

THE INFLUENCE OF TOTAL FLIGHT  
TIME, RECENT FLIGHT TIME AND AGE  
ON PILOT ACCIDENT RATES

FINAL REPORT

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ACUMENICS

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## INTRODUCTION

### Background

This paper has been prepared for the Transportation Systems Center and the Federal Aviation Administration under Order No. DTRS57-83-P-80750 by Acumenics Research and Technology, Incorporated.

The paper presents initial findings from a research effort conducted for the Safety Analysis Division, Office of Aviation Safety, Federal Aviation Administration (FAA). The analysis considers the influence of recent pilot flight time, total pilot flight time and age on general aviation pilot accident rates in the United States for the period, 1976 through 1980. This research is based on the integration of the NTSB accident record and the FAA Medical History file to compare relative accident rates. The lack of pilot flight hour exposure data has been noted in prior research.<sup>1</sup> This study uses civil flight hour exposure data for all pilots (those who had accidents and those who did not) to calculate accident rates for pilots falling into certain classes based on:

- recent flight time (estimated annual hours flown),
- total flight time (cumulative lifetime experience),
- recent and total flight time together, and
- pilot age.

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<sup>1</sup>See, for example: National Transportation Safety Board, Special Study: Single-Engine Fixed-Wing General Aviation Accidents 1972-1976, NTSB-AAS-79-1, p. 40; and, Acumenics Research and Technology, Inc. Analysis of Pilot Caused Accidents for Rotorcraft and Selected Fixed Wing Aircraft (Draft Final Report) prepared for FAA Technical Center, (May 14, 1982), p. 5-3.

This method permits the FAA to focus on those classes of pilots which exhibit the highest accident rates after controlling for exposure. This is important because of the large number of accidents that involve pilot error.<sup>2</sup> Thus, it would be beneficial to examine those factors which differentiate between pilots who have had accidents and those who did not have accidents. The principal focus of the present study is on pilots with Class III medical certificates (generally Private Pilots or Student Pilots). To provide a reference point, the experience of Class III pilots is compared to that of the entire pilot population and, in selected instances, to the experience of pilots with Class I medical certificates (generally Air Transport Pilots) and Class II medical certificates (generally Commercial Pilots).

Controversy still exists regarding the appropriate exposure measure for risk in aviation. This is especially the case in accident rate comparisons between classes of aviation such as air carrier operations vs. general aviation operations or private pilots vs. air transport pilots. This occurs because the inherently different characteristics of such activity (e.g., the number of takeoffs and landings per hour, the number of persons on-board, differences in operating costs and revenues, etc.) do influence the relative risks and benefits between such classes of activity. However, the accident rate per flight hour appears to be an appropriate measure as it accounts for differential activity.<sup>3</sup> It is an

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<sup>2</sup>See, for example: National Transportation Safety Board, Annual Review of Aircraft Accidents - 1979, NTSB-ARG-81-1, November, 1981; and, Acumenics Research and Technology, Inc., op. cit.

<sup>3</sup>Brookmeyer, Ron, Recommendations and Critique of Statistical Methodologies for General Aviation Accident and Pilot Occupation Data, Department of Biostatistics, Johns Hopkins University, October 1981.

especially good measure for accident rate comparisons within a specific class of aviation (e.g., general aviation). When used for comparisons between classes of aviation, it is important to recognize the likely bias that such a measure could introduce in that exposure risk may be different between the two classes.

#### Method

The general approach to this study was to merge two databases on a flight hour class basis for recent pilot flight time, total pilot flight time and recent and total flight time combined. The Medical History File was used to develop annual exposure estimates for all pilots and for Class III pilots on the basis of total and recent flight time. These data derive from information provided by pilots who take mandatory flight physicals and report civil flight time (both cumulative total hours and hours flown in the last six months).

Data from the National Transportation Safety Board (NTSB) were used to calculate the number of accidents for which pilots had various levels of experience in both recent flight time and total flight time. The standard accident report contains information about total pilot flight hours and the pilot flight hours in the 90 day period preceding the accident. Each database contains information to calculate pilot age and the class of medical certificate held.

The development of accident rate data by flight hour class requires that certain calculations be made. The reliability of the resultant measures depends on whether the assumptions underlying such calculations are valid. The pilot hours database contains information obtained at the time a pilot takes a flight

physical. Three classes of medical certificates are issued and each is valid for a specific interval according to the following:

- Class I (renewed every six months),
- Class II (renewed each year), and
- Class III (renewed every two years)

The type of flight physical required depends on the nature of the pilot license which the applicant holds and wants to maintain: air transport pilot -- Class I; commercial pilot -- Class II; and, private pilot or student pilot -- Class III.

However, pilots with an out-of-date medical examination may exercise the privileges of a lower rating as long as the medical certificate is not out of date for that class. For example, an air transport pilot can exercise the privileges of a commercial pilot as long as the medical certificate is less than one year old or the privileges of a private pilot if the medical certificate is more than one year old but less than two years old.

Because of the different intervals at which certificates are renewed, the following factors were used to calculate the number of pilots and recent flight hours on an annual basis by recent flight hour class and by total flight hour class.

- Number of Pilots (per year)

Class I:  $1/2 \times 1 = 1/2$

Class II:  $1 \times 1 = 1$

Class III:  $1 \times 2 = 2$

- Recent Flight Hours (per year)

Class I:  $1/2 \times 2 = 1$

Class II:  $1 \times 2 = 2$

Class III:  $2 \times 2 = 4$

For those pilots with Class I medical certificates, the annual number of pilots is equal to one-half of the Class I certificates issued (to account for pilots renewing this certificate every six months). Similarly, the number of recent flight hours is calculated by multiplying the flight hours in the last six months by two and then accumulating as if this were for one-half a pilot. On the average, pilots with Class I certificates have two flight physicals a year. Thus, the total pilot count is accurately estimated, along with a correct estimate of annual hours flown. Similar logic was employed to calculate the annual number of pilots and hours flown for Class II and Class III medical certificates. (In the case of Class III medical certificates, recent flight hours are multiplied by two and then counted to represent two pilots.)

The following class boundaries were used to assign pilots and flight hours for recent and total flight time.

<u>Recent Flight Time (Hours)</u>	<u>Total Flight Time (Hours)</u>
0-20	0-100
21-50	101-500
51-100	501-1000
101-400	1001-5000
401 & Over	5001 & Over

Recent flight hours and the number of pilots were assigned to the above class structure on a record-by-record basis. It should be noted that estimated annual flight hours (recent time) were used for the calculation of accident rates for pilots in each total time class. Flight hours data and the number of pilots were developed for Class III pilots and for the entire pilot population (Class I, II & III pilots).

A second level of decomposition of the flight hours data was by pilot age. The following class boundaries were used for pilot age.

Age Classes (in years)

17-19  
20-29  
30-39  
40-49  
50-59  
60-69  
70 & Over

It should be noted that a pilot may be in one class in one year (for both pilot hours and accidents) and move to a higher class in a later year. Data for pilots 16 years old and younger were not included in the analysis because of a limited number of observed accidents and airmen and because some data records had certain obvious errors.

The data used in the present study are not amenable to analysis using parametric statistical techniques. Such statistical techniques are relevant when investigating the reliability of sample data to accurately portray normally distributed continuous population parameters. In the present case, the data used in this study represent the entire population of pilots and the entire population of general aviation accidents (less unusable data). Thus, the most important measure of the reliability of the results presented in this report is whether the underlying data are accurate. If this is the case, then the results presented herein accurately portray the experience of the pilot population. In addition, if the underlying data are accurate, then the significance of the findings is whether they provide a basis to FAA to alter its policies. An analysis of the validity of the Medical History File data is contained in Appendix B.

ACUMENICS

### Limitations

Limitations may arise because the NTSB accident data were used in the numerator of accident rate equations while Medical History data were used as the denominator. Also, recent pilot flight times were annualized in both files. In addition, accident records had to be eliminated from the analysis where recent flight time, total flight time or pilot age was not recorded. Another limitation to the data presented in this report results from the fact that the flight hours contained in Medical History file are self-reported by the pilot.

The third major limitation is that the accident rates presented herein are calculated on the basis of pilot hours.<sup>4</sup> Most other general aviation safety research has been based on aircraft hours flown. It also must be noted that the study considers all types of flying (general aviation, commuter, air carrier, etc.) in the estimate of total hours flown. However, air carrier and commuter accidents are not used here because the limited number of such accidents would not appreciably affect the relative accident rates developed in this study. However, the hours flown in such operations do affect the absolute pilot hour accident rate. Where important, the likely bias introduced by including such pilot hours is noted.

A fourth limitation to the data used herein was the inability to isolate only pilot hours flown in general aviation for the assignment of accidents and hours flown to the classes used in the study. For example, some air carrier pilots are engaged in personal flying in general aviation aircraft. It was impossible

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<sup>4</sup>Also, as noted above, some accidents were excluded from analysis.

to account for this and other similar factors. Thus, as noted above, the absolute accident rates presented herein are understated. However, it is assumed that the relative accident rates are valid and can provide meaningful insights.

#### ANALYTIC RESULTS

The accident rates presented in this section for the total population (Class I, II & III pilots) are based on pilot hours flown in all classes of aviation. Accident rates for Class III pilots are based on pilot hours flown in general aviation. Prior research utilizes aircraft hours in the computation of accident rates. In addition, accidents without complete data for flight time and age were eliminated from the analysis. Thus, the absolute accident rates presented herein are based on a different measure than is usual (pilot hours vs. aircraft hours), include all flying activity (for the Class I, II and III pilots combined data) and do not reflect all accidents. Numeric data for the accident rate graphs are contained in Appendix A.

#### Recent Flight Time

The influence of recent flight time on pilot accident rates can be viewed as a measure of pilot proficiency. That is, the more that a pilot flies in a given period, the more familiar the pilot will be with the operation of the aircraft and the aviation system. It could be expected that pilots with more recent flight time would exhibit a lower accident rate (after controlling for risk) than would pilots with less recent flight time. The accident rates for Class III pilots with various levels of recent flight time are shown in Figure 1. It can be seen that, for all ages, the accident rate decreases slightly as recent time increases except that for pilots with substantial recent flight time (over 400 hours) the accident rate reduction is more pronounced. For very low values of recent flight

# 1976-1980

CLASS III PILOTS OVERALL ACCIDENT RATE  
 NUMBER OF ACCIDENTS PER 100,000 RECENT FLIGHT-HOURS  
 FROM ASF-200 FAA HIERARCHY SYSTEM

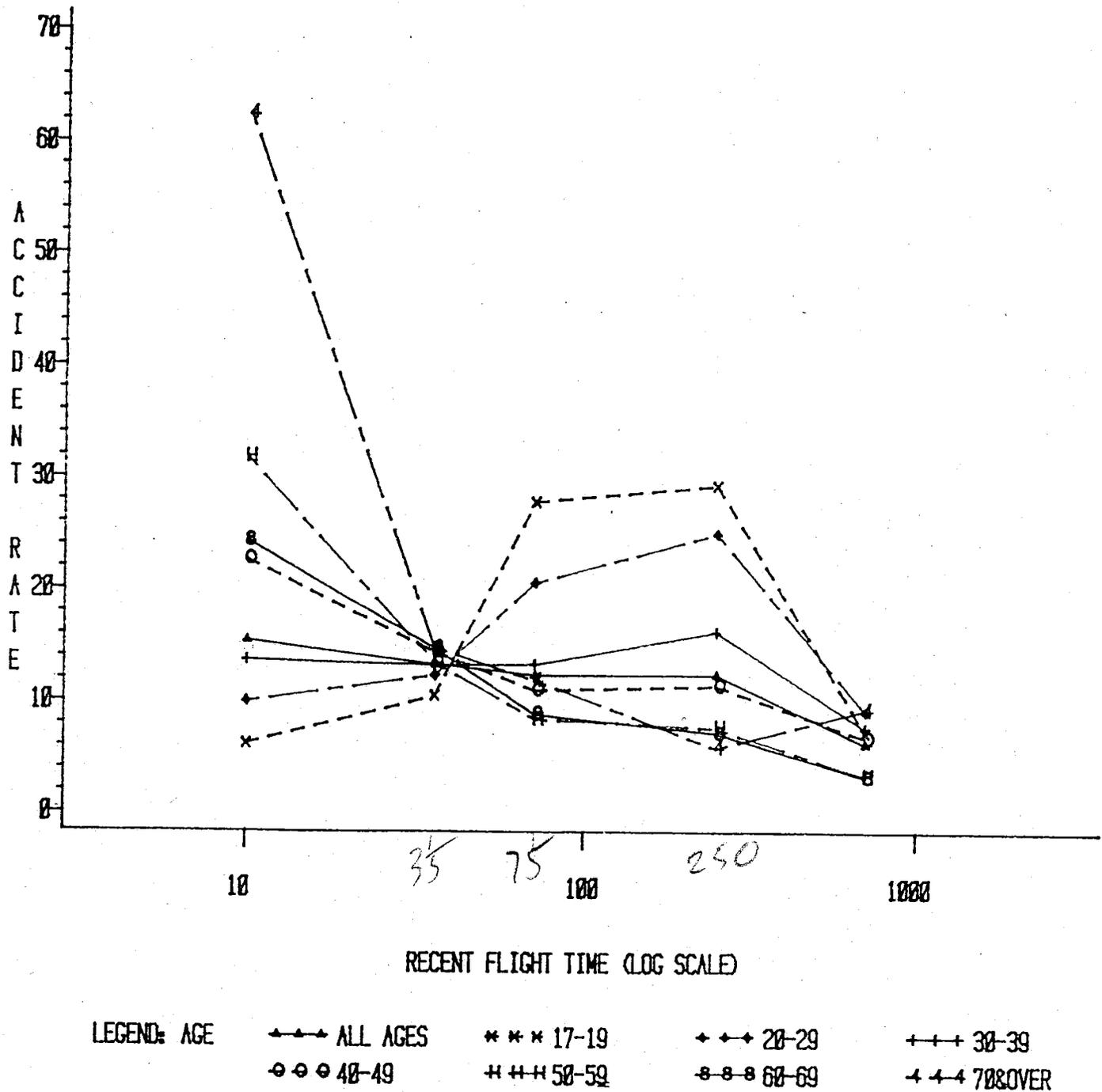


Figure 1

time (under 50 hours a year) accident rates generally increase with the age of the pilot. Past the 50 hour level, the accident rates generally decrease with age. Also, for younger pilots (under age 30), the accident rate is highest for those Class III pilots with between 50 and 400 hours of recent flight time.

