



AVIATION
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SAFETY DATA REPORT

U.S. NTSB ACCIDENT DATA 2016–2025

Fixed-Wing and Rotary-Wing Defining Events in GA Business,
Executive/Corporate and Part 135 On-Demand Operations



LET THE DATA SPEAK

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Terms and acronyms

Table 1 defines the key terms used throughout the report, and Table 2 lists the acronyms. NTSB data fields are defined in Section 2.9 (Table 6).

Table 1. Key terms

Term	Meaning in this report
Type of operation	The NTSB operation category of the flight: GA Business, GA Executive/Corporate or Part 135 On-Demand. Each type of operation is analyzed separately (Section 2.2).
Study period	Accidents with an event date from January 1, 2016, through December 31, 2025.
Defining event	The NTSB DefiningEvent category assigned to each accident. In this report, "event" means a defining-event category, never a single accident.
Accident, fatal accident, fatality	The three measures. Each accident is counted once even when more than one aircraft is involved (event totals; Section 2.5).
n	Sample size: the number of accidents, fatal accidents or fatalities in the type of operation for the study period.
Share	A defining event's percentage of the type-of-operation total for the same measure. A share is not a rate.
Other (defining event)	The CICTT occurrence category for any occurrence not covered under another category (CICTT, 2017). Kept in totals and denominators but not ranked (Section 2.9).
Rate	Accidents, fatal accidents or fatalities per 100,000 flight hours, using FAA flight-hour estimates (Section 6.2).

Table 2. Acronyms

Acronym	Meaning
CAROL	Case Analysis and Reporting Online (NTSB)
CAST	Commercial Aviation Safety Team
CICTT	CAST/ICAO Common Taxonomy Team
FAA	Federal Aviation Administration
GA	General aviation
ICAO	International Civil Aviation Organization
IMC	Instrument meteorological conditions
NTSB	National Transportation Safety Board
UPRT	Upset prevention and recovery training
USHST	U.S. Helicopter Safety Team

Executive summary

This report analyzes National Transportation Safety Board (NTSB) records of accidents from January 1, 2016, through December 31, 2025, in three U.S. types of operation: GA Business, GA Executive/Corporate and Part 135 On-Demand (NTSB, 2026). Airplanes (fixed-wing) and helicopters (rotary-wing) are analyzed separately. In each type of operation, the NTSB defining-event categories are ranked three ways, by fatalities, by fatal accidents and by accidents, and each ranked defining event is reported with all three counts. The reader sees both how often a defining event occurred and what it cost in lives. Table 3 gives the ten-year totals (*n*) for each type of operation, 2016–2025, with the leading defining event by fatalities, by fatal accidents and by accidents.

Table 3. Ten-year totals and leading defining events

Aircraft	Type of operation	Accidents (<i>n</i>)	Fatal accidents (<i>n</i>)	Fatalities (<i>n</i>)	Leading defining event by fatalities (share of fatalities)	Leading defining event by fatal accidents (share of fatal accidents)	Leading defining event by accidents (share of accidents)
Fixed-wing	GA Business	202	42	102	Loss of Control In-Flight (59%)	Loss of Control In-Flight (57%)	Loss of Control In-Flight (21%)
Fixed-wing	Executive / Corporate	38	2	6	Loss of Control In-Flight (83%)	Loss of Control In-Flight (50%)	System/Component Failure - Non-power (18%)
Fixed-wing	Part 135 On-Demand	237	41	92	Loss of Control In-Flight (24%)	Loss of Control In-Flight (27%)	Abnormal Runway Contact (14%)
Rotary-wing	GA Business	35	6	11	Loss of Control In-Flight (27%)	Loss of Control In-Flight (33%)	Loss of Control In-Flight (14%)
Rotary-wing	Executive / Corporate	1	1	1	Unintended Flight Into IMC (1 accident)	Unintended Flight Into IMC (1 fatal accident)	Unintended Flight Into IMC (1 accident)
Rotary-wing	Part 135 On-Demand	131	29	88	Unintended Flight Into IMC (40%)	Unintended Flight Into IMC (24%)	Loss of Control In-Flight (15%)

Totals include accidents coded Other or Unknown; these are not ranked. In fixed-wing Executive/Corporate, two events tie on fatal accidents (Appendix A).

Key findings

1. Loss of Control In-Flight leads fatalities in every fixed-wing type of operation. It

accounts for 59% of GA Business fatalities, 83% of Executive/Corporate fatalities and 24% of Part 135 On-Demand fatalities, and it leads or shares the lead for fatal accidents in each (Figure 1).

2. The event that kills most is not the event that happens most. In fixed-wing GA Business,

Loss of Control In-Flight accounts for 21% of accidents, 57% of fatal accidents and 59% of fatalities. In fixed-wing Part 135 On-Demand, the most frequent event, Abnormal Runway Contact, accounts for 14% of accidents, 2% of fatal accidents and 2% of fatalities.

3. In Part 135 helicopter operations, Unintended Flight Into IMC leads fatalities.

Unintended Flight Into IMC is the NTSB category for unintended flight into instrument meteorological conditions (IMC). It accounts for 8% of accidents, 24% of fatal accidents and 40% of fatalities.

4. Helicopter GA Business follows the airplane pattern, on small totals. Loss of Control

In-Flight leads all three measures, with 14% of accidents, 33% of fatal accidents and 27% of fatalities ($n = 35$ accidents and 6 fatal accidents in ten years).

5. Estimated accident rates differ widely by type of operation.

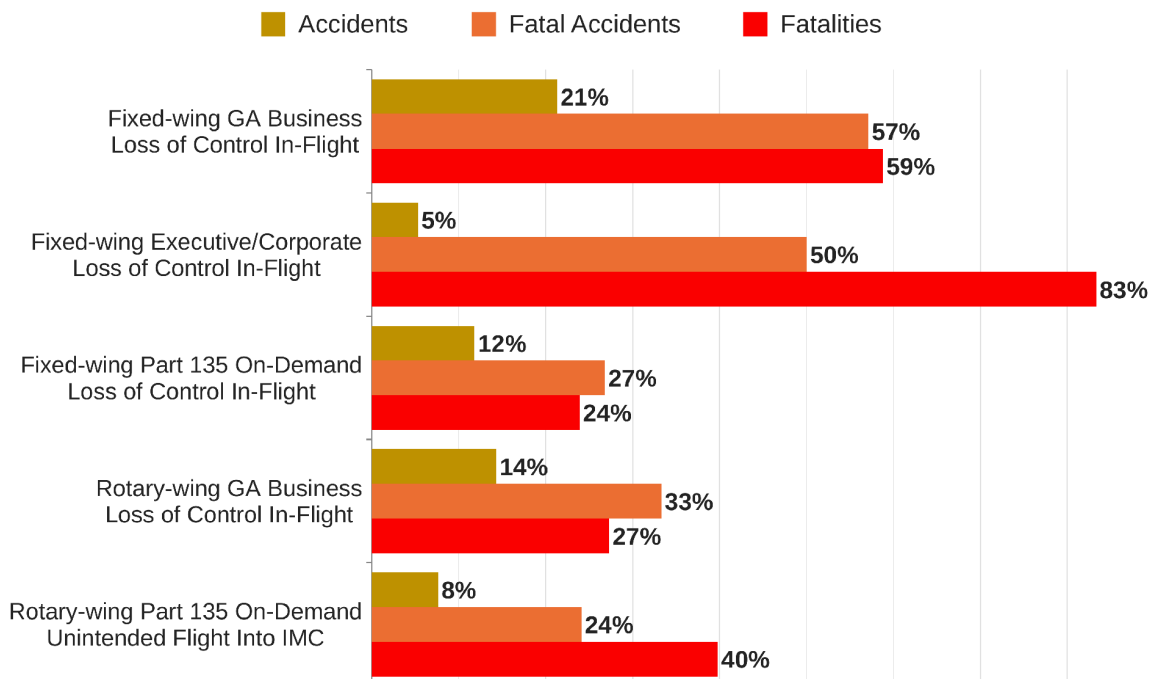
Using Federal Aviation Administration (FAA) survey flight hours for 2016–2024, with 2025 extrapolated (FAA, 2017–2025), estimated fixed-wing accident rates are 1.33 per 100,000 hours in GA Business, 0.83 in Part 135 On-Demand and 0.17 in Executive/Corporate (Section 6.2).

6. The loss-of-control pattern matches worldwide commercial jet data for the same ten

years. In Boeing's summary for 2016–2025, Loss of Control In-Flight accounted for 6 of 31 fatal accidents and 428 of 1,115 onboard fatalities (38%), more than any other category (Boeing Commercial Airplanes, 2026).

Executive Summary

The Defining Event Behind the Most Fatalities in Each Type of Operation, 2016–2025



Share of the type-of-operation total for the same measure. Percentages use all defining-event lookups, including Unknown and Other. n (accidents, fatal accidents, fatalities) is shown on each section divider. Executive/Corporate fixed-wing: $n = 2$ fatal accidents; rotary-wing Executive/Corporate ($n = 1$ accident) not shown. IMC: instrument meteorological conditions.

Source: NTSB accident data, 2016–2025.

Figure 1. Leading-event shares by measure

Figure 1 shows, for the leading defining event by fatalities in each type of operation, its share of accidents, fatal accidents and fatalities, 2016–2025. It shows the gap between frequency and consequence. In every type of operation shown, the leading defining event's share of fatalities is larger than its share of accidents. The fixed-wing Executive/Corporate shares rest on $n = 2$ fatal accidents and 6 fatalities and change substantially with a single accident. Rotary-wing Executive/Corporate had one accident, which was fatal (Unintended Flight Into IMC, 1 fatality); with $n = 1$ every share is 100%, so it is reported in Table 3 and Table 10 rather than charted.

What the findings mean

The data point prevention attention toward the defining events that produce the most fatalities, and not only toward those that occur most often. The two leading defining events by fatalities in each type of operation are:

- **Fixed-wing GA Business:** Loss of Control In-Flight (60) and System/Component Failure - Powerplant (11) of 102 fatalities.
- **Fixed-wing Executive/Corporate:** Loss of Control In-Flight (5) and Runway Excursion (1) of 6 fatalities.
- **Fixed-wing Part 135 On-Demand:** Loss of Control In-Flight (22) and Midair (18) of 92 fatalities.
- **Rotary-wing GA Business:** Loss of Control In-Flight (3) and Midair (2) of 11 fatalities.
- **Rotary-wing Part 135 On-Demand:** Unintended Flight Into IMC (35) and Loss of Control In-Flight (12) of 88 fatalities.
- **Rotary-wing Executive/Corporate:** one accident (Unintended Flight Into IMC, 1 fatality).

Loss of Control In-Flight is first or second by fatalities in every type of operation with more than one accident. The shares describe where recorded outcomes concentrated. They do not establish cause, and only the estimated rates in Section 6.2 account for exposure.

1. Introduction and framing

1.1 Purpose

This report is a factual, traceable analysis of accident records supplied by the National Transportation Safety Board (NTSB) for accidents from January 1, 2016, through December 31, 2025 (EventYear 2016–2025). It identifies the defining events associated with the most fatalities, fatal accidents and accidents in three types of operation, for airplanes and helicopters separately, and presents those results in a consistent, repeatable format. The analysis is findings-led: it reports where outcomes accumulated and does not make causal claims from aggregate data. Defining-event names follow the occurrence categories of the CAST/ICAO Common Taxonomy Team (CICTT, 2017), the taxonomy also used by ICAO, Boeing and the USHST, which allows the results to be read against those sources (Boeing Commercial Airplanes, 2026; ICAO, 2025; USHST, 2017).

1.2 What reaches an accident report

Accident records capture only the most consequential end of a wider range of safety events. Heinrich (1931) introduced the widely reproduced idea that serious injuries sit at the top of a much larger base of less serious occurrences, a concept often drawn as a triangle or pyramid. The specific ratios Heinrich proposed have since been examined critically, and Manuele (2011) concluded that they are not soundly supported and that reducing the frequency of minor events will not necessarily produce an equivalent reduction in serious outcomes.

This report uses the triangle for one purpose only: to remind the reader that many events never reach an accident report. The accidents analyzed here are known, reported accidents; the underlying and precursor events that lead to them may be underreported. Figure 2 illustrates that framing. The report does not imply any fixed ratio between accidents and lesser events, and it does not estimate the number of unreported events from these data.

Figure 2 places the NTSB accident records analyzed in this report at the top tier. The lower tiers are shown only to indicate that other events exist outside these data; their size is not known from this analysis. The figure is conceptual and not to scale, and no ratio is implied.

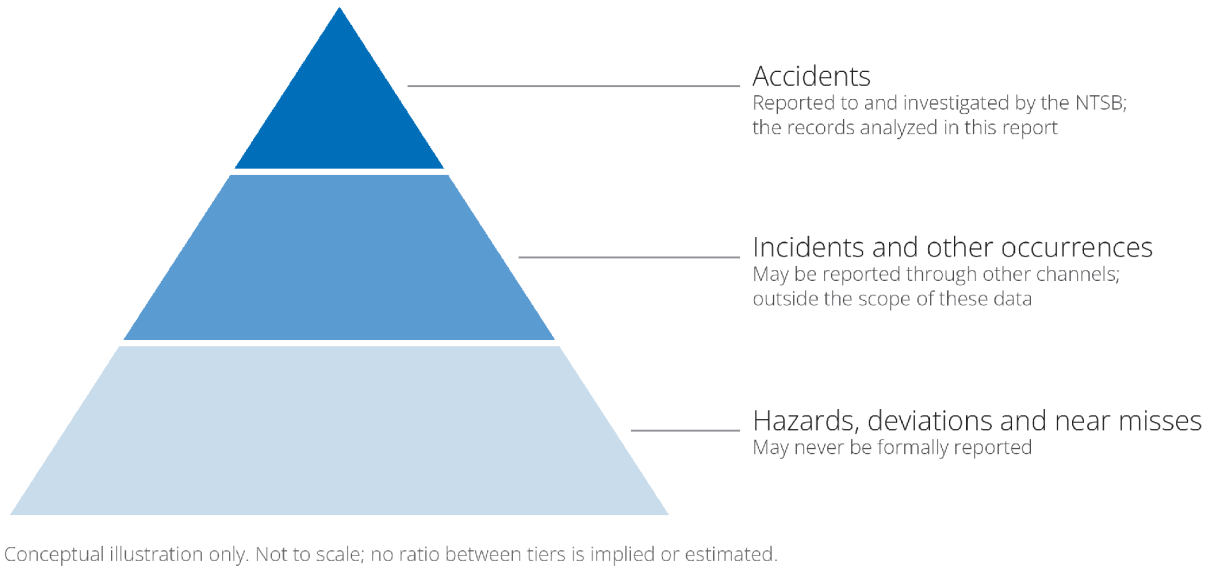


Figure 2. Conceptual framing of reported accidents

1.3 Contribution of this report

Published analyses of U.S. accident data commonly rank occurrence categories by fatal accidents across general aviation as a whole. The NTSB reported that about 47 percent of fatal fixed-wing general aviation accidents from 2008 through 2014 involved loss of control in flight (NTSB, 2016), the FAA ranks loss of control in flight first among the causes of fatal general aviation accidents for 2014 through 2023 (FAA, 2025b), and the USHST assigned one CICTT category to each of 104 fatal helicopter accidents from 2009 through 2013 (USHST, 2017). These analyses focus mainly on fatal accidents and on broad groupings of operations.

