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A Review of Civil Aviation Propeller-to-Person Accidents: 1980 - 1989

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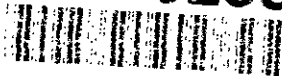
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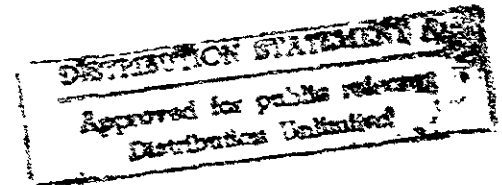


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16. Abstract <p>Various types of paint schemes on aircraft propeller and rotor blades are used to improve the visual conspicuity and attention-getting value of those blades when they are rotating. The improved conspicuity resulting from the paint schemes has the purpose of reducing the number of injuries and fatalities that might occur due to accidental contact with a rotating blade by pilots, passengers, or ground crew. The present study was undertaken to provide information regarding the circumstances surrounding such accidents in recent years and to compare those findings with the frequency and circumstances of propeller accidents during the 1965-1979 period. Computer retrievals of brief reports of all propeller accidents during the period from 1980 through 1989 were provided by the National Transportation Safety Board. Those reports were examined and analyzed in terms of type of accident, degree of injury, actions of pilots, action of passengers and ground crew, night or day, and other conditions. The computer search yielded a total of 104 reports of "propeller-to-person" accidents involving 106 persons. "Prop-to-person" accident frequency for the 1980-1989 period was notably lower than that previously reported for the 1960's and 1970's. Recent declines appear due to a combination of FAA educational efforts, economic conditions, and changes in the types of aircraft used by present aviation pilots. Irrespective of the decade under study, persons at most risk for a propeller-to-person accident are deplaning passengers and passengers attempting to assist the pilot prior to takeoff and after landing.</p>					
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A REVIEW OF CIVIL AVIATION PROPELLER-TO-PERSON ACCIDENTS: 1980-1989

INTRODUCTION

Although helicopter tail rotors are required by Federal Aviation Regulations to be marked so that the perceptual disks created by their rotation are "conspicuous under normal daylight ground conditions," there are no requirements regarding the conspicuity of aircraft propellers. Improved conspicuity is generally considered an essential preventive to the occurrence of civil aviation accidents which involve injury or death to persons struck by rotating propellers and rotor blades. Virtually all U.S. aircraft have some propeller markings; most are of factory design while others represent the choice of the owner. Although other colors are often used, black and white markings yield the best conspicuity (23, 24).

While propeller and rotor paint schemes may reduce the number of propeller-to-person accidents, there is little information available regarding the various circumstances surrounding the accidents that do occur. A previous study (1) examined some features of propeller-to-person accidents from 1965-1979. The present study extended those findings; the frequency, time of day, weather conditions, pilot and passenger activities, and other factors coincident with injuries and fatalities caused by strikes from propeller or rotor blades were examined for the 1980 decade and compared with the earlier accidents of this type.

METHOD

Special requests were made to the National Transportation Safety Board (NTSB) for computer printouts of report briefs of all propeller-to-person accidents from 1980 through 1989. Although there have been changes in format and content over time, these briefs each contain standard information regarding aviation accidents (e.g., statement of cause, nature of injuries, etc.). In addition, further review of the complete accident file for each propeller or rotor accident was conducted in all but 2 cases (those files were not available) to confirm background information. Data were analyzed in terms of time of day, actions of pilots, action of passengers and ground crew, phase of flight operation, weather conditions, and others.

RESULTS

Tabulations over the 10-year period (1980-89) yielded a total of 104 accidents (see Table 1). All of these accidents involved propeller deaths or injuries to single persons with 2 exceptions: (i) in 1980 a helicopter discharging two passengers was turned by a high wind, fatally struck one of the passengers (tail rotor), and caused debris to strike the other passenger, resulting in minor injury, and (ii) in 1983, a pilot handcranking the prop sustained a serious injury while his son, who was helping him, was bruised by the prop (minor injury). The 104 accidents thus involved 106 people (78 males, 28 females) and resulted in 29 deaths; 69 persons were seriously injured and 8 experienced minor injuries. Of the 78 males, 4 were children; of the 28 females, 1 was a child. 5 were wives of the pilots, and 1 was the sister of a pilot. Table 1 also shows a sustained reduction in accidents following 1983.

