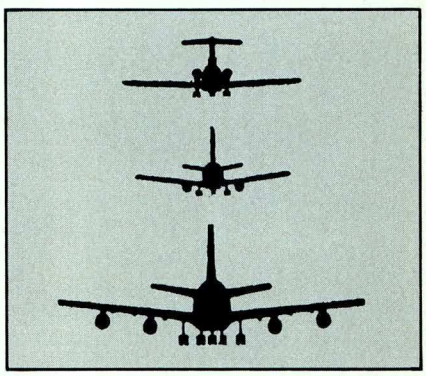
Accident Experience of Civilian Pilots* With Static Physical Defects

J. Robert Dille and Charles F. Booze
FFA Civil Aeromedical Institute

US study indicates that pilots with certain visual deficiencies had significantly more accidents than were expected on the basis of the observed-to expected ratio . . .

The 1974 and 1975 aircraft accident experiences of civilian pilots with eight selected static physical defects were examined and reported on earlier. These conditions were blindness or absence of either eye, use of contact lenses, deficient color vision with a statement of demonstrated ability (waiver) and no operational limitations, deficient color vision with a restriction "not valid for night flight or color signal control," deficient distant vision, paraplegia, deafness, and amputations. For each category, we determined the number in the active airman population, the rate per 1,000 airmen, the expected number of accident airmen on a ratio basis to total airmen and total accidents, the observed accident airmen, the observed-to-expected accident airman ratio, and the statistical significance by the chi-square test. Three groups – blindness or absence of either eye, deficient color vision with a waiver, and deficient distant vision – had significantly more accidents than were expected on the basis of observed-to-expected ratios. In 1974, pilots with these three conditions reported considerably higher (4- to 8-fold) median 6-month flight times in the 6 months preceding their most recent physical examinations before their accidents than did an active airman population sample, but the study was not designed to determine the role of exposure by calculation of accident rates.

In 1975, the same three categories plus the contact lens group had more accidents than were expected as demonstrated by the observed-to-expected ratio. For this year, the self-reported 6-month and total flying times for all airmen and all airmen with these three defects significant in 1974 were determined and accident rates were calculated. The rates for airmen with blindness or absence of an eye were found to be significantly higher than the total active airman population. The rates for airmen with deficient distant vision and deficient color vision and a waiver were not significant when the 6-month flying times were used; the rate for the color vision group using total time was significantly higher



but was felt to be of marginal importance considering the 6-month rate.

Individual accident records were reviewed to determine any possible relationship between visual defects of the pilot and accident cause, phase of light, type of flying, time of day, and weather, but no usual associations were determined.

The contact lens group was selected to receive special attention in a study of the 1976 data because a marginal significance was found in the analysis of the 1975 accidents and, after 1976, this group will not carry a pathology code or require a waiver, and thus will be very difficult to study.

Materials and Methods

For the 1976 active airman population of 780,408, the numbers were determined who had blindness or absence of either eye (includes uncorrectable distant visual acuity of 20/200 or worse in one eye); contact lenses; deficient color vision but who had taken and passed a signal light gun test and had no operational limitation; and deficient distant vision (uncorrected distant vision poorer than 20/100 for first and second class, or does not correct to standards for any class). The deficient distant vision category ordinarily includes many who also have absence of an eye and some who wear contact lenses, but these were subtracted for this study.

For each of these four categories, their representation per 1,000 active airmen, expected frequencies for 4,355 total accidents, actual accident experience, ratio of observed to expected accidents, and significance by the chi-square test were calculated.

Total and last-6-months civilian flight hours, reported at the time of the most recent physical examinations, were obtained for all active airmen, those with blindness or absence of either eye, those with deficient distant vision, those with deficient color vision, and those who wear contact lenses. From these flight time data, accident rates per 100,000 h of flying experience, both total and in the last 6 months, were calculated and statistically compared.

Finally, the records of all accidents involving pilots in one of these four defect categories were reviewed by the authors to determine if medical conditions had been considered by

TABLE I. AIRMEN AND ACCIDENT FREQUENCIES FOR SELECTED PATHOLOGY CATEGORIES.

Pathology Category		Freq. Active Airmen Pop.	Rate/ 1,000	Expected Accident Airmen	Observed Accident Airmen	No. Observed / No. Expected	Chi-Square Test
Contact Lenses	(1976)	17,657	22.62	98.5	126.0	1.28	7.8****
	(1975)	15,737	20.60	86.1	104.0	1.21	3.80**
	(1974)	14,421	18.91	87.0	99.0	1.14	1.70*
Blindness or Absence of Either Eye	(1976)	4.855	6.22	27.1	37.0	1.37	3.67**
	(1975)	4,781	6.26	26.2	35.0	1.34	3.01**
	(1974)	4,704	6.17	28.4	45.0	1.58	9.86***
Deficient Distant Vision	(1976)	21.909	28.10	122.3	198.0	1.62	16.50****
	(1975)	21.464	28.10	117.5	145.0	1.23	6.66***
	(1974)	20,247	26.55	122.1	165.0	1.35	15.55****
Deficient Color Vision—No Restriction	(1976)	6,861	8.79	38.3	73.0	1.91	31.93****
	(1975)	5.690	7.45	31.1	61.0	1.96	28.99****
	(1974)	5.157	6.76	31.1	52.0	1.67	14.21****

*Not significant at 0.10
**Significant at 0.10
***Significant at 0.01
****Significant at 0.001

the accident investigators or if time of day, phase of flight, nature of accident, or other findings offered any plausible explanation for the accident experience of these groups.