Building on that work, this report adds three elements to the published accident statistics for these types of operation. First, it ranks defining events separately by fatalities, fatal accidents and accidents and shows all three measures for every event, so frequency and human consequence can be read together. Second, it treats airplanes and helicopters as separate analyses of the same three types of operation over the same ten years, without pooling. Third, it documents a traceable method designed for annual repetition, and it sets the accident totals against estimated exposure built from published FAA flight-hour data.

1.4 How to read the findings

Each type of operation has three figures, presented in a fixed order: top three defining events by fatalities, by fatal accidents and by accidents. Every figure shows all three measures for each displayed defining event, so the reader can compare human consequence and frequency for the same defining event. The legend gives the sample size (n) for each measure. The callout on each figure identifies the leading defining event and its share of the full type-of-operation total

for the ranking measure. Every bar carries its value. Where ground, external or incidental fatalities beyond the aircraft occupants are recorded, the Fatalities label reads X (Y), where X is total fatalities and Y is the number of those fatalities outside the aircraft. When there are no such fatalities, the label shows X only; X (0) is not used. The supplied extract has no field that separates these fatalities, so every label shows the count only (Section 2.9).

2. Scope and method

2.1 Data source and permission

The accident records were supplied by the NTSB Office of Research and Engineering, Safety Research Division, for this analysis (NTSB, 2026). The NTSB Safety Research Division confirmed that the data may be used in this published report, with the NTSB identified as the data source and without implying NTSB review or endorsement of the analysis (NTSB Safety Research Division, personal communication, October 13, 2026). The fields correspond to those of the NTSB investigation database available through the Case Analysis and Reporting Online (CAROL) system (NTSB, n.d.-b). The analysis reflects the extract obtained on September 21, 2026. Recent records may change as investigations progress and preliminary information is replaced or supplemented by final reports. NTSB-supplied data are treated as a trusted source; the review focuses on the authors' handling of the data: filters, aggregation and interpretation.

2.2 Study period and study operations

Study period. Accidents with an event date from January 1, 2016, through December 31, 2025 (EventYear 2016–2025, calendar years). The earliest record in the extract is dated January 10, 2016, and the latest December 23, 2025.

Study operations. Three types of operation are analyzed separately, using the NTSB OperationCategory field (Table 4):

Table 4. Types of operation and source filters

Type of operation	Source filter
GA Business	OperationCategory = GA Business
GA Executive/Corporate	OperationCategory = GA Executive/Corporate
Part 135 On-Demand	OperationCategory = Part 135 On Demand

RegulationFlightConductedUnder is used only as a reasonableness check on the Part 135 type of operation, not as a replacement filter. Types of operation are not combined.

2.3 Aircraft scope and exclusions

One report contains two separate analyses: fixed-wing airplanes (AircraftCategory = Airplane) first, then rotary-wing aircraft (AircraftCategory = Helicopter), with no pooled totals. The supplied extract contains 672 aircraft rows. Table 5 shows how they divide by aircraft category. The 22 balloon and 2 glider accidents, all in GA Business, are excluded from this report, logged and left for a subsequent report. Aircraft category is taken from the source field and is not inferred from make or model.

Table 5. Supplied records by aircraft category

Aircraft category	Aircraft rows	Accidents (events)	Treatment
Airplane	480	477	Fixed-wing analysis (Section 3)
Helicopter	168	167	Rotary-wing analysis (Section 4)
Balloon	22	22	Excluded and logged
Glider	2	2	Excluded and logged

2.4 Records at non-U.S. locations

N-registered aircraft accident records at non-U.S. locations remain in the analysis as supplied by the NTSB, which confirmed that these records belong in the extract (NTSB Safety Research Division, personal communication, October 13, 2026). Registration and accident location are different attributes; the scope is therefore described as NTSB-supplied accident records, 2016–2025, rather than exclusively U.S.-located accidents. Nine airplane accidents have a non-U.S. or blank country field: eight occurred in Austria, the Bahamas (two), France, Honduras, Ireland, Mexico and the Federated States of Micronesia, and one (ERA19LA096, one fatality) has no country recorded; its location field reads Atlantic Ocean, and its coordinates place it near the Bahamas. One helicopter accident occurred in Afghanistan. Only ERA19LA096 involved a fatality. Retaining these records changes no ranking. No analysis of overseas accident factors is made.

2.5 Unit of analysis: event totals

The report uses the term event totals: each accident is counted once, with aircraft involvement stated separately where it differs. No valid aircraft rows are deleted. The NTSB Safety Research Division confirmed this treatment (NTSB Safety Research Division, personal communication, October 13, 2026).

2.6 Fatalities in multi-aircraft accidents

A source check found that the injury fields in the supplied extract are event totals repeated on each aircraft row. For example, both aircraft rows for CEN19MA141, the May 13, 2019 midair

collision near Ketchikan, Alaska, show the event totals of 6 fatal and 9 serious injuries. These values must not be summed (6, not 12). The analysis counts each accident's fatalities once per event: fixed-wing Part 135 On-Demand Midair has 18 fatalities in total, counting each accident once, compared with 24 if aircraft rows were summed. The same rule applies to the one multi-aircraft helicopter accident, CEN20FA012, a midair collision between two Robinson R22 helicopters in GA Business on October 23, 2019: it counts as one accident with 2 fatalities, not 4. The NTSB Safety Research Division confirmed that the injury fields are event totals and that each accident and its fatalities are counted once (NTSB Safety Research Division, personal communication, October 13, 2026).

2.7 Blank injury fields

Blank FatalInjuries and SeriousInjuries fields follow NTSB guidance: they generally mean zero on the AccidentAircraft and Results_AccidentAircraft_AllGA tabs, with possible exceptions (NTSB Safety Research Division, personal communication, September 29, 2026). Original blanks are preserved in the source files and treated as zero only in calculations. Totals are compared with NTSB summary counts where types of operation match.

2.8 Corrections protocol

Supported corrections and verified gap-filling are allowed. Original NTSB files remain unchanged; any change is made in a working copy with the original value and source recorded, and any change that affects the findings requires co-author agreement. Gaps that could change the findings are prioritized; engine data are enrichment, not a release prerequisite. Every repeated accident identifier is checked to confirm whether it is a midair and that no fatality is counted twice.

2.9 Field definitions

Table 6 defines the terms and NTSB data fields used in this report.

Table 6. Field definitions

Term	Definition used in this report
Accident	An aircraft accident as defined in the NTSB regulation (Definitions, 49 C.F.R. § 830.2, 2026): an occurrence associated with the operation of an aircraft in which any person suffers death or serious injury or the aircraft receives substantial damage. Counted as one unique event after duplicate and multi-aircraft review.
Fatal accident	An accident with FatalInjuries of 1 or more. A fatal injury is one that results in death within 30 days of the accident (Definitions, 49 C.F.R. § 830.2, 2026).
Fatalities	The sum of FatalInjuries, counted once per event. The supplied extract has no separate onboard or ground injury field (see Ground fatalities).

Term	Definition used in this report
Defining event	The NTSB DefiningEvent field, used as the primary category. The NTSB describes the defining event as "the point at which the flight turned from normal operation to abnormal" (NTSB, n.d.-b, Defining Event entry). Category names follow the CICTT occurrence categories (CICTT, 2017). Event-sequence occurrences are not treated as separate primary categories.
Unknown and Other	CICTT categories for occurrences with insufficient information to classify, or not covered by another category (CICTT, 2017). Retained in full lookup tables and in all denominators; not eligible as displayed top-three defined-event categories.
Share (%)	Defining-event total divided by the full type-of-operation total for the same measure, across all defining-event lookups.
Type of operation	The NTSB OperationCategory value: GA Business, GA Executive/Corporate or Part 135 On Demand (Section 2.2).
Ground fatalities	Persons fatally injured outside the aircraft, such as people on the ground. Where present, the Fatalities label reads X (Y): X is total fatalities and Y is the ground, external or incidental fatalities included in X. Where there are none, the label shows X only. NTSB final reports carry a Ground Injuries entry, but the supplied extract does not, so ground fatalities cannot be separated in this analysis. The NTSB confirmed that FatalInjuries includes any persons fatally injured on the ground (NTSB Safety Research Division, personal communication, October 13, 2026).

2.10 Outcome shares, not rates

Percentages describe where recorded outcomes concentrate within each type of operation. They are not rates per flight, per departure or per flight hour, and the supplied records contain no exposure denominator. A share describes how outcomes are distributed among defining events within a type of operation; a rate requires a measure of exposure, such as flight hours (FAA, 2025a). Underlying totals for all three measures are shown alongside every share, and small totals are identified. Section 6.2 adds estimated exposure-adjusted rates from separate FAA data.

2.11 Chart construction

Each chart selects its own top three defined events, sorted by the stated ranking measure, and shows accidents, fatal accidents and fatalities side by side. The callout gives the leading defining event's share of the full type-of-operation total for the ranking measure, never only the displayed events. Ties follow the documented tie-break rule in Appendix A. In fixed-wing Executive/Corporate, only two defined events produced fatalities and fatal accidents; a third category is retained for consistent top-three comparison. Rotary-wing Executive/Corporate, with one accident, is shown as a table. Each chart legend gives n for the three measures.

3. Fixed-wing findings

3.1 GA Business

Fixed-wing GA Business operations include a broad mix of aircraft, missions, airport environments and crew configurations. This type of operation contains $n = 202$ accidents, 42 fatal accidents and 102 fatalities.

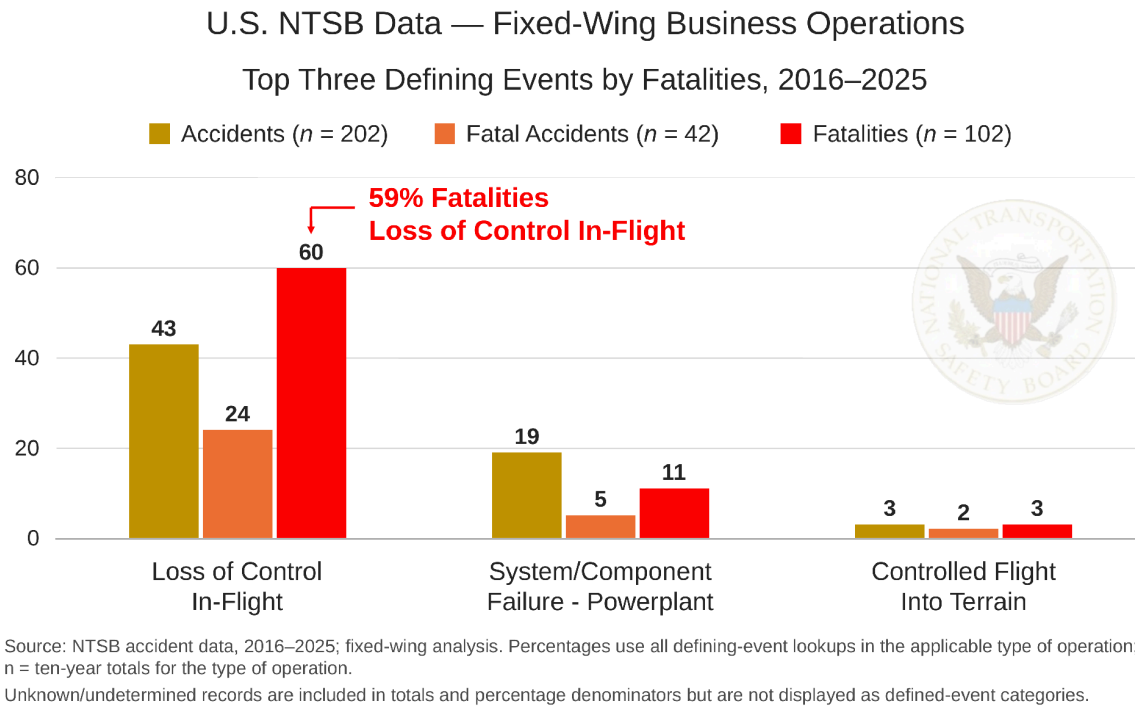


Figure 3. Fixed-wing GA Business: top events by fatalities

Figure 3 shows the top three defined events by fatalities. Loss of Control In-Flight accounts for 60 of 102 fatalities (59%), followed by System/Component Failure - Powerplant with 11 and Controlled Flight Into Terrain with 3.

Figure 4 ranks the same type of operation by fatal accidents. Loss of Control In-Flight accounts for 24 of 42 fatal accidents (57%). System/Component Failure - Powerplant follows with 5 and Controlled Flight Into Terrain with 2.