In comparison to the total pilot population (Figure 2), Class III pilots exhibit a higher pilot hour accident rate. The Class III rate is 12.5 accidents per 100,000 pilot hours and the rate for Class I and II pilots is 4.3 accidents per 100,000 pilot hours.<sup>5</sup> However, for low values of recent flight time (0-50 hours), Class I and Class II pilots exhibit a higher accident rate than Class III pilots (22.3 vs. 11.0 accidents per 100,000 pilot hours). Class I and II pilots, however, show a decreasing accident rate with increased values of recent flight time. The data from Figure 1 and Figure 2 are displayed with age as the horizontal axis in Figure 3 and Figure 4. These graphs highlight the trend in accident rates by age for specific values of recent flight time.

#### Total Flight Time

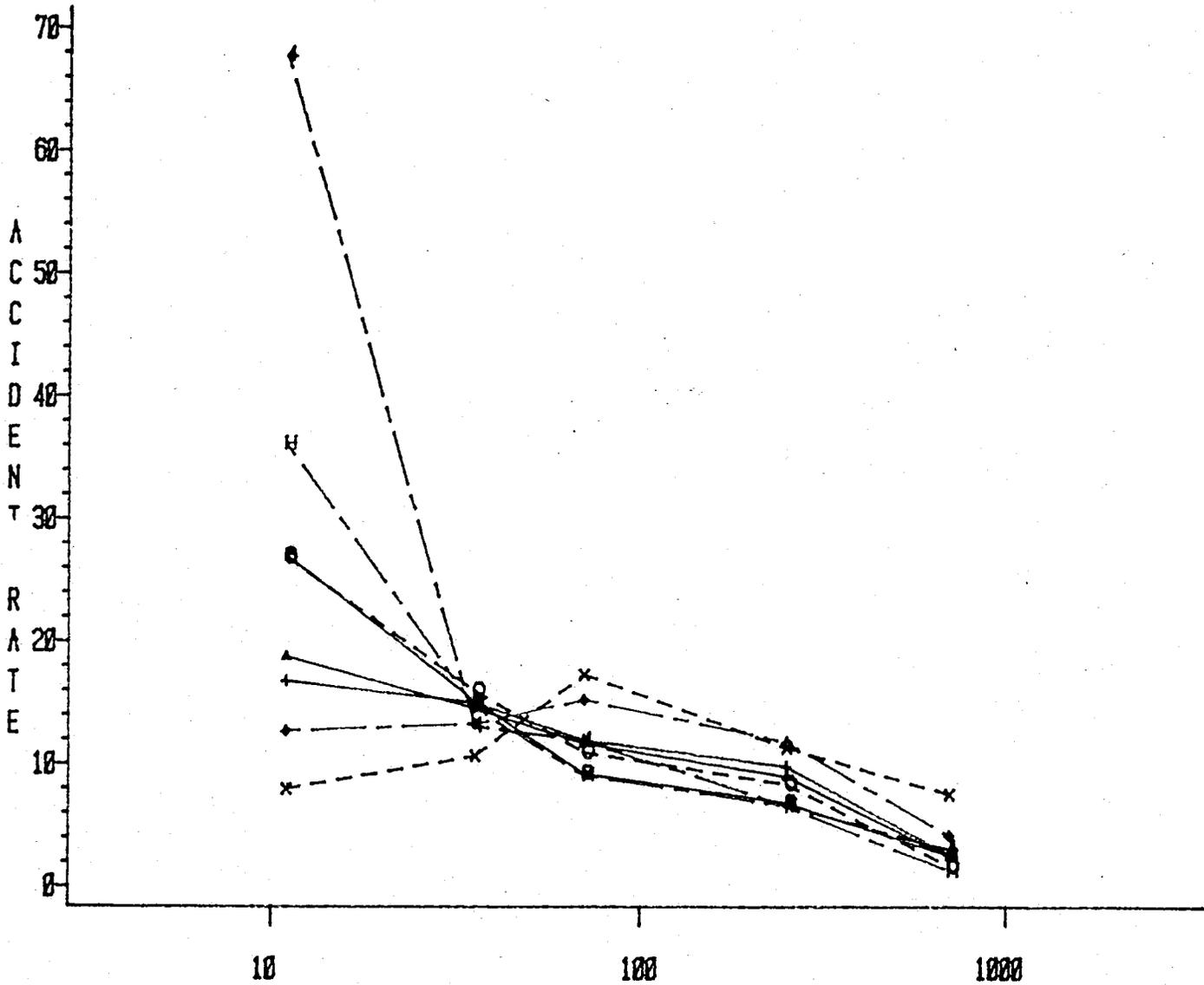
The influence of total flight time on pilot accident rates can be viewed as a measure of the effects of cumulative pilot experience. That is, the more that a pilot has flown over the years, the more likely it is for the pilot to have encountered diverse operating conditions and to have developed means of handling non-routine situations. Such reasoning accounts for employers and insurance

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<sup>5</sup>Accident rate data for Class I and Class II pilots (as a group) are derived from subtracting the Class III pilot data from that for all pilots.

# 1976-1980

CLASS I, II, AND III PILOTS OVERALL ACCIDENT RATE  
 NUMBER OF ACCIDENTS PER 100,000 RECENT FLIGHT-HOURS  
 FROM ASF-200 FAA HIERARCHY SYSTEM



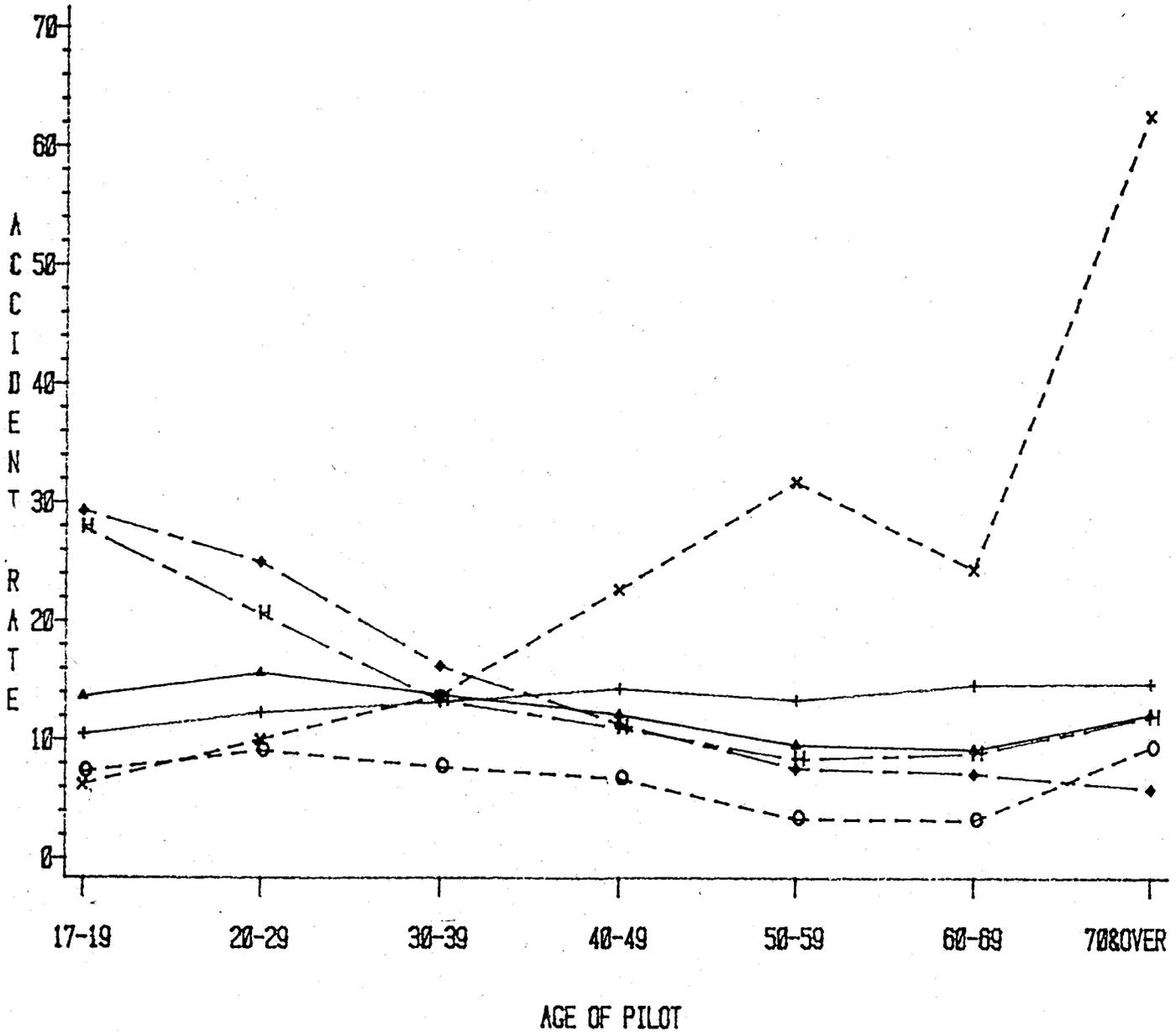
RECENT FLIGHT TIME (LOG SCALE)

LEGEND: AGE    ◆◆◆ ALL AGES    \*\*\* 17-19    ◆◆◆ 20-29    + + + 30-39  
                  ○○○ 40-49    + + + 50-59    - - - 60-69    + + + 70&OVER

Figure 2

# 1976-1980

CLASS III PILOTS OVERALL ACCIDENT RATE  
 NUMBER OF ACCIDENTS PER 100,000 RECENT FLIGHT-HOURS  
 FROM ASF-200 FAA HIERARCHY SYSTEM-RECENT HOURS



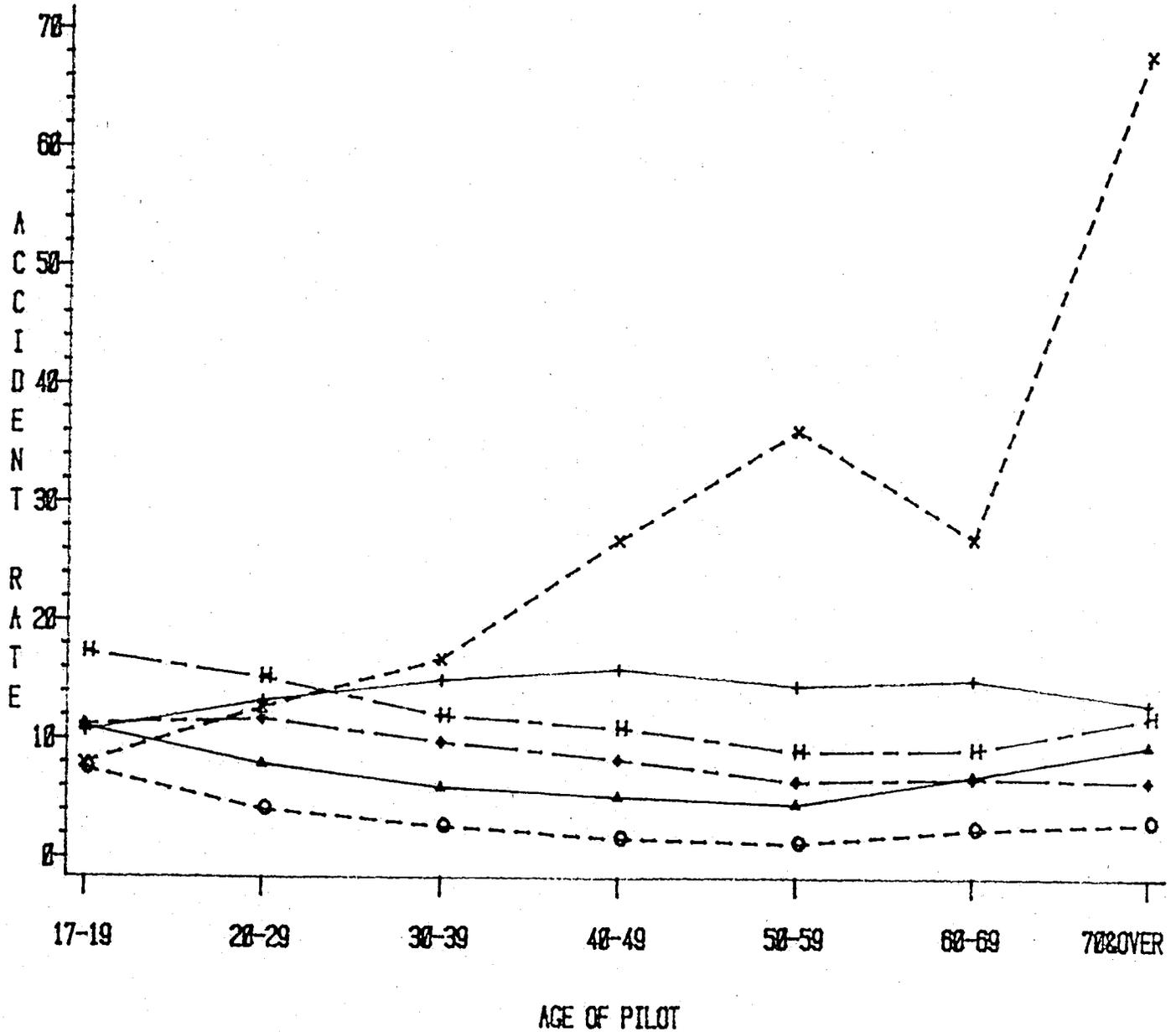
LEGEND: FTIME\*    --- ALL TIME    \*\*\*o 0- 20    \*\*\*\* 101- 400  
 +++ 21- 50    ooo 401 & OVER    ++++ 51- 100

Figure 3

\*FTIME=RECENT TIME

# 1976-1980

CLASS I, II AND III PILOTS OVERALL ACCIDENT RATE  
 NUMBER OF ACCIDENTS PER 100,000 RECENT FLIGHT-HOURS  
 FROM ASF-200 FAA HIERARCHY SYSTEM-RECENT HOURS



LEGEND: FTIME \*    ◆◆◆ ALL TIME    \*\*\* 0- 20    ◆◆◆ 101- 400  
                           ◆◆◆ 21- 50    ○○○ 401 & OVER    ◆◆◆ 51- 100

Figure 4

\*FTIME=RECENT TIME

companies specifying minimum experience levels in order to hire and insure pilots. Thus, pilots with more total flight time could be expected to exhibit a lower accident rate than pilots with less total flight time.