Results

The numbers of active airmen in each of the four categories and their accident experience in 1976 are shown in Table I. The 1974 and 1975 data are included for comparison. Again, the same four categories had more than their expected numbers of accidents—deficient color vision with no restriction, deficient distant vision, blindness or absence of either eye, and contact lens use.

When the accident experiences of airmen with each of the four static defects of major concern were compared with the total active airman population accident experience per unit of total (cumulative) and recent (6 months) exposure (Table II), both rates for airmen with blindness or absence of an eye were again found to be significantly higher as were those for the contact lens group; the rates for those with deficient color vision were again insignificant when total experience was used but not significant when calculated for recent exposure. Similar findings to those for color vision were observed for the deficient distant vision category.

TABLE II. ACCIDENT RATES PER 100,000 h OF CIVILIAN FLIGHT TIME FOR SELECTED STATIC DEFECT GROUPS.

Defect	Civilian Flight Hours: Last 6 Months	Civilian Flight Hours: Cumulative to Date
Contact Lenses	15.3**	0.9**
Blindness or Absence of Either Eye	20.0**	0.7**
Deficient Distant Vision	12.1*	0.5**
Deficient Color Vision	13.9*	0.7**
Total Active Airman Population	11.2	0.4

*Not Significant
**Significant at 0.05

Review of each of the accidents and extraction of factors of interest and concern did not reveal any unusual associations of these accidents with weather, time of day, mid-air collisions, or agricultural flying. Physical findings had not been ascribed causal roles. Landing accidents, which usually account for about 40% of the total, were listed in our preliminary tabulation as the phase for 8% of the monocular pilot accidents. However, after review of the reports for the correct phase and adjustment for emergency landings reportedly caused by mechanical problems, the final figure was 41% (15 of 27). Of these, two struck objects (power line, trees) on approach, one misjudged snow depth,

Performance & Style

New Aquasept II Dry Heat Disinfecting System

The first high-style disinfecting system... designed to enhance your practice image and appeal to all your patients.

- Compact, lightweight, easy to use (actual size above).
- Advanced lens carrying case... less likely to leak, crack or discolor.
- Proven dependability of thermal disinfection.
- Safety Light stays on until lenses are cool.

Call toll-free today...800-268-6558 Quebec
800-268-6573 Ontario, Manitoba, Maritimes
800-661-1121 British Columbia, Alberta, Saskatchewan

Designed for use with Aquaflex® (tetrafilcon A) Hydrophilic Contact Lenses.
Aquaflex and Aquasept are registered trademarks of UCO Optics, Inc.

AQUAFLEX™
Contact Lens Products

Union Optics Corp. (Canada) Ltd.
2 Principal Road
Scarborough, Ontario M1R 4Z3

two landed left or right of the runway (one on a downwind landing), two lost directional control, and one accident was blamed on a downdraft. Most of the 15 were pilot factor accidents but not definitely associated with their visual problems. Binocular pilots have similar accidents. Some of the accidents with "loss of power" and other cited mechanical problems could also have been due to human errors and loss of power is an easy excuse for landing short.

When the medical records of 36 "monocular" pilots with the 37 accidents were reviewed, we were surprised to learn that 3 had been miscoded and 5 who were originally correctly coded were subsequently reported as having better than 20/200 corrected visual acuity in their "bad" eye.

No corrections to the tables and calculations have been made as a result of this finding. We assume that the errors and variations apply equally to the 37 accident airmen and to the 4,855 total "monocular" airmen groups. The ratios and rates which we have calculated here are, by definition, estimates and we feel that they are still best estimates. We do not have sufficient resources or priority to review all 4,885 medical records at this time.

Of the 36 monocular airmen who had acccidents, 18 had no useful vision in one eye, 9 had best corrected vision of 20/200 or worse in one eye, 5 had previous visual recordings which caused correct assignment of a monocular code but do not presently meet the criteria, the record cannot be located for 1, and 3 never should have been coded as monocular. One of the non-monocular pilots had two accidents in 1976.

Six of the 37 accidents were fatal; 2 of these 6 pilots did not meet the monocular criteria at the time of their accidents.

No unusual associations were found with phase of flight, accident cause, weather, time of day, or recency of experience for the contact lens, deficient distant vision, or deficient color vision groups, either.

Conclusions

Despite the recent discovery of errors and variations in the assignment of the code for monocularity, the increased accident ratios and rates for monocular pilots, which have been observed for 3 consecutive years, are felt to be real. However, there is no clear indication at this point of the exact nature of the problem or how to avoid it. No changes in medical standards or policies are proposed at this time. Studies have shown normal performances by binocular pilots suddenly rendered monocular so no further research is recommended, either, for now.

We do suggest greater awareness of these findings and of our concern, increased knowledge about depth perception, and recognition of the disadvantages of monocularity by flight instructors, physicians, affected airmen, and accident investigators.

At a recent staff seminar, 15 visual cues for depth perception were identified. Only two (steropsis and convergence) are binocular; the other 13 are monocular including retinal size, which is better than steropsis, and motion parallax, which is also very effective. However, with monocularity there is 1) no spare, 2) possible incapacitation by a foreign body, 3) a reduced field of vision, 4) an uncompensated blind spot, 5) increased awareness of floaters, and, perhaps most important, 6) frequent denial by the individual.

The variable classification of many pilots as monocular, which has complicated the analysis herein, can probably be attributed to the frequent imprecise measurement of acuities of 20/100 or worse. A case which varied from 20/400 to 20/13 uncorrected probably involved undetected contact lenses. Improved accuracy will be stressed for Aviation Medical Examiners. There is some regret that administrative monocularity is combined with actual monocularity in our data base and that refractive error information is not obtained.

*Reprinted by Permission of Canadian Flight Magazine