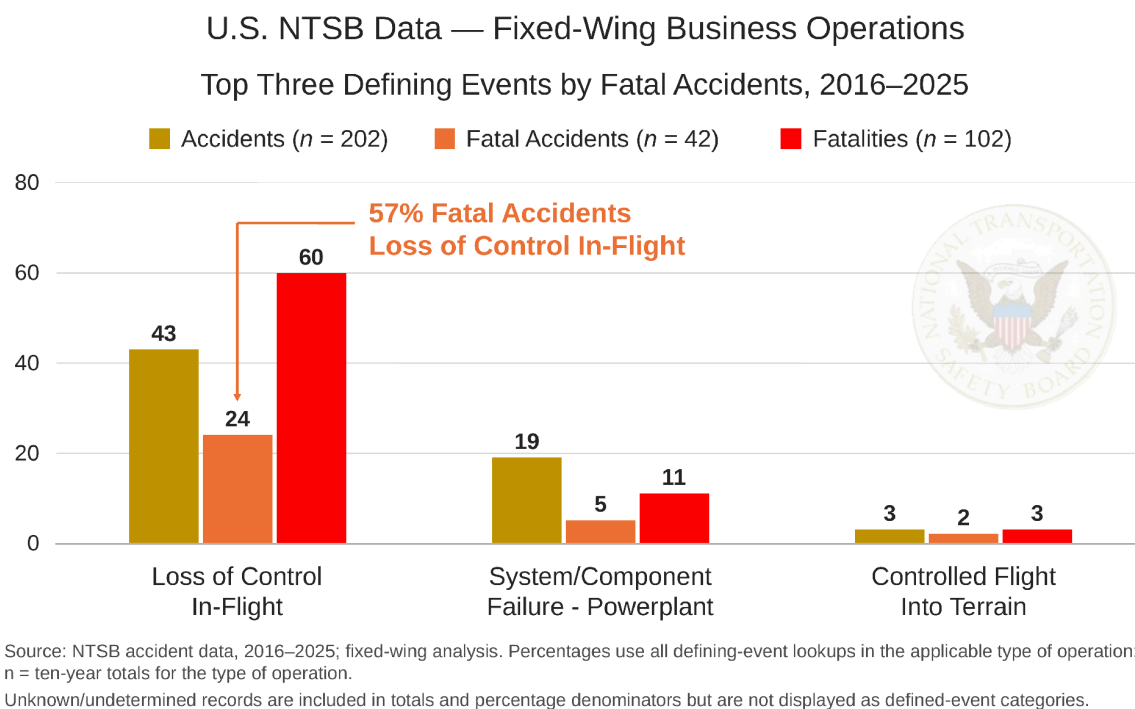


Figure 4. Fixed-wing GA Business: top events by fatal accidents

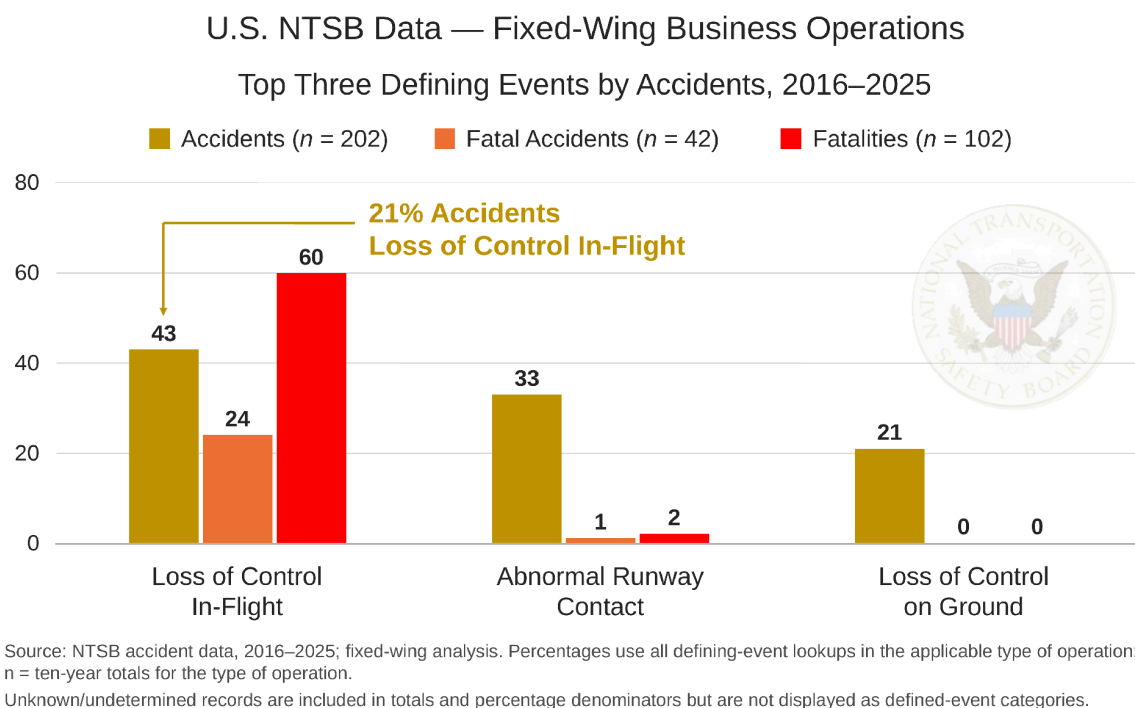


Figure 5. Fixed-wing GA Business: top events by accidents

Figure 5 ranks the type of operation by accidents. Loss of Control In-Flight leads with 43 of 202 accidents (21%), followed by Abnormal Runway Contact with 33 and Loss of Control on Ground with 21. Abnormal Runway Contact and Loss of Control on Ground together account for 54 accidents but 2 fatalities, while Loss of Control In-Flight leads all three measures.

3.2 Executive/Corporate

Fixed-wing Executive/Corporate is the smallest of the three types of operation: $n = 38$ accidents, 2 fatal accidents and 6 fatalities. Only two defined events produced fatalities and fatal accidents. A single accident changes the shares substantially, so these results should be interpreted with caution.

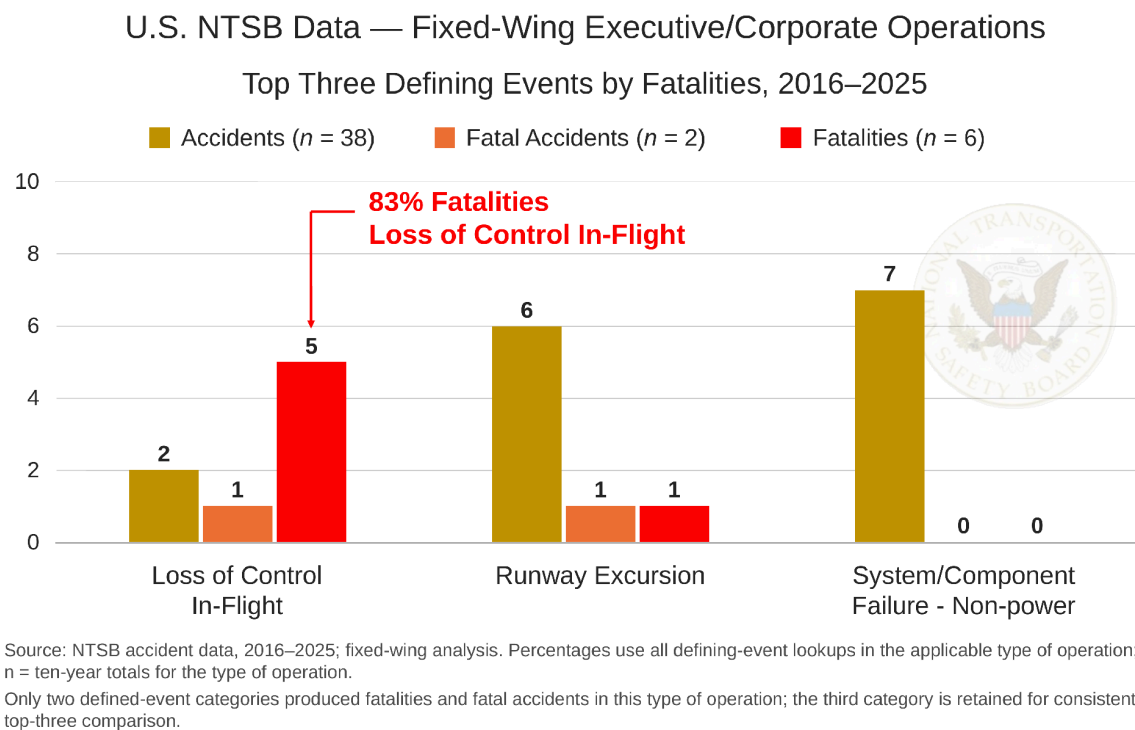


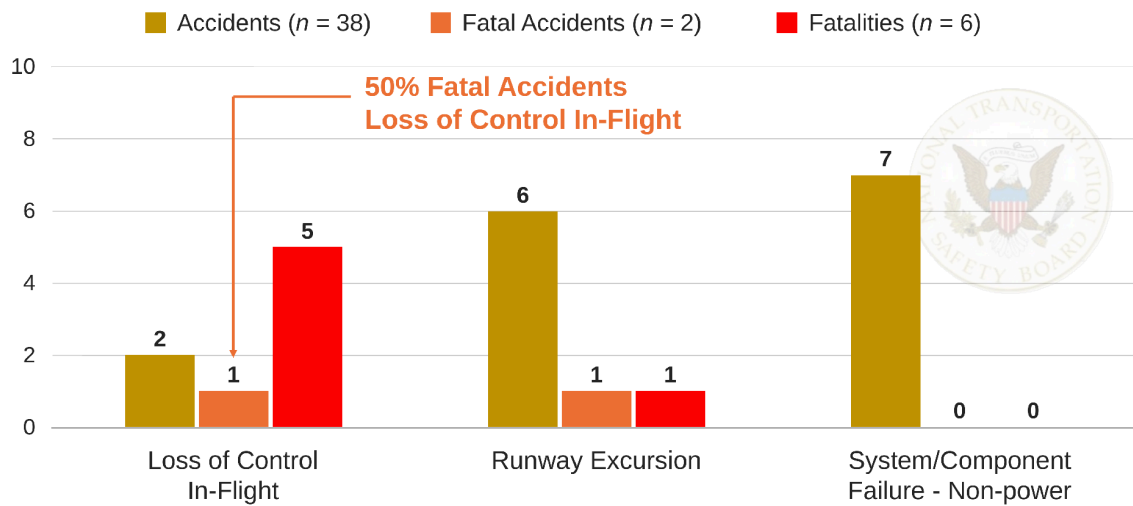
Figure 6. Fixed-wing Executive/Corporate: top events by fatalities

Figure 6 shows the top three defined events by fatalities. Loss of Control In-Flight accounts for 5 of 6 fatalities (83%), followed by Runway Excursion with 1 and System/Component Failure - Non-power with 0. System/Component Failure - Non-power produced no fatalities; it is shown as the third category for consistent comparison.

Figure 7 ranks the same type of operation by fatal accidents. Loss of Control In-Flight accounts for 1 of 2 fatal accidents (50%). Runway Excursion also accounts for 1 fatal accident (50%); the two events are tied, and Loss of Control In-Flight carries the callout under the documented tie-break rule (fatalities descending).

U.S. NTSB Data — Fixed-Wing Executive/Corporate Operations

Top Three Defining Events by Fatal Accidents, 2016–2025

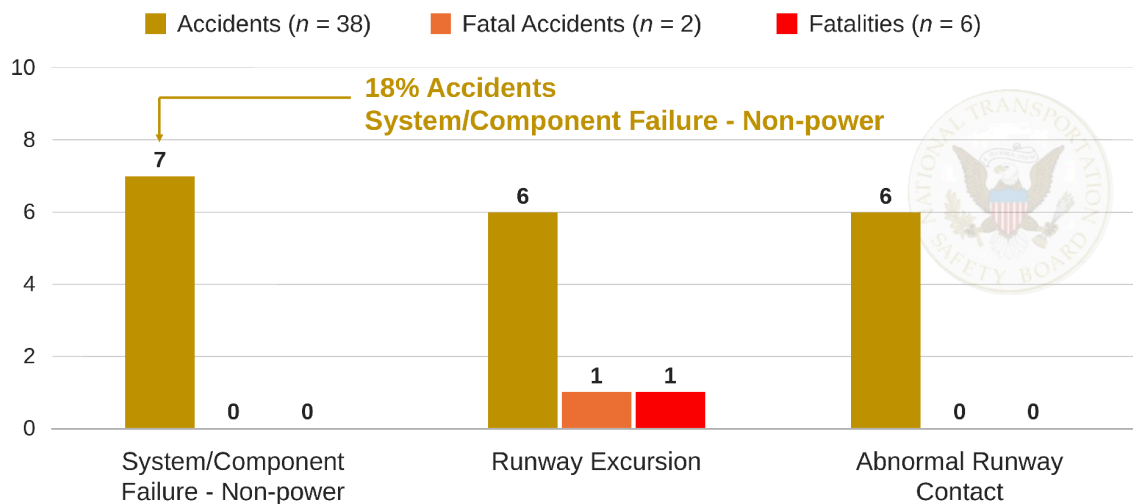


Source: NTSB accident data, 2016–2025; fixed-wing analysis. Percentages use all defining-event lookups in the applicable type of operation; n = ten-year totals for the type of operation.
Only two defined-event categories produced fatalities and fatal accidents in this type of operation; the third category is retained for consistent top-three comparison.

Figure 7. Fixed-wing Executive/Corporate: top events by fatal accidents

U.S. NTSB Data — Fixed-Wing Executive/Corporate Operations

Top Three Defining Events by Accidents, 2016–2025



Source: NTSB accident data, 2016–2025; fixed-wing analysis. Percentages use all defining-event lookups in the applicable type of operation; n = ten-year totals for the type of operation.

Figure 8. Fixed-wing Executive/Corporate: top events by accidents

Figure 8 ranks the type of operation by accidents. System/Component Failure - Non-power leads with 7 of 38 accidents (18%), followed by Runway Excursion with 6 and Abnormal Runway Contact with 6. Runway Excursion and Abnormal Runway Contact are tied at 6 accidents; Runway Excursion ranks second under the tie-break rule (fatal accidents descending).

3.3 Part 135 On-Demand

Part 135 On-Demand operations include passenger, cargo and other for-hire flights conducted under a distinct operating and regulatory environment. This type of operation contains $n = 237$ accidents, 41 fatal accidents and 92 fatalities.

Figure 9 shows the top three defined events by fatalities. Loss of Control In-Flight accounts for 22 of 92 fatalities (24%), followed by Midair with 18 and Controlled Flight Into Terrain with 12.