Accident rates for Class III pilots are shown on the basis of total flight time in Figure 5. It can be seen that, for all ages, the accident rate decreases with cumulative flight time.<sup>6</sup> With respect to age classes, the data indicate that pilots of age 70 and over and younger pilots have higher accident rates at total experience levels from 500 to 5,000 hours. Class III pilots have a higher accident rate than do Class I and Class II pilots (12.5 accidents per 100,000 pilot hours vs 5.1 accidents per 100,000 pilot hours) at all total flight time levels (see Figure 6). Also, it is interesting to note that older pilots have a higher accident rate when considering the entire pilot population. Such a finding warrants further investigation in that older and presumably more experienced pilots are contributing to an increased accident rate.

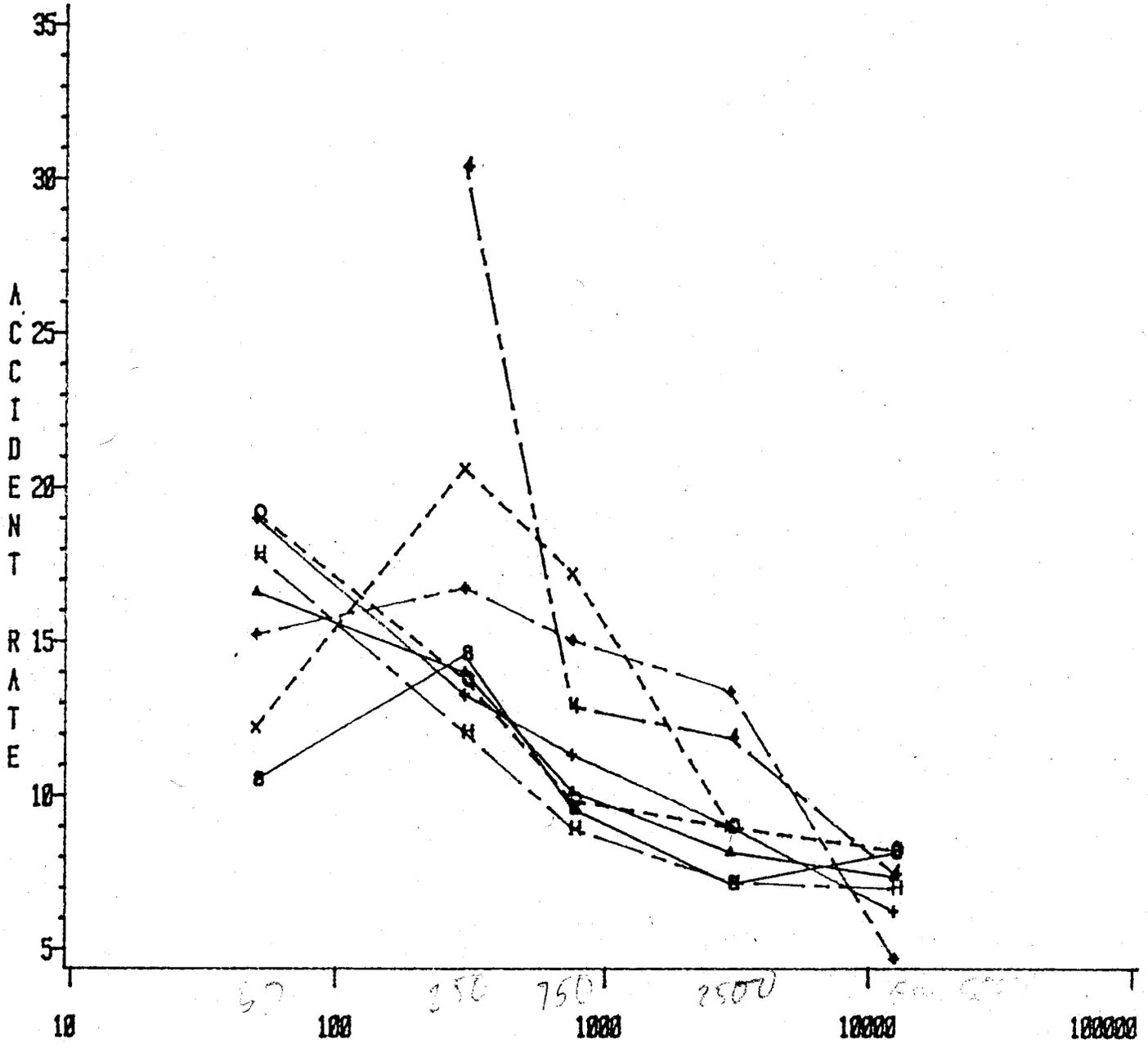
The data in Figure 7 show that, except for the most and least experienced Class III pilots, accident rates generally decline as age increases except for pilots of age 60 and over and for those pilots with over 5,000 hours of total flight time. However, Class III pilots of age 60 and over account for only five percent of all Class III pilot accidents. Corresponding data for all pilot classes, as depicted in Figure 8, show that accident rates generally increase

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<sup>6</sup>Total flight time accident rates are calculated on the basis of estimated annual hours flown (recent flight time) in the 1976-1980 period. The data were then distributed to pilots on the basis of the total flight time classes for those pilots.

# 1976-1980

CLASS III PILOTS OVERALL ACCIDENT RATE  
 NUMBER OF ACCIDENTS PER 100,000 RECENT FLIGHT-HOURS  
 FROM ASF-200 FAA HIERARCHY SYSTEM



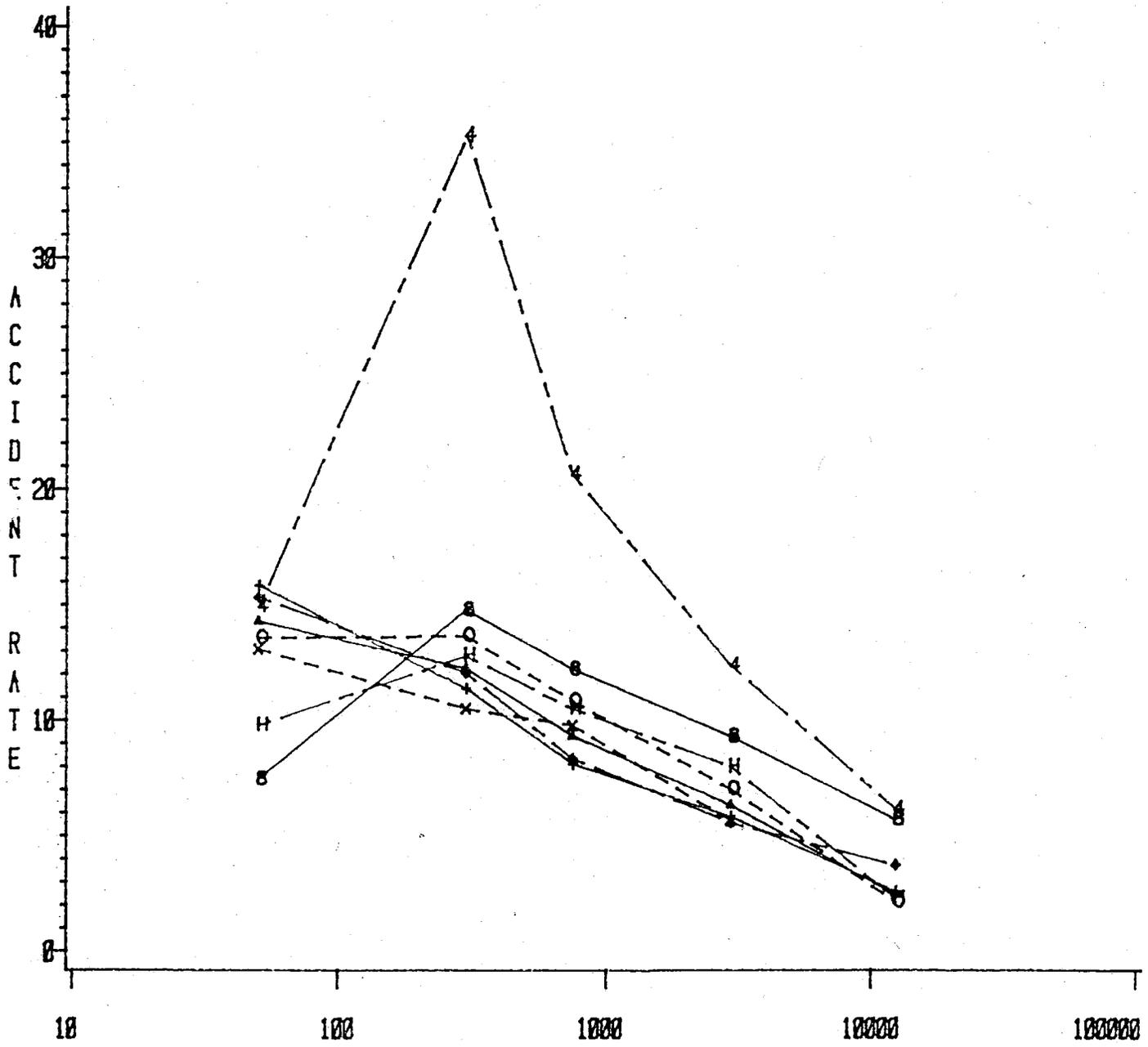
TOTAL FLIGHT TIME (LOG SCALE)

LEGEND: AGE     $\text{---}\blacktriangle\text{---}$  ALL AGES     $\text{---}\ast\ast\ast\text{---}$  17-19     $\text{---}\blacklozenge\text{---}$  20-29     $\text{---}\blacktriangleright\text{---}$  30-39  
                   $\text{---}\bullet\bullet\bullet\text{---}$  40-49     $\text{---}\text{H}\text{H}\text{H}\text{---}$  50-59     $\text{---}\text{S}\text{S}\text{S}\text{---}$  60-69     $\text{---}\blacktriangleleft\text{---}$  70&OVER

Figure 5

# 1976-1980

CLASS I, II AND III PILOTS OVERALL ACCIDENT RATE  
 NUMBER OF ACCIDENTS PER 100,000 RECENT FLIGHT-HOURS  
 FROM ASF-200 FAA HIERARCHY SYSTEM



