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Accidents

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M. A. A. 1175
NATIONAL TRANSPORTATION SAFETY BOARD
Department of Transportation
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An Analysis of Aircraft Accident Data
U. S. General Aviation

1967 APA

ACCIDENTS, RATES, GROWTH CHANGES FROM PREVIOUS YEAR

As it has the last eleven years, U. S. General Aviation Flying continued to grow during calendar year 1967. Comparing several yardsticks to assess this increase, it appears the growth rate was a significant one, although not as significant as the 1965 to 1966 growth rate. Some of these criteria as compared with 1966 are as follows:

<u>Estimated Hours Flown</u>	<u>1966</u>	<u>1967</u>	<u>Percentage Change</u>
Total Flying	21,023,000	22,153,000	+5.38
Instructional Flying	5,264,000	5,754,000	+9.31
Pleasure Flying	6,077,000	6,859,000	+12.87
<u>Estimated Number of Aircraft</u>			
Total Eligible Aircraft	104,706	114,186	+9.05
<u>Accidents, Aircraft Damage, Injuries</u>			
Total Accidents	5712	6115	+7.06
Fatal Accidents	573	603	+5.24
Aircraft Involved	5762	6163	+6.96
Aircraft Destroyed	986	1034	+4.86
Fatal Injuries	1151	1228	+6.69
Serious Injuries	588	617	+4.93
Minor Injuries	987	1146	+16.11
Total Persons Aboard	11,221	12,193	+8.66

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It is interesting to note that despite a 6.96 percent increase in aircraft involved in accidents the increase in aircraft destroyed was only 4.86. In other words, the percent of aircraft involved in accidents which were destroyed in those accidents decreased from 17.1 for 1966 to 16.8 during 1967. This is the second consecutive year that this indicator has declined.

In marked contrast to 1966, the utilization (hours per year) of aircraft showed a decline in 1967. In 1966 the average number of hours flown per aircraft was 200.8, while in 1967 it decreased to 194.0.

The accident rate for total accidents increased slightly over the rate for 1966, while the fatal accident rate was unchanged. The rates were as follows:

<u>Accidents</u>	<u>Aircraft Accident Rate Per 100,000 Aircraft Hours Flown</u>		<u>Percentage Change</u>
	<u>1966</u>	<u>1967</u>	
Total Accidents	27.2	27.6	+1.47
Fatal Accidents	2.7	2.7	-

The percent of all accidents which were fatal decreased from 10 percent in 1966 to 9.9 percent in 1967. Even so, the number of fatal injuries increased almost 7 percent.

Fire After Impact

There was an increase in the number of fatal accidents and total accidents involving fire after impact. Total accidents increased 6.0 percent to 266, and fatal accidents increased 17.73 percent to 166. Fire after impact in nonfatal accidents decreased 9.1 percent to 100.

ANALYSES BY TYPE OF AIRCRAFT

In both 1966 and 1967 the single engine fixed-wing aircraft category had the largest number of active aircraft, flew the most hours, had

the most total and fatal accidents and the most aircraft destroyed. The accident rates, however, show that rotorcraft have the largest number of total and fatal accidents per 100,000 hours. The rates are: a/

<u>Aircraft Category</u>	<u>Total Accident Rate Per 100,000 Hours</u>		<u>Fatal Accident Rate Per 100,000 Hours</u>	
	<u>1966</u>	<u>1967</u>	<u>1966</u>	<u>1967</u>
Rotorcraft	62.80	49.07	5.49	5.95
S.E. Fixed-Wing	29.56	29.29	2.87	2.67
M.E. Fixed-Wing	13.88	19.91	1.76	2.99

Injury Index and Accident Lethality

As indicated in the previous section, all multi-engine fixed-wing aircraft had lower or comparable rates total and fatal when compared with all single-engine fixed-wing aircraft. However, let us exclude all large fixed-wing aircraft accidents, some 56, and compare the percent of accidents which are fatal for single engine small fixed-wing aircraft (9.7 in 1966 and 9.1 in 1967) versus multi-engine small fixed-wing aircraft (12.7 in 1966 and 14.7 in 1967). This higher lethality rate of accidents for multi-engine small fixed-wing aircraft is related, in part at least, to the higher rate of fire after impact for this aircraft category: 5.2 percent for ME/SFW vs. 4.0 percent for SE/SFW in 1966 and 5.7 percent vs. 3.9 percent respectively during 1967. That lethality is associated with fire after impact is shown clearly in the following:

<u>Accident Category</u>	<u>Percent of Accidents Which Have Fire After Impact</u> <u>b/</u>	
	<u>1966</u>	<u>1967</u>
Fatal Accidents	24.6%	27.5%
Nonfatal Accidents	2.1%	1.8%

a/ Refer to Table 2 in the Review.

b/ Refer to Table 3 in the Review.