**TABLE 1. NUMBER AND DEGREE OF
PROPELLER-TO-PERSON INJURIES IN
GENERAL AVIATION, 1980-1989**

Year	Fatal Injury	Serious Injury	Minor Injury	Total
1980	7	8	5	20
1981	0	6	2	8
1982	4	6	0	10
1983	6	14	1	21
1984	1	10	0	11
1985	3	6	0	9
1986	3	5	0	8
1987	2	6	0	8
1988	1	5	0	6
1989	2	3	0	5
TOTALS	29	69	8	106

TABLE 2. NUMBER OF PROPELLER-TO-PERSON ACCIDENTS (1980-1989) BY CATEGORY OF VICTIMS AND BY THE ACTIVITIES IN WHICH THEY WERE ENGAGED

(NOTE: There were 104 accidents; two involved more than one victim.)

Persons	Fatal Injury	Serious Injury	Minor Injury	Total
Passengers	20	46	4	70
Ground Crew	5	9	3	17
Pilots	3	11	1	15
Spectators	0	3	0	3
Vendor	1	0	0	1
TOTALS	29	69	8	106
Activities	Fatal Injury	Serious Injury	Minor Injury	Total
Deplaning	14	19	2	35
Assisting Pilot	6	15	5	26
Handcranking	3	16	0	19
Enplaning	1	14	0	15
Loading, Delivering	2	2	1	5
Spectator	0	3	0	3
Vendor	1	0	0	1
Other	2	0	0	2
TOTALS	29	69	8	106

Table 2 contains categories of persons injured or killed during the 1980's by contact with propellers or rotors. Sixty-six percent of the injuries involved passengers and about 16% involved ground crew, followed by pilots (14%), and a spectator category (4%) that includes such persons as a sister, a friend, and an "unauthorized person," plus a farmer (vendor) selling produce at the airport (the latter was a taxiing accident).

Table 2 also presents a listing of the activities of the individuals that were associated with the accidents. One-third of the accidents occurred during deplaning, another 26% occurred when persons were otherwise trying to assist the pilot (e.g., by helping to dock a seaplane, removing wheel chocks, etc.), approximately 18% in-

involved handcranking the aircraft, about 14% occurred during enplaning, and the remainder were divided among walking visitors, delivery men, and loaders, plus one fatality each resulting from a vendor hit by a taxiing aircraft, a hunter (passenger) using dogs around a helicopter to capture wild hogs, and a ground crewperson struck by a moving, unattended aircraft. Fourteen of the 19 handcranking accidents (including all 3 fatalities) involved pilots; of the remaining 5, 3 involved passengers and 2 were ground crew injuries.

Only 5 accidents involved a moving aircraft. One of these was an aircraft left unattended by the pilot, another involved rotation of the aircraft caused by high winds, and three were taxiing aircraft (one for takeoff and two

after landing). Thus, the vast majority of the 104 propeller-to-person accidents occurred while the aircraft was stationary. Helicopters were involved in 21 (20%) of the accidents and seaplanes in 2 (2%). Almost three-fourths of the helicopter accidents involved the tail rotor (N=15) and almost half of all rotor accidents were fatal. Moreover, over 40% (N=9) of those helicopter accidents occurred during deplaning and about 25% during enplaning (N=5), all but one of these during daylight hours. Of the 2 accidents involving seaplanes, both occurred while passengers were "assisting the pilot" and both were in daylight hours.

