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Flight time is an important index of the flight exposure of pilots and is used in estimating the accident rates of pilots, but we are not aware of prior attempts to determine how the underlying data are obtained. This study used two surveys of civilian U.S. pilots to learn how they measured and recorded flight time. Pilots used a timer, watch, the Hobbs meter or tachometer to measure the duration of flights. Professional pilots flying on scheduled flights used company or block time as the criterion of the duration of a flight, while 79% of private pilots used the time from engine(s)-on to shut-down and others the time from take-off to landing. About 80% of the pilots made a temporary or permanent record of the hours flown on the day of the flight. But, only about 71% of pilots with class III medical certificates, 58% with class II and 42% with class I reviewed their flight logs before the medical exam. The accuracy of the flight hours data could be improved if pilots used a uniform criterion of flight time, recorded it before leaving the cockpit and checked their flight logs before the medical exam.

Introduction

The objectives of this study were to learn the criteria used by pilots in determining the duration of a flight and how pilots went about recording their flying hours. In addition, the habits of pilots of different medical classes, age and flight experience may have a bearing on those activities and also on whether or not the pilots reviewed their logs of flight time before the medical exam. The medical exam is relevant to this issue of flight exposure because it is at that time that pilots are asked to complete a medical history form, which includes a section in which they indicate the number of hours they have flown in the last six months and their total flying hours. The data of flight time are important because they have been used by researchers as the measure of flight exposure of pilots and, hence, evaluations of the risks associated with various characteristics of pilots are dependent on the quality of the exposure measures.

For example, some studies have been done to look at the role of the age of pilots on accidents (Golaszewski, 1983; Mortimer,1991; Kay et al., 1993). Those studies used the FAA's Medical History File to compute the pilots' flight exposure and, hence, the validity of the results is contingent upon the accuracy of the flight time that pilots reported during their medical exam. This raised a number of questions such as, how and when do pilots record their hours flown and what proportion of pilots usually refer to their logbooks before the medical? This study has looked at these issues.

Method

We Conducted two separate mail surveys of civilian pilots, resident in all the FAA's geographic regions in the United States. The survey was mailed to a non representative sample of 1413 pilots 40% of whom held a class I medical certificate and 30% each a class II or III.

Also, in each group, half the pilots had single-engine and half multi-engine ratings. We also gave 50 questionnaires to pilots who attended an aviation safety seminar to mail back to us, in order to increase the number of pilots with class II and III certificates in our sample, who had a low mail response rate. The usable survey response rate was 36%. The sample was specifically not intended to be representative by medical certificate of the U.S. pilot population but was intended to ensure a sufficient number of cases in each medical class/ engine rating category to make estimates about their behavior in measuring and recording their flight hours.

Characteristics of the Sample

The youngest pilot in our sample was 18 and the oldest was 82 years old. 43% of the respondents had a Class I medical certificate, 30% Class II, 27% Class III. Compared to the age and class composition of the civilian pilot population at the national level (US. DOT, 1991), younger and Class III pilots were under-represented in our sample, while pilots between 30 and 59 years of age and Class I pilots were over-represented. The hours reported by the pilots in our sample are somewhat greater than those reported at the national level. In addition, 3.2% of the respondents were female.

Results

How Flight Time is Measured

The tools that pilots used to measure the time of a flight differed according to their medical class (P<0.01, Chi-Square). Class III pilots clearly favored (59%) the Hobbs meter, 23% used the elapsed time on the tachometer and 17% a watch or timer. Class II pilots used the Hobbs meter (39%) and a watch or timer (33%) almost equally, 26% used the tachometer and 1.5% company scheduled time. Class I pilots mostly (46%) used a watch or timer, 27% the Hobbs meter, 26% company schedule and only 2% a tachometer (Table 1).

The Criterion of Flight Time

The differences in the criteria used as flight time by the pilots were significantly (P<0.01) associated with their medical classes (Table 2). Just over half of pilots with a Class I medical certificate used company scheduled or block time while 86% of those with a Class II medical and 97% of those with a Class III medical used the time from starting to stopping the engines or the time from take-off to landing. Also, Class II pilots used the time from take-off to landing more often than those with Class I or III certificates (30% v. 19%, 17%).

