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ABSTRACT

The document addresses the question of the degree to which United States Air Force (USAF) pilot skills deteriorate as a function of reduced or deleted aircraft flying time. An examination of the results of several studies concerning the effects of periods of inactivity on pilot skill retention and subsequent retraining requirements indicate that a more efficient and cost-effective method for maintaining a pool of near combat-ready pilots may be possible. Adoption of an annual massed retraining program (as opposed to the present method of conducting continuation training over a full year) could achieve a reduction of more than 50% in required aircraft flying hours. Data from these studies suggest that if USAF pilot requirements permit, recurrent training could be delayed for an indefinite number of years with no significant increase in the average number of aircraft hours required per pilot when such recurrent training is conducted. The data also suggest that the use of high fidelity instrument and procedures simulators, during non-aircraft flying periods, would foster overlearning of system operation and voice procedures and the maintenance of limited motor skills. Integration of training in these devices into the aircraft recurrent training course would enhance the effectiveness of the total program. (Author/EC)

AFHRL-TR-76-4



# AIR FORCE HUMAN RESOURCES LABORATORY

## CONTINUATION VERSUS RECURRENT PILOT TRAINING

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May 1976
Final Report for Period November 1974 – October 1975





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This final report was submitted by Flying Training Division, Air Force Human Resources Laboratory, Williams Air Force Base, Arizona 85224, under project 1123, with HQ Air Force Human Resources Laboratory (AFSC), Brooks Air Force Base, Texas 78235.

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This technical report has been reviewed and is approved.

WILLIAM V. HAGIN, Technical Director
Flying Training Division

Approved for publication

DAN D. FULGHAM, Colonel, USAF
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This report provides a brief survey of literature on retention of motor, procedural and communication skills judged relevant to pilot training. Also included are data concerning more recent pilot recurrent training information available from the United States Air Force, the United States Army and the Federal Aviation Agency. Implications of these data for USAF continuation pilot training are discussed and an approach to obtaining more specific information is recommended.

## PREFACE

This report was prepared in support of Project 1123, Flying Training Development, Task 112303, Exploitation of Flight Simulation in Undergraduate Pilot Training. Dr. William V. Hagin was the project scientist, and Mr. James F. Smith was the task scientist.

This report was prepared by the Flying Training Division of the Air Force Human Resources Laboratory (AFSC) in coordination with Life Sciences, Inc., Hurst, Texas. The subject was addressed because of expressed general interest from several sources and because of continuing concern over the impact of reduced monies on maintaining a USAF combat ready force structure.

Special appreciation is expressed to Captain Ron Helsel, ATC, 12 FTW, 560 FTS/DOF, Randolph AFB, Texas, who provided the POW data and to Dr. Paul Caro, HumRRO, for his communication concerning combat readiness proficiency training in device 2B24.

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# CONTINUATION VERSUS RECURRENT PILOT TRAINING

## I. INTRODUCTION

Continuation training (i.e., proficiency flying for the rated supplement) for rated personnel, as a means of maintaining a viable reserve for the combat force structure while maximizing flight safety, has always been a concern of the United States Air Force. The degree of concern is exemplified by provisions contained in Air Force Regulation 60-1, and in supplements thereto, generated by MAJCOMS responsible for maintaining mission capable and combat ready active and reserve forces. These regulations specify monthly, quarterly, semiannual and annual training requirements which, when analyzed in terms of total flight hours required, provide a sound basis for estimating annual budget requirements.

However, recent public and government officials' concern over peacetime matters such as budget reductions, fuel shortages, ecology and inflation has resulted in close scrutiny of military requirements for several billion dollars to maintain a force structure whose most visible role is combat and military support flying. Monies for hardware maintenance, new weapon system procurements and technology developments are relatively easily defended. On the other hand, justification for training dollars is more subjective, more difficult to defend and more vulnerable to suggestions aimed at reduction or deletion. Most certainly, the DOD budget situation will always be tight; therefore, it seems timely to examine USAF aircraft continuation flight training programs with the intent of increasing efficiency and/or reducing costs.