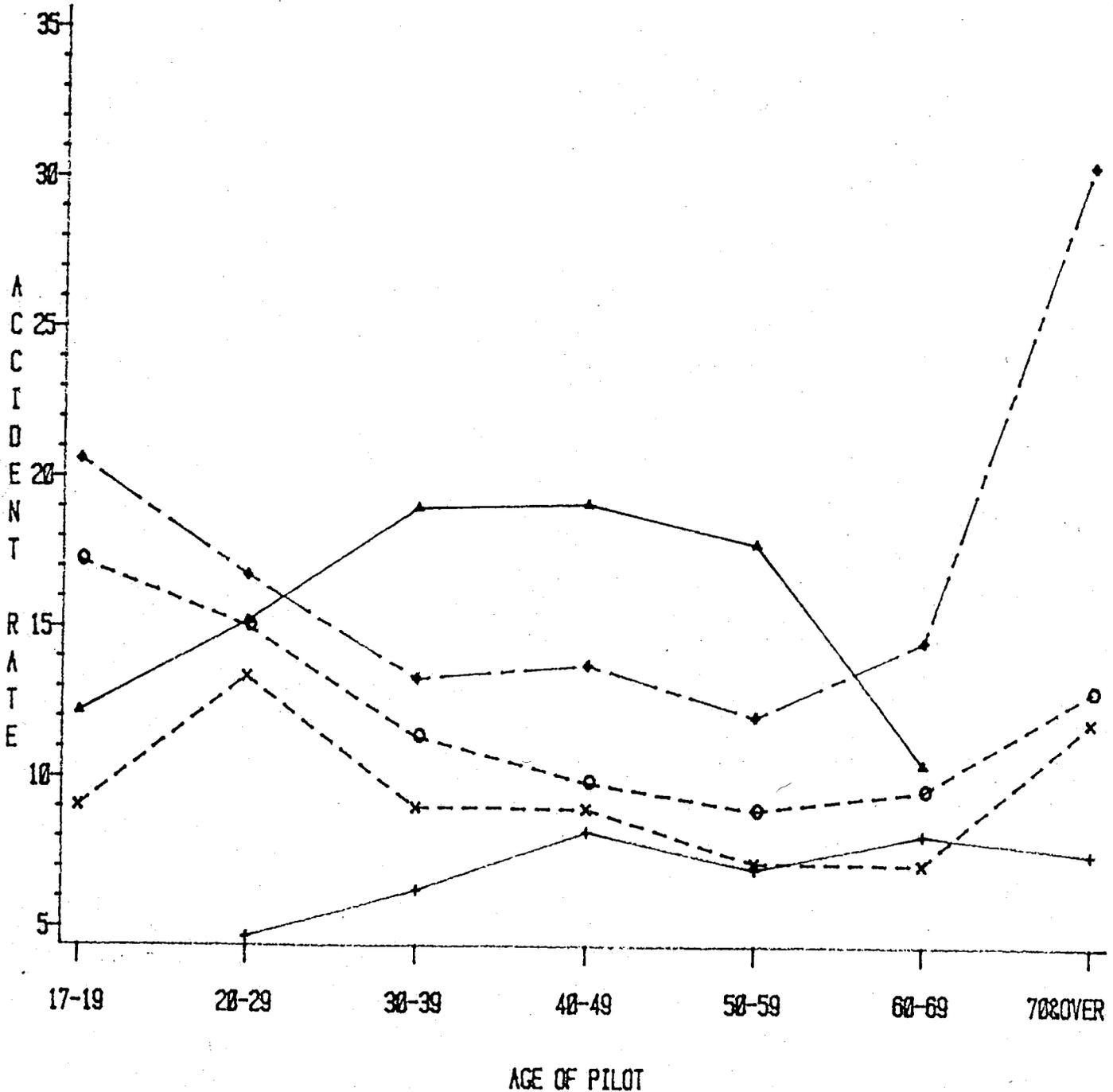
TOTAL FLIGHT TIME (LOG SCALE)

LEGEND: AGE     $\text{---}$  ALL AGES     $***$  17-19     $+\text{---}+$  20-29     $\text{---}+$  30-39  
 $\text{---}o\text{---}$  40-49     $\text{---}H\text{---}$  50-59     $\text{---}o\text{---}$  60-69     $\text{---}+\text{---}$  70&OVER

Figure 6

# 1976-1980

CLASS III PILOTS OVERALL ACCIDENT RATE  
 NUMBER OF ACCIDENTS PER 100,000 RECENT FLIGHT-HOURS  
 FROM ASF-200 FAA HIERARCHY SYSTEM-TOTAL HOURS



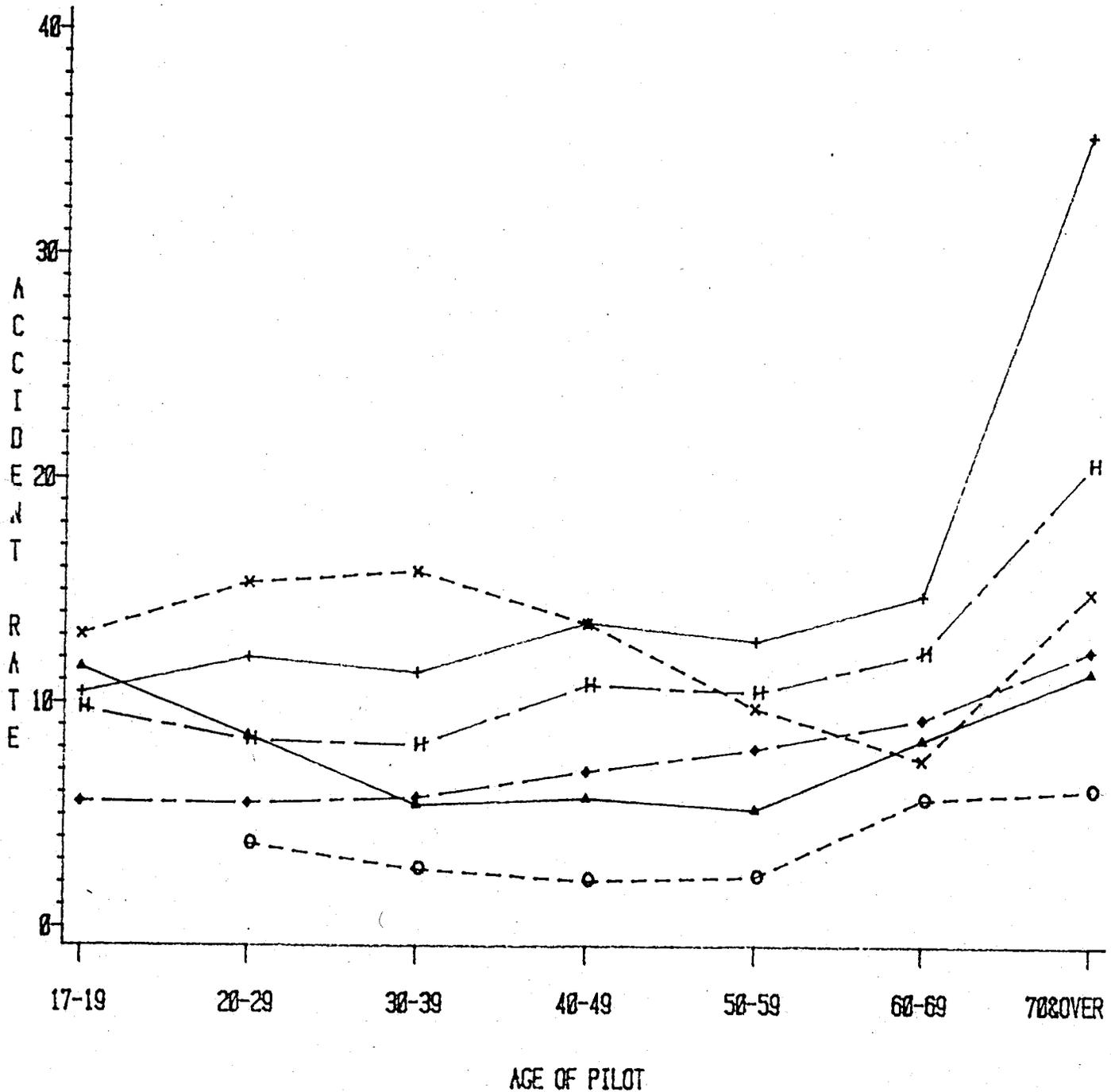
LEGEND: FTIME \*    +--+ 1- 100    \*\*\* 1001- 5000    +--+ 101- 500  
                           +--+ 5001 & OVER    ○○○ 501- 1000

Figure 7

\*FTIME=TOTAL TIME

# 1976-1980

CLASS I, II AND III PILOTS OVERALL ACCIDENT RATE  
 NUMBER OF ACCIDENTS PER 100,000 RECENT FLIGHT-HOURS  
 FROM ASF-200 FAA HIERARCHY SYSTEM-TOTAL HOURS



LEGEND: FTIME \*    ▲-▲-▲ ALL TIME    \*\*\* 1- 100    ◇-◇-◇ 1001- 5000  
                   +--+ 101- 500    ○-○-○ 5001 & OVER    H-H-H 501- 1000

Figure 8

\*FTIME=TOTAL TIME

with age for all experience levels beyond 100 hours of total flight time. Also, accident rates are lower for pilots with the most cumulative experience. The substantial increase in accident rates beyond age 70 represents less than one percent of all accidents.

#### Recent and Total Time

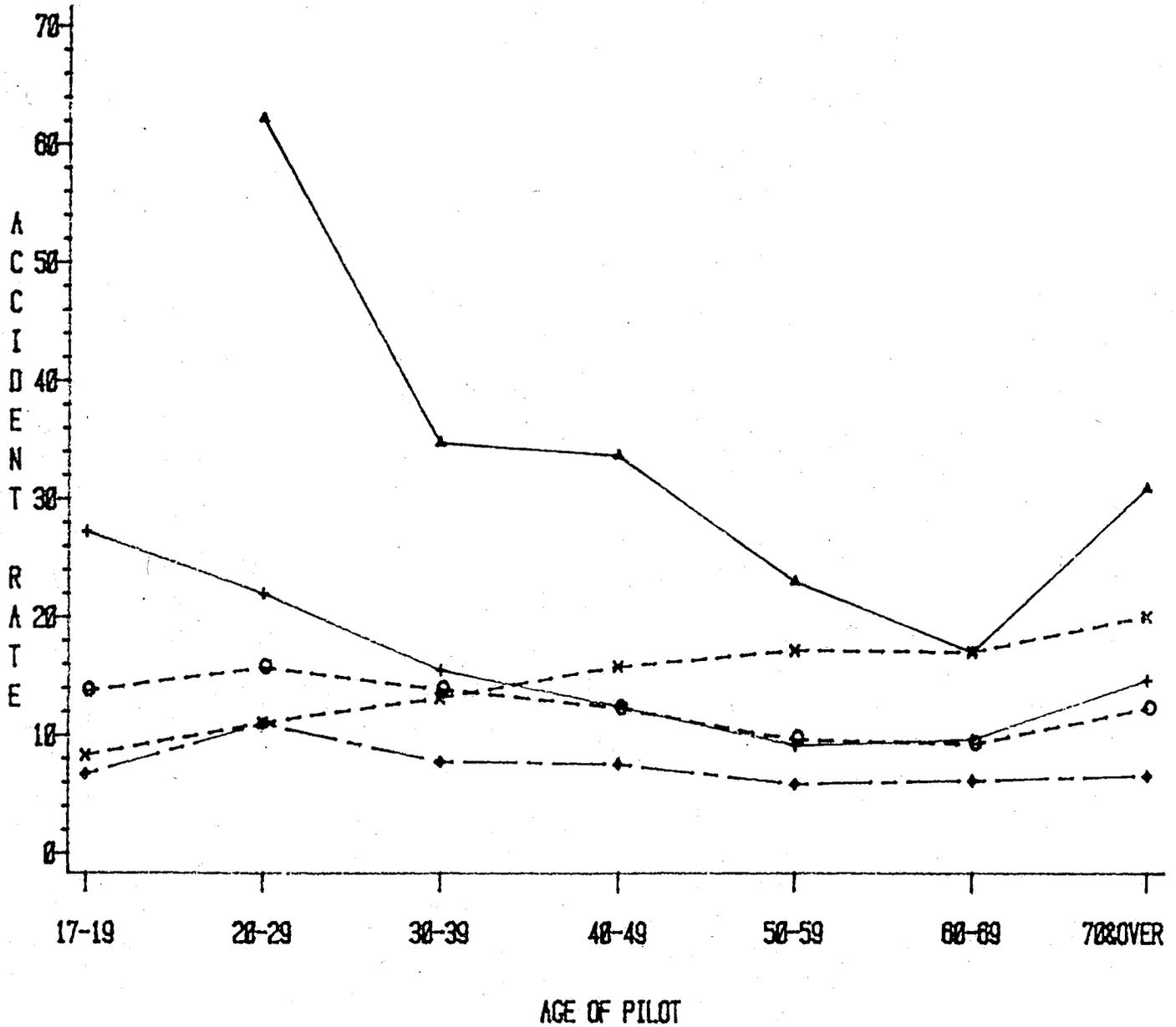
The final level of data decomposition in this analysis was to examine the effects of recent flight time and age while controlling for cumulative experience (total flight time). Also, the comparison of Class III pilots to the overall population is a method of examining the effects of pilot training. The pilot population was divided into the following four elements:

- Less than or equal to 50 hours recent flight time and less than or equal to 1,000 hours total flight time;
- Less than or equal to 50 hours recent flight time and greater than 1,000 hours total flight time;
- Greater than 50 hours recent flight time and less than or equal to 1,000 hours total flight time; and,
- Greater than 50 hours recent flight time and greater than 1,000 hours total flight time.

Accident rates for Class III pilots divided into the above four categories are shown in Figure 9. It can be seen that the Class III pilot group with the lowest accident rate has the highest level of both recent flight time and total flight time. This group accounts for almost 13 percent of all Class III pilot accidents. The highest accident rate group consists of those pilots with less than or equal to 50 hours of recent flight time and greater than 1,000 hours of total flight time. However, this group accounts for only 3.4 percent of all Class III pilot accidents.

