TYPE AIRMAN CERTIFICATION AS RELATED TO ACCIDENTS

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I. Introduction.

Soon after the first flight at Kitty Hawk, accident rates were established, based on the number of accidents in relation to the number of hours spent in the air (exposure incident to flight), as a measure of relative safety in aviation. Over the last 63 years exposure has been considered the common denominator of all accidents. While this position is true, for without exposure there would be no accident, it fails to account for those factors or components which make up exposure. Since accidents are chance phenomena, the greater the exposure the greater the probability of an accident. Exposure is simply the measure of the length of time during which a condition or circumstance accumulates. Exposure should be a qualitative measure of expressing conditions of flying, type of airman certification, and hours of flying. While the general term "exposure" is an overall expression of proficiency in flying, proficiency as measured by conditions of exposure is a constantly changing phenomenon which varies with circumstances of the flight, such as varying light and weather conditions, length of flight, altitude at which flight is flown, and the physiological condition of the pilot. With this in mind, the use of exposure data as expressed in terms of flight hours has been omitted from the analysis of accident data for this paper.

II. Method.

Pilots are certificated as student, private, commercial, or airline transport. This analysis will deal only with *general aviation* accidents and has no relation to air carrier operations. Each type of pilot certification is distinguished by standards of training, medical fitness, and experience, predetermined by the Federal Aviation Administration, and is specifically so designated in the Federal Aviation Regulations[1]. As he progresses from a lower to higher certificate, the pilot must demonstrate his knowledge of aeronautics and his ability to apply this knowledge both by a written examination and a flight test. While a minimum number of flight hours is required for a higher certificate, this requirement covers the least amount of time necessary during which the pilot may be able to acquire the flight skills for the next higher certificate. As the pilot advances from one certificate to another, he gains new skill and experience which contribute to his proficiency as a flyer. A relationship between proficiency and the probability of being involved in an accident will exist as long as the type of flying continues to be of low risk nature (excluding aerial applications, fire fighting, aerobatics, coyote hunting, etc.).

To evaluate correctly the effect of airman certification and accidents for this report, items not common to flying as practiced by the average pilot (e.g., aerial applications) were eliminated from both the pilot and accident population data. Additional adjustments in such data were made to charge the student pilot with accidents which he caused, but which had been charged to his flight instructor.

The term "accident" can refer to a fatal accident, a serious injury, or an accident with sustained damage:

1. "Fatal Accident" is any accident which leads to death within seven (7) days.
2. "Serious Injury" is any injury which:
   a. Requires hospitalization for more than 48 hours commencing within seven days from the date the injury was received.
   b. Results in a fracture of any bone (except simple fractures of fingers, toes, or nose).
   c. Involves lacerations which cause severe hemorrhages, nerve, muscle, or tendon damage.
   d. Involves injury to any internal organ.
   e. Involves second or third degree burns affecting more than 5 percent of the body surface.
3. "Substantial Damage" in aircraft of 12,500 pounds maximum certificated take-off weight or less, means damage or structural failure reasonably estimated to cost $300 or more to repair.

The Aviation Psychology Program[2] in the Army Air Force showed, in studies conducted on a controlled group of about 1,000 airmen, that the higher stanine groups which produced 40 percent of the graduates had 25 percent of the total accidents, none of which was fatal: the lower stanine groups produced 60 percent of the graduates and had 75 percent of the accidents, which included 100 percent of the fatalities. However, it must be pointed out that in this test the stanine groups were based on AAF Qualifying Examination scores, which are measures of individual applications selected for flight training, while the airman certifications are levels of training achieved by pilots.

The student certificate is the most elementary and, as such, requires only that an individual be at least 16 years old and medically fit. However, to achieve the higher certificate of private pilot, an individual must pass a written test and a flight test to demonstrate his proficiency; in addition, he must have at least 40 hours of flight experience. The commercial certificate requires 200 hours of flight experience and the ability to perform more complicated flight maneuvers. The pilot with an ATR certificate, the highest airman certificate, is required to pass an instrument flight test, handle larger and more complex aircraft, and possess greater aeronautical knowledge and skill, as well as have at least 1200 hours of flight time distributed over a range of flight conditions such as night flying, instrument time, and pilot-in-command. Based on these differences in training and experience, the level of proficiency should increase from one certification to another as long as the type of flying remains the same.

All figures relating to accidents and their distribution by type of light and weather conditions were furnished by the Civil Aeronautics Board and represent only 1964 reports of accidents received, reviewed, and coded as of December 10, 1965. In order to show the distribution of certificate holders by qualification, Table #3 was constructed using 1964 data showing the percentage each group represents in the total population of 426,317 active pilots. Combined with these data are the number and percentage of accidents within each certification and their proportion of the year's total accident population.