It is realized there are many significant aspects to maintaining a combat capable force structure besides pilot continuation training. This report addresses only one aspect of the total problem, i.e., maintenance of pilot proficiency for pilots filling other than mission-essential cockpit spaces.

Under current regulations, "behind-the-line" pilots who fly receive approximately 100 aircraft hours per year to maintain proficiency (subject to changes as reflected in the AFM 60 series and the AFM 51 series; e.g., 72 sorties per year). How this figure was selected, and why it is better than some amount of training massed on a quarterly, semiannual or annual basis is unknown. Furthermore, since there are individual differences in pilot skill retention at all skill levels, and because the amount of practice to remain proficient undoubtedly differs from aircraft to aircraft, the designation of the same specified number of hours or training events for each pilot appears suspect as being the most logical and economical method. For example, if 72 sorties are required to maintain proficiency in a training aircraft (instruments and transition), this must surely be inadequate to maintain proficiency in higher performance aircraft whose roles include instruments, transition *and* weapons delivery. Thus, it seems reasonable that a requirement exists to compile valid skill retention data on which to base continuation flying requirements if support of the training budget to Congress is to be successful or to justify adoption of some alternative program which is more compatible with USAF mission requirements and budget limitations.

## II. RELEVANT DATA

The general question addressed is the degree to which pilot skills deteriorate as a function of reduced or deleted aircraft flying time. While there is not a great deal of hard experimental evidence bearing directly upon this question, findings of those experiments which are relevant combined with the findings of general training literature having to do with retention of skills (and tempered by the experienced and anecdotal evidence available to those who have been working in the field) provide some basis for certain conclusions.

Two major points supported by the literature and other evidence are cited; the first is that overlearning of a task promotes its retention and the second is that motor skills will be retained longer than procedural or verbal materials. Four references provide information bearing upon the first point (Mengelkoch, Adams & Gainer, 1960; Naylor, Briggs & Reed, 1962; Bjorkman, 1959; Krueger, 1929). In each of these studies, the conclusion is supported that the greater the amount of training, the greater the degree of retention of the skill.

Three studies are cited that provide findings relevant to the second point, i.e., that motor skills are retained longer than are verbal or procedural skills (Mengelkoch et al., 1960; Leavitt & Schlosberg, 1944; Ammons, R. B., Farr, Block, Neumann, Dey, Marion & Ammons, C. H., 1958). No differences in the relative amount retained has been found between procedural and verbal tasks (Van Dusen & Schlosberg, 1948). In a more recent study conducted for NASA, it is reported that while both procedural and control skills deteriorated to an unacceptable level after four months of inactivity, procedural skills degraded over a much shorter period of time (Sitterley & Berge, 1972).

An interesting finding by Goldstein and King (1961) has a bearing on the course which might be followed in auxiliary training of pilots standing down from training in the aircraft. Goldstein and King studied the effect of time away from the task on retention under three different conditions. The first condition was regular retention in which the subject took up the same task upon which he had been trained. Amount of retention was measured after six different no-practice intervals of 10 minutes, two hours, one day, one week, one month and four months. Two transfer-retention groups were studied. One group was trained such that negative transfer occurred. In verbal tasks, the results showed that changing either the stimulus or the response tasks aspects of such a discrete task produced low transfer effects and that these effects persisted over time. This implies that for training this type of task, the characteristics of the training task should correspond very closely to that of the actual operational task regardless of the length of time intervening between training and actual task assignment. The interesting result comes in the motor task in which retention after periods of time for the positive transfer retention group was the same as that for the regular retention group and both were different from the negative transfer retention group. Negative transfer was brought about by changing the response characteristics of the task and leaving the stimulus characteristics the same. These differences among the groups were affected by the length of the no-practice interval with larger differences between the negative transfer retention group and the other two groups occurring after a one week interval. At the one month interval, this difference was not so marked. However, there was a marked difference in retention between the one month and the four month intervals with the greater loss occurring at four months. The authors conclude that the implication for training of continuous tracking skills is that the characteristic of the *stimulus* inputs during training can be different from those occurring in the operational system. However, the characteristics of the *response* components in the training situation should be made compatible with those response elements actually required in the operational task. Even here, changes can be made if the interval intervening between the original training and operational task assignment exceeds one week. That is to say, that the negative transfer effects of having changed the response elements between the training and transfer tasks tends to fade after one week.