# 1976-1980

CLASS III PILOTS OVERALL ACCIDENT RATE  
 NUMBER OF ACCIDENTS PER 100,000 RECENT FLIGHT-HOURS  
 FROM ASF-200 FAA HIERARCHY SYSTEM-RECENT/TOTAL HOURS



LEGEND: FTIME \*     $\blacktriangle$   $\blacktriangle$   $\blacktriangle$   $\leq 50 > 1000$      $\ast \ast \ast$   $\leq 50 \leq 1000$      $\blacklozenge$   $\blacklozenge$   $\blacklozenge$   $> 50 > 1000$   
                           $\blackplus$   $\blackplus$   $\blackplus$   $> 50 \leq 1000$      $\circ \circ \circ$  ALL TIME

Figure 9

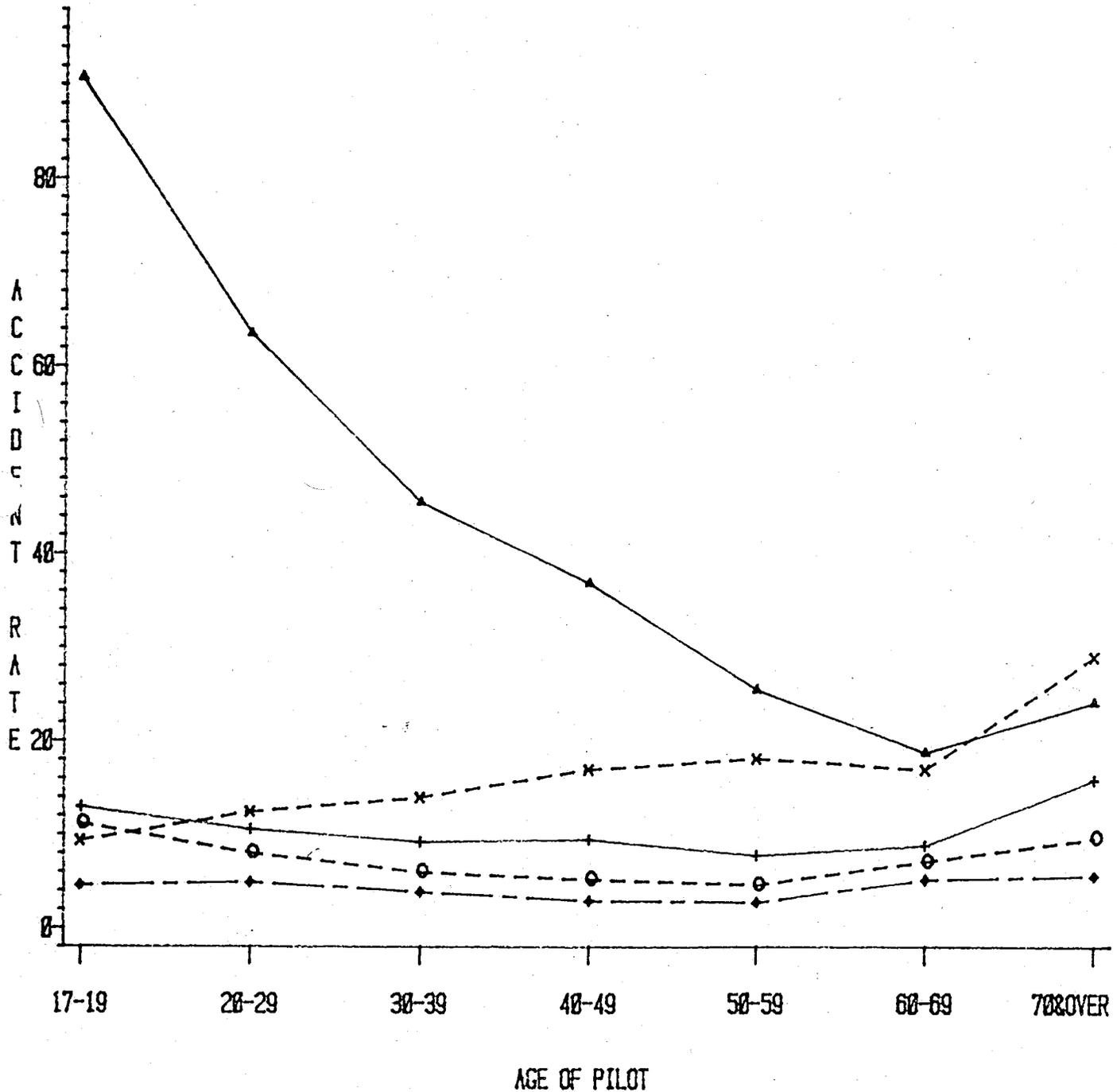
\*FTIME=RECENT AND TOTAL TIME

Pilots with less than 1,000 hours of total flight time account for nearly 84 percent of Class III pilot accidents. Such Class III pilots with less than 50 hours of recent flight time have an overall accident rate of 13.4 accidents per 100,000 flight hours while pilots with over 50 hours of recent flight time have an accident rate of 14.3 accidents per 100,000 flight hours. The data indicate that younger pilots with more than 50 hours of recent flight time have a higher accident rate than do older pilots with equivalent recent flight time. For pilots with less than 50 hours of recent flight time, older pilots have a higher accident rate than do younger pilots. Thus, for pilots with low recent and total flight time, accident rates increase with age, and for pilots with high recent flight time and low total flight time, accident rates decrease with age, except for pilots of age 60 and over.

Data for all pilot classes arrayed into the above four groups are shown in Figure 10. As for Class III pilots, pilots with both the highest recent and total flight time to exhibit the lowest accident rate. Such pilots account for 40 percent of all accidents. Pilots with less than 50 hours of recent flight time and more than 1,000 hours of total flight time have the highest accident rate but account for only 3.8 percent of all accidents. It is interesting to note that, in this group, Class I and II pilots exhibit a higher accident rate than do Class III pilots (36.9 accidents per 100,000 flight hours vs. 25.4 accidents per 100,000 flight hours). Such a finding may indicate that well-trained pilots with substantial lifetime experience who do little annual flying may become complacent. The analysis of additional total and recent flight time intervals could provide additional insights in this area.

# 1976-1980

CLASS I, II AND III PILOTS OVERALL ACCIDENT RATE  
 NUMBER OF ACCIDENTS PER 100,000 RECENT FLIGHT-HOURS  
 FROM ASF-200 FAA HIERARCHY SYSTEM-RECENT/TOTAL HOURS



LEGEND: FTIME \*    —▲—▲—▲ ≤50 >1000    \* \* \* ≤50 ≤1000    —◆—◆—◆ >50 >1000  
                          —+—+—+ >50 ≤1000    ○○ ○ ALL TIME

Figure 10

\*FTIME=RECENT AND TOTAL TIME

For all pilots with less than 1,000 hours of total flight experience, those with over 50 hours of recent flight time exhibit a lower accident rate (9.6 accidents per 100,000 flight hours vs. 14.6 accidents per 100,000 flight hours) than do those with less than 50 hours of recent flight time except in the 17-19 age class. Class I and II pilots with less than 50 hours of recent experience and less than 1,000 hours of total flight time have a higher accident rate than do Class III pilots (18.3 accidents per 100,000 flight hours for Class I and II pilots vs. 13.4 accidents per 100,000 flight hours for Class III pilots).

For pilots with less than 50 hours of recent flight time and less than 1,000 hours of total flight time, accident rates increase with age. Pilots who have less than 50 hours of recent flight time and more than 1,000 hours of total flight experience exhibit an accident rate that declines with age up to age 60. For the remaining two groups, pilots with greater than 50 hours of recent flight time, accident rates decrease with increasing age and then increase again. The age cohort of 50-59 is the one with the lowest accident rate for both groups as was the case for Class III pilots.

#### SUMMARY FINDINGS

##### Recent Flight Time

- On the basis of recent flight time alone, pilot accident rates decrease as flight time increases. This holds for both Class III pilots and for the entire pilot population.
- For low values of recent flight time, older pilots exhibit higher accident rates. For high values of recent flight time, younger pilots exhibit some-what higher accident rates. Such findings are independent of medical certificate class.
- Class I and II pilots (who are presumably better trained) exhibit a higher accident rate than Class III pilots for low values of recent flight time (less than 50 hours per year).

*Seems unusual*

### Total Flight Time

- Accident rates decrease as total flight time increases for both Class III pilots and the entire pilot population. However, Class III pilots have a higher overall accident rate at all levels of total flight time.
- Older Class I and II pilots have a higher accident rate at all levels of total flight time between 101 hours and 5,000 hours. For Class III pilots, the accident rate initially decreases with age and then increases at age 60 and over.

### Recent and Total Flight Time

- Pilots with over 1,000 hours total time and less than 50 hours recent time exhibit the highest accident rates for both Class III pilots and the entire pilot population. Also, Class I and II pilots exhibit a higher accident rate than Class III pilots at this level of experience.
- All pilot classes with over 50 hours of recent flight time and over 1,000 hours of total flight time exhibit the lowest accident rate for all age classes.
- For Class III pilots with low total flight time, accident rates generally decrease as age increases when recent flight time exceeds 50 hours per year. Accident rates increase with age when recent flight time is less than 50 hours per year.
- For the overall pilot population with total flight time of less than 1,000 hours, those pilots with more than 50 hours of recent flight time have the lowest accident rate at all age levels except that of 17-19 years old.
- Class III pilots with less than 50 hours of recent flight time and less than 1,000 hours of total flight time exhibit a lower accident rate than do Class I and II pilots with this experience level.
- The accident rate for both Class III pilots and all pilots with more than 50 hours recent time and less than 1,000 hours total time decreases with age (up to age 60).
- The accident rate for both Class III pilots and the entire pilot population who have less than 1,000 hours total flight time and less than 50 hours of recent flight time increases with age.

APPENDIX A  
NUMERIC DATA FOR ACCIDENT RATE GRAPHS

Numeric Data for Figures 1 through 4

RECENT FLIGHT TIME

ALL AGES

Class III Pilots

Recent Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-20	1365.7	7444.9	1140	15.3
21-50	344.2	12200.8	1609	13.2
51-100	221.0	17476.1	2148	12.3
101-400	116.9	21258.0	2614	12.3
401 & Over	5.3	3722.6	227	6.1
<u>ALL</u>	<u>2053.0</u>	<u>62102.4</u>	<u>7738</u>	<u>12.5</u>

Class I, II, and III Pilots

0-20	1930.2	9030.6	1684	18.6
21-50	459.0	16659.7	2415	14.5
51-100	381.6	<del>307578.8</del> 30758.6	3577	11.6
101-400	338.8	74006.2	6585	8.9
401 & Over	241.0	177123.7	4105	2.3
<u>ALL</u>	<u>3350.5</u>	<u>307578.8</u>	<u>18366</u>	<u>6.0</u>

Numeric Data for Figures 1 through 4

RECENT FLIGHT TIME

AGE 70 & OVER

Class III Pilots

Recent Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-20	3.9	19.2	12	62.5
21-50	1.8	61.0	9	14.7
51-100	1.5	109.7	13	11.8
101-400	0.9	154.5	9	5.8
401 & Over	*	32.5	3	9.2
<u>ALL</u>	<u>8.2</u>	<u>377.0</u>	<u>46</u>	<u>12.2</u>

Class I, II, and III Pilots

0-20	4.3	23.6	16	67.8
21-50	2.0	76.5	10	13.1
51-100	1.9	151.5	18	11.9
101-400	1.6	305.7	20	6.5
401 & Over	0.2	165.1	5	3.0
<u>ALL</u>	<u>10.0</u>	<u>722.3</u>	<u>69</u>	<u>9.6</u>

\* Less than 100 pilots.

RECENT FLIGHT TIME

AGE 60-69

Class III Pilots

Recent Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-20	33.9	181.5	44	24.2
21-50	14.1	535.3	78	14.6
51-100	14.4	1152.7	101	8.8
101-400	9.0	1643.4	116	7.1
401 & Over	0.4	254.1	8	3.1
<hr/> ALL	<hr/> 71.8	<hr/> 3766.9	<hr/> 347	<hr/> 9.2

Class I, II, and III Pilots

0-20	43.3	230.1	62	26.9
21-50	18.4	703.4	106	15.1
51-100	20.1	1619.0	148	9.1
101-400	17.7	3604.5	243	6.7
401 & Over	3.9	2717.6	66	2.4
<hr/> ALL	<hr/> 103.4	<hr/> 8874.6	<hr/> 625	<hr/> 7.0

RECENT FLIGHT TIME

AGE 50-59

Class III Pilots

Recent Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-20	144.8	754.0	239	31.7
21-50	56.5	2155.3	287	13.3
51-100	55.3	4438.7	369	8.3
101-400	33.2	6108.2	462	7.6
401 & Over	1.4	970.9	32	3.3
<hr/> ALL	<hr/> 291.2	<hr/> 14427.0	<hr/> 1389	<hr/> 9.6

Class I, II, and III Pilots

0-20	189.6	923.3	333	36.1
21-50	71.5	2744.8	399	14.5
51-100	77.6	6286.8	567	9.0
101-400	69.5	14951.9	968	6.5
401 & Over	47.1	33121.6	398	1.2
<hr/> ALL	<hr/> 455.3	<hr/> 58028.5	<hr/> 2665	<hr/> 4.6

Numeric Data for Figures 1 through 4

RECENT FLIGHT TIME

AGE 40-49

Class III Pilots

Recent Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-20	235.0	1203.3	272	22.6
21-50	73.2	2728.3	392	14.4
51-100	61.9	4952.1	543	11.0
101-400	36.4	6708.5	759	11.3
401 & Over	1.6	1022.5	68	6.7
<hr/> ALL	<hr/> 408.1	<hr/> 16614.8	<hr/> 2034	<hr/> 12.2

Class I, II, and III Pilots

0-20	340.8	1496.5	401	26.8
21-50	97.6	3686.9	588	13.6
51-100	97.9	7952.6	868	10.8
101-400	90.1	19903.8	1653	7.0
401 & Over	70.9	50250.8	795	2.1
<hr/> ALL	<hr/> 697.3	<hr/> 83290.7	<hr/> 4305	<hr/> 5.2

ACUMENICS

RECENT FLIGHT TIME

AGE 30-39

Class III Pilots

Recent Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-20	357.7	1922.5	263	13.7
21-50	86.4	3055.2	404	13.2
51-100	52.4	4118.0	548	13.3
101-400	24.9	4508.1	730	16.2
401 & Over	1.3	931.4	71	7.6
<hr/> ALL	<hr/> 522.6	<hr/> 14535.2	<hr/> 2016	<hr/> 13.9