Several factors that might have contributed to these propeller-to-person accidents were examined. No alcohol involvement was reported; but alcohol involvement may be underestimated since it is relatively unlikely that a pilot would be subjected to a blood or breath test if the passenger was fatally injured. Two cases (1987 and 1989) involved drug use by the accident victim. In the earlier case, a lineman was killed while performing his duties; a urine sample showed 50 ng/mL of carboxy THC suggesting recent use of marijuana, and both cocaine and marijuana metabolites were found in his blood. In the 1989 case, a female passenger assisting the pilot was seriously injured and indicated that she had taken 5 Fiorinal tablets (usually prescribed for tension headaches) with codeine. Rain, snow, fog, or high wind was present in only 6 accidents and ground that was wet,

icy, or snow covered was reported 3 times. Although weather factors were infrequently involved, they may well have contributed to the occurrence of those particular accidents. Approximately 27% of the accidents happened during the hours of dusk or darkness. With respect to the 29 accidents in the dark, more (N=12) occurred with persons attempting to assist the pilot than for persons deplaning (N=10), enplaning (N=2), or for "other" reasons. Overall, these findings indicate that about 44% of accidents involving persons assisting the pilots, 29% of deplaning accidents, and 13% of enplaning accidents occurred at night when ordinary propeller conspicuity (even at a well-lighted airport) would be considerably reduced.

Comparisons of the frequency and types of propeller-to-person accidents during 1980-1989 were made with similar data (1) from 1965-1979. The accidents were arbitrarily grouped in 5-year periods; averages per year were calculated for total accidents (Table 3), categories of persons (Table 4), and for the types of activities in which the victims were engaged when the accidents occurred (Table 5). These tables show a peaking of accidents in the 1970-74 period and a subsequent decline; the decline is specially marked from 1975-79 (almost 40% less than the previous half-decade) and again from 1984-89 (a 48% drop from the previous 5-year period).

TABLE 3. THE AVERAGE ANNUAL NUMBER OF PROPELLER-TO-PERSON ACCIDENTS AND TYPES OF INJURIES FOR 5-YEAR INTERVALS FROM 1965-1989

Years	Fatal	Serious	Minor	Average Annual Total
1965-69	6.2	16.2	-	22.4
1970-74	10.2	15.4	-	25.6
1975-79	5.2	10.6	-	15.8
1980-84	3.6	8.8	1.6	14.0
1985-89	2.2	5.0	0	7.2

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TABLE 4. THE AVERAGE ANNUAL NUMBER OF INJURIES BY CATEGORIES OF PERSONS IN PROPELLER-TO-PERSON ACCIDENTS FOR 5-YEAR INTERVALS FROM 1965-1989

Years	Pilots	Passengers	Ground Crew	Spectators	Other	Average Annual Total
1965-69	3.0	11.8	4.0	2.4	1.2	22.4
1970-74	5.8	11.6	3.2	2.8	2.2	25.6
1975-79	3.4	8.6	1.0	1.4	1.4	15.8
1980-84	1.6	10.0	2.0	0.4	0.0	14.0
1985-89	1.4	4.0	1.4	0.2	0.2	7.2

TABLE 5. THE AVERAGE ANNUAL NUMBER OF PROPELLER-TO-PERSON ACCIDENTS BY TYPES OF ACTIVITY FOR 5-YEAR INTERVALS FROM 1965-1989

Years	Hand Crank	Assisting Pilot	Enplane	Deplane	Load	Spectator	Other
1965-69	4.0	6.6	2.6	6.6	0.4	1.0	1.2
1970-74	7.2	4.2	6.6	2.8	1.0	1.8	2.0
1975-79	3.8	2.6	1.2	4.6	0.8	1.4	1.4
1980-84	2.0	3.8	1.8	5.2	0.4	0.4	0.4
1985-89	1.8	1.4	1.2	1.8	0.6	0.2	0.2

TABLE 6. THE AVERAGE ANNUAL AVIATION ACTIVITY FOR 5-YEAR INTERVALS FROM 1965-1989 (ref. 8-22)

Years	Active Airmen (Thous)	Hours Flown (Million)	Active Aircraft (Thous)	Total Accidents (Thous)	Fatal Accidents (Actual)
1965-69	612	21.9	116	5.4	611
1970-74	735	28.2	147	4.5	690
1975-79	774	37.8	188	4.3	709
1980-84	753	37.9	214	3.3	592
1985-89	702	34.1	216	2.5	456

DISCUSSION

The data show clearly that passengers who are either deplaning or attempting to assist the pilot are most at risk for a propeller-to-person accident. That the accident frequency is high for these groups is perhaps surprising since, in some respects at least, pilots would seem to have reasonable, direct, and timely opportunities to control, caution, or counsel passengers regarding safe procedures in deplaning or in providing assistance with the aircraft. Two features of this finding seem clear: (i) pilots have a major role in preventing propeller-to-person accidents to their passengers, and (ii) the means by which passenger accidents could be reduced or virtually eliminated require no special equipment and are relatively simple (careful instruction of passengers prior to their deplaning; either not using passengers as assistants or instructing them more carefully regarding hazards; and having engines shut down prior to loading or unloading passengers).