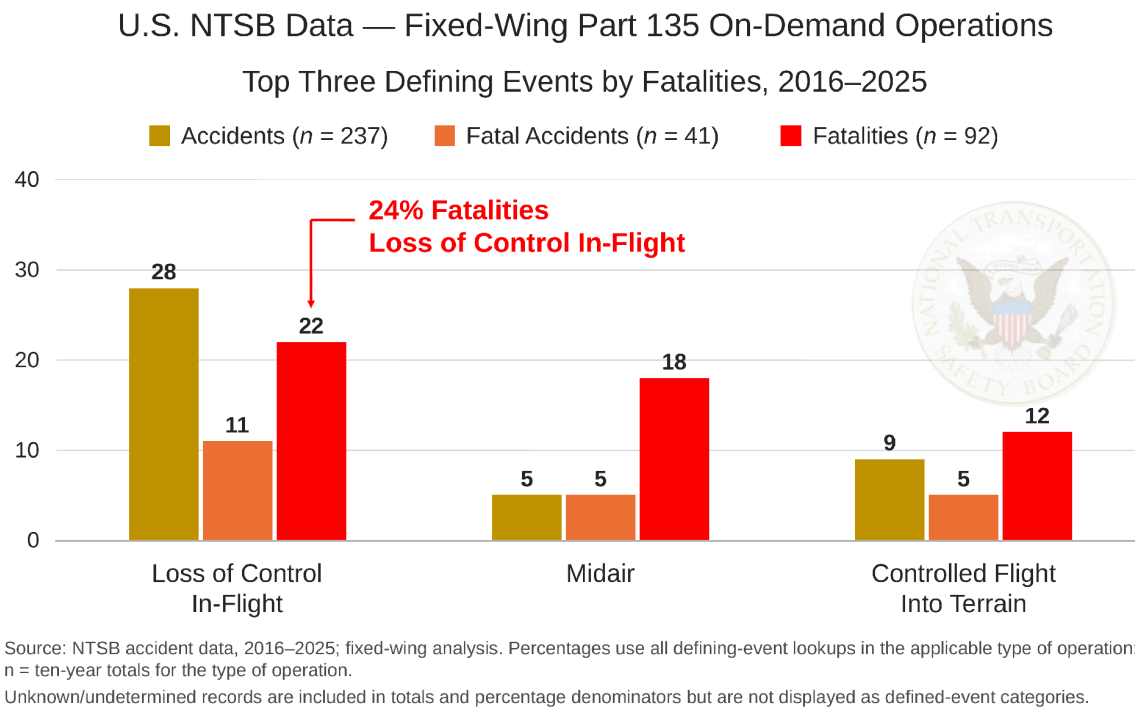


Figure 9. Fixed-wing Part 135: top events by fatalities

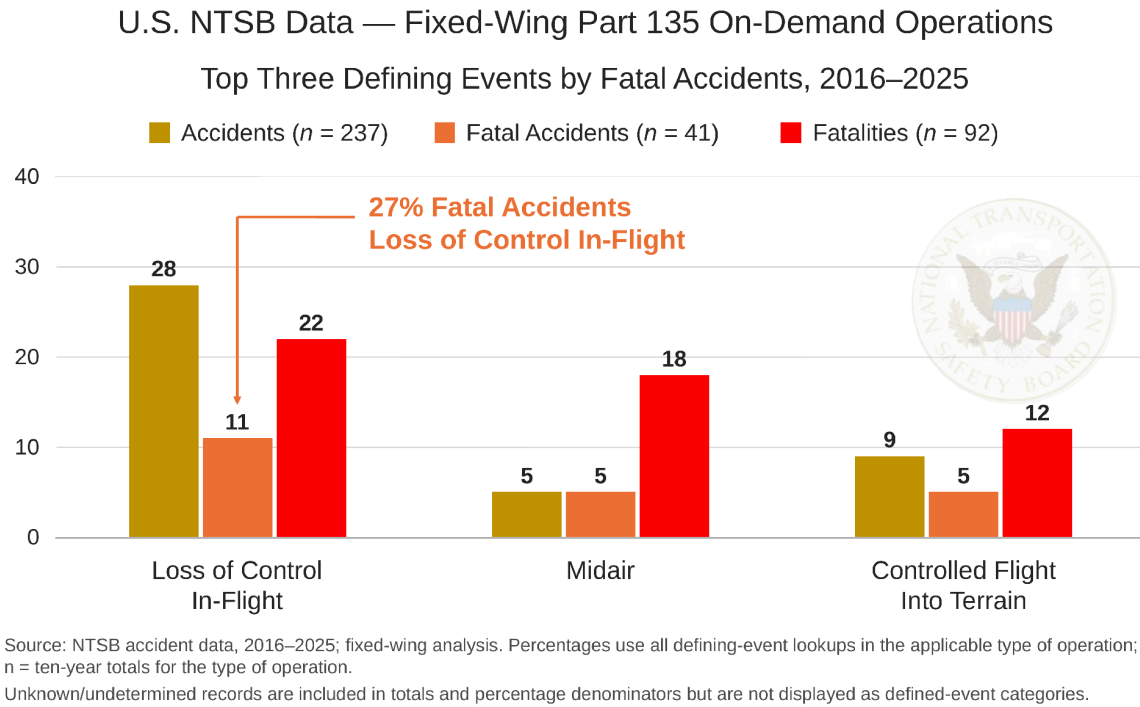


Figure 10. Fixed-wing Part 135: top events by fatal accidents

Figure 10 ranks the same type of operation by fatal accidents. Loss of Control In-Flight accounts for 11 of 41 fatal accidents (27%). Midair and Controlled Flight Into Terrain follow with 5 fatal accidents each.

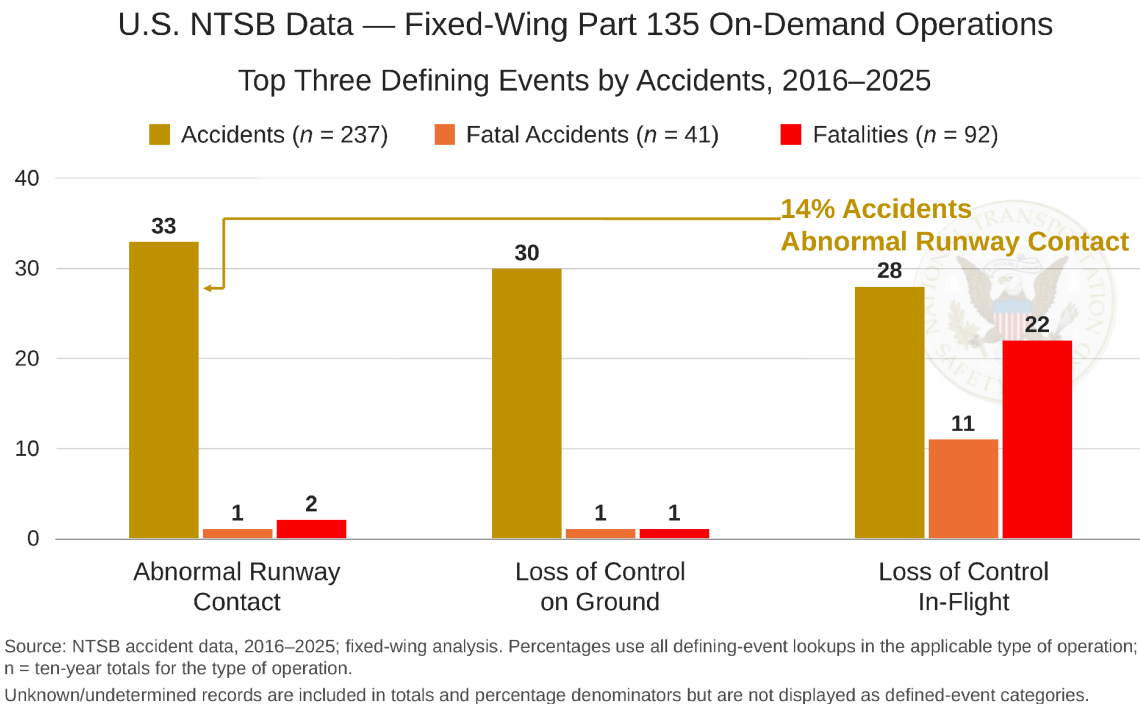


Figure 11. Fixed-wing Part 135: top events by accidents

Figure 11 ranks the type of operation by accidents. Abnormal Runway Contact leads with 33 of 237 accidents (14%), followed by Loss of Control on Ground with 30 and Loss of Control In-Flight with 28. Loss of Control In-Flight ranks third by accidents but first by fatalities and fatal accidents. Abnormal Runway Contact is the CICTT category for any landing or takeoff involving abnormal runway or landing surface contact. It includes hard landings, long or fast landings, off-center and crabbed landings, tail strikes, wingtip and nacelle strikes and gear-up landings (CICTT, 2017).

3.4 Same-event comparison across measures

Because every figure shows all three measures, the same defining event can be compared across accidents, fatal accidents and fatalities within a type of operation. Table 7 sets out the fixed-wing counts and shares by measure for the leading events, 2016–2025. It makes no per-flight risk claim.

Table 7. Same-event comparison, fixed-wing

Type of operation	Defining event	Accidents	Fatal accidents	Fatalities
GA Business	Loss of Control In-Flight	43 (21.3%)	24 (57.1%)	60 (58.8%)
GA Business	System/Component Failure - Powerplant	19 (9.4%)	5 (11.9%)	11 (10.8%)
GA Business	Abnormal Runway Contact	33 (16.3%)	1 (2.4%)	2 (2.0%)
Executive/Corporate	Loss of Control In-Flight	2 (5.3%)	1 (50.0%)	5 (83.3%)
Executive/Corporate	Runway Excursion	6 (15.8%)	1 (50.0%)	1 (16.7%)
Executive/Corporate	System/Component Failure - Non-power	7 (18.4%)	0 (0.0%)	0 (0.0%)
Part 135 On-Demand	Loss of Control In-Flight	28 (11.8%)	11 (26.8%)	22 (23.9%)
Part 135 On-Demand	Midair	5 (2.1%)	5 (12.2%)	18 (19.6%)
Part 135 On-Demand	Abnormal Runway Contact	33 (13.9%)	1 (2.4%)	2 (2.2%)

In GA Business, Loss of Control In-Flight accounts for 21% of accidents, 57% of fatal accidents and 59% of fatalities. In Part 135 On-Demand, Midair accounts for 2% of accidents, 12% of fatal accidents and 20% of fatalities; this value counts each midair collision once, as confirmed by the NTSB (Section 2.6).

3.5 Comparative lethality of events

A second way to read the same counts is to ask how often a defining event, once it occurred, was fatal. Table 8 shows, for each fixed-wing event with at least five accidents, the share of its accidents that were fatal and the average number of fatalities per fatal accident.

Table 8. Share of accidents that were fatal

Type of operation	Defining event	Accidents	Fatal accidents	Share fatal	Fatalities per fatal accident
GA Business	Unknown	5	3	60%	4.3
GA Business	Loss of Control In-Flight	43	24	56%	2.5
GA Business	System/Component Failure - Powerplant	19	5	26%	2.2
GA Business	Turbulence Encounter	5	1	20%	2.0
GA Business	Collision on Takeoff or Landing	6	1	17%	2.0
GA Business	Fuel Related	10	1	10%	1.0
GA Business	Abnormal Runway Contact	33	1	3%	2.0
GA Business	Loss of Control on Ground	21	0	0%	–
GA Business	Runway Excursion	14	0	0%	–
GA Business	System/Component Failure - Non-power	11	0	0%	–
GA Business	Bird Strike	7	0	0%	–
GA Business	Other	5	0	0%	–
GA Business	Undershoot/Overshoot	5	0	0%	–
GA Business	Wildlife Encounter	5	0	0%	–
Executive/Corporate	Runway Excursion	6	1	17%	1.0
Executive/Corporate	System/Component Failure - Non-power	7	0	0%	–
Executive/Corporate	Abnormal Runway Contact	6	0	0%	–
Part 135 On-Demand	Midair	5	5	100%	3.6
Part 135 On-Demand	Controlled Flight Into Terrain	9	5	56%	2.4
Part 135 On-Demand	Unknown	10	5	50%	2.2
Part 135 On-Demand	Loss of Control In-Flight	28	11	39%	2.0
Part 135 On-Demand	Other	6	2	33%	2.5
Part 135 On-Demand	Unintended Flight Into IMC	6	2	33%	1.0
Part 135 On-Demand	Collision on Takeoff or Landing	9	2	22%	1.5
Part 135 On-Demand	Fire - Non-Impact	5	1	20%	4.0
Part 135 On-Demand	System/Component Failure - Powerplant	17	3	18%	2.3
Part 135 On-Demand	System/Component Failure - Non-power	14	2	14%	2.0
Part 135 On-Demand	Loss of Control on Ground	30	1	3%	1.0
Part 135 On-Demand	Abnormal Runway Contact	33	1	3%	2.0
Part 135 On-Demand	Runway Excursion	17	0	0%	–
Part 135 On-Demand	Ground Collision	8	0	0%	–
Part 135 On-Demand	Turbulence Encounter	6	0	0%	–
Part 135 On-Demand	Bird Strike	5	0	0%	–

In GA Business, 24 of 43 Loss of Control In-Flight accidents were fatal (56%), compared with 1 of 33 Abnormal Runway Contact accidents (3%). In Part 135 On-Demand, 11 of 28 Loss of Control In-Flight accidents were fatal (39%). Frequent ground and runway events were rarely fatal; loss of control in flight was fatal in a large share of cases. These proportions describe recorded outcomes and do not account for occupants on board or exposure. The pattern is consistent with the ICAO Global Aviation Safety Plan, which treats Abnormal Runway Contact and System/Component Failure - Non-power as frequent occurrence categories that may not carry a high fatality risk (ICAO, 2025).

3.6 Runway excursions: make and model

Runway excursion is not the leading defining event by fatalities in any fixed-wing type of operation. This subsection looks at it separately because the authors agreed to examine runway excursions by make and model to identify trends among business jets, across all three fixed-wing types of operation.

Runway excursion is one of five global high-risk accident categories in the ICAO Global Aviation Safety Plan (ICAO, 2025). The Global Action Plan for the Prevention of Runway Excursions sets out consensus recommendations for aircraft operators, aerodrome operators, air navigation service providers, manufacturers and regulators, including stabilized-approach and go-around policies and the use of runway overrun alerting systems where available (Flight Safety Foundation & EUROCONTROL, 2021).

The reporting framework includes make-and-model detail for runway excursions to identify trends among business jets. The extract contains 37 fixed-wing Runway Excursion accidents: 14 in GA Business, 6 in Executive/Corporate and 17 in Part 135 On-Demand. One was fatal, with one fatality. 31 occurred during landing and 6 during takeoff. A second pilot was recorded as present in 21 of the 37. Accidents with the separate NTSB defining event Undershoot/Overshoot are not included in this subsection or in Table 9; the extract contains 11 such fixed-wing accidents, none fatal (Tables C1 to C3).