The data for 1967 again indicate that multi-engine small fixed wing aircraft had a much higher percent of their fatal accidents involving fire after impact than single-engine small fixed-wing aircraft: 31.3 percent vs. 23.5 percent in 1966 and 29.5 percent vs. 26.9 percent in 1967.

The multi-engine large fixed-wing aircraft had the highest percent of fatal accidents among its total accidents:

<u>Aircraft Category</u>	<u>Percent of Accidents Within Each Aircraft Category Which Were Fatal</u> ^{a/}	
	<u>1966</u>	<u>1967</u>
Multi-Engine Large Fixed-Wing	20.0	20.0
Multi-Engine Small Fixed-Wing	12.1	14.7
Single-Engine Small Fixed-Wing	9.7	9.1

and conversely the multi-engine large fixed-wing aircraft again had the lowest percent of accidents involving no injury.

<u>Aircraft Category</u>	<u>Percent of Accidents Within Each Aircraft Category Involving No Injury</u> ^{b/}	
	<u>1966</u>	<u>1967</u>
Multi-Engine Large Fixed-Wing	62.2	61.0
Multi-Engine Small Fixed-Wing	80.6	75.5
Single-Engine Small Fixed-Wing	73.7	73.1

Aircraft Damage

Multi-engine large fixed-wing aircraft have a much higher percentage of aircraft involved in accidents destroyed in those accidents for both years.

a/ Refer to Table 3.

b/ Ibid.

<u>Aircraft Category</u>	<u>Percent of Aircraft Within Each Aircraft Category Destroyed</u>	
	<u>1966</u>	<u>1967</u>
Multi-Engine Large Fixed-Wing	31.1	36.6
Multi-Engine Small Fixed-Wing	16.2	19.3
Single-Engine Small Fixed-Wing	16.5	15.9

Injuries to Occupants: Within Type of Aircraft

Note: Crew is defined as all crew members other than the pilot.

In single-engine small fixed-wing aircraft and in rotorcraft for 1966 and 1967, passengers incurred more fatal injuries than any other category of occupant other than crew members of single-engine small fixed-wing aircraft. The percentages are:

<u>Occupant</u>	<u>Percent of Occupants Fatally Injured Single-Engine Small Fixed-Wing a/</u>	
	<u>1966</u>	<u>1967</u>
Passenger	11.4	10.4
Pilot	9.1	8.5
Crew	7.4	12.4

	<u>Rotorcraft</u>	
	<u>1966</u>	<u>1967</u>
Passenger	12.0	14.1
Pilot	7.1	11.7
Crew	2.6	0

Injuries to Occupants: By Types of Aircraft

Note: Crew defined as all crew members other than the pilot.

The table below shows the percentage of pilots aboard in each aircraft category who were fatally injured.

a/ Refer to Table 4 in the Review.

Percent of Fatalities
Within each Aircraft Category^{a/}

<u>Aircraft Category</u>	<u>1966</u>	<u>1967</u>
Multi-Engine Large Fixed Wing	13.3	19.5
Multi-Engine Small Fixed-Wing	11.0	13.6
Single-Engine Small Fixed-Wing	9.1	8.5
Rotorcraft	7.1	11.7

Multi-engine large fixed-wing aircraft have the poorest record in this respect, while rotorcraft and single-engine small fixed-wing aircraft tend to have much better rates.

In both years crew members incurred the lowest percentage of fatal injuries in rotorcraft:

Percent of Crew Fatalities^{b/}

<u>Aircraft Category</u>	<u>1966</u>	<u>1967</u>
Multi-Engine Small Fixed-Wing	12.6	14.1
Multi-Engine Large Fixed-Wing	6.1	19.1
Single Engine Small Fixed-Wing	7.4	12.4
Rotorcraft	2.6	0

Passenger fatalities show a great deal of variation from year to year in the multi-engine large fixed-wing and rotorcraft categories, possibly because of the relatively small number of fatal accidents in these aircraft categories.

a/ Refer to Table 4 in the Review.

b/ Ibid.