Major Accident Categories. Perhaps surprisingly, more accidents occurred during the handcranking of an aircraft than occurred during passenger enplaning. Pilots were most often victims of handcranking accidents followed in frequency by ground crew members. Moreover, the vast majority of the handcranking accidents occurred with "nose wheel" (tricycle gear) aircraft as compared with "tail wheel" (conventional gear) configurations. And the proportion of handcranking accidents involving these closer-to-the-ground propellers increased from 68% (1965-69) to 75% (1970-74) to 94% (1975-79) to 100% (1980-89). These values may reflect, to some degree, the extra cautions needed while hand propping a tricycle-gear aircraft, but surely represent the gradual shift to proportionately more use of tricycle gear aircraft as the older, conventional gear planes have been replaced or sold to other countries.

Among propeller-to-person accidents involving pilots, all but one occurred during handcranking; the exception was a co-pilot who was attempting to assist the pilot. As noted above, passengers were involved most often in deplaning accidents, followed by accidents that occurred while passengers were attempting to assist the pilot, and while enplaning. Almost all propeller-to-person accidents involving ground crew occurred while they were assisting the pilot or attempting to handcrank the propeller.

Changes in the Accident Rate. The tabulations show a marked drop in the average number of propeller-to-person accidents during 1975-1979. That drop seems attributable to several actions taken by the FAA in the mid-1970s (1). The actions were primarily educational and were largely effected through the FAA Accident Prevention Program. The methods included safety seminars, handouts, posters, a film depicting an actual accident resulting from improper handpropping, and the release of FAA advisory circulars on the hazard of propellers (3,4,5). It seems probable that the combination of those actions helped to produce the overall decline in propeller accidents in the 5-year period from 1975 through 1979. A second sharp decline in propeller-to-person accidents, from 1985-89, reflects, to some degree, both the steady improvement in general aviation accident statistics (Table 6) and recessionary economic conditions that have resulted in reductions both in the number of active pilots and the number of hours flown. A reduction in hand propping accidents over the 1975-89 period seems to have multiple causes. In addition to the FAA's educational efforts (including distribution of the "Propwatcher's Guide" (7) and participation in the Pilot Proficiency Award Program (6)) and the economic conditions already noted, there has also been increased use of twin engine rather than single engine aircraft with what appears to be concomitantly more dependence on the ground crew and others for maintenance assistance.

Supplementary means of further reducing propeller-to-person accidents have been suggested elsewhere (1). Those suggestions include additions to the flight instructor's handbook (2) and the Flight Training Handbook, strategically placed warning signs, use of the rotating beacon whenever the aircraft engine is in operation, and potential technical developments. Among the latter are: (i) auditory or visual warning signals to indicate that aircraft doors are open while engines are running; (ii) additional lighting of the propeller blades (e.g., by a wing light aimed at the blades, switch-operated by the pilot) to increase conspicuity in reduced illumination; (iii) propeller markings on the side of the blades facing the pilot with patterns such that the markings would be visible to the pilot only at low (idling) propeller speed, but not at taxi, takeoff, or cruising speeds; (iv) markings on propeller spinners which are forward of the pilot, similar to those on the propeller blades, to increase

conspicuity; and (v) back-lighting (switch-operated by the pilot) of the propeller spinner, modified by translucent patterns, to create a conspicuous configuration particularly in reduced lighting.

SUMMARY

Persons most at risk for a propeller-to-person accident are deplaning passengers and passengers attempting to assist the pilot. That finding clearly assigns considerable responsibility to pilots to ensure safety of their passengers in this regard.

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