Table 9. Jet runway excursions by make and model

Make (as recorded)	Model	Engine type	Accidents	Type(s) of operation
Beech	400	Turbo fan	1	Business
Cessna	525	Turbo fan	2	Business, Part 135
Cessna	551	Turbo fan	1	Business
Cessna	560XL	Turbo fan	2	Executive/Corporate, Part 135
Cirrus Design Corp	SF50	Turbo fan	1	Business
Embraer	EMB-500	Turbo fan	1	Executive/Corporate
Embraer Executive Aircraft Inc	EMB-500	Turbo fan	1	Business
Gates Learjet Corp.	35A	Turbo fan	1	Executive/Corporate
Honda Aircraft Co Llc	HA-420	Turbo fan	2	Executive/Corporate, Part 135
Honda Jet	HA-420	Turbo fan	1	Part 135
Israel Aircraft Industries	GULFSTREAM 200	Turbo fan	1	Executive/Corporate
Learjet	35	Turbo fan	1	Part 135
Learjet	55	Turbo fan	1	Part 135
Learjet	60	Turbo fan	1	Part 135
Learjet Inc	45	Turbo fan	1	Business
Raytheon	400A	Turbo fan	1	Part 135
Raytheon Aircraft Company	390	Turbo fan	1	Part 135
Raytheon Aircraft Company	400A	Turbo fan	1	Part 135
Raytheon Aircraft Company	HAWKER 800XP	Turbo fan	1	Business
Textron Aviation Inc	525C	Turbo fan	1	Business
Textron Aviation Inc	680A	Turbo fan	1	Business

Turbofan or turbojet airplanes account for 24 of the 37 runway excursions (24 turbofan, 0 turbojet); 10 involved piston airplanes and 3 turboprops. Three of the turbofan records (a

Gulfstream 200, a Learjet 35A and a Honda HA-420) carry an unknown engine type in the extract, and one (an Embraer EMB-500) is recorded as a turbojet; all four are reclassified as turbofan from make and model under the corrections protocol (Section 2.8; log entries EX-007 and EX-008). Table 9 lists the turbofan and turbojet records by make and model, as recorded in the extract.

Several model families recur in Table 9: the Cessna Citation 525 and 560XL series, the Honda HA-420, the Embraer EMB-500 and the Beechcraft and Raytheon 400 and 400A series. With one to three accidents per model and no exposure data by model, the counts identify where to look more closely; they do not show that any model has a higher excursion rate.

4. Rotary-wing findings

The rotary-wing analysis mirrors the fixed-wing structure: the same three types of operation, the same three measures in the same order and no pooling with airplane totals. The extract contains 167 helicopter accidents: 35 in GA Business, 1 in Executive/Corporate and 131 in Part 135 On-Demand. Executive/Corporate is shown as a table. Two ranking points matter here. Other is not eligible for ranking: if it were, it would rank first by fatalities in GA Business (4 fatalities) and second by accidents in Part 135 On-Demand (16 accidents). Unintended Flight Into IMC is the NTSB category name for unintended flight into instrument meteorological conditions (IMC).

4.1 GA Business

Rotary-wing GA Business is a small sample: $n = 35$ accidents, 6 fatal accidents and 11 fatalities in ten years. A single accident changes a share by several percentage points, so these results should be read with caution.

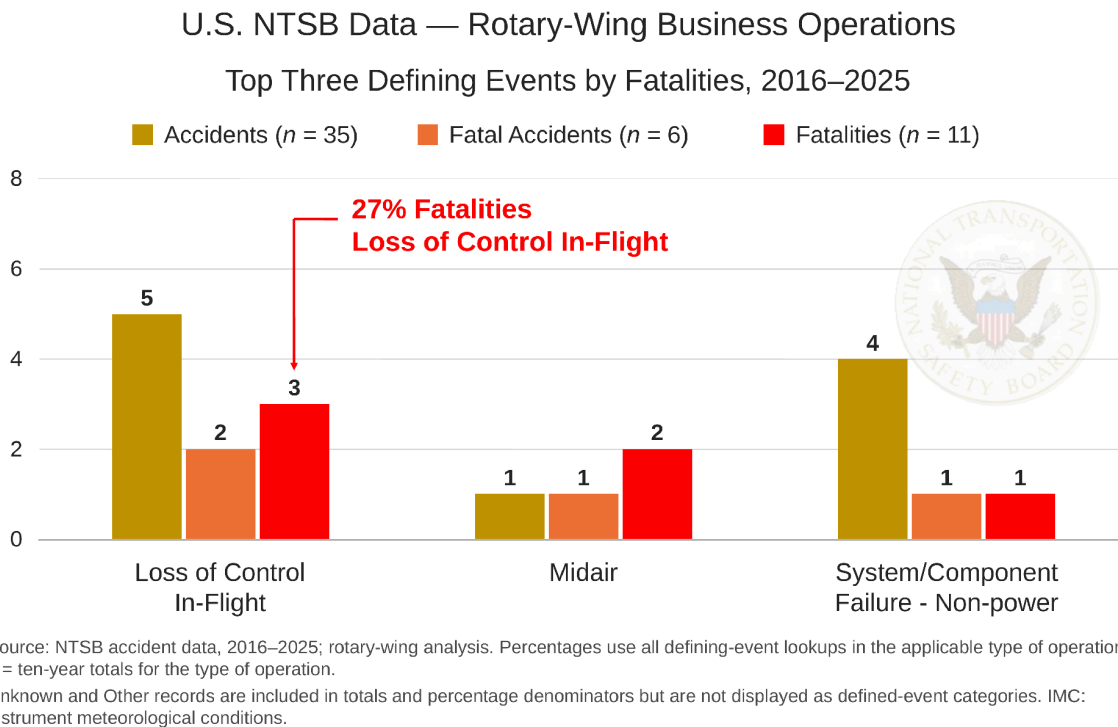
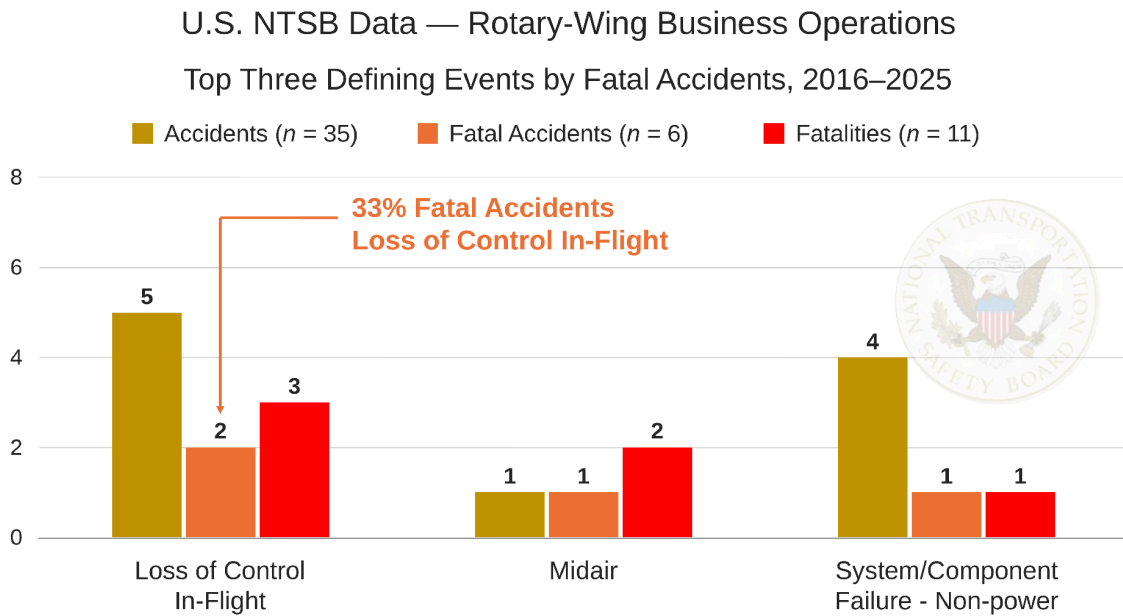


Figure 12. Rotary-wing GA Business: top events by fatalities

Figure 12 shows the top three defined events by fatalities. Loss of Control In-Flight accounts for 3 of 11 fatalities (27%), followed by Midair with 2 (the two-helicopter collision described in Section 2.6) and System/Component Failure - Non-power with 1. System/Component Failure -

Non-power and Controlled Flight Into Terrain are tied at 1 fatality and 1 fatal accident; System/Component Failure - Non-power ranks third on accidents (4 against 2).



Source: NTSB accident data, 2016–2025; rotary-wing analysis. Percentages use all defining-event lookups in the applicable type of operation; n = ten-year totals for the type of operation.

Unknown and Other records are included in totals and percentage denominators but are not displayed as defined-event categories. IMC: instrument meteorological conditions.

Figure 13. Rotary-wing GA Business: top events by fatal accidents

Figure 13 ranks the type of operation by fatal accidents. Loss of Control In-Flight accounts for 2 of 6 fatal accidents (33%). Midair and System/Component Failure - Non-power follow with 1 each; Controlled Flight Into Terrain also has 1 and ranks fourth under the tie-break rule.

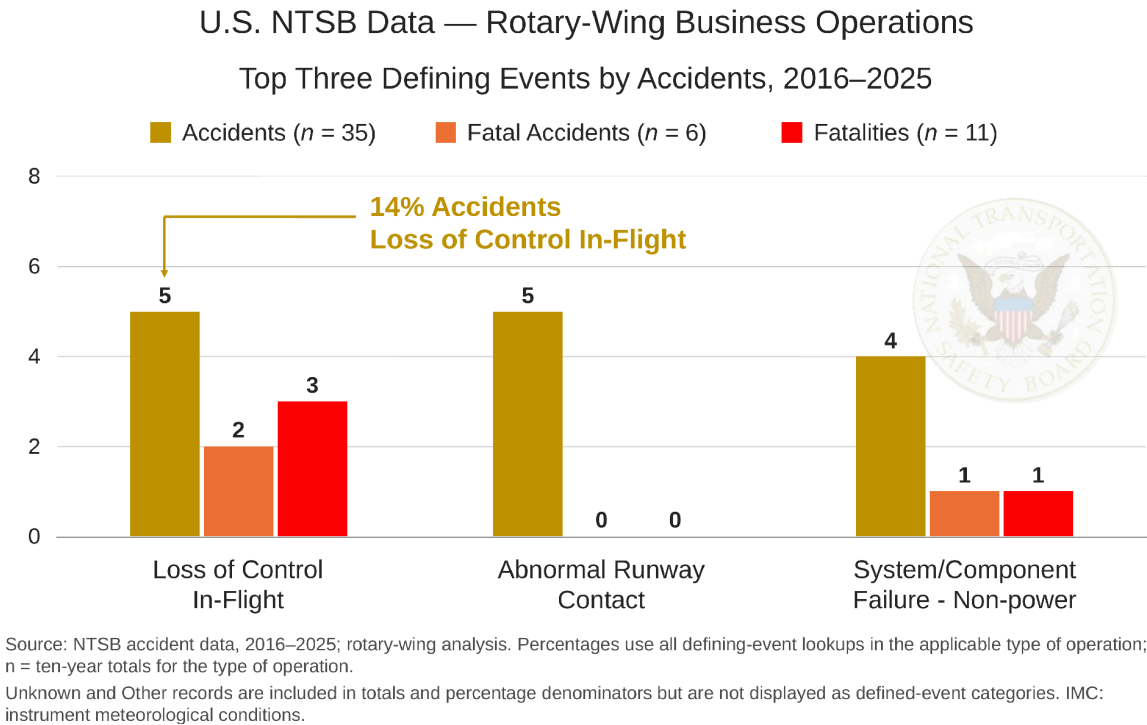


Figure 14. Rotary-wing GA Business: top events by accidents

Figure 14 ranks the type of operation by accidents. Loss of Control In-Flight and Abnormal Runway Contact are tied at 5 accidents each (14%); Loss of Control In-Flight ranks first because it has more fatal accidents (2 against 0). System/Component Failure - Non-power and Low Altitude Operation follow with 4 each, and System/Component Failure - Non-power ranks third on fatal accidents. Loss of Control In-Flight leads all three measures, as it does in fixed-wing GA Business.

4.2 Executive/Corporate

Rotary-wing Executive/Corporate contains one accident in ten years. A chart would not be meaningful, so Table 10 reports it directly.

Table 10. Rotary-wing Executive/Corporate accidents

Defining event	Accidents	Fatal accidents	Fatalities
Unintended Flight Into IMC	1	1	1
All defining events	1	1	1

4.3 Part 135 On-Demand

Rotary-wing Part 135 On-Demand is the largest helicopter type of operation: $n = 131$ accidents, 29 fatal accidents and 88 fatalities. It includes on-demand passenger, air tour, air medical and other for-hire helicopter flights.

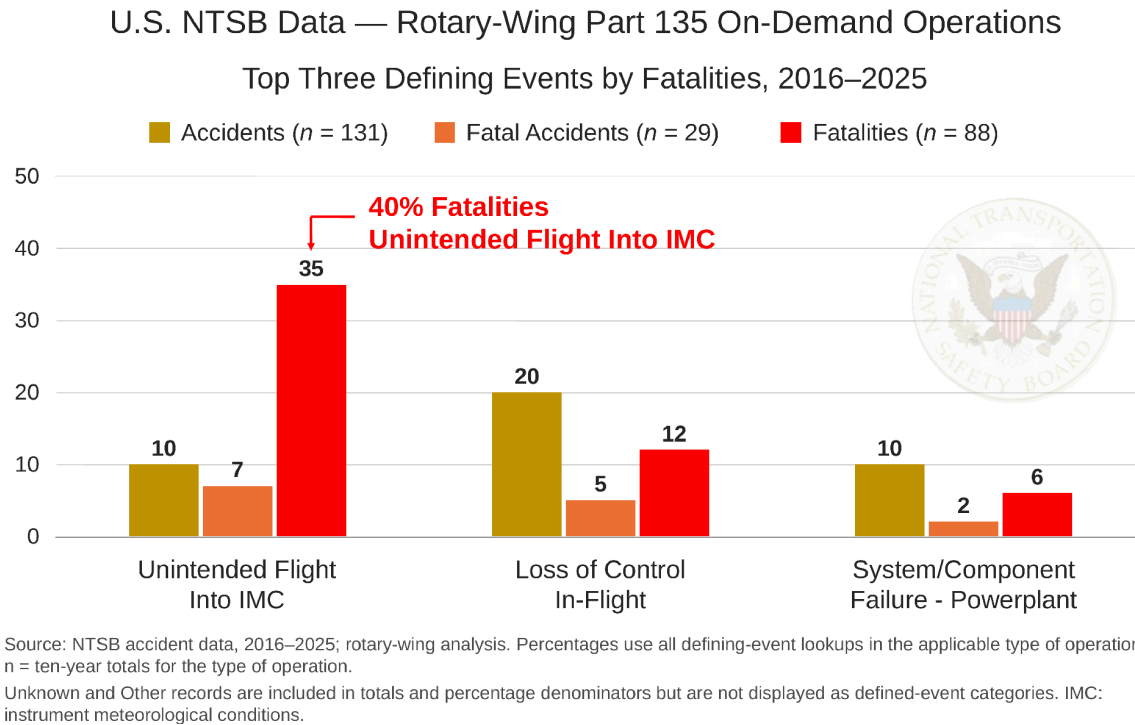
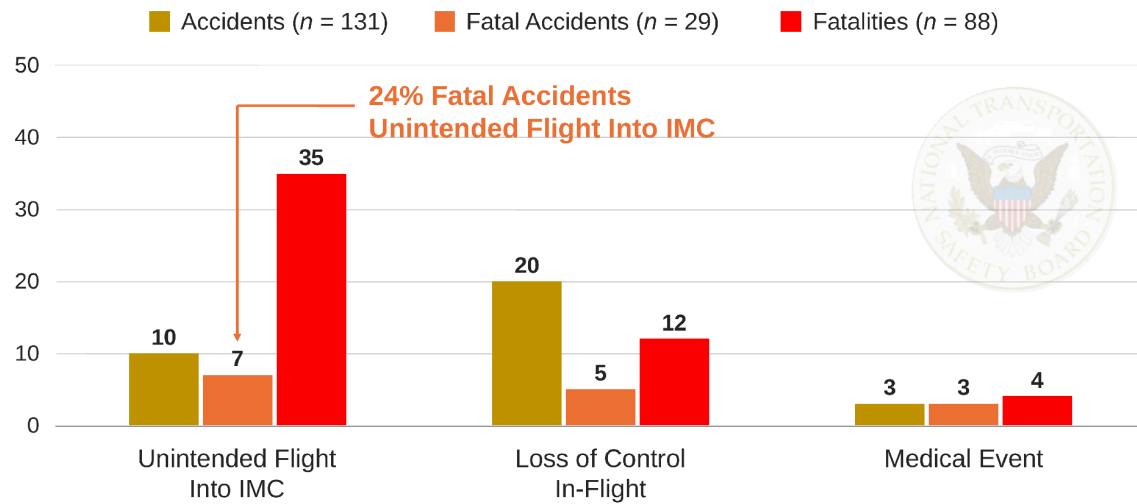


Figure 15. Rotary-wing Part 135: top events by fatalities

Figure 15 shows the top three defined events by fatalities. Unintended Flight Into IMC accounts for 35 of 88 fatalities (40%), more than three times the next event, Loss of Control In-Flight, with 12. System/Component Failure - Powerplant and Bird Strike are tied at 6 fatalities and 2 fatal accidents; System/Component Failure - Powerplant ranks third on accidents (10 against 9).