In a recent study conducted by MIT (Hollister, LaPointe, Orman & Tole, 1973), researchers flew a series of flights in a late model Cessna 150 with 60 non-instrument rated private and commercial pilots. The objective was to determine the effects of layoff on flight skills. Findings indicated: (a) flight skills deteriorate rapidly for those who fly only occasionally, (b) flying regularly is far more important in maintaining proficiency than the amount of experience a man has, and (c) skills came back quickly after an extended layoff period.

A HumRRO study (Wright, 1973) reports relevant data obtained by means of administering questionnaires to numerous U.S. Army aviators. The findings suggest: (a) VFR flying skills generally remain acceptable for more than one year; (b) IFR flying skills become less than acceptable after one year even if minimums are flown; (c) after 12 months of flight excusal, refresher training requirements stabilize; (d) the use of light aircraft for skill retention is probably ineffective due to different procedure and skill requirements; and (e) instrument training simulators of proper configuration may be useful in maintaining proficiency. While findings in this study are based on subjective opinion rather than empirical evidence, finding (e), the value of instrument trainers, is supported by other NASA-sponsored studies (Sitterley, Zaitzeff & Berge, 1972; Sitterley, 1974) in which the application of both static and dynamic skill rehearsal devices were found to be effective in maintaining flight skills and in refresher training.

In a subsequent HumRRO study (Caro, 1975) the performance of three groups of subjects (10 each) was examined with respect to regaining instrument and contact proficiency in a UH-1 helicopter. Group I was composed of unit aviators whose duties usually required flying more than 80 hours per year. Group II was composed of aviators authorized to fly a maximum of 80 hours per year and who had less than 1,500 hours total flight time. Group III was composed of aviators who were prohibited from piloting

aircraft and had been in that category for at least one year. All subjects were trained to instrument proficiency in the 2B24 simulator (a high fidelity device), and then trained in UH-1 helicopters on instruments and contact flight until they could pass proficiency check rides. Standard instrument and contact check rides were developed and used as performance criteria for all pilots. Table 1 presents the results reported in this study.

*Table 1.* **Mean Pilot Training Hours**

| Group | 2B24 Simul | UH-1 Helo Instruments | UH-1 Helo Contact | Total |
|---|---|---|---|---|
| I | 6.2 (61%) | 2.2 | 1.7 | 10.1 |
| II | 11.4 (71%) | 2.6 | 2.1 | 16.1 |
| III | 11.7 (69%) | 2.6 | 2.6 | 16.9 |

These data indicate that some 10 training hours are required to sharpen the performance levels of aviators who fill active flying roles (Group I) and that 60 percent of that training can be achieved in a high fidelity simulator. Aviators who fly less frequently (Group II) or not at all (Group III) require approximately 65 percent more time to reach combat ready proficiency of which most can be completed in the simulator. These data support findings reported in other studies which suggest that procedural skills and knowledge deteriorate with time more than do aircraft control skills and techniques.

In addition to literature reported above, aircraft hours required to provide recurrent training for returned South East Asia (SEA) prisoners of war (POW) provide added insight into flying skill retention. All readers must agree that USAF pilots who flew combat missions in Vietnam were current and combat ready at the time they were shot down and that conditions under which they existed as POWs were as far removed from flying as possible. Upon return, each POW pilot was offered complete contact and instrument recurrent training in T-38 aircraft. These returnee pilots differed significantly with respect to pilot experience and length of inactivity; total hours ranged from 300 to over 7,000 and POW time ranged from 13 to 102 months as of January 1974. Also, their SEA flying represented a variety of different types of aircraft and many had never flown T-38 aircraft.