III. Findings.

Individual pilots will react individually to the same or changing conditions. Pilots with advanced airman certificates and more current flight exposure will be better equipped to handle these changes than those with lower ratings and less current flight experience. Table #1 indicates the exposure rates associated with each of the airman certificates. It is apparent that there are differences between certificate classes. However, here again the accident rate per se does not address itself to the difference within the elements of exposure that account for these differences. It is only when the accident percentages are calculated for airman certificates by increasingly difficult light and weather conditions that we begin to understand some of the components associated with proficiency (see Table #2).

An examination of Table #3 also shows that the accident percentage does not follow the population percentage for students and commercially rated pilots. Our first assumption would be that students, based on their representation in the pilot population, have fewer accidents, while the commercial pilots have about 8 percent more than would be expected based on their representation in the total population. This would seem to indicate that students are safer than commercial pilots. If one looks at the makeup of the four groups, he would find the type of flying done is heterogeneous between them rather than homogeneous. For example, students on the average are required to fly with a flight instructor for the first 10 hours, in addition to several hours of dual cross-country flying, during which the flight instructor, who is a commercially rated pilot, is charged with the student's accidents. Secondly, the commercial pilots who fly as crop dusters (there were 4,500 registered as aerial applicators in 1964) fly under conditions which are foreign to the ATR, private, and student pilot. If we adjust the commercially rated group by excluding from Table #3 those pilots who are aerial applicators and those accidents which occurred while crop dusting, and by charging to the student group those accidents which students caused during pre-solo or dual flight time instruction, for which the instructors are charged, we obtain the distribution shown in Table #4, which shows that accident numbers tend to follow the distribution of the pilot population. If accidents are due to

light and weather conditions, one sees that as flight conditions deteriorate, the total number of accidents decreases. This can be explained in part as indicating that the exposure rate is lower during the more severe light and weather conditions. The Aircraft Owners and Pilots Association (AOPA) found, in a survey conducted in 1961, that only 5 percent of flying is done at night and less than 4 percent by Instrument Flight Rules (IFR). However, IFR total hours were about 50% higher than night total hours flown[3].

The point to be made, however, is that even though fewer flights occur under increasingly difficult flying conditions, the percentage of both non-fatal and fatal accidents rises sharply. Review of the accident records shows that pilots involved in accidents where severe light and weather conditions existed were, in most cases, those pilots who were least prepared for the conditions they encountered: student pilots with only a minimum of instrument understanding and very little night time; private and commercial pilots who were aware of the conditions but pushed into weather such as ice, thunderstorms, snowstorms and severe turbulence; pilots with very little current time, low time in the aircraft being flown, flying over unfamiliar territory, and poor preflight preparation. The ATR (non-airline) pilots, for the most part, were victims of instrument failures, fatigue from long flights, and "pushing their luck". Table #5 shows the results of such actions graphically. Students were involved in six accidents at night under IFR conditions. Of these, four were fatal. In these four, only the students and *illegal* passengers were aboard. The two non-fatals were accidents in which flight instructors were aboard. The presence of the flight instructor might well have saved the two non-fatals from being fatal.

It was reported during the time this study was made that in general aviation there was a high percentage of cases in which alcohol was involved as shown by a blood alcohol test. Medical investigators were successful in obtaining specimens for the testing of blood alcohol in 42 percent of all fatal accidents; of these 39 percent showed positive alcohol levels 10mg% and above. The percentage of alcohol involvement within the ratings based on *Total Fatal* accidents was 23 percent for students, 16 percent for privates, and 17+ percent for both commercial and ATR pilots. Approximately three-fourths of all pilots known to be involved with alcohol (39 percent of those tested), had a level greater than 50mg%. Dr. Herman Heise's report to the Flying Physicians Association indicated "that individuals tested for judgment, sensory and motor functions, prior to and shortly after consumption of alcohol, showed deterioration at blood alcohol levels in the range of 50mg% and above"[5]. Dr. Heise feels that such levels causing degeneration of performance may be judged to have been contributory to the accident rate by resulting in a decrease of pilot proficiency. It is interesting to note that previously unpublished data on alcohol involvement (1964) verifies the results of "Alcohol and General Aviation Accidents", reported by Albers and Harper (1963)[4], and "Recent Findings on the Impairment of Airmanship by Alcohol" by Stanley R. Mohler, M.D.[6].