Class I, II, and III Pilots

0-20	555.1	2447.3	410	16.8
21-50	123.2	4501.3	674	15.0
51-100	105.2	8502.9	1015	11.9
101-400	94.7	21443.6	2093	9.8
401 & Over	79.8	58799.0	1530	2.6
<hr/> ALL	<hr/> 958.0	<hr/> 95694.2	<hr/> 5722	<hr/> 6.0

RECENT FLIGHT TIME

AGE 20-29

Class III Pilots

Recent Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-20	482.5	2727.8	271	9.0
21-50	93.2	3070.7	377	12.3
51-100	31.6	2410.6	495	20.5
101-400	11.3	1931.4	482	25.0
401 & Over	0.6	467.4	42	9.0
<hr/> ALL	<hr/> 619.3	<hr/> 10607.9	<hr/> 1667	<hr/> 15.7

Class I, II, and III Pilots

0-20	666.4	3214.7	407	12.7
21-50	123.5	4228.5	562	13.3
51-100	71.1	5647.3	860	15.2
101-400	59.7	12777.7	1495	11.7
401 & Over	38.6	31713.2	1285	4.1
<hr/> ALL	<hr/> 959.3	<hr/> 57581.3	<hr/> 4609	<hr/> 8.0

RECENT FLIGHT TIME

AGE 17-19

Class III Pilots

Recent Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-20	107.8	634.4	39	6.1
21-50	19.1	590.2	62	10.5
51-100	3.8	284.0	79	27.8
101-400	1.2	191.4	56	29.3
401 & Over	*	41.6	3	7.2
<u>ALL</u>	<u>132.0</u>	<u>1741.6</u>	<u>239</u>	<u>13.7</u>

Class I, II, and III Pilots

0-20	130.2	692.5	55	7.9
21-50	22.6	712.1	76	10.7
51-100	7.6	585.2	101	17.3
101-400	5.4	1000.0	113	11.3
401 & Over	0.5	349.5	26	7.4
<u>ALL</u>	<u>166.2</u>	<u>3339.2</u>	<u>371</u>	<u>11.1</u>

\*Less than 100 pilots

TOTAL FLIGHT TIME

ALL AGES

Class III Pilots

Total Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-100	1216.4	13688.5	2269	16.57
101-500	550.3	23229.2	3246	13.97
501-1000	140.9	9699.2	980	10.10
1001-5000	133.2	13452.3	1094	8.13
5001 & over	12.2	2033.1	149	7.32
<hr/> ALL	<hr/> 2053.1	<hr/> 62102.3	<hr/> 7738	<hr/> 12.46

Class I, II, and III Pilots

0-100	1621.5	20,704	2960	14.29
101-500	867.9	45290.7	5561	12.27
501-1000	261.2	28823.6	2688	9.32
1001-5000	381.9	98641.0	6249	6.33
5001 & Over	218.0	114,118.3	2780	2.43
<hr/> ALL	<hr/> 3350.5	<hr/> 307,578.6	<hr/> 20238	<hr/> 6.62

TOTAL FLIGHT TIME

AGE 70 & OVER

Class III Pilots

Total Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-100	0.9	20.3	0	—
101-500	1.5	36.1	11	30.4
501-1000	1.3	46.6	6	12.9
1001-5000	3.6	193.8	23	11.9
5001 & over	0.9	80.1	6	7.5
<hr/> ALL	<hr/> 8.2	<hr/> 377.0	<hr/> 46	<hr/> 12.2

Class I, II, and III Pilots

0-100	0.9	26.8	4	14.9
101-500	1.5	39.7	14	35.3
501-1000	1.4	53.4	11	20.6
1001-5000	4.0	259.3	32	12.3
5001 & Over	2.3	343.1	21	6.1
<hr/> ALL	<hr/> 10.0	<hr/> 722.3	<hr/> 82	<hr/> 11.4

Numeric Data for Figures 5 through 8

TOTAL FLIGHT TIME

AGE 60-69

Class III Pilots

Total Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-100	10.4	171.9	18	10.5
101-500	21.4	707.3	103	14.6
501-1000	13.3	659.0	63	9.6
1001-5000	23.2	1772.7	126	7.1
5001 & over	3.4	456.1	37	8.1
<hr/> ALL	<hr/> 71.8	<hr/> 3766.9	<hr/> 347	<hr/> 9.2

Class I, II, and III Pilots

0-100	12.3	294.5	22	7.5
101-500	24.2	810.9	120	14.8
501-1000	16.1	825.9	101	12.2
1001-5000	33.5	2892.7	269	9.3
5001 & Over	17.4	4050.6	231	5.7
<hr/> ALL	<hr/> 103.4	<hr/> 8874.6	<hr/> 743	<hr/> 8.4

ACUMENICS

TOTAL FLIGHT TIME

AGE 50-59

Class III Pilots

Total Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-100	68.0	931.6	166	17.8
101-500	109.8	4229.3	509	12.0
501-1000	51.2	3070.6	273	8.9
1001-5000	57.1	5361.9	383	7.1
5001 & over	4.9	833.6	58	7.0
<hr/> ALL	<hr/> 291.2	<hr/> 14427.0	<hr/> 1389	<hr/> 9.6

Class I, II, and III Pilots

0-100	85.6	2066.6	202	9.8
101-500	131.1	5225.5	668	12.9
501-1000	68.1	4386.2	459	10.5
1001-5000	99.8	11941.6	950	8.0
5001 & Over	70.7	34408.5	774	2.2
<hr/> ALL	<hr/> 455.3	<hr/> 58028.4	<hr/> 3053	<hr/> 5.3

TOTAL FLIGHT TIME

AGE 40-49

Class III Pilots

Total Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-100	161.3	1931.3	370	19.2
101-500	160.5	6714.0	923	13.7
501-1000	47.9	3417.7	336	9.8
1001-5000	36.4	4137.7	371	9.0
5001 & over	2.1	414.1	34	8.2
<u>ALL</u>	<u>408.1</u>	<u>16614.8</u>	<u>2034</u>	<u>12.2</u>

Class I, II, and III Pilots

0-100	220.6	3482.2	471	13.5
101-500	222.0	9938.7	1353	13.6
501-1000	81.9	6968.7	752	10.8
1001-5000	96.3	19333.3	1348	7.0
5001 & Over	76.5	43567.8	909	2.1
<u>ALL</u>	<u>697.3</u>	<u>83290.6</u>	<u>4833</u>	<u>5.8</u>

TOTAL FLIGHT TIME

AGE 30-39

Class III Pilots

Total Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-100	328.2	3659.7	695	19.0
101-500	159.6	7034.5	934	13.3
501-1000	22.8	2010.7	228	11.3
1001-5000	11.4	1637.4	147	9.0
5001 & over	0.7	192.9	12	6.2
<hr/> ALL	<hr/> 522.6	<hr/> 14535.2	<hr/> 2016	<hr/> 13.9

Class I, II, and III Pilots

0-100	459.6	5571.9	882	15.8
101-500	283.1	14805.6	1686	11.4
501-1000	65.9	9069.9	735	8.1
1001-5000	102.3	37124.3	2151	5.8
5001 & Over	47.1	29122.5	749	2.6
<hr/> ALL	<hr/> 958.0	<hr/> 95694.2	<hr/> 6203	<hr/> 5.5

TOTAL FLIGHT TIME

AGE 20-29

Class III Pilots

Total Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-100	520.4	5571.3	849	15.2
101-500	92.9	4185.8	700	16.7
501-1000	4.3	485.9	73	15.0
1001-5000	1.5	322.2	43	13.3
5001 & over	0.2	42.7	2	4.7
<hr/> ALL	<hr/> 619.3	<hr/> 10607.9	<hr/> 1667	<hr/> 15.7

Class I, II, and III Pilots

0-100	688.3	7508.4	1151	15.3
101-500	194.5	13217.0	1589	12.0
501-1000	27.2	7310.3	610	8.3
1001-5000	45.6	26947.2	1482	5.5
5001 & Over	3.7	2598.4	96	3.7
<hr/> ALL	<hr/> 959.3	<hr/> 57581.3	<hr/> 4938	<hr/> 8.6

35

TOTAL FLIGHT TIME

AGES 17-19

Class III Pilots

Total Time Interval	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
0-100	127.3	1399.8	171	12.2
101-500	3.8	320.2	66	20.6
501-1000	*	5.8	1	17.2
1001-5000	*	11.1	1	9.0
5001 & over	*	4.7	—	—
<hr/> ALL	<hr/> 132.0	<hr/> 1741.6	<hr/> 239	<hr/> 13.7

Class I, II, and III Pilots

0-100	154.0	1750.8	228	13.0
101-500	11.5	1251.2	131	10.5
501-1000	0.5	205.5	20	9.7
1001-5000	0.2	124.8	7	5.6
5001 & Over	0.1	6.9	—	—
<hr/> ALL	<hr/> 166.2	<hr/> 3339.2	<hr/> 386	<hr/> 11.6

\*Less than 500 pilots.

TOTAL AND RECENT FLIGHT TIME

ALL AGES

Class III Pilots

Recent and Total Flight Time Intervals(1)	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
>50 & >1000	84	14,439	977	6.76
>50 & <=1000	259	28,018	4,012	14.31
<=50 & >1000	61	1,047	266	25.41
<=50 & <=1000	1,649	18,599	2,483	13.35
<hr/> All	<hr/> 2,053	<hr/> 62,102	<hr/> 7,738	<hr/> 12.46

Class I, II, and III Pilots

>50 & >1000	466	210,539	7,389	3.50
>50 & <=1000	495	71,350	6,837	9.58
<=50 & >1000	134	2,222	700	31.50
<=50 & <=1000	2,255	23,469	3,375	14.38
<hr/> All	<hr/> 3,350	<hr/> 307,579	<hr/> 18,301	<hr/> 5.95

(1) Key:

- >50 & > 1,000 Greater than 50 hours recent time and greater than 1,000 hours total time.
- >50 & <=1,000 Greater than 50 hours recent time and less than or equal to 1,000 hours total time.
- <=50 & >1,000 Less than or equal to 50 hours recent time and greater than 1,000 hours total time.
- <=50 & <=1,000 Less than or equal to 50 hours recent time and less than or equal to 1,000 hours total time.

ACUMENICS

TOTAL AND RECENT FLIGHT TIME

AGE 70 & OVER

Class III Pilots

Recent and Total Flight Time Intervals(1)	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
>50 & >1000	1	229	15	6.55
>50 & <=1000	1	68	10	14.69
<=50 & >1000	2	45	14	30.92
<=50 & <=1000	3	35	7	20.00
<u>                    </u>	<u>                    </u>	<u>                    </u>	<u>                    </u>	<u>                    </u>
All	7	377	46	12.20

Class I, II, and III Pilots

>50 & >1000	3	540	30	5.55
>50 & <=1000	1	82	1	15.88
<=50 & >1000	3	62	15	24.17
<=50 & <=1000	3	38	11	28.92
<u>                    </u>				
All	10	722	69	9.56

(1) Key:

- >50 & > 1,000 Greater than 50 hours recent time and greater than 1,000 hours total time.
- >50 & <=1,000 Greater than 50 hours recent time and less than or equal to 1,000 hours total time.
- <=50 & >1,000 Less than or equal to 50 hours recent time and greater than 1,000 hours total time.
- <=50 & <=1,000 Less than or equal to 50 hours recent time and less than or equal to 1,000 hours total time.

ACUMENICS

TOTAL AND RECENT FLIGHT TIME

AGE 60-69

Class III Pilots

Recent and Total Flight Time Intervals(1)	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
>50 & >1000	14	1,995	123	6.16
>50 & <=1000	10	1,056	102	9.66
<=50 & >1000	13	234	40	17.08
<=50 & <=1000	35	483	82	16.99
<u>All</u>	<u>71</u>	<u>3,767</u>	<u>347</u>	<u>9.21</u>

Class I, II, and III Pilots

>50 & >1000	30	6,561	334	5.09
>50 & <=1000	12	1,381	122	8.83
<=50 & >1000	21	383	72	18.81
<=50 & <=1000	41	551	93	16.88
<u>All</u>	<u>103</u>	<u>8,875</u>	<u>621</u>	<u>7.00</u>

(1) Key:

- >50 & > 1,000 Greater than 50 hours recent time and greater than 1,000 hours total time.
- >50 & <=1,000 Greater than 50 hours recent time and less than or equal to 1,000 hours total time.
- <=50 & >1,000 Less than or equal to 50 hours recent time and greater than 1,000 hours total time.
- <=50 & <=1,000 Less than or equal to 50 hours recent time and less than or equal to 1,000 hours total time.

ACUMENICS

TOTAL AND RECENT FLIGHT TIME

AGE 50-59

Class III Pilots

Recent and Total Flight Time Intervals(1)	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
>50 & >1000	36	5,741	336	5.85
>50 & <=1000	54	5,777	527	9.12
<=50 & >1000	26	455	105	23.07
<=50 & <=1000	175	2,454	421	17.15
<u>                    </u>	<u>                    </u>	<u>                    </u>	<u>                    </u>	<u>                    </u>
All	291	14,427	1,389	9.63

Class I, II, and III Pilots

>50 & >1000	124	45,539	1,242	2.72
>50 & <=1000	71	8,821	683	7.74
<=50 & >1000	47	811	207	25.53
<=50 & <=1000	214	2,857	517	18.09
<u>                    </u>				
All	455	58,028	2,649	4.57

(1) Key:

- >50 & > 1,000 Greater than 50 hours recent time and greater than 1,000 hours total time.
- >50 & <=1,000 Greater than 50 hours recent time and less than or equal to 1,000 hours total time.
- <=50 & >1,000 Less than or equal to 50 hours recent time and greater than 1,000 hours total time.
- <=50 & <=1,000 Less than or equal to 50 hours recent time and less than or equal to 1,000 hours total time.