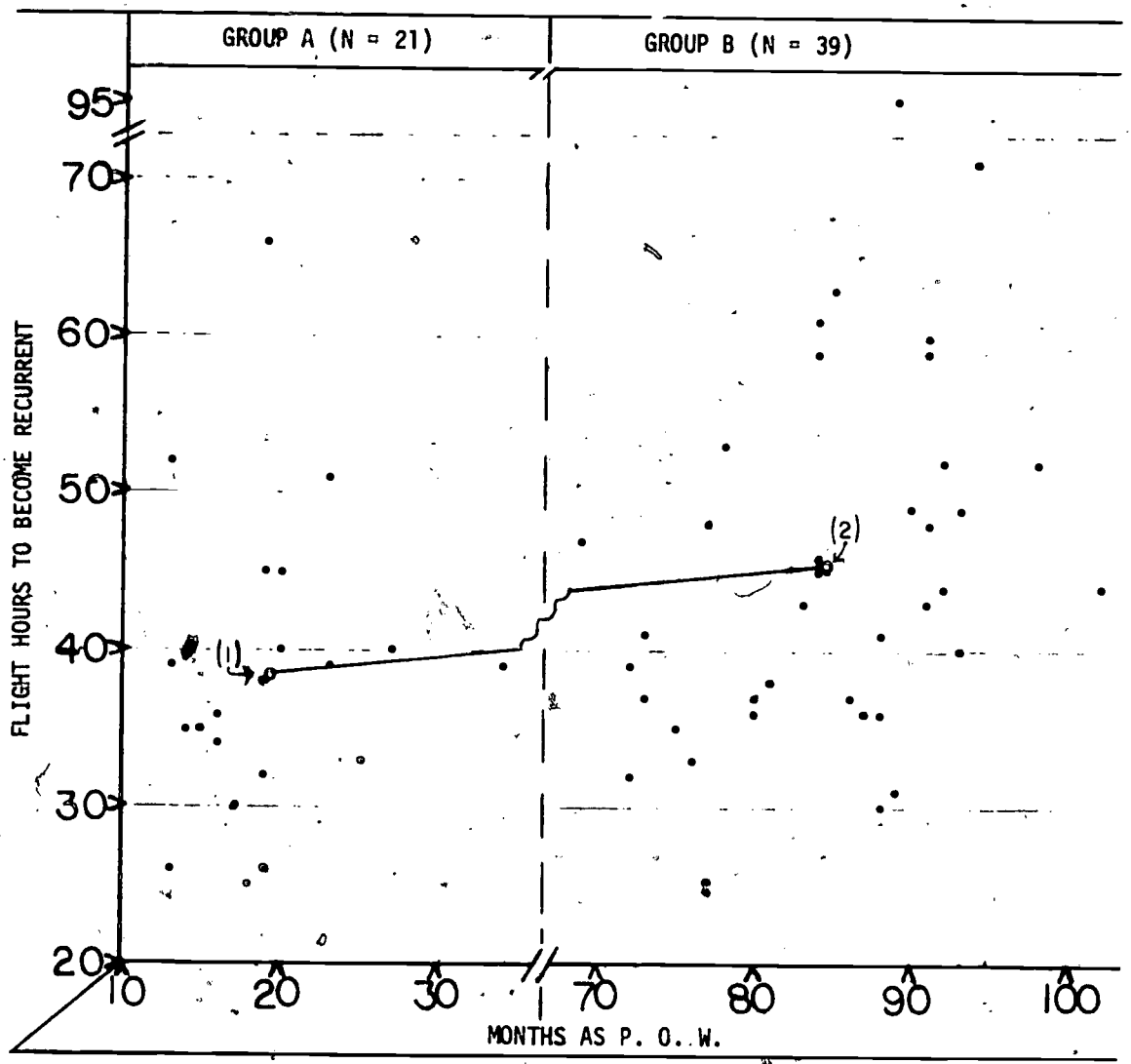
The T-38 recurrent training course was tailored to individual needs; no minimum or maximum hours were established. Special requests such as extra time for a senior pilot rating were honored. However, a basic syllabus was used as a departure point and the experienced USAF/ATC instructor pilots involved spared no effort to insure that when the course was completed, each pilot was highly proficient in T-38 transition and instrument flying.