<u>Aircraft Category</u>	<u>Percent of Passenger Fatalities</u> ^{a/}	
	<u>1966</u>	<u>1967</u>
Multi-Engine Small Fixed-Wing	11.3	11.5
Multi-Engine Large Fixed-Wing	14.0	0
Single-Engine Small Fixed-Wing	11.4	10.4
Rotorcraft	8.3	14.1

ANALYSES BY KIND OF FLYING

Accidents and Rates^{b/}

Pleasure flying was involved in the greatest number of accidents (2658) and had the greatest number of hours flown (6.859 Million); Instructional flying was next with 1303 accidents representing a 36.5% increase over the 1966 figure of 827, and 5.754 million hours flown (by contrast, only a 9.3% increase over 1966.) Business and Corporate flying together had 5.078 million hours of flying, and had 865 and 119 accidents respectively. All other non-commercial flying had 142 accidents.

Aerial Application had 404 accidents (an increase of 25.1% over 1966) and 1.128 million hours (an increase of 8.8% over 1966). Air Taxi, in 1.766 million hours, had 234 accidents. All other commercial flying had 101 accidents.

a/ Refer to Table 4 in the Review.

b/ Refer to Table 5 in the Review.

Accident Rates Per 100,000 Hours^{a/}

Pleasure flying had the highest rates for both total and fatal accidents, 38.75 and 4.49 respectively. Aerial application was next highest in both categories with 35.82 and 3.72 respectively. Air Taxi had the lowest total accident rate with 13.25 and the second lowest fatal rate of 1.87. Business-Corporate had total and fatal rates of 19.38 and 2.07 respectively. Instructional flying had the lowest fatal accident rate (.89) while its total accident rate was 22.65. All rates except one were higher for 1967 than for 1966, with the total accident rate for instructional flying showing the largest increase. The one exception to the general increase was the fatal accident rate for pleasure flying, which declined from 5.36 in 1966 to 4.49 in 1967.

Injury Index^{b/}

Instructional flying had the lowest ratio of fatal to total accidents in 1967 with 51 to 1303, or 3.91%. Corporate flying had the highest percentage, with 14.29. In rank order, the percentages were:

a/ Refer to Table 5 in the Review.

b/ Ibid.

<u>Type of Flying</u>	<u>Fatal Accidents As A Percentage Of the Total Accidents Within Each Type of Flying a/</u>
Corporate	14.29
Miscellaneous	14.19
Air Taxi	14.10
All Others (Commercial)	13.86
Pleasure	11.59
Aerial Application	10.39
Business	10.17
All Others (Non commercial)	9.86
Instructional	3.91
All Accidents	9.86

In nearly 100% of the accidents the aircraft involved was either substantially damaged or destroyed. This is not uncommon because of the Board's definition of an accident which states that unless personal injury is involved, an aircraft accident occurs when damage to aircraft involved is substantial or greater. The percent of aircraft destroyed ranged from a low of 7.8% for Instructional flying to a high of 28.2% for Aerial Application. Air Taxi and Pleasure flying were next highest in percent of aircraft destroyed (19.2% and 18.1% respectively).

Injuries to Occupants: Within Kind of Flying

Note: Crew is defined as all crew members other than the pilot.

In Pleasure and Business flying, crew members sustained higher rates of fatal injuries than did pilots or passengers, for both years:

a/ Refer to Table 5 in the Review.

Percent of Fatal and Total Injuries

<u>Occupant</u>	<u>Pleasure Flying</u>				<u>Business Flying</u>			
	<u>1966</u>		<u>1967</u>		<u>1966</u>		<u>1967</u>	
	<u>Fatal</u>	<u>Total</u>	<u>Fatal</u>	<u>Total</u>	<u>Fatal</u>	<u>Total</u>	<u>Fatal</u>	<u>Total</u>
Crew	38.7	54.8	48.8	65.1	41.7	41.7	11.5	15.4
Passengers	12.9	25.1	10.3	24.2	10.7	20.2	9.2	18.0
Pilots	12.1	27.7	10.6	27.2	9.1	20.9	9.7	19.9

In Corporate flying, crew members incurred a higher percent of fatalities than passengers in 1966 but not in 1967.

<u>Occupant</u>	<u>Percent of Fatal Injuries^{a/} Corporate Flying</u>	
	<u>1966</u>	<u>1967</u>
Crew	10.3	10.5
Passengers	4.6	12.4

ANALYSIS BY TYPE OF ACCIDENT

Collision Between Aircraft^{b/}

Collisions between aircraft occurred 50 times in 1966 and 48 times in 1967. In both years, the percent of such accidents which were fatal was well over 20%, compared with about 10% for all accidents, and the percent of such accidents in which there was injury was 50% for both years, compared to an overall figure of approximately 27%.