U.S. NTSB Data — Rotary-Wing Part 135 On-Demand Operations

Top Three Defining Events by Fatal Accidents, 2016–2025



Source: NTSB accident data, 2016–2025; rotary-wing analysis. Percentages use all defining-event lookups in the applicable type of operation; n = ten-year totals for the type of operation.

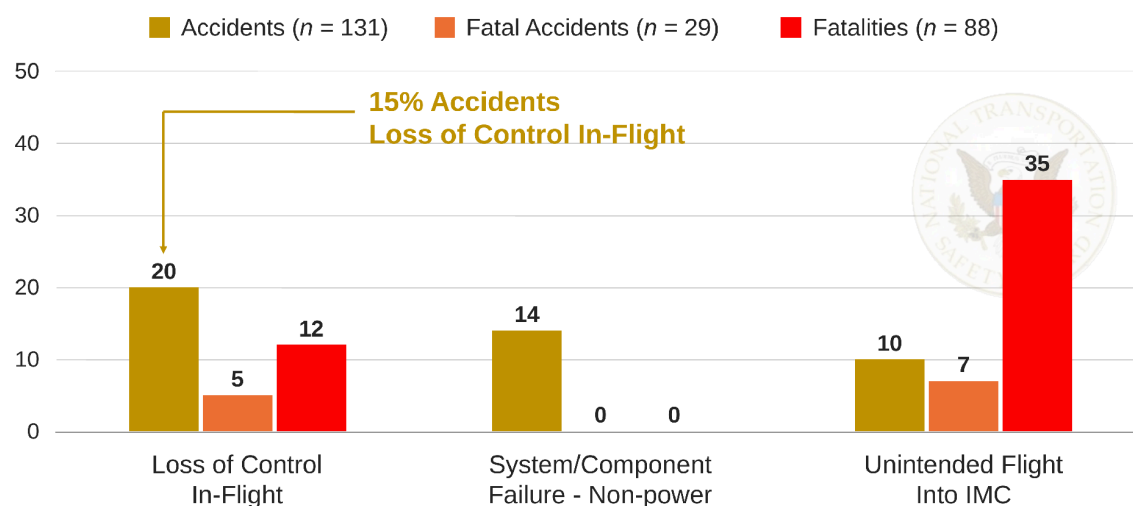
Unknown and Other records are included in totals and percentage denominators but are not displayed as defined-event categories. IMC: instrument meteorological conditions.

Figure 16. Rotary-wing Part 135: top events by fatal accidents

Figure 16 ranks the type of operation by fatal accidents. Unintended Flight Into IMC accounts for 7 of 29 fatal accidents (24%), followed by Loss of Control In-Flight with 5 and Medical Event with 3. All three Medical Event accidents were fatal. Unknown also has 3 fatal accidents but is not eligible for ranking.

U.S. NTSB Data — Rotary-Wing Part 135 On-Demand Operations

Top Three Defining Events by Accidents, 2016–2025



Source: NTSB accident data, 2016–2025; rotary-wing analysis. Percentages use all defining-event lookups in the applicable type of operation; n = ten-year totals for the type of operation.

Unknown and Other records are included in totals and percentage denominators but are not displayed as defined-event categories. IMC: instrument meteorological conditions.

Figure 17. Rotary-wing Part 135: top events by accidents

Figure 17 ranks the type of operation by accidents. Loss of Control In-Flight leads with 20 of 131 accidents (15%), followed by System/Component Failure - Non-power with 14, none of them fatal. Unintended Flight Into IMC, Collision on Takeoff or Landing and System/Component Failure - Powerplant are tied at 10 accidents; Unintended Flight Into IMC ranks third on fatal accidents. Unintended Flight Into IMC accounts for 8% of accidents, 24% of fatal accidents and 40% of fatalities.

4.4 Rotary-wing and fixed-wing compared

Loss of Control In-Flight is prominent in both aircraft categories. It leads all three measures in helicopter GA Business and leads helicopter Part 135 accidents. The main difference is in Part 135 fatalities: for airplanes Loss of Control In-Flight leads (12% of accidents, 27% of fatal accidents and 24% of fatalities), while for helicopters Unintended Flight Into IMC leads (8% of accidents, 24% of fatal accidents and 40% of fatalities). The two categories describe different stages of a similar chain of events in many weather-related accidents, which the discussion in Section 5 takes up with cited NTSB findings. The helicopter results are consistent with the USHST analysis of 104 fatal U.S. helicopter accidents from 2009 through 2013, in which Loss of Control In-Flight, Unintended Flight in IMC and Low Altitude Operations together accounted for half of the fatal accidents and more fatalities than all other categories combined (USHST, 2017). In a later review of 2009 through 2018, the USHST found that Unintended Flight in IMC accounted for 15 percent of fatal helicopter accident events (USHST, 2021).

5. Discussion

5.1 Frequency and consequence diverge

Across every type of operation analyzed, the defining events that occur most often are not the events that produce the most fatalities. Runway and ground events, such as Abnormal Runway Contact, Loss of Control on Ground and System/Component Failure - Non-power, are frequent and rarely fatal. Loss of Control In-Flight, and in helicopter Part 135 operations Unintended Flight Into IMC, account for a much larger share of fatal accidents and fatalities than of accidents. This is why the report presents three rankings rather than one: a ranking by accidents alone would direct attention to events that are frequent but seldom fatal. ICAO draws a similar distinction at the global level, separating high-risk categories such as loss of control in flight and runway excursion from categories such as Abnormal Runway Contact that are frequent but may not carry a high fatality risk (ICAO, 2025).

5.2 Loss of control across types of operation

The fixed-wing results are consistent with worldwide commercial jet experience over the same ten years. In Boeing's summary of the worldwide commercial jet fleet for 2016–2025, Loss of Control In-Flight accounted for 6 of 31 fatal accidents and 428 of 1,115 onboard fatalities, the largest share of any occurrence category (Boeing Commercial Airplanes, 2026). The types of operation, aircraft and categorization methods differ (Section 6.1), so the comparison shows a shared pattern, not equivalent values. U.S. general aviation analyses point the same way: the NTSB placed loss of control in flight on its Most Wanted List, reporting that it was involved in about 47 percent of fatal fixed-wing general aviation accidents from 2008 through 2014 (NTSB, 2016), and the FAA lists it first among the causes of fatal general aviation accidents for 2014 through 2023 (FAA, 2025b).

5.3 Weather, spatial disorientation and helicopter operations

NTSB findings illustrate how the two leading helicopter Part 135 events can be connected. In its investigation of the January 26, 2020 Sikorsky S-76B accident at Calabasas, California, an on-demand Part 135 flight, the NTSB determined that the probable cause was the pilot's decision to continue flight under visual flight rules into instrument meteorological conditions, which resulted in spatial disorientation and loss of control (NTSB, 2021). The NTSB recommended that the FAA require appropriate simulation devices in initial and recurrent training for Part 135 helicopter pilots, with scenario-based training on recognizing and responding to changing weather, transitioning to the flight instruments to reduce the risk of spatial disorientation, and the influences that can affect pilot decision-making (NTSB, 2021,

Safety Recommendation A-21-5). The accident's nine fatalities are included in the Unintended Flight Into IMC total for helicopter Part 135 On-Demand. A single investigation does not explain the type-of-operation totals, but it shows the sequence the NTSB has documented: flight into deteriorating weather, followed by disorientation and loss of control. Research on spatial disorientation supports that reading. In a review of more than 30 studies, Gibb et al. (2011) estimated that spatial disorientation contributes to nearly a third of mishaps, with a fatality rate of almost 100 percent. An FAA review of fixed-wing general aviation accidents from 2003 through 2021 found that 94 percent of accidents involving spatial disorientation were fatal, compared with 19 percent of all general aviation accidents (Baumgartner et al., 2025). The USHST estimated a median of 56 seconds from unintended entry into instrument conditions to the fatal crash in the helicopter accidents it reviewed (USHST, 2021).

5.4 Published risk controls for the leading events

Training and risk controls are outside the scope of this report, and published guidance already addresses the three leading defining events by fatalities. For Loss of Control In-Flight, upset prevention and recovery training is set out in ICAO Doc 10011 (ICAO, 2014) and FAA Advisory Circulars 120-111, 120-109A and 120-123 (FAA, 2015a, 2015b, 2022a), with extended envelope training required of Part 121 air carriers only (Pilots: Extended Envelope Training, 14 C.F.R. § 121.423, 2026); for Unintended Flight Into IMC, see NTSB Safety Recommendation A-21-5 and the USHST safety enhancements (NTSB, 2021; USHST, 2017, 2021); and for Midair, FAA Advisory Circular 90-48E addresses the pilot's role in collision avoidance (FAA, 2022b).

5.5 What the data do not show

The defining event marks the point at which the NTSB judged the flight to have turned from normal operation to abnormal (NTSB, n.d.-b). It is not a probable cause, and this report does not infer causes from the totals. A structured review of NTSB probable-cause findings and contributing factors across the dataset would show which human, organizational and technical factors recur within the leading events. That review is proposed as future work.

6. Published-rate context

This closing section places the accident totals alongside published accident information for the same ten years. Section 6.2 adds exposure-adjusted rates estimated from published FAA flight-hour data. This is supplementary context. Outcome shares in this report remain distinct from rates.

6.1 Comparison with worldwide commercial jet data compiled by Boeing

Boeing's Statistical Summary of Commercial Jet Airplane Accidents reports accidents by type of operation and fatal accidents and fatalities by CAST/ICAO Common Taxonomy Team occurrence category for the worldwide commercial jet fleet (Boeing Commercial Airplanes, 2026). Its latest ten-year period, 2016–2025, matches the study period of this report. Table 11 shows Boeing's accident summary by type of operation for that period (Boeing Commercial Airplanes, 2026, p. 10).

Table 11. Worldwide commercial jet accidents by operation

Type of operation (Boeing)	Accidents	Fatal accidents	Onboard fatalities (external)
Passenger, scheduled	246	24	1,028 (18)
Passenger, charter	5	1	71
Cargo	54	6	16 (48)
Maintenance test, ferry, positioning, training and demonstration	1	0	0
Total	306	31	1,115 (66)

External fatalities are shown in parentheses only where they are greater than zero; they include people on the ground and on other aircraft. By occurrence category, Loss of Control In-Flight accounted for 6 of the 31 fatal accidents (19%) and 428 of the 1,115 onboard fatalities (38%), with 1 external fatality. The next largest categories by onboard fatalities were Bird (179), System/Component Failure or Malfunction (Non-Powerplant) (160) and Runway Excursion, including Undershoot/Overshoot and Abnormal Runway Contact (123) (Boeing Commercial Airplanes, 2026, p. 14).

Three differences limit the comparison. Boeing's data cover commercial jet airplanes heavier than 60,000 pounds operating worldwide (Boeing Commercial Airplanes, 2026, p. 25), not U.S. general aviation or on-demand operations; its charter category is the closest analog to Part 135 On-Demand, with 5 accidents in ten years (Boeing Commercial Airplanes, 2026, p. 10). Each fatal accident is assigned one principal category by CAST (Boeing Commercial Airplanes, 2026, p. 13), while this report uses the NTSB DefiningEvent field. Boeing reports onboard and external fatalities separately (Boeing Commercial Airplanes, 2026, p. 10); the supplied NTSB extract does not. With those limits, both sources place loss of control in flight at the top of the fatality

ranking for the same ten years, at 38% of onboard fatalities in commercial jets compared with 59% in fixed-wing GA Business, 83% in Executive/Corporate ($n = 6$ fatalities) and 24% in Part 135 On-Demand.

6.2 Exposure context: accident rates per 100,000 flight hours

Source of the flight hours. The FAA General Aviation and Part 135 Activity Survey is the federal source of flight-hour estimates for general aviation and on-demand Part 135 operations. Each year the FAA surveys a sample of registered aircraft and estimates hours flown by actual use and aircraft type, with a standard error for each estimate (FAA, 2025a). The surveys published from 2017 through 2025 cover calendar years 2016 through 2024 (FAA, 2017–2025), and the FAA states that its use categories match NTSB accident-reporting definitions (FAA, 2025a). No survey for 2025 had been published when this report was prepared, so 2025 hours are extrapolated as the 2022–2024 average. Every rate in this section is therefore an estimate: the hours for 2016 through 2024 are the FAA's published survey estimates, and the hours for 2025 are extrapolated.