Each returnee was also scheduled for approximately fifteen hours of instrument training and eight hours of procedures training in a T-26 Instrument and Procedures Trainer. Reportedly the actual trainer hours used varied widely as a result of trainee desires but no specific data were obtained.

Individual performance records are sensitive; therefore, only summary data from 60 upgrade records are discussed. (Some 30 other records were not included because notes on the data obtained from the 560 FTS/DOF indicated they did not complete or they flew extra time for personal reasons such as to qualify for senior pilot wings.)

These data were analyzed to answer two questions: (a) What effect does the length of inactive time have on regaining flying skills? (b) Does total time have a marked influence on the rate at which flying skills are regained?

The data are presented in two figures. The first (Figure 1) provides a distribution of individual retraining times versus months of inactivity. Due to events in the SEA conflict, there were two distinct categories of POWs. Group A (N=21) averaged 19 months of inactivity with a range of 13 to 34 inactive months (as of 1 January 1974) and required an average of 38.4 aircraft hours to become recurrent. Group B (N=39) averaged 84 months of inactivity with a range of 69 to 102 months and required an average of 45.4 aircraft hours to become recurrent. The average retraining time for all returnees was 42.2 hours. Assuming

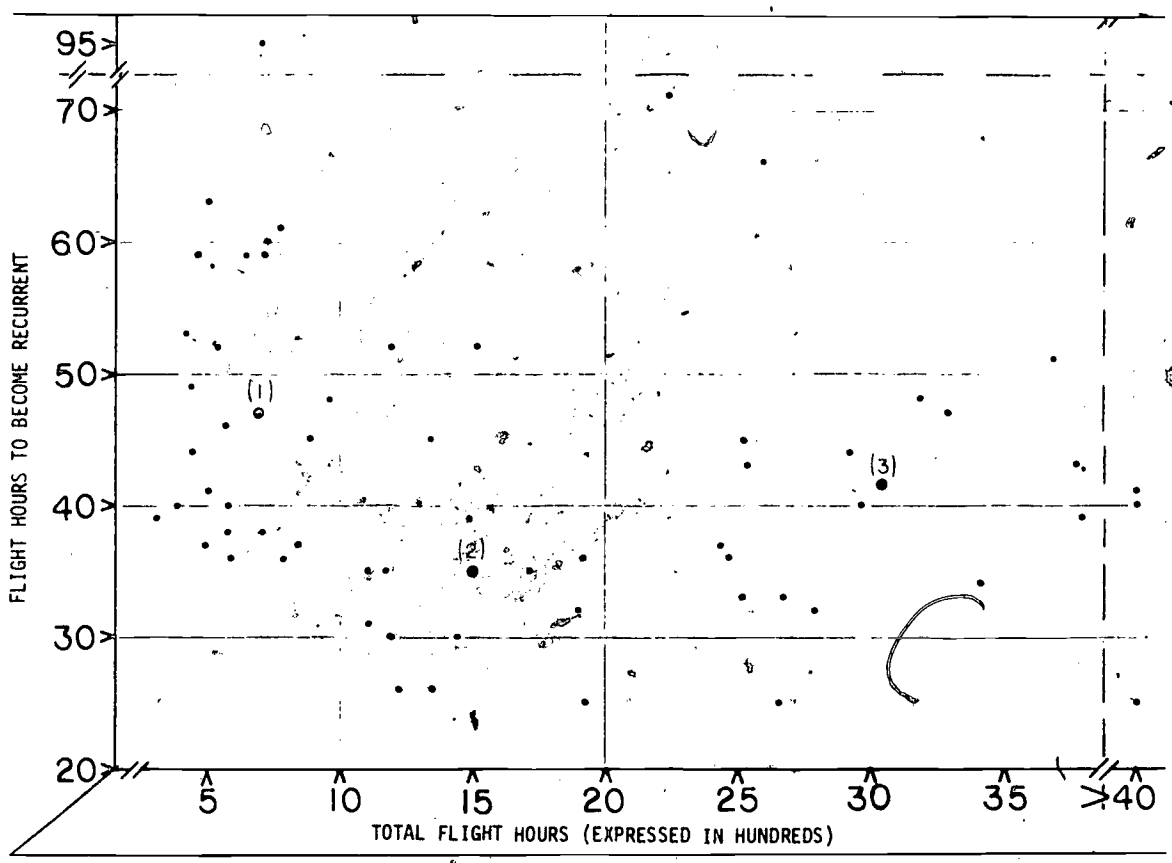



NOTE.—(1) represents average months as POW, Group A (M = 19.1 months; range = 13-34) versus average T-38 hours to become current (M = 38.4 hours; range = 25-66). (2) represents similar data for longer term POWs, Group B (M = 84.4 months; range = 69-102 months; M = 45.4 hours, range = 25-95 hours).

*Figure 1.* Scattergram of flying hours required to become recurrent in T-38 aircraft versus months as POW for sample of USAF Vietnam POW returnees.

these data as representative, a straight line was plotted through the means of both groups and extended to 12 months. This suggests that transition and instrument retraining requirements for pilots who have not flown for 12 months, and who are being upgraded in an aircraft other than the type they had flown last, would average, at the most, around 38 aircraft hours.

Figure 2 presents a distribution of these same data in terms of total hours versus retraining time. As may be seen, total hours ranged from 300 to 7,250. Means were computed for three groups selected as follows: a low-time group, 300 to 1,000 hours; a mid-time group, 1,001 to 2,000 hours; and a high-time group, 2,001 hours and above. An analysis of variance of the mean retraining time for each of the three groups showed significant differences ($F(2.57)=6.16$, $p<.001$). This result is accounted for by the difference ($p \leq .05$) between the low-time group ($X = 48.5$ hours) and the mid-time group ($X = 35.3$ hours) and the difference ($p \leq .05$) between training times for the low-time and high-time group ($X = 41.6$ hours). Mean training times for the mid-time and high-time groups were not significantly different. These data suggest that if an annual recurrent training system were adopted, a new pilot should be kept in a flying job until he has accumulated at least 1,000 aircraft hours (or equivalent simulator experience). Beyond that experience level, the average recurrent training time for pilots in the rated supplement category should remain relatively stable.




NOTE:—Circles noted by (1), (2) and (3) represent means for three levels of flight experience (i.e., 300 to 1000 hours, 1001 to 2000 hours, and more than 2001 hours respectively.

*Figure 2.* Scattergram of flying hours to become recurrent in T-38 aircraft versus total flight time for sample of USAF Vietnam POW returnees.

## III. DISCUSSION

Findings of the studies discussed suggest that a major issue, which should be addressed, is whether or not aircrew continuation training (also known as rated supplement flying, AFR 60-1 proficiency flying, etc.) pays off. If the decision is to continue, existing data supplemented by results of new studies can be applied to re-define a more cost-effective flight skill retention program which would meet USAF requirements within anticipated budget constraints. If the decision is to reduce or delete aircraft flying from the aircrew continuation training program, efforts should be directed toward determining what, if any, simulator continuation training should be used and toward development of "hip pocket" upgrade programs for emergency use.

It is beyond the scope of this report to discuss all issues relevant to deciding whether or not continuation training for aircrews should be retained. Many of the issues relate to USAF wartime and contingency mission requirements as well as trainee motivation and retention. This report addresses only data relevant to pilot skill retention and retraining issues. The more significant findings may be summarized as follows:

(a) Motor skills associated with VFR flight are retained longer and regained much more quickly than instrument or procedural and verbal skills.

(b) Inactivity for one year results in near maximum loss of skills (one estimate is 90 percent), and subsequent periods of inactivity add little to average upgrade time requirements.

(c) If instrument flight skills are maintained at a high level, contact flight skills tend to remain at an acceptable level.

(d) Overlearning promotes improved retention of all categories of skills.

(e) Simulators are effective in either learning or relearning procedural and verbal tasks and instrument flying skills, and their use should significantly reduce the hours noted in paragraph (f), following.

(f) Retraining of contact and instrument aircraft flight skills after extended periods of inactivity (13 to 102 months) can be completed in an average of 45 aircraft hours or less per student.