<u>Percent of Accidents Which Were Fatal</u>	<u>1966</u>	<u>1967</u>
All Accidents	10.0	9.9
Collision Between Aircraft	22.0	39.6
<u>Percent of Accidents in Which There Was Injury</u>	<u>1966</u>	<u>1967</u>
All Accidents	26.8	27.2
Collision Between Aircraft	50.0	50.0

^{a/} Refer to Table 6 in the Review.

^{b/} Refer to Table 30 and 31 in the Review.

The pattern of aircraft damage is different for collisions between aircraft when compared with the pattern for all accidents. In both years there was a higher percentage of aircraft destroyed and a lower percentage of aircraft substantially damaged, when compared to the percentages for all accidents.

<u>1966</u>		<u>1967</u>	
<u>Collisions Between Aircraft</u>	<u>All Accidents</u>	<u>Collisions Between Aircraft</u>	<u>All Accidents</u>
<u>Aircraft Damage</u>			
Destroyed	30.0	17.1	34.4
Substantial	60.0	82.2	52.1
			16.8
			82.5

In both years, more than half of the collisions between aircraft were mid-air, 27 of 50 (54%) in 1966 and 25 of 48 (52%) in 1967. Of the mid-air collisions, over 40% of them in 1966 and 76% of them in 1967 were fatal.

EIGHT MOST SERIOUS ACCIDENT TYPES

While 57 different accident types are defined, eight account for almost 80% of all fatal accidents:

<u>First Accident Type</u>	<u>Percentage of Fatal Accidents</u>
Uncontrolled Collision with Ground/water	16.6
Stall/spin	12.3
Stall	12.1
Engine failure or malfunction	11.8
Controlled collision with ground/water	8.6
Collision with trees	7.6
Airframe failure: in flight	5.3
Collision with wires/poles	4.5

Eight accident types, including six of those mentioned for fatal accidents, account for almost 75% of all serious-injury accidents. These are:

<u>First Accident Type</u>	<u>Percentage of Serious Injury Accidents</u>
Engine failure of malfunction	26.2
Stall	12.2
Collision with wires/poles	9.1
Controlled collision with ground/water	6.1
Propeller/rotor accident to person	5.8
Undershoot	5.2
Collision with trees	5.0
Stall/mush	5.0

The eight accident types mentioned above in fatal accidents account for over 71% of all aircraft destroyed. The percentages are:

<u>First Accident Type</u>	<u>Percentage of Aircraft Destroyed</u>
Engine Failure or malfunction	16.2
Stall	11.8
Uncontrolled collision with ground/water	11.3
Stall/spin	7.7
Controlled collision with ground/water	7.5
Collision with trees	7.3
Collision with wires/poles	6.0
Stall/mush	3.4

In Air Taxi flying, pilots sustained higher rates of fatal injuries and total injuries in both years.

<u>Occupant</u>	<u>1966</u>		<u>1967</u>	
	<u>Injuries</u>		<u>Injuries</u>	
	<u>Fatal</u>	<u>Total</u>	<u>Fatal</u>	<u>Total</u>
Pilots	11.0	27.1	12.0	22.6
Passengers	7.1	19.8	10.4	22.5

Injuries to Occupants: By Kind of Flying

Notes: Crew is defined as all crew members other than the pilot.

Pilots

Of the specific kinds of flying, Instructional had the lowest percentage of fatal injury to pilots (3.8%) in 1967 compared with 4.1% in 1966.

Aerial Application had the highest percentage of injury to pilots in both years (38.7% for 1966 and 34.6% for 1967). Instructional flying was the only specific kind of flying which had less than 20% of injury to pilots in both years. The likelihood of some injury to pilots during accidents appears greatest for Aerial Application and least for Instructional flying, while the likelihood of fatal injury appears lowest for Instructional flying.

Passengers

Of the specific kinds of flying, Business and Instructional had the lowest rate of fatal injury to passengers in 1967.

<u>Kind of Flying</u>	<u>Percent of Fatal Injuries to Passengers</u>	
	<u>1966</u>	<u>1967</u>
Instructional	10.0	7.6
Pleasure	12.9	10.3
Business	10.7	9.2
Corporate	4.6	12.4
Aerial Application	0	16.7
Air Taxi	7.1	10.4

Crew

In 1967, Pleasure flying alone stands out as having high percentages of fatal and total injuries to crew members in both years.