As the various light and weather factors were analyzed, it was found that 88 percent of all accidents occurred during the day under Visual Flight Rule (VFR) conditions and accounted for 59 percent of the fatal accidents. The remaining 12 percent occurred during Day IFR, Night VFR and Night IFR conditions and accounted for 41 percent of the fatal accidents. Here we can see that the percentage of fatal accidents increases sharply over the total accidents as flight conditions become more hazardous. See Table #5.

A review of the fatal accidents by type of certificate and their representation in the total population indicates that there is what could be defined as a fatal base rate. That is a percentage of fatal accidents which will occur regardless of the number of accidents. The *average* base rate is 9.31 percent of the total accidents. See Chart #1. If one checks the percentage of fatal accidents in relation to the total number of accidents over the last 10 years, they will find that approximately 10 percent of all accidents are fatal.

IV. Summary and Conclusions.

The analysis of 1964 accidents reveals:

1. Students generally were involved less frequently in accidents than any other class of airmen. However, the high percentage of fatal accidents for students flying when light and weather conditions were marginal points up

dramatically the need to impress upon them the limits of their ability under such conditions.

2. Generally, all airman certification groups showed a high percentage of accidents as flying conditions became more demanding, i.e., as visibility decreased because of light and/or weather conditions (see Table #5). Here we see the direct relationship between accidents and changing flight conditions.

3. Eighty-eight percent of all accidents occurred during the day under VFR conditions and accounted for 59 percent of all fatal accidents. (Ninety percent of all flights take place during day VFR conditions.) Only 12 percent of the accidents occurred under less favorable conditions but accounted for 41 percent of all fatalities. It is quite evident that as exposure goes down (10 percent of all flying occurs during Day IFR, Night VFR, IFR conditions) and light and weather conditions become more hazardous, the percentage of fatal accidents increases. However, the percentage of fatal accidents decreases as the type of certification is upgraded.

4. Regardless of the percentage of accidents associated with a particular airman certification, 10 percent, on the average, were fatal. However, although student pilots accounted for 14.47 percent of all fatal accidents, only 7.36 percent of the accidents involving students were fatal. In the other three classes of pilots, the percentage of accidents which were fatal was somewhat greater than for students.

ACCIDENT RATES PER 10,000 PILOT POPULATION
1964

	UNADJUSTED	ADJUSTED
STUDENT	78	92
PRIVATE	118	118
COMMERCIAL	153	104
ATR	80	80

NOTE: Adjusted figures are based on the same criteria as Table #4

TABLE #1

ACCIDENTS AS A PERCENT OF ALL ACCIDENTS ACCORDING TO AIRMAN RATINGS AND LIGHT AND WEATHER CONDITIONS

1964

	DAY VFR	DAY IFR	NIGHT VFR	NIGHT IFR
STUDENT	20.0 %	10.5 %	14.5 %	7.7 %
PRIVATE	40.7 %	52.8 %	53.9 %	51.2 %
COMMERCIAL	34.9 %	27.0 %	27.3 %	28.2 %
ATR	3.0 %	7.0 %	4.3 %	10.3 %
OTHER	1.4 %	2.7 %	-----	2.6 %
	100 %	100 %	100 %	100 %
% of TOTAL ACCIDENTS	88 %	7 %	3	2 %

VFR - Visual Flight Rules IFR - Instrument Flight Rules

TABLE #2

UNADJUSTED PILOT POPULATION VS. UNADJUSTED ACCIDENT POPULATION (BY AIRMAN RATINGS)

1964

PILOT RATING	TOTAL ACTIVE PILOT POPULATION	PERCENT OF POPULATION	NUMBER OF ACCIDENTS	PERCENT OF ACCIDENTS
STUDENT	120,743	28%	937	19%
PRIVATE	175,574	41%	2,081	43%
COMMERCIAL	108,428	26%	1,668	34%
ATR	21,572	5%	174	4%
TOTAL	426,317	100%	4,861	100%

TABLE #3

PILOT POPULATION VS. ACCIDENT POPULATION
(BY AIRMAN RATINGS)
1964

PILOT RATING	ACTIVE PILOT POPULATION (ADJUSTED)	PERCENT OF POPULATION	NUMBER OF ACCIDENTS (ADJUSTED)	PERCENT OF ACCIDENTS
STUDENT	120,743	29%	1,115	25%
PRIVATE	175,574	42%	2,081	47%
COMMERCIAL	103,928	24%	1,088	24%
ATR	21,572	5%	174	4%
TOTAL	421,817	100%	4,458	100%