(g) Pilots of low experience levels (less than 1,000 hours) will require more hours to become recurrent but the overall average should remain below 50 hours per pilot.

Assuming the findings summarized above to be valid, some inferences with respect to aircrew contact and instrument skill continuation training may be made. It seems clear that a program which provides periodic recurrent training has the potential for significant cost avoidance when compared with one requiring a fixed number of hours and/or sorties per year for each pilot. Furthermore, while massed annual recurrent training would result in a significant reduction in aircraft hours required, there is evidence that such recurrent training could be deleted for this category of pilots until such time as dictated by USAF requirements with little increase in the number of aircraft hours required to conduct the recurrent training program.[1] If such a program were adopted, the data also indicates that incorporation of continuous instrument and procedures training in good fidelity simulators for the type aircraft to be used in eventual recurrent training would result in a further reduction of aircraft hours required for both contact and instrument proficiency. The net effect would be to reduce the length of time required to complete aircraft recurrent training. (There does not appear to be substantial support for the use of large costly contact visual systems on the simulators.) Whether or not a flight simulator which is procured only to support recurrent training would be cost-effective in this role would have to be determined using factors such as cost of simulator continuation training versus aircraft hours and training days saved in recurrent training.

The preceding paragraph explores what should result if continuation training were deleted. As noted earlier, the other alternative is to retain and revise continuation training to reflect the findings of the studies

[1] Using massed recurrent training after one year of non-flying would equate to avoidance of the cost of flying some type of aircraft at least 50 hours per pilot. Extension of recurrent training to every two years would equate to a savings of 150 hours per pilot, three years, 250 hours, etc.

reported earlier which indicate simulators can be used effectively in such a program. Again, the use of flight simulators for instrument and procedures training as a part of any continuation training program is supported. Furthermore, it is also suggested that properly controlled use of such devices in the existing programs could result in more efficient learning and some reduction in aircraft hours required to maintain proficiency. In most programs, such changes would require revised or restructured continuation training requirements which incorporate; updating existing simulators to better quality devices, developing specific performance requirements for each training objective, using proficiency advancement criteria, and incorporating overlearning to improve retention.

As noted earlier, the comments provided above are based on the assumption that findings of studies reported are valid. Since none of the studies specifically addressed (or were conducted in) the USAF continuation training program, such an assumption may not be acceptable and direct application of the results (which would require USAF and command policy changes) could not be achieved. However, all of the relevant data and particularly the data obtained in the POW returnee retraining program which was USAF-conducted suggests that the policy of continuation training should be re-examined.

## IV. CONCLUSIONS AND RECOMMENDATIONS

Examination of the results of several studies concerning the effects of periods of inactivity on pilot skill retention and subsequent retraining requirements indicate that a more efficient and cost-effective method for maintaining a pool of near combat ready USAF pilots may be possible. Data obtained from school records collected while retraining SEA POW returnee pilots suggest that adoption of an annual massed retraining program (as opposed to the present method of conducting continuation training over a full year) could achieve a reduction in required aircraft flying hours of more than 50 percent. These data also suggest that if USAF pilot requirements permit, recurrent training could be delayed for an indefinite number of years with no significant increase in the average number of aircraft hours required per pilot when such recurrent training is conducted.

Available data also suggest that the use of high fidelity instrument and procedures simulators, during non-aircraft flying periods, would foster overlearning of system operation and voice procedures, the maintenance of limited motor skills, and that integration of training in these devices into the aircraft recurrent training course would further enhance the effectiveness of the total program.

Recent USAF policy changes which permit non-career pilots to be relieved of aircraft duties for extended periods while awaiting separation provide an ideal opportunity for the collection of relatively low cost empirical data on which to base future USAF pilot continuation and/or retraining program recommendations.

In consideration of data discussed in this report, it is recommended that the existing continuation training program for USAF pilots in the rated supplement category be re-examined; first, to determine whether or not a recurrent training program would be operational, feasible and more cost-effective, and second, to determine to what extent existing ground training devices can be used more effectively in either program.

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