TOTAL AND RECENT FLIGHT TIME

AGE 40-49

Class III Pilots

Recent and Total Flight Time Intervals(1)	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
>50 & >1000	24	4,318	326	7.55
>50 & <=1000	76	8,366	1,044	12.47
<=50 & >1000	15	234	79	33.71
<=50 & <=1000	294	3,697	585	15.82
<u>                    </u>	<u>                    </u>	<u>                    </u>	<u>                    </u>	<u>                    </u>
All	408	16,615	2,034	12.24

Class I, II, and III Pilots

>50 & >1000	140	62,369	1,823	2.92
>50 & <=1000	119	15,738	1,487	9.44
<=50 & >1000	33	532	196	36.85
<=50 & <=1000	405	4,652	787	16.91
<u>                    </u>				
All	697	83,291	4,293	5.15

(1) Key:

- >50 & > 1,000 Greater than 50 hours recent time and greater than 1,000 hours total time.
- >50 & <=1,000 Greater than 50 hours recent time and less than or equal to 1,000 hours total time.
- <=50 & >1,000 Less than or equal to 50 hours recent time and greater than 1,000 hours total time.
- <=50 & <=1,000 Less than or equal to 50 hours recent time and less than or equal to 1,000 hours total time.

TOTAL AND RECENT FLIGHT TIME

AGE 30-39

Class III Pilots

Recent and Total Flight Time Intervals(1)	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
>50 & >1000	7	1,767	137	7.75
>50 & <=1000	71	7,790	1,212	15.55
<=50 & >1000	5	63	22	34.81
<=50 & <=1000	439	4,915	645	13.12
<u>All</u>	<u>523</u>	<u>14,535</u>	<u>2,016</u>	<u>13.87</u>

Class I, II, and III Pilots

>50 & >1000	125	65,900	2,515	3.81
>50 & <=1000	154	22,846	2,109	9.23
<=50 & >1000	24	347	158	45.51
<=50 & <=1000	654	6,601	921	13.95
<u>All</u>	<u>958</u>	<u>95,694</u>	<u>5,703</u>	<u>5.96</u>

(1) Key:

- >50 & > 1,000 Greater than 50 hours recent time and greater than 1,000 hours total time.
- >50 & <=1,000 Greater than 50 hours recent time and less than or equal to 1,000 hours total time.
- <=50 & >1,000 Less than or equal to 50 hours recent time and greater than 1,000 hours total time.
- <=50 & <=1,000 Less than or equal to 50 hours recent time and less than or equal to 1,000 hours total time.

TOTAL AND RECENT FLIGHT TIME

AGE 20-29

Class III Pilots

Recent and Total Flight Time Intervals(1)	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
>50 & >1000	1	355	39	10.97
>50 & <=1000	43	4,454	980	22.00
<=50 & >1000	1	10	6	62.18
<=50 & <=1000	575	5,789	642	11.09
<u>All</u>	<u>619</u>	<u>10,608</u>	<u>1,667</u>	<u>15.71</u>

Class I, II, and III Pilots

>50 & >1000	44	29,465	1,439	4.88
>50 & <=1000	125	20,673	2,189	10.58
<=50 & >1000	5	80	51	63.50
<=50 & <=1000	785	7,363	916	12.44
<u>All</u>	<u>959</u>	<u>57,581</u>	<u>4,595</u>	<u>7.98</u>

(1) Key:

>50 & > 1,000 Greater than 50 hours recent time and greater than 1,000 hours total time.

>50 & <=1,000 Greater than 50 hours recent time and less than or equal to 1,000 hours total time.

<=50 & >1,000 Less than or equal to 50 hours recent time and greater than 1,000 hours total time.

<=50 & <=1,000 Less than or equal to 50 hours recent time and less than or equal to 1,000 hours total time.

ACUMENICS

TOTAL AND RECENT FLIGHT TIME

AGE 17-19

Class III Pilots

Recent and Total Flight Time Intervals(1)	Pilots (000)	Recent Flight Hours (000)	Accidents	Accident Rate (per 100,000 recent flight hours)
>50 & >1000	(2)	15	1	6.73
>50 & <=1000	5	502	137	27.28
<=50 & >1000	(2)	1	(2)	(2)
<=50 & <=1000	127	1,224	101	8.25
<u>All</u>	<u>132</u>	<u>1,742</u>	<u>239</u>	<u>13.72</u>

Class I, II, and III Pilots

>50 & >1000	(2)	130	6	4.59
>50 & <=1000	13	1,804	234	12.97
<=50 & >1000	(2)	1	1	90.82
<=50 & <=1000	153	1,403	130	9.26
<u>All</u>	<u>166</u>	<u>3,339</u>	<u>371</u>	<u>11.11</u>

(1) Key:

>50 & > 1,000 Greater than 50 hours recent time and greater than 1,000 hours total time.

>50 & <=1,000 Greater than 50 hours recent time and less than or equal to 1,000 hours total time.

<=50 & >1,000 Less than or equal to 50 hours recent time and greater than 1,000 hours total time.

<=50 & <=1,000 Less than or equal to 50 hours recent time and less than or equal to 1,000 hours total time.

(2) No figure provided by printout.

(3) Less than .5 but greater than 0.

APPENDIX B

VALIDATION OF MEDICAL HISTORY FILE DATA

## Background

Pilot hour accident rates in the report, "The Influence of Total Flight Time, Recent Flight Time and Age on Pilot Hour Accident Rates", utilize data from two sources: (1) the FAA Medical History file for flight hour exposure; and, (2) the National Transportation Safety Board (NTSB) records for accident counts. The Medical History file is developed from information provided by pilots who take mandatory flight physicals and report civil flight time (both hours flown in the last six months and cumulative flight time), date of birth and other information. The NTSB accident record contains detailed data for all U. S. general aviation accidents, and includes information about total pilot flight time, flight time in the last 90 days, pilot age, and other information. As such, the two databases represent population parameters for all pilots and all accidents. The issue of data validity, then, is one of whether the two databases accurately portray the variables of interest for the respective populations.

The principal variables used in the study include recent flight time, total flight time, medical certificate class, and pilot age. The number of accidents, recent flight hours and the number of pilots were assigned to a class structure based on variable values falling into specific intervals of recent flight time, total flight time, medical certificate class and age. A limited number of intervals are used for the variables of interest which serves to minimize the potential for misclassification. The number of intervals are as follows:

- Medical Certificate -- 3 classes
- Recent Flight Time -- 5 classes
- Total Flight Time -- 5 classes
- Pilot Age -- 7 classes.

The class of medical certificate held by the pilot is a direct entry item in both databases. Pilot age can be calculated from date of birth in the Medical History file and is a direct entry item in the NTSB accident record. Other than recording and data entry errors, the above variables should exhibit a high degree of accuracy. Thus, the variables which must be closely examined for validity are recent flight time and total flight time. However, at the present level of analysis the only errors which could substantially influence the analytic results are those which cause exposure (pilot hours) or accidents to move from one class interval to another.

Total flight time is recorded in the Medical History file and NTSB accident record as cumulative lifetime flight hours for an individual. Recent flight time was annualized from flight time in the last 90 days in the NTSB accident record and from flight time in the last 6 months in the Medical History file. The first key assumption about data validity is that pilots accurately report recent and total flight time when they take a flight physical and when reporting information in an accident investigation. It is believed that most pilots do not take the logbook to flight physicals and report flight hours data from memory. It is believed that flight hours data reported in an accident investigation may be more precise because of the more formal nature of the investigation process. The second key assumption in the analysis is whether recent and total flight time as reported in the Medical History file are equivalent to recent and total flight time as reported in the NTSB accident record. This is important because data from two independent sources are used to assign accidents and flight hour exposure to the classes of recent flight time, total flight time and age. Thus, two independent sources of information are used to produce the accident rate data used in the report.

ACUMENICS

There are no practical methods of directly testing the first assumption about the accuracy of reported recent and total flight time without a comparison with original pilot logbook data. In addition, such a test would rely on the assumption that a pilot logbook accurately reflects the individual's actual flight experience. A comparison of aircraft hours flown as adjusted for a crewing factor with the pilot hours data is presented below. This is an indirect method of testing the first assumption about data reported in the Medical History file.

The second assumption could be addressed by using the Medical History file flight hours data for both accidents and exposure. This would require that the Medical History file be linked with the NTSB accident record on an individual record basis. To accomplish this, however, would require that five steps of database linkage be accomplished. The first step would be to merge the NTSB accident record with the FAA/AIDS accident records. The second step would be to link the CAIS system and the Airman Directory file on a record by record basis. The third step would be to link the results of Step 2 and Step 3 to produce an NTSB/AIDS accident record that contained the pilot's social security number. The fourth step would be to link the Medical History file with the results of Step 2. The final step would be to link the results of Steps 3 and 4. This would produce a linked database of all pilots and would permit using the Medical History file flight hour data for both accidents and exposure. In addition, it would provide the capability to perform other analyses with the Medical History file database. However, the database linkage described above was beyond the scope of the present effort.

### Data Validation

Two means of data validation were performed in this study. The first was to analyze the pilot hours data from the Medical History file to determine if such data produce reasonable estimates of population parameters. In addition, the pilot hours data were compared to the aircraft hours flown database developed by the FAA Office of Management Systems. The aircraft hours flown data were adjusted by a crew factor to account for more than one individual logging flight time for certain aircraft flights. The results of this validation are reported below in the section, "Pilot Hours Database Summary Statistics and Validation.

The second method of data validation was to manually link a selected sample of NTSB accident records with Medical History file data for the same pilot. The Medical History file contains social security numbers for pilots who take flight physicals. In the case of pilot certificates issued after the early 1970's, the social security number is used for the pilot certificate number. NTSB no longer provides pilot certificate numbers in the computer accident record. However, it is available for some accidents in the original accident records.

It was determined that this phase would be limited to Class III pilots with relatively low values of total flight time so that accidents would be selected that were likely to contain social security numbers for pilot certificate numbers. A random sample of 1978 accidents was used to obtain social security numbers. Also, recent flight time and total flight time values were recorded from the accident record along with social security numbers.

The social security numbers from the selected accident records were used to identify and obtain all Medical History file data for the pilots of interest in the 1976 to 1980 time period. The NTSB accident data and Medical History file data were then compared to determine whether the recent and total flight time data for the sample of individual pilots were consistent and reasonable. The results of this validation are reported below in the section titled, "Comparison of Flight Time Data in NTSB Accident Record and Medical History File".

#### Utility of Pilot Hours Data for Safety Analysis

The two validation steps undertaken indicate that the the Medical History file data for pilot flight hours can be used in conjunction with the NTSB accident record for safety analysis studies. The pilot hours database provides a new analytic capability to FAA in that it provides exposure information for pilots who did have accidents and pilots who did not have accidents. However, to fully utilize the new capability provided by the pilot hours database, the database linkage steps described above must be implemented. Such an effort would provide the capability to perform a number of additional comparative analyses of the pilot population. Future studies could include the following, among others:

- analyses by pilot certificate class,
- analyses of instrument rated vs non instrument rated pilots,
- analyses of epidemiology, etc.

While the Medical History file data cannot be directly examined to determine validity, the two validation steps herein indicate that no significant biases were identified. As noted above, the two most critical variables with respect to data validity are recent flight time and total flight time. It is recommended

that, for these two variables, a minimum number of class intervals for variable values be used in subsequent research. This would minimize the potential for data reporting errors to influence the analytic results.

#### Pilot Hours Database Summary Statistics and Validation

One method of assessing the validity of the pilot hours database is to determine whether it produces reasonable descriptive statistics for the pilot population and subsets of the population. Such results can be compared to measures of aviation activity. The data in Table B-1 represent five years (1976 to 1980) of pilot flight time records from the Medical History file. It can be seen that total pilot flight hours have ranged from 56.5 million to 65.0 million per year during the period. The estimated number of pilots ranges from approximately 622,000 to 704,000 per year during the same time period.<sup>1</sup> The average pilot recorded from 86 to 105 hours of annual flight time during the period.

Class III pilots account for approximately 20 percent of all pilot hours and for slightly over 60 percent of all pilots. Both proportions are relatively constant over the period of interest. Class III pilots fly about 30 hours per year on an average. Class II pilots account for approximately 36 percent of all pilot flight hours, although the data indicate a decreasing share of flying for this class of pilots (39% in 1976 and 33% in 1980). Class II pilots account for about 30 percent of all pilots, however, this also decreased during the period (33% in 1976 and 28% in 1980). Class II pilots fly just over 100 hours per year on average.

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<sup>1</sup>The pilot counts do not agree with data reported by FAA's Office of Management Systems (MS) because the above data only counts pilots who have taken current flight physicals. FAA-MS data assume that pilots remain in the population for two years after the last physical.