When Pilots Make a Temporary or Permanent Record of Flight Time

Slightly over half of the pilots (55%) made a temporary or permanent record of the duration of a flight before leaving the cockpit after a flight and another 25% later on the same day (Table 3). Thus, a total of 80% of the pilots made a record of their flight time some time on the day of the flight. Another 7% of pilots recorded later than the day of the flight, but before the next flight. There were significant (P<0.01) differences when flight time was recorded. Only 47% of Class II pilots recorded flight time before leaving the cockpit compared with 58% and 60% of Class I and III, respectively. Class I pilots made a record of flight time later on the day of the flight less often (18%) than Class II and III (32% and 29%) respectively. Overall, 89% of Class III pilots made a record of their flight time some time on the day of the flight compared with 76% of class I and 79% of Class II pilots.

Pilots Who Do Not Record Flight Time

A few pilots (4%) did not record flight time. They were mostly professional pilots with an Airline transport pilot certificate and their hours were recorded by their airline. The remainder, estimated at less than 1%, may not record their hours.

Logbook Referral Prior to the Medical

About 54% of the pilots usually referred to the logbook before the medical exam, and the percentage of pilots who did so varied by their class of medical certificate and flight experience. 41% with class I medical certificates, 57% with class II and 71% with class III referred to their logbooks before their medical exam. There was not a significant association between the age of the pilots and their referral to their flight logs before the medical.

Discussion

This study has provided information about the way pilots recorded the hours flown. Since this is the most frequently used measure of the flight exposure of pilots, the manner in which it is obtained is important because it forms the basis of risk assessments of various characteristics of pilots. However, the criteria that pilots use and if and when they record the time of flight and if they review their logs, before responding to the question on the medical history form asking their flight experience, have not been studied previously.

How Flight Time Was Recorded

This study has shown that various methods are used by pilots to measure the time of a flight, but most general aviation pilots rely on the Hobbs meter or the tachometer or a watch or timer. In this sample, 77% of class III (private) pilots used the Hobbs or a watch or timer. The tachometer was used by the rest. The same (73%) was basically the case for pilots with class II medical certificates. Company schedule was used by 26% of class I pilots and 73% used the Hobbs meter, watch or timer. It is important to remember that the stratified sampling procedure that was used would include non-professional, single engine rated pilots among up to half of those with class I medical certificates.

Criteria

There were also various criteria used to denote the time of a flight which differed by medical class. Company schedule or block in/out time was used by about half of class I pilots. Those would be professional airline pilots. Class II and III pilots mostly used the time from

engine(s)-on to shut-down. The time from take-off to landing was used by 30% of those with class II medicals and by about 20% of those with class I and III certificates. While engine-on to shut-down will maximize the time, by including the time on the ground and taxi time, using the take-off to landing will minimize it. On short flights, of an hour or so, the ground portion can be 25% or more. That suggests that the hours of many general aviation pilots may be inflated compared with the official definition. The official definition of flight time (FAR 14 CFR, Ch 1) is the time from the moment that the aircraft first moves until it stops after the next landing (block to block time). Other than block-to-block time, none of the criteria used by the pilots in our sample met the FAA's criterion.

When Flight Time was Recorded.

Between 47% and 59% of pilots recorded the flight time before leaving the cockpit and about 80% at some time on the day of the flight. Class I and III pilots made a record before leaving the cockpit more often than class II pilots, so memory was less of a factor for the former. Only one class III pilot out of 135 kept no record in this sample.

Reviewing the Log Before the Medical

About 54% of the sample reviewed their logs of flight time before the medical exam. Age alone was not a factor in the frequency of referral to the log before the medical, but medical class and total flight hours were significant factors affecting this behavior.

Pilots have to report the hours they flew in the prior six months and their total hours on the form they complete when applying to renew their FAA medical certificate. This form is completed immediately before the exam itself.

The results show that class III pilots refer to their logs before the medical substantially more often than class I or II. Overall, 71% of class III, 57% of class II and 41% of class I pilots checked their logs before the medical, and pilots aged less than 30 or 60 and above were more likely to do so as well as those with less than 4000 hours.

Sources of Errors

The study has shown that errors in the flight hours reported by pilots can occur because of various factors: 1. Pilots use various means by which to measure flight time (e.g., Hobbs, timer, company schedule); 2. Pilots use various criteria (e.g., take-off to landing, engine(s)-on to shut-down, block-block); 3. Some pilots fail to record the index of flight time before leaving the cockpit, which necessitates later reliance on memory; and 4. Some pilots do not refer to their logs before completing the medical history form, basing their response on memory.