<u>Kind of Flying</u>	<u>Percent of Crew Injuries</u>			
	<u>1966</u>		<u>1967</u>	
	<u>Percent Fatal Injuries</u>	<u>Percent Total Injuries</u>	<u>Percent Fatal Injuries</u>	<u>Percent Total Injuries</u>
Instructional	4.9	19.4	6.8	23.5
Pleasure	38.7	54.8	51.2	68.3
Business	41.7	41.7	11.5	15.4
Corporate	10.3	17.2	10.5	18.4
Aerial Application	0	0	0	0
Air Taxi	4.0	8.0	11.5	10.4

It is clear that rates of severity of injury to occupants are somehow related to occupant categories and to the kind of flying involved at the time of the accident. Further research would be required to determine the nature of this relationship.

ANALYSES BY ENVIRONMENTAL CONDITIONS

In both years, approximately 93% of all accidents occurred between 0700 and 2059, approximately the daylight hours. The percentage of accidents which were fatal is related to time of day, in both years:

<u>Time Groupings</u>	<u>Percentage Range of^{a/} Accidents Which Were Fatal</u>	
	<u>1966</u>	<u>1967</u>
0100 - 0959	7.1 - 33.3	7.4 - 42.9
1000 - 1759	5.8 - 9.0	7.3 - 8.8
1800 - 0059	10.4 - 43.2	12.3 - 23.8

^{a/} Refer to Table 21 in Review.

Conversely, only 7% of all accidents occur between 2100 and 0659, but it is during this period that 18.1% of all fatal accidents occur.

Conditions of Light^{b/}

Conditions of light, closely related to time groupings, indicate the same general trend. The percent of accidents which were fatal is lower for dawn, daylight and dusk, and higher for night (dark) and night (moonlight bright):

<u>Conditions of Light</u>	<u>Percent of Accidents Which were Fatal</u>	
	<u>1966</u>	<u>1967</u>
Dawn	15.6	9.7
Daylight	8.4	8.2
Dusk	9.2	10.6
Night (dark)	24.2	24.5
Night (moonlight-bright)	20.0	15.8

Type of Weather Conditions

In both years, approximately 94% of all accidents occurred during VFR weather conditions. The percent of accidents occurring in IFR weather conditions and in "below minimum" weather conditions which were fatal is several times higher than the percentage of accidents occurring in VFR weather conditions, thus:

b/ Refer to Table 22 in Review.

<u>Category of Weather Conditions</u>	<u>Percent of Accidents In Each Category Which Were Fatal ^{a/}</u>	
	<u>1966</u>	<u>1967</u>
VFR	7.4	7.5
IFR	53.6	47.1
Below Minimum	23.1	66.7

Airport Proximity

Approximately 60% of all accidents in both years occurred on the airport (or other prepared/intended landing site), but only slightly above 9% of the fatal accidents occurred there:

<u>Airport Proximity</u>	<u>Percent of Total Accidents</u>		<u>Percent of Fatal Accidents</u>	
	<u>1966</u>	<u>1967</u>	<u>1966</u>	<u>1967</u>
On Airport (or intended landing site)	60.1	59.6	9.1	10.4
In Traffic Pattern or within 5 miles of airport	16.8	17.2	38.9	39.5
Beyond 5 miles of airport	22.2	21.7	48.2	45.6

The percent of accidents on the airport which were fatal is only a fraction as high when compared with any other proximity category in both years:

<u>Category of Airport Proximity</u>	<u>Percent of Accidents In Each Category Which Were Fatal</u>	
	<u>1966</u>	<u>1967</u>
On Airport (or intended landing site)	1.5	1.7
In Traffic Pattern or within 5 miles of airport	12.9 - 35.0	17.3 - 34.8
Beyond 5 miles of airport	21.8	20.7

a/ Refer to Table 23 in Review.

ANALYSES BY CAUSE AND RELATED FACTORS ^{a/}

Pilot was cited as a cause (not necessarily the cause) in about 82% of the accidents in all general aviation operations in 1967. Personnel (other than the pilot), powerplant and weather were cited often as causes.

In fatal accidents, all operations, Pilot was cited in almost 84% of the accidents, while Personnel, Airframe, Powerplant and Weather were cited in from 3.8% to 7.6% of the accidents.

Weather was cited as a related factor in 13.1% of all accidents, while the percentages for Terrain; Airport, Airways, and Facilities; and Pilot were 6.7, 5.6, and 3.8, respectively.

Weather was cited as a related factor in a much higher percentage of fatal accidents (27.7%). Pilot, Personnel, and Terrain were cited in 6.0%, 3.6%, and 3.3%, respectively of fatal accidents:

^{a/} Refer to Table 36 in the Review.

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