4 NAV-A, NAV-B, NAV-D NAV-G, NAV-H, NAV-L
Piper	PA-24, PA-28R, PA-28RT PA-32S-300 PA-32R, PA-46
Raytheon	Commander 114
Reims	FR-182
SIAI Marchetti	S-205 SF-260 FN-333
Socata	TB-20
Spartan	7W
STOL Aircraft	RC-3
Thurston	Teal TSC-1A
Yakovlev	Yak-3

Single-Engine (Reciprocating) Fixed Gear

Aero Mercantil	Gavilan 358
Air Tractor	AT-301 AT-400, AT-401 AT-501, AT-502
AMD	Alarus-2000
American Legend	AL-11 AL-3
Avions Robin	R-2160
Arctic	S1A, S1B
Aeronca	AR-7, BL-7, AR-11, AR-15 AR-50, AR-65 AR-C3, AR-K, AR-L3 Bubeck-Irving
Aviat	A-1
Ayres	Thrush
Bellanca	BL-7, BL-8, BL-11 BL-DW1
Beech	BE-19, BE-23, BE-77
Boeing	B-75
Call Aircraft	A-2, A-3, A-9
Centaur	Longren
Cessna	CE-120, CE-140, CE-145, CE-150, CE-152 CE-165, CE-170, CE-172, CE-175, CE-177 CE-180, CE-182, CE-185, CE-188 CE-190, CE-195, CE-205, CE-206, CE-207, CE-305
Champion	Champ-7, Champ-8

Single-Engine (Reciprocating) Fixed Gear (continued)

Cirrus	SR-20, SR-22
Columbia	350
Commonwealth	Skyranger, Sportster
Convair – General Dynamics	BT-13, BT-15, CV-L13
Cub Crafters	CC-18
Culver	Dart-G
DeHavilland	DHC-1, DHC-2, DHC-3, DHC-60, DHC-82, U-6
Diamond	DA-20, DA-40
Dornier	DO-27
Eagle	DW-1
ERCO	Alon-415 Ercoupe-415 Forney-415
Emigh	Trojan
Extra	EA
Fairchild	F-24, M-62 PT-19, PT-23, PT-26
Fieseler	Fi-156
Fleet	Model 16
Found	FBA-2
Funk	Model B
Great Lakes	2T1
Grumman	G-164

Single-Engine (Reciprocating) Fixed Gear (continued)

Gulfstream	GA-AA, GA-AG
Helio	H-250, H-295, H-391, H-395 H-700, H-800
Helton	Lark-95
Howard	DGA-15
Lancair	LC-40, LC-41, LC-42
Liberty	XL-2
Lockheed	L-402
Luscombe	LL-8, LL-11 Phantom
Maule	M-4, M-5, M-6, M-7, M-8 MX-7, MT-7, MXT-7
MBB	BO-209
Meyers	OTW
Monocoupe	D-145
Morane-Saulnier	MS-880, MS-893, MS-894
Mooney	M-10
Moravan	Zlin-242
Mudry	CAP-10
Naval Aircraft Factory	N3N-3
New Standard	D-25
Noordyun	UC-64
OMF	Symphony

Single-Engine (Reciprocating) Fixed Gear (continued)

Pilatus	PC-6-350
Piper	L-21, L-4 PA-11, PA-12, PA-14, PA-15, PA-16 PA-17, PA-18, PA-19 PA-20, PA-22, PA-25, PA-28 PA-32, PA-36, PA-38 PA-J2, PA-J3, PA-J3C, PA-J3F, PA-J3L, PA-J4, PA-J5
Pitts	S-1, S-2
Porterfield	CP-35, CP-50, CP-55, CP-65, FP-65, LP-65
PZL-Mielec	M-18, M-104, M-150, M-160, AN-2
Quartz Mountain	11E
Rawdon	T-1
Rearwin	Cloudster
Reims	FA-150, FR-172
Rockwell	Commander-100
Rose	Parakeet
Ryan	ST-A, ST-3, SCW-145
Socata	TB-9, TB-10, TB-200, MS-Ralleye
Stinson	AT-19, SR-7, SR-8, SR-10, SR-V77, SR-JR, SR-L5, SR-108
Stampe	SV-4
Sukhoi	SU-26, SU-29
Taylorcraft	15A, 19, 20, 21, 22 BC, BF, BL DC, DF, DL
Tecnam	P-2002

Single-Engine (Reciprocating) Fixed Gear (continued)

Timm	N2T
Varga	2150A, 2180
Volaircraft	Aero Commander 100
WACO	AGC, AQC, ARE, ASO, ATO, AVN BSO, CRG, CUC, GXE, HRE, QCF RNF, SRE, UBF, UIC, UKC, UKS, UPF VKS, YKS, YMF, YPF, ZPF
Weatherly	201, 620
XtremeAir GMBH	Sbach-342
Zenair	CH-2000

Light Sport Aircraft

Aero Ltd.	AT-4
Aeropro	Eurofox
Aerosport	Ikarus
Aerospool	WT-9 (Dynamic)
AMD	CH-601 (Zodiac)
Arion	Lightning
Aveko	VL-3
B&F Technik	FK-9
Bush Caddy	LSA
Cessna	CE-162
Colyaer	Freedom
Cub Crafters	CC-11
Czech Aircraft Works	Dynamic Mermaid Parrot Sport Cruiser PiperSport
Diamond	DV-20
Dova	DV-1
Evektor	Sportstar
Fantasy Air	Allegro 2000
Flight Design	CT
FPNA	A-22
Gryf Aircraft	MD-3

Light Sport Aircraft (continued)

Higher Class Aviation	Sport Hornet
Indus	Thorp T-11 Thorp T-211
Iniziative	Sky Arrow 600
Jabiru	J-170, J-230, J-250
Jihlavan	KP-5
M-Squared	Breese II
Moravan/Zlin	Savage
Paradise	P1
Quicksilver	GT-500
Rans	S-7LS
Remos	G3, GX
Skykits	Savannah
SportAir	Stingsport Sting S-3
Tecnam	P-92, P-2004

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14. ABSTRACT

Civilian aircraft are flown for many different reasons, including passenger transport, cargo delivery, flight instruction and pleasure. For the analysis reported here, the primary flight purpose was determined for twenty consecutive years of civil aviation accidents and differences in various factors were examined among nine general regimes. Some of the factors examined were the accident severity, aircraft characteristics and accident occurrence categories. In general, the lowest incidence of adverse outcomes (injuries, fatal accidents, aircraft destruction, major accidents) occurred in scheduled passenger flights and instructional flights, while the highest incidence of adverse outcomes was seen in intentional low-altitude flights and personal cross-country flights. Regardless of the purpose of the flight, certain accident categories were more common than others. In particular, loss of control – in flight occurs frequently in every regime except scheduled passenger flight. Additionally, runway excursion, loss of control – on ground, abnormal runway contact and fuel-related loss of engine power are a major part of all but three regimes.

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