TABLE #4

FATAL ACCIDENTS AS A PERCENT OF ALL ACCIDENTS ACCORDING TO AIRMAN RATING AND LIGHT AND WEATHER CONDITIONS

1964

	DAY VFR	DAY IFR	NIGHT VFR	NIGHT IFR
STUDENT	4.49%	20.51%	75.00%	66.67%
PRIVATE	5.72%	15.34%	56.18%	82.50%
COMMERCIAL	7.87%	17.39%	42.22%	54.55%
ATR	5.92%	16.67%	28.57%	37.50%
% GROUP TOTAL	6.45%	16.18%	53.94%	67.95%

VFR - Visual Flight Rules IFR - Instrument Flight Rules

TABLE #5

FATAL ACCIDENTS BY CERTIFICATES
COMPARISON OF TOTAL FATAL POPULATION BY RATINGS
VS. FATAL WITHIN CERTIFICATES
1964 DATA

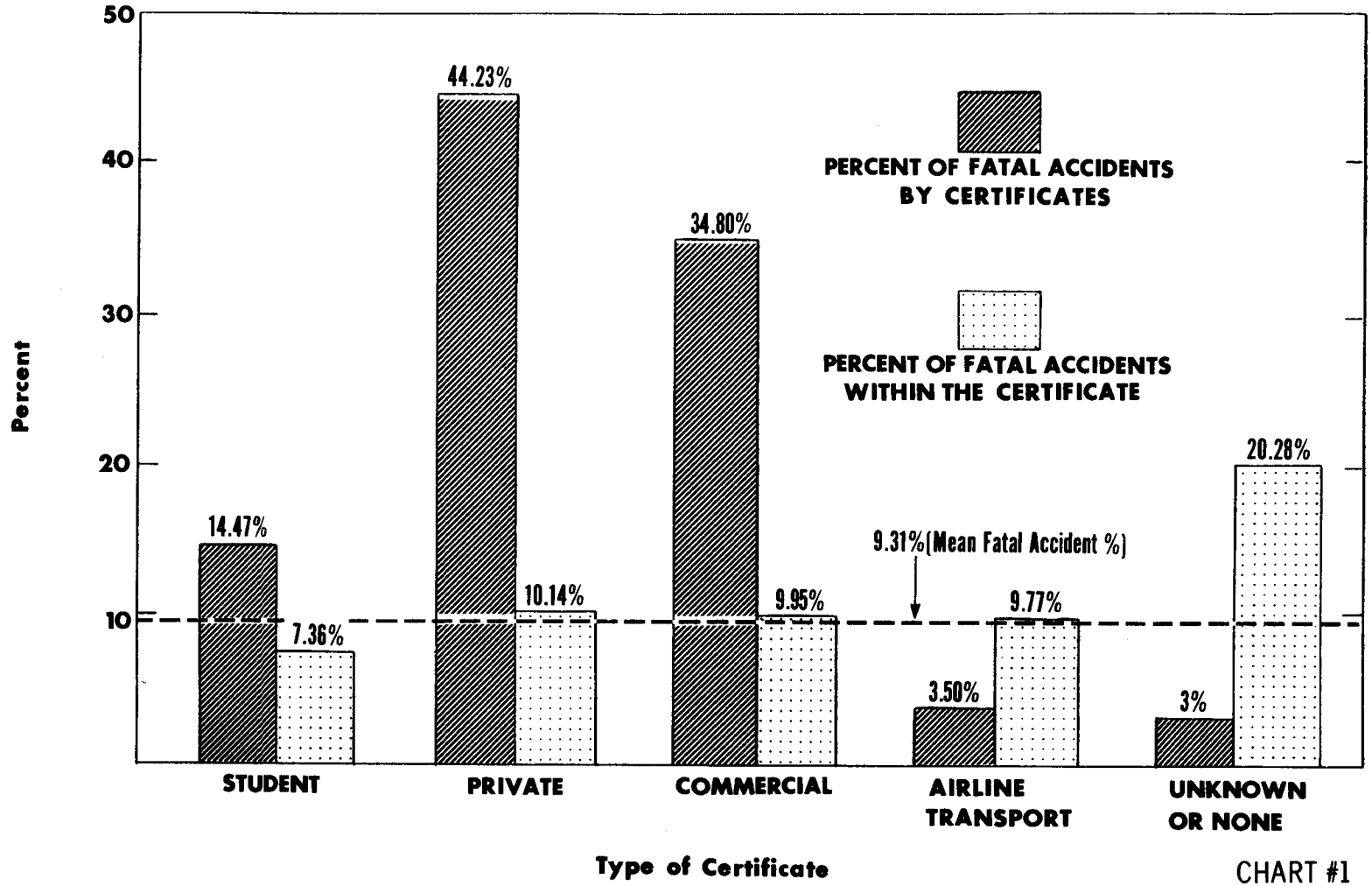

CHART #1

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