Check against published NTSB rates. The NTSB publishes accident rates for Part 135 on-demand operations, separately for fixed-wing airplanes and helicopters, using the same FAA survey hours (NTSB, 2024; NTSB, n.d.-a). Table 12 compares the NTSB published Part 135 on-demand accidents, fatal accidents and rates per 100,000 flight hours for 2016 through 2023, the latest year published, with the same calculation from the extract used in this report.

Table 12. Validation against NTSB Part 135 rates

Aircraft	Source	Accidents	Fatal accidents	Flight hours (FAA)	Accident rate	Fatal accident rate
Fixed-wing	NTSB published (NTSB, 2024, Table 17)	200	39	22,052,808	0.91	0.18
Fixed-wing	This report's extract	199	39	22,052,808	0.90	0.18
Rotary-wing	NTSB published (NTSB, 2024, Table 20)	101	22	8,031,795	1.26	0.27
Rotary-wing	This report's extract	103	22	8,031,795	1.28	0.27

The accident counts agree within one accident for airplanes and two for helicopters, and the fatal accident counts agree. The flight hours are the same FAA values. The Part 135 On-Demand rates in this report therefore reproduce the published NTSB rates for the years both cover. The small count differences have not been traced record by record; investigation updates between the NTSB publication and the September 2026 extract are one possible source.

Estimated rates for 2016–2025. For GA Business and Executive/Corporate the NTSB does not publish rates, so they are estimated with the same source and method: the survey's fixed-wing and rotorcraft hours for business flying without a paid crew (GA Business), business flying with

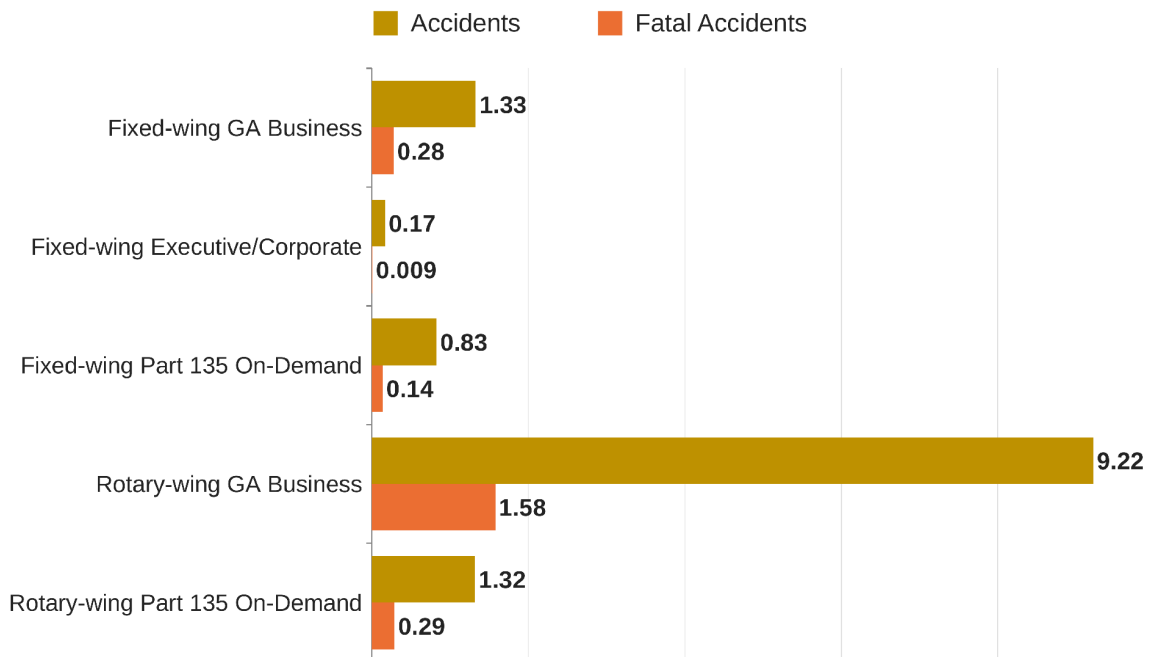
a paid crew (Executive/Corporate) and on-demand Part 135 air taxi, air tours and air medical (Part 135 On-Demand). Table 13 shows the estimated rates by type of operation for 2016–2025, using FAA survey hours for 2016–2024 with 2025 extrapolated.

Table 13. Estimated rates per 100,000 flight hours

Aircraft	Type of operation	Flight hours (millions)	Accidents	Fatal accidents	Fatalities	Basis
Fixed-wing	GA Business	15.2	1.33	0.28	0.67	Estimate; mapping to survey use category
Fixed-wing	Executive/Corporate	22.6	0.17	0.009	0.027	Estimate; mapping to survey use category
Fixed-wing	Part 135 On-Demand	28.4	0.83	0.14	0.32	Method reproduces NTSB published rates, 2016–2023
Rotary-wing	GA Business	0.38	9.22	1.58	2.90	Estimate; mapping to survey use category
Rotary-wing	Executive/Corporate	0.49	0.21	0.21	0.21	Estimate; mapping to survey use category
Rotary-wing	Part 135 On-Demand	9.95	1.32	0.29	0.88	Method reproduces NTSB published rates, 2016–2023

Exposure Context: Estimated Rates per 100,000 Flight Hours

Accidents and Fatal Accidents by Type of Operation, 2016–2025 (ESTIMATE)



ESTIMATE. Numerators: NTSB event totals. Denominators: FAA General Aviation and Part 135 Activity Survey flight hours by actual use, 2016–2024 (published survey estimates); 2025 extrapolated as the 2022–2024 average. Part 135 method reproduces the NTSB published on-demand rates for 2016–2023. Rotary-wing Executive/Corporate (n = 1 accident) not shown.

Sources: NTSB accident data, 2016–2025; FAA GA and Part 135 Activity Survey, Table 3.2, CY2016–CY2024.

Figure 18. Estimated accident and fatal accident rates

Figure 18 plots the estimated accident and fatal accident rates per 100,000 flight hours from Table 13; they are estimates, built as described above. Both show large differences between types of operation. For airplanes, the estimated accident rate is about 1.33 per 100,000 hours in GA Business, 0.83 in Part 135 On-Demand and 0.17 in Executive/Corporate; fatal accident rates follow the same order. Loss of Control In-Flight fatal accidents occur at about 0.16 per 100,000 hours flown in fixed-wing GA Business and 0.04 in Part 135 On-Demand. For helicopters, the estimated accident rate is about 1.32 in Part 135 On-Demand, close to the airplane GA Business rate, and about 9.22 in GA Business, the highest of any type of operation (exact Poisson 95% range 6.4 to 12.8; Garwood, 1936). The Executive/Corporate values rest on $n = 2$ fatal accidents for airplanes and $n = 1$ accident for helicopters and are the least certain.

How far the estimates can be relied upon. The rates are order-of-magnitude estimates, and the ordering between types of operation is robust to the assumptions tested. Survey hours are sample estimates, with percent standard errors of about 3 to 5 percent a year for fixed-wing and about 3 to 11 percent for rotorcraft (FAA, 2017–2025). Experimental and light-sport airplanes are outside the survey's fixed-wing rows (FAA, 2017–2025); including experimental business hours would lower the fixed-wing GA Business rates by about 4 percent. Counting only air taxi hours would raise the fixed-wing Part 135 On-Demand accident rate to about 0.92. Removing all fractional-ownership hours from Executive/Corporate would raise its accident rate to about 0.21. The choice of 2025 hours changes no fixed-wing rate by more than about 1 percent. The main uncertainty for GA Business and Executive/Corporate is the mapping of NTSB operation categories to survey use categories, which is an assumption of this report rather than an NTSB-confirmed mapping. The numerators are the event totals confirmed by the NTSB (Section 2.6).

FAA OpsNet was considered and not used as a denominator. It counts towered-airport operations in four user classes (air carrier, air taxi, general aviation and military) and cannot separate the types of operation analyzed here (FAA, n.d.).

7. Limitations

- **Exposure.** The accident records contain no flights, departures or flight hours. Shares are not rates and cannot support per-flight risk comparisons. The rates in Section 6.2 are estimates that rely on FAA survey hours, an extrapolated 2025 and stated assumptions.
- **Small totals.** Fixed-wing Executive/Corporate has $n = 2$ fatal accidents and 6 fatalities; helicopter GA Business has $n = 6$ fatal accidents and 11 fatalities; helicopter Executive/Corporate has $n = 1$ accident. Small totals make shares unstable, and a single event can change a ranking.
- **Unreported events.** The accidents in these data are known, reported accidents. The underlying and precursor events that lead to accidents may be underreported; incidents and lesser events are outside these data, and their number is not estimated.
- **Ground fatalities.** The supplied extract has no separate ground-injury field, so fatalities outside the aircraft cannot be separated from occupant fatalities.
- **Recency of 2025 records.** The extract was obtained on September 21, 2026. Some recent investigations may still be updated as preliminary information is replaced by final reports.
- **Counting method.** Each accident and its fatalities are counted once, as confirmed by the NTSB (Section 2.6). Counts by aircraft would differ only for the few multi-aircraft accidents.
- **Classification.** Results depend on the NTSB DefiningEvent field, which records one defining event per accident even where several CICTT categories could apply (CICTT, 2017). Unknown and Other records remain in denominators but are not displayed as defined events. In helicopter GA Business, Other would rank first by fatalities if it were eligible.
- **Location scope.** Ten N-registered records at non-U.S. or unrecorded locations are included (Section 2.4).

8. Conclusions

The conclusions below restate findings presented in Sections 3 to 6 and add no new analysis.

- 1. Loss of Control In-Flight leads fatalities in every fixed-wing type of operation.** It accounts for 59% of GA Business fatalities, 83% of Executive/Corporate fatalities and 24% of Part 135 On-Demand fatalities (Sections 3.1 to 3.3).
- 2. Frequency and consequence diverge.** The most frequent defining event is not always the one that produces the most fatalities. In fixed-wing Part 135 On-Demand, Abnormal Runway Contact leads accidents at 14% but accounts for 2% of fatalities (Sections 3.4 and 5.1).
- 3. Unintended Flight Into IMC leads fatalities in helicopter Part 135 On-Demand operations.** It accounts for 40% of fatalities, followed by Loss of Control In-Flight (Section 4.3).
- 4. Helicopter GA Business follows the fixed-wing pattern, on small totals.** Loss of Control In-Flight leads all three measures (Section 4.1).
- 5. Loss of Control In-Flight is first or second by fatalities in every type of operation with more than one accident.** This holds for airplanes and helicopters (Sections 3 and 4).
- 6. Estimated accident rates differ widely by type of operation.** Estimated fixed-wing rates range from 0.17 per 100,000 flight hours in Executive/Corporate to 1.33 in GA Business. These estimates rely on FAA survey hours and stated assumptions (Section 6.2).
- 7. The loss-of-control pattern is consistent with worldwide commercial jet data.** In Boeing's summary for 2016–2025, Loss of Control In-Flight accounted for more onboard fatalities than any other category (Boeing Commercial Airplanes, 2026). Section 6.1 sets out the comparison.

These shares describe where recorded outcomes concentrated. They do not establish cause, and they are not rates. This report is descriptive and makes no safety recommendations; Section 5.4 summarizes published risk controls for the leading defining events.

9. Repeatability and future work

The method is designed to be repeated annually. Before it is called repeatable and applied to wider data, four conditions must be met: documented filters and definitions, totals reproduced independently from the source files, a complete exceptions log and co-author sign-off. The rotary-wing computation for this report reproduced every approved fixed-wing total and lookup value from the source extract, which is a first independent reproduction. Methods and assumptions are set out in Appendix A, with AI used to structure the data and support faster annual execution.

The annual data request cycle with the NTSB is: notice in March, reminder in August and final contact in early September.

Future work includes a structured review of NTSB probable-cause findings within the leading events, a separate follow-on report applying the same method to the wider NTSB general aviation file (including personal, instructional and other operations), and an option to apply the method to Part 121 and Boeing/CAST data, with Part 121 data from the NTSB. Co-author priorities for that work include the same analysis for airplane and helicopter flight training and checking operations, accidents by airframe manufacturer grouped by engine type and a keyword-based review of human factors elements in the accident records.

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Generative AI and other electronic research and writing tools were used to assist with research, data organization and analysis, drafting and editorial refinement. The authors reviewed and verified the resulting content against the underlying data and cited sources and take full responsibility for all methodological decisions, interpretations, findings and conclusions.

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The personal communications (NTSB Safety Research Division, September 29 and October 13, 2026) are cited in text only, following APA 7. Appendices follow the reference list, in APA order.

Appendix A. Methodology and assumptions

- **Source control.** Row-level source: 2026.V2-NTSB_LOCI_Bus.Corp.135_2016-to-2025_Ransbury_09212026_BusCorpPart135_2016-2025.xlsx (V2 active). Fixed-wing analysis source: NTSB_FixedWing_2016-2025_Master_Analysis_WORKING_v0.2.xlsx (approved September 22, 2026). Rotary-wing values are computed from the same row-level source by the same method. Source files are read-only.
- **Scope.** Accidents from January 1, 2016, through December 31, 2025 (EventYear 2016–2025); AircraftCategory = Airplane (fixed-wing) or Helicopter (rotary-wing), analyzed separately; OperationCategory = GA Business, GA Executive/Corporate or Part 135 On Demand.
- **Unit.** Unique accident event, by NTSBNumberFull and MKey (confirmed by the NTSB, October 13, 2026).
- **Measures.** Accidents = unique events; fatal accidents = events with FatalInjuries of 1 or more; fatalities = sum of FatalInjuries, counted once per event.
- **Blank injury counts.** Treated as zero for calculations per NTSB guidance; original blanks preserved.
- **Unknown, Other and blank.** Retained in full tables and denominators; excluded from top-three chart eligibility.
- **Denominators.** All percentages use the complete type-of-operation total across every defining-event lookup, never only the displayed categories.
- **Top-three tie rule.** Fatalities: fatal accidents, then accidents, then name. Fatal accidents: fatalities, then accidents, then name. Accidents: fatal accidents, then fatalities, then name.
- **Executive/Corporate consistency rule.** A zero-severity third category is retained for consistent top-three comparison, with disclosure. A type of operation with a single accident is shown as a table.
- **Exposure estimates.** FAA General Aviation and Part 135 Activity Survey, Table 3.2, hours by actual use for fixed-wing and rotorcraft totals, 2016–2024; 2025 extrapolated as the 2022–2024 average; Part 135 On-Demand = air taxi + air tours + air medical. Part 135 method checked against NTSB published on-demand rates, 2016–2023 (NTSB, 2024). Estimates.
- **Change control.** Any change to source, filters, unit, classification, denominator, eligibility or tie rule requires a log entry, a QA rerun and reapproval of affected tables and visuals.