PILOT HOURS DATA  
AIRMAN'S MEDICAL RECORDS

	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
<u>ALL PILOTS</u>					
Annual Flight Hours (000)	56,507	59,071	62,131	64,911	64,959
Pilots	661,536	679,557	703,732	683,776	621,922
Hours Per Pilot	85.9	87.4	88.7	95.4	104.9
<u>CLASS III PILOTS</u>					
Annual Flight Hours (000)	11,673	12,174	12,806	12,818	12,631
Pilots	397,904	414,324	434,188	418,130	388,510
Hours Per Pilot	29.8	29.8	29.9	31.1	33.0
<u>CLASS II PILOTS</u>					
Annual Flight Hours (000)	22,057	22,187	22,180	21,843	21,571
Pilots	217,456	215,361	213,594	204,446	172,612
Hours Per Pilot	101.9	103.5	104.3	107.3	125.4
<u>CLASS I PILOTS</u>					
Annual Flight Hours (000)	22,776	24,710	27,144	30,249	30,757
Pilots	46,170	49,872	55,950	61,200	60,800
Hours Per Pilot	493.8	495.9	485.6	494.7	506.3

Table B-1

ACUMENICS

Class I pilots account for about 44 percent of all pilot hours flown. In contrast to Class II pilots, the share of hours accounted for this group has increased during the period studied (40% in 1976 and 47% in 1980). Class I pilots account for about 8 percent of all pilots, but the proportion of Class I pilots has been increasing throughout the period (7% in 1976 and 10% in 1980). Class I pilots average about 500 flight hours per year. The above data appear to produce reasonable relationships for hours flown between pilot classes.

A second perspective can be gained about the quality of the pilot hours database through a comparison with aircraft hours flown estimates. The aircraft hours flown estimates must be adjusted to account for the fact that more than one pilot can record flight time for a particular aircraft at the same time. The results of such a comparison for the 1976 to 1980 period are shown in Table B-2. It can be seen that estimates of hours flown correspond closely.

The data in Table B-2 derive from calculations shown in Tables B-3 through B-7. For the year 1980 (as shown in Table B-3), air carrier and general aviation aircraft hours flown are shown for each major aircraft type.<sup>2</sup> The aircraft hours are adjusted by an assumed crew factor to produce an estimate of pilot hours flown. The estimated pilot hours flown (68 million) correspond to the pilot hours produced from the medical records (65 million).

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<sup>2</sup>Data are from: FAA Statistical Handbook of Aviation, Calendar Years 1980, 1978 and 1977, FAA, Office of Management Systems.

SUMMARY TABLE  
 FLIGHT HOURS COMPARISON  
 (In Thousands)  
 1976-1980

YEAR	PILOT HOURS FROM MEDICAL RECORDS	ESTIMATED PILOT HOURS FROM AIRCRAFT HOURS	RATIO OF MEDICAL HOURS TO PILOT HOURS FROM AIRCRAFT HOURS
1976	56,507	58,187	.971
1977	59,071	58,949	1.002
1978	62,131	63,758	.974
1979	64,911	69,675	.932
1980	64,959	68,488	.948

Table B-2

ACUMENICS

FLIGHT HOURS COMPARISON  
1980  
(In Thousands)

	<u>TOTAL</u>	<u>CLASS I</u>	<u>CLASS II</u>	<u>CLASS III</u>
PILOT HOURS FROM MEDICAL RECORDS	64,959	30,757	21,571	12,631
AIRCRAFT HOURS FROM FAA - MS	<u>AIRCRAFT HOURS</u>	<u>CREW FACTOR</u>	<u>ESTIMATED PILOT HOURS</u>	
<u>AIR CARRIER</u>				
4 Engine Jet & Turbo Prop	1,381	3	4,143	
3 Engine Jet	3,693	3	11,079	
2 Engine Jet & Turbo Prop	2,667	2	5,334	
Piston	484		968	
Rotary Wing	*	2	1	
Total	8,225		21,525	
<u>GENERAL AVIATION</u>				
Piston	34,747	1.1	38,222	
Turbo Prop	2,240	1.3	2,912	
Turbo Jet	1,332	2	2,664	
Rotorcraft	2,338	1.2	2,806	
Other	359	1	359	
Total	41,016		46,963	
<u>Grand Total</u>	49,241		68,488	

\*Less than 0.5

FLIGHT HOURS COMPARISON  
1979  
(In Thousands)

	<u>TOTAL</u>	<u>CLASS I</u>	<u>CLASS II</u>	<u>CLASS III</u>
PILOT HOURS FROM MEDICAL RECORDS	64,911	30,249	21,843	12,818
AIRCRAFT HOURS FROM FAA - MS	<u>AIRCRAFT HOURS</u>	<u>CREW FACTOR</u>	<u>ESTIMATED PILOT HOURS</u>	
<u>AIR CARRIER</u>				
4 Engine Jet & Turbo Prop	1,650	3	4,950	
3 Engine Jet	3,520	3	10,560	
2 Engine Jet & Turbo Prop	2,156	2	4,312	
Piston	224	2	448	
Rotary Wing	2	2	4	
Total	7,552		20,274	
<u>GENERAL AVIATION</u>				
Piston	37,302	1.1	41,032	
Turbo Prop	1,871	1.3	2,432	
Turbo Jet	1,259	2	2,518	
Rotorcraft	2,555	1.2	3,066	
Other	353	1	353	
Total	43,340		49,401	
<u>Grand Total</u>	50,892		69,675	

Table B-4

FLIGHT HOURS COMPARISON

1978

(In Thousands)

	<u>TOTAL</u>	<u>CLASS I</u>	<u>CLASS II</u>	<u>CLASS III</u>
PILOT HOURS FROM MEDICAL RECORDS	62,131	27,144	22,180	12,806
AIRCRAFT HOURS FROM FAA - MS	<u>AIRCRAFT HOURS</u>	<u>CREW FACTOR</u>	<u>ESTIMATED PILOT HOURS</u>	
<u>AIR CARRIER</u>				
4 Engine Jet & Turbo Prop	1,693	3	5,079	
3 Engine Jet	3,160	3	9,480	
2 Engine Jet & Turbo Prop	1,961	2	3,922	
Piston	166	2	332	
Rotary Wing	5	2	10	
Total	6,985		18,823	
<u>GENERAL AVIATION</u>				
Piston	34,043	1.1	37,447	
Turbo Prop	1,606	1.3	2,088	
Turbo Jet	1,194	2	2,388	
Rotorcraft	2,228	1.2	2,674	
Other	338	1	338	
Total	39,409		44,935	
<u>Grand Total</u>	46,394		63,758	

Table B-5

FLIGHT HOURS COMPARISON  
1977  
(In Thousands)

	<u>TOTAL</u>	<u>CLASS I</u>	<u>CLASS II</u>	<u>CLASS III</u>
PILOT HOURS FROM MEDICAL RECORDS	59,071	24,710	22,187	12,174
AIRCRAFT HOURS FROM FAA - MS	<u>AIRCRAFT HOURS</u>	<u>CREW FACTOR</u>	<u>ESTIMATED PILOT HOURS</u>	
<u>AIR CARRIER</u>				
4 Engine Jet & Turbo Prop	1,771	3	5,313	
3 Engine Jet	2,917	3	8,751	
2 Engine Jet & Turbo Prop	1,814	2	3,628	
Piston	175	2	350	
Rotary Wing	7	2	14	
Total	6,684		18,056	
<u>GENERAL AVIATION</u>				
Piston	30,965	1.1	34,062	
Turbo Prop	1,549	1.3	2,014	
Turbo Jet	1,165	2	2,330	
Rotorcraft	1,868	1.2	2,242	
Other	245	1	245	
Total	35,792		40,893	
<u>Grand Total</u>	42,476		58,949	

Table B-6

ACUMENICS

FLIGHT HOURS COMPARISON  
1976  
(In Thousands)

	<u>TOTAL</u>	<u>CLASS I</u>	<u>CLASS II</u>	<u>CLASS III</u>
PILOT HOURS FROM MEDICAL RECORDS	56,507	22,776	22,057	11,673
AIRCRAFT HOURS FROM FAA - MS	<u>AIRCRAFT HOURS</u>	<u>CREW FACTOR</u>	<u>ESTIMATED PILOT HOURS</u>	
<u>AIR CARRIER</u>				
4 Engine Jet & Turbo Prop	1,749	3	5,247	
3 Engine Jet	2,696	3	8,088	
2 Engine Jet & Turbo Prop	1,743	2	3,486	
Piston	150	2	300	
Rotary Wing	6	2	12	
Total	6,344		17,133	
<u>GENERAL AVIATION</u>				
Piston	31,755	1.1	34,931	
Turbo Prop	1,327	1.3	1,725	
Turbo Jet	1,000	2	2,000	
Rotorcraft	1,762	1.2	2,114	
Other	284	1	284	
Total	36,128		41,054	
<u>Grand Total</u>	42,472		58,187	

Table B-7

### Comparison of Flight Time Data - NTSB Accident Record and Medical History File

The comparison of flight time data from the NTSB accident record with that from the Medical History file for Class III pilots is complicated by the fact that data for an individual are reported intermittently. The recent flight time data obtained from the Application for Medical Certificate is for the six months prior to the date of the flight physical. Class III pilots take flight physicals and report flight time data at two year intervals. Accidents are randomly distributed between the interval at which flight physicals are taken. The accident report contains recent flight experience for the 90 days preceeding the accident. Accidents for Class III pilots were randomly selected from those which occurred in 1978, the midpoint of the five years of medical data. The specific pilot who had the accident was identified and all medical records for that pilot were selected. An observation consists of flight time data from one accident record and from one or more flight physicals and consists of at least two records but not more than five records. A schematic of the available data is shown in Figure B-1.

The test for the reasonableness of total flight time values is whether such values increase with the passage of time and whether the flight time increase between two records is greater than the recent flight time reported (given that the recent time data does not overlap the two reporting periods) in the later record. Only eight observations out of 196 observations had totally inconsistent total flight time data. Another eight observations had small errors in total flight time, given reported recent flight time.

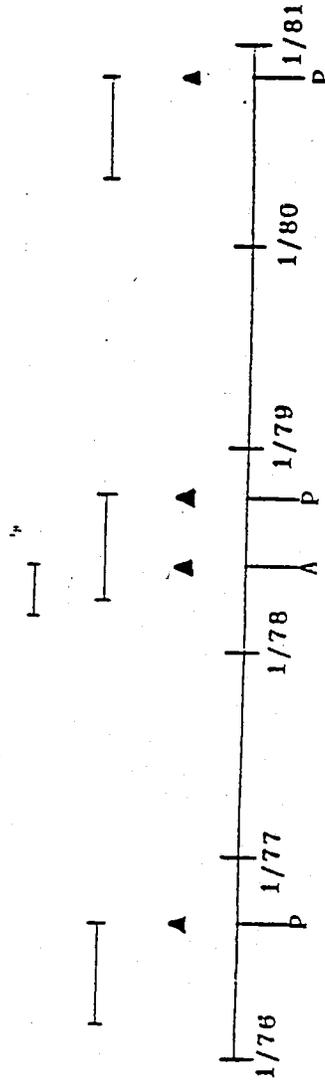
SCHEMATIC OF FLIGHT TIME DATA AVAILABLE FOR AN INDIVIDUAL  
IN MEDICAL HISTORY FILE AND NTSB ACCIDENT RECORD

RECENT FLIGHT  
TIME REPORT:

1. ACCIDENT

2. PHYSICAL

TOTAL FLIGHT  
TIME REPORT



P: Physical -- report of recent flight time in last 6 months and cumulative total flight time.  
A: Accident -- report of recent flight time in last 90 days and cumulative total flight time.

Figure B-1

The test of reasonableness for recent flight time requires a more complex calculation. In this case, each set of chronologically adjacent records for a pilot were examined. The total flight time from the earlier record was subtracted from total flight time from the later record. The months between the two records were calculated and divided into the difference in total flight time. This produced a measure of hours flown per month based on total flight time changes. The reported recent time on the later record also was converted to a monthly estimate of hours flown. The difference between monthly hours flown from the change in total time and from reported recent time was calculated.

There is no a priori reason to expect that the above calculation would produce a zero difference for any adjacent pair of records because Class III pilots typically do not fly a fixed, regular number of hours per month. Also, because of the time interval between records, it is not possible to account for all differences in total flight time with reported recent flight time estimates (see Figure B-1). However, when a large number of observations are considered, it is reasonable to assume that such differences will cancel out to a large degree.

The first test performed was to examine the number of cases with positive differences and negative differences. Also, it was noted whether the later observation was from an accident record or medical record. The following results are for each calculation made for a set of paired records.

	<u>Accident</u>	<u>Medical</u>	<u>Total</u>	<u>Percent</u>
Positive Difference	42	48	90	39.8
Negative Difference	54	66	120	53.1
No Difference	<u>2</u>	<u>14</u>	<u>16</u>	<u>7.1</u>
Total	98	128	226	100.0

It should be noted that an observation could have from one to four differences tested. It can be seen that negative differences are somewhat more preponderant than positive differences. This indicates that reported recent flight time exceeds the recent flight time based on the difference in total flight time. However, it should be noted that the differences between positive and negative results should be more the appropriate measure of the reasonableness of the data. In this case, the difference (30) represents 13.3 percent of the records.

A second test was to evaluate the summed numeric value of such deviations in relation to the absolute value of all deviations. This allows one to evaluate the degree of bias in the data set because, as noted above, deviations are expected because of irregular flying patterns and incomplete information. This was done for two datasets, good observations and acceptable observations. Acceptable observations had at least one record with questionable data and include all good observations. The following are the results of the analysis.

	<u>Good Observations</u>	<u>Acceptable Observations</u>
Number of Observations	67.0	104.0
Sum of Deviations	-15.9 hours	-362.6 hours
Absolute Value of Deviations	770.6 hours	1336.2 hours
Net Average Monthly Deviation	-0.24 hours	-3.5 hours
Ratio of Sum to Absolute Value	0.021	0.271

It can be seen that by using only good observations that the flight time data from the medical records are quite consistent with flight time data from the accident records. When considering acceptable cases, the data appear to be only reasonably consistent.