The errors introduced by the method of measurement used is probably small in affecting the time of a flight, but may have a bearing on the pilots' ability to recall the value if it is not immediately recorded. A direct reading of the time of a flight, by clock or timer, should be easier to memorize correctly than a Hobbs or tachometer reading, which only show the cumulative time --not the time of a flight.

The criteria of the duration of a flight will converge if the flights are relatively long. But, in short flights, say of an hour, there can be substantial differences between the time from engine(s)-on to-off and the time from take-off to landing.

The hours recorded by pilots in their logs can be expected to be least affected by memory for class I and III pilots because more of them made a temporary or permanent record before leaving the cockpit. However, 45% of class I pilots used a watch or timer as did 33% of class II and only 17% of class III pilots to measure flight time (Table 1). If it is true that pilots can recall the duration of a flight better from a watch or timer, which reads the actual flight time in hours and minutes, than the cumulative time on a Hobbs or tachometer, the accuracy of recordings made after leaving the cockpit, taking account of inaccuracies due to memory, should be better for class I and II pilots than class III.

Considering also that another 26% of class I pilots (Table 1) used company or block time, suggests that the hours recorded by or for class I pilots may be among the most accurate, followed by those for class III pilots because of their greatest tendency to record flight time before leaving the cockpit.

Finally, the accuracy of the hours reported on the medical history form should be a function of whether the pilots referred to their logs beforehand. We have already seen that class III pilots check their logs (71%) much more than class II (57%) and class I (41%). For the latter groups in particular, the ability to recall flight time will be a factor. That ability will be affected by how often pilots update their logs and their consistency in the hours they fly.

The medical history form requests information of total time and also time in the prior six months. Pilots who frequently update their logs can be expected to estimate their total hours quite accurately. However, their ability to estimate the hours flown in a prior period of six months may be much worse. That is because logbooks show the cumulative hours and a special effort has to be made to add the hours over any six month or other period.

Therefore, pilots who do not refer to their logs prior to the medical may be expected to estimate their hours in the prior six months with greater relative error than those who do and with greater relative error than their total time.

However, professional pilots fly a relatively fixed number of hours per month. Even if they do not refer to their logs before the medical, they should be able to estimate their hours quite well. Therefore, even though they refer to their logs least often, class I pilots as a group, may report the most veridical hours. Class II pilots include some professional pilots who also fly on a regular basis and they referred to their logs more than class I pilots but less than class III pilots. Table 3 shows that they made a

record before leaving the cockpit least often so that their records are most subject to errors of memory. It is hypothesized that their reports on the medical form may be the least veridical.

Class III pilots recorded flight time before leaving the cockpit or later on the day of the flight and referred to their logs before the medical most often, which will enhance the accuracy of their reports. The 40% of them who did not record flight time before leaving the cockpit did have to remember the reading on the Hobbs or tachometer, which may lead to errors.

Recommendations

The study has shown that the procedures used by pilots on which they base their reports of flight hours are quite variable and subject to intrinsic errors. At least three of the major sources of error could be removed if pilots could be induced to (1) record flight time before leaving the cockpit and (2) check their logs or company records before the medical and (3) use the same criterion of flight time.

While flight time is a basic measure of exposure of pilots, we recommend that more extensive studies be done, not only to verify our findings, but to extend our knowledge of the types of conditions to which pilots are exposed. The risks associated with a broader range of factors affecting flight safety could then be ascertained.

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Table 1. *How Flight Time was Measured by Medical Class, in Percent*

How Measured	Class I	Class II	Class III
Hobbs Meter	27	39	59
Tachometer	2	26	23
Watch/Timer	46	33	17
Company Schedule	26	2	2

Table 2. *The Criteria used as Flight Time by Medical Class, in Percent*

Criterion	Class I	Class II	Class III	%
Engine(s) on to shut down	30	65	80	53
Take-off to landing	19	30	17	22
Company schedule/ Block in/out	51	5	3	25

Table 3. *Temporary or Permanent Recording of Flight Time by Medical Class, in Percent*

Time	Class I	Class II	Class III	%
Before leaving cockpit	58	47	60	55
Later on the day of the flight	18	32	29	25
Other	18	17	10	15
Do not record flight time	6	4	2	4