QA reconciliation: fixed-wing GA Business 203 rows to 202 events; Executive/Corporate 38 rows to 38 events; Part 135 On-Demand 239 rows to 237 events. Rotary-wing GA Business 36 rows to 35 events; Executive/Corporate 1 row to 1 event; Part 135 On-Demand 131 rows to 131 events. Full lookups reconcile to type-of-operation totals, and percentages total 100% in each type of operation. Recomputing the fixed-wing lookups from the row-level source reproduced all 66 approved lookup rows without a difference. AI-assisted tools were used for data processing; the reported values were checked against the row-level NTSB source through the reconciliation and recomputation described above.

Appendix B. Exceptions and decision log

Sources: fixed-wing working analysis exceptions log; Co-Author Working Meeting Record, October 9, 2026; formula reproduction audit; v0.2 rotary-wing computation. IDs beginning with D, G or N refer to decisions in the meeting record. Table B1 lists each exception and decision with its effect and status.

Table B1. Exceptions and decision log

ID	Record(s)	Issue	Decision	Effect	Status
EX-001	ERA22LA379 / 105776	Two-aircraft Business event	Count once by MKey	One Business accident	Resolved
EX-002	CEN19MA141 / 99423	Two-aircraft fatal Midair	Count once; six fatalities	Prevents double count	Confirmed by NTSB (October 13, 2026)
EX-003	CEN22LA149 / 104818	Two-aircraft ground collision	Count once	One Part 135 accident	Resolved
EX-004	Unknown	Material classification status	Keep in totals; exclude from charts	No denominator change	Decided
EX-005	CEN20FA012 / 100475	Two-helicopter GA Business Midair	Count once; 2 fatalities (4 if summed)	One rotary-wing Business accident	Confirmed by NTSB (October 13, 2026)
EX-006	ANC23LA071	Repeated accident number spanning two categories	Retained as recorded	No fatal or serious injuries; no effect on rankings	Closed
EX-007	CEN18RA187; WPR25FA088; WPR25LA124	EngineType recorded as Unknown (Gulfstream 200, Learjet 35A, Honda HA-420)	Reclassify as turbofan from make and model in the working copy; NTSB extract unchanged	Section 3.6 engine-type counts only; no ranking change	Agreed by the authors
EX-008	CEN22LA126	EngineType recorded as Turbo jet (Embraer EMB-500)	Reclassify as turbofan from make and model in the working copy; NTSB extract unchanged	Section 3.6 engine-type counts only (24 turbofan, 0 turbojet); no ranking change	Agreed by the authors
EX-009	ERA21LA208; 11 fixed-wing accidents (Tables C1 to C3)	Overruns and undershoots have a separate NTSB defining event, not Runway Excursion	Retain the NTSB defining event as recorded; clarifying sentence in Section 3.6	Section 3.6 wording only; no count or ranking change	Agreed by the authors
RW-01	Other (rotary-wing)	Ranking eligibility	Not eligible, same as Unknown	Would rank 1st by fatalities in RW GA Business and 2nd by accidents in RW Part 135	Agreed by the authors
D1	All multi-aircraft events	Unit of analysis: events or aircraft	Event totals; aircraft stated separately	Every total and denominator	Confirmed by NTSB (October 13, 2026)
D2	Multi-aircraft events	Fatality allocation	Event totals counted once	FW Part 135 Midair 18 (24 if summed)	Confirmed by NTSB (October 13, 2026)
D3	10 location-review events	N-registered, non-U.S. or blank locations	Retain; Kipp verifies and documents	One fatality (ERA19LA096, Atlantic Ocean near the Bahamas); no ranking change	Confirmed by NTSB (October 13, 2026)
D4	Balloon (22) and glider (2) accidents	Aircraft scope	Exclude and log; fixed-wing then rotary-wing	Scope	Decided

ID	Record(s)	Issue	Decision	Effect	Status
D5	In-scope records	Ground fatalities	Label X, or X (Y) only when Y is greater than 0	Visuals, definitions; no ground field in extract, so ground fatalities cannot be separated	Confirmed by NTSB (October 13, 2026)
D6	Findings wording	Severity observation	Same-event comparison	Summary, findings	Decided
D7	Discussion	Evidence standard for "why"	Cited, labeled content only	Section 5	Decided
D8	Front matter	Contribution statement	After findings final	Section 1.3	Agreed by the authors
D9	Context sections	Heinrich and published rates	Front matter framing; Boeing and exposure context closing	Sections 1 and 6	Decided
D10	Title page	Byline, permission, dates	Byline alphabetical by surname; final comments due COB October 13, 2026	Title page, schedule	Agreed by the authors; data use confirmed by NTSB (October 13, 2026)
D11	Method	Repeatability test	Accepted; annual cycle	Section 9	Decided
N1	Runway excursions	Make-and-model granularity	Include in framework	Section 3.6	Decided
R-002	Aircraft rows	Blank FatalInjuries fields	Zero per NTSB guidance	None expected	Closed
R-004	Five rows	Regulation metadata differs from type of operation	Retained as recorded by OperationCategory	No effect on rankings	Closed
T-01	Whole report	Terminology	"Type of operation" replaces "population"; "study period" and "study operations"; n for sample size	Text, tables and figures	Decided

Appendix C. Full lookup tables

Fixed-wing source: NTSB_FixedWing_2016-2025_Master_Analysis_WORKING_v0.2.xlsx, full lookup sheets.

Rotary-wing source: computed from the V2 extract by the same method. Shares use full type-of-operation denominators. Tables C1 to C6 give the full lookup for each aircraft category and type of operation.

C.1 Fixed-wing GA Business

Table C1. Fixed-wing GA Business full lookup

Defining event	Accidents	%	Fatal accidents	%	Fatalities	%
Abnormal Runway Contact	33	16.3%	1	2.4%	2	2.0%
Abrupt Maneuver	1	0.5%	1	2.4%	2	2.0%
Bird Strike	7	3.5%	0	0.0%	0	0.0%
Collision on Takeoff or Landing	6	3.0%	1	2.4%	2	2.0%
Controlled Flight Into Terrain	3	1.5%	2	4.8%	3	2.9%
External Load	1	0.5%	1	2.4%	2	2.0%
Fire - Non-Impact	2	1.0%	0	0.0%	0	0.0%
Fuel Related	10	5.0%	1	2.4%	1	1.0%
Ground Collision	2	1.0%	0	0.0%	0	0.0%
Loss of Control In-Flight	43	21.3%	24	57.1%	60	58.8%
Loss of Control on Ground	21	10.4%	0	0.0%	0	0.0%
Midair	1	0.5%	0	0.0%	0	0.0%
Navigation Error	1	0.5%	1	2.4%	1	1.0%
Other	5	2.5%	0	0.0%	0	0.0%
Runway Excursion	14	6.9%	0	0.0%	0	0.0%
System/Component Failure - Non-power	11	5.4%	0	0.0%	0	0.0%
System/Component Failure - Powerplant	19	9.4%	5	11.9%	11	10.8%
Turbulence Encounter	5	2.5%	1	2.4%	2	2.0%
Undershoot/Overshoot	5	2.5%	0	0.0%	0	0.0%
Unintended Flight Into IMC	2	1.0%	1	2.4%	3	2.9%
Unknown	5	2.5%	3	7.1%	13	12.7%
Wildlife Encounter	5	2.5%	0	0.0%	0	0.0%
All defining events	202	100.0%	42	100.0%	102	100.0%

C.2 Fixed-wing Executive/Corporate

Table C2. Fixed-wing Executive/Corporate full lookup

Defining event	Accidents	%	Fatal accidents	%	Fatalities	%
Abnormal Runway Contact	6	15.8%	0	0.0%	0	0.0%
Aerodrome	1	2.6%	0	0.0%	0	0.0%
Bird Strike	1	2.6%	0	0.0%	0	0.0%
Cabin Safety Events	1	2.6%	0	0.0%	0	0.0%
Collision on Takeoff or Landing	1	2.6%	0	0.0%	0	0.0%
Fuel Related	1	2.6%	0	0.0%	0	0.0%
Ground Collision	2	5.3%	0	0.0%	0	0.0%
Ground Handling	1	2.6%	0	0.0%	0	0.0%

Defining event	Accidents	%	Fatal accidents	%	Fatalities	%
Loss of Control In-Flight	2	5.3%	1	50.0%	5	83.3%
Loss of Control on Ground	3	7.9%	0	0.0%	0	0.0%
Low Altitude Operation	1	2.6%	0	0.0%	0	0.0%
Runway Excursion	6	15.8%	1	50.0%	1	16.7%
System/Component Failure - Non-power	7	18.4%	0	0.0%	0	0.0%
System/Component Failure - Powerplant	3	7.9%	0	0.0%	0	0.0%
Undershoot/Overshoot	2	5.3%	0	0.0%	0	0.0%
All defining events	38	100.0%	2	100.0%	6	100.0%

C.3 Fixed-wing Part 135 On-Demand

Table C3. Fixed-wing Part 135 On-Demand full lookup

Defining event	Accidents	%	Fatal accidents	%	Fatalities	%
Abnormal Runway Contact	33	13.9%	1	2.4%	2	2.2%
Abrupt Maneuver	1	0.4%	0	0.0%	0	0.0%
Aerodrome	1	0.4%	0	0.0%	0	0.0%
Bird Strike	5	2.1%	0	0.0%	0	0.0%
Collision on Takeoff or Landing	9	3.8%	2	4.9%	3	3.3%
Controlled Flight Into Terrain	9	3.8%	5	12.2%	12	13.0%
Fire - Non-Impact	5	2.1%	1	2.4%	4	4.3%
Fuel Related	4	1.7%	0	0.0%	0	0.0%
Ground Collision	8	3.4%	0	0.0%	0	0.0%
Ground Handling	4	1.7%	0	0.0%	0	0.0%
Icing	1	0.4%	0	0.0%	0	0.0%
Loss of Control In-Flight	28	11.8%	11	26.8%	22	23.9%
Loss of Control on Ground	30	12.7%	1	2.4%	1	1.1%
Loss of Lift	1	0.4%	0	0.0%	0	0.0%
Low Altitude Operation	1	0.4%	0	0.0%	0	0.0%
Medical Event	2	0.8%	1	2.4%	1	1.1%
Midair	5	2.1%	5	12.2%	18	19.6%
Navigation Error	2	0.8%	0	0.0%	0	0.0%
Other	6	2.5%	2	4.9%	5	5.4%
Runway Excursion	17	7.2%	0	0.0%	0	0.0%
Runway Incursion - Vehicle	1	0.4%	0	0.0%	0	0.0%
System/Component Failure - Non-power	14	5.9%	2	4.9%	4	4.3%
System/Component Failure - Powerplant	17	7.2%	3	7.3%	7	7.6%
Turbulence Encounter	6	2.5%	0	0.0%	0	0.0%
Undershoot/Overshoot	4	1.7%	0	0.0%	0	0.0%
Unintended Flight Into IMC	6	2.5%	2	4.9%	2	2.2%
Unknown	10	4.2%	5	12.2%	11	12.0%
Wildlife Encounter	3	1.3%	0	0.0%	0	0.0%
Windshear/Thunderstorm	4	1.7%	0	0.0%	0	0.0%
All defining events	237	100.0%	41	100.0%	92	100.0%

C.4 Rotary-wing GA Business

Table C4. Rotary-wing GA Business full lookup

Defining event	Accidents	%	Fatal accidents	%	Fatalities	%
Abnormal Runway Contact	5	14.3%	0	0.0%	0	0.0%
Bird Strike	1	2.9%	0	0.0%	0	0.0%
Collision on Takeoff or Landing	1	2.9%	0	0.0%	0	0.0%
Controlled Flight Into Terrain	2	5.7%	1	16.7%	1	9.1%
Fuel Related	2	5.7%	0	0.0%	0	0.0%
Loss of Control In-Flight	5	14.3%	2	33.3%	3	27.3%
Loss of Control on Ground	3	8.6%	0	0.0%	0	0.0%
Low Altitude Operation	4	11.4%	0	0.0%	0	0.0%
Midair	1	2.9%	1	16.7%	2	18.2%
Other	4	11.4%	1	16.7%	4	36.4%
System/Component Failure - Non-power	4	11.4%	1	16.7%	1	9.1%
Unintended Flight Into IMC	1	2.9%	0	0.0%	0	0.0%
Unknown	2	5.7%	0	0.0%	0	0.0%
All defining events	35	100.0%	6	100.0%	11	100.0%

C.5 Rotary-wing Executive/Corporate

Table C5. Rotary-wing Executive/Corporate full lookup

Defining event	Accidents	%	Fatal accidents	%	Fatalities	%
Unintended Flight Into IMC	1	100.0%	1	100.0%	1	100.0%
All defining events	1	100.0%	1	100.0%	1	100.0%

C.6 Rotary-wing Part 135 On-Demand

Table C6. Rotary-wing Part 135 On-Demand full lookup

Defining event	Accidents	%	Fatal accidents	%	Fatalities	%
Abnormal Runway Contact	5	3.8%	0	0.0%	0	0.0%
Abrupt Maneuver	3	2.3%	1	3.4%	3	3.4%
Aerodrome	1	0.8%	0	0.0%	0	0.0%
Bird Strike	9	6.9%	2	6.9%	6	6.8%
Collision on Takeoff or Landing	10	7.6%	0	0.0%	0	0.0%
Controlled Flight Into Terrain	5	3.8%	2	6.9%	5	5.7%
Fire - Non-Impact	3	2.3%	1	3.4%	2	2.3%
Fuel Related	2	1.5%	0	0.0%	0	0.0%
Ground Collision	3	2.3%	0	0.0%	0	0.0%
Ground Handling	2	1.5%	0	0.0%	0	0.0%
Loss of Control In-Flight	20	15.3%	5	17.2%	12	13.6%
Loss of Control on Ground	3	2.3%	1	3.4%	4	4.5%
Low Altitude Operation	3	2.3%	1	3.4%	1	1.1%
Medical Event	3	2.3%	3	10.3%	4	4.5%
Midair	2	1.5%	0	0.0%	0	0.0%
Other	16	12.2%	1	3.4%	3	3.4%
System/Component Failure - Non-power	14	10.7%	0	0.0%	0	0.0%
System/Component Failure - Powerplant	10	7.6%	2	6.9%	6	6.8%
Unintended Flight Into IMC	10	7.6%	7	24.1%	35	39.8%
Unknown	6	4.6%	3	10.3%	7	8.0%
Windshear/Thunderstorm	1	0.8%	0	0.0%	0	0.0%
All defining events	131	100.0%	29	100.0%	88	100.0%

About the Authors

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