

## REPORT DOCUMENTATION PAGE

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                        |                                                                                             |                                                       |                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------------------------------------|---------------------------------------------------------------------------------------------|-------------------------------------------------------|---------------------------|
| 1a. REPORT SECURITY CLASSIFICATION<br>Unclassified                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |                                        | 1b. RESTRICTIVE MARKINGS                                                                    |                                                       |                           |
| 2a. SECURITY CLASSIFICATION AUTHORITY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |       |                                        | 3. DISTRIBUTION STATEMENT A<br>Approved for public release<br>Distribution Unlimited        |                                                       |                           |
| 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |                                        | 4. PERFORMING ORGANIZATION REPORT NUMBER(S)                                                 |                                                       |                           |
| 5. MONITORING ORGANIZATION REPORT NUMBER(S)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                                        |                                                                                             |                                                       |                           |
| 6a. NAME OF PERFORMING ORGANIZATION<br>U.S. Naval Safety Center                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       | 6b. OFFICE SYMBOL<br>(If applicable)   |                                                                                             | 7a. NAME OF MONITORING ORGANIZATION                   |                           |
| 6c. ADDRESS (City, State, and ZIP Code)<br>Naval Air Station<br>Norfolk, Virginia 23511                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       |                                        |                                                                                             | 7b. ADDRESS (City, State, and ZIP Code)               |                           |
| 8a. NAME OF FUNDING/SPONSORING ORGANIZATION<br>Chief of Naval Operations (OP-04)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       | 8b. OFFICE SYMBOL<br>(If applicable)   |                                                                                             | 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER       |                           |
| 8c. ADDRESS (City, State, and ZIP Code)<br>Navy Department<br>Washington, D.C. 20350-2000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       | 10. SOURCE OF FUNDING NUMBERS          |                                                                                             |                                                       |                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       | PROGRAM ELEMENT NO.                    |                                                                                             | PROJECT NO.                                           |                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       | TASK NO.                               |                                                                                             | WORK UNIT ACCESSION NO.                               |                           |
| 11. TITLE (Include Security Classification)<br>READINESS AND RETENTION: PILOT FLIGHT EXPERIENCE AND AIRCRAFT MISHAPS (UNCLASSIFIED)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |                                        |                                                                                             |                                                       |                           |
| 12. PERSONAL AUTHOR(S)<br>Borowsky, Michael S.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |                                        |                                                                                             |                                                       |                           |
| 13a. TYPE OF REPORT<br>Final                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       | 13b. TIME COVERED<br>FROM 1977 TO 1985 |                                                                                             | 14. DATE OF REPORT (Year, Month, Day)<br>1986/June/24 |                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                        |                                                                                             | 15. PAGE COUNT<br>15                                  |                           |
| 16. SUPPLEMENTARY NOTATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       |                                        |                                                                                             |                                                       |                           |
| 17. COSATI CODES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |                                        | 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)           |                                                       |                           |
| FIELD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | GROUP | SUB-GROUP                              |                                                                                             |                                                       |                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                        | Safety, Accident, Mishap, Aircraft, Aviation,<br>Flight Experience, Readiness and Retention |                                                       |                           |
| 19. ABSTRACT (Continue on reverse if necessary and identify by block number)<br><br>Budget constraints which yield reductions in flight hours per pilot imply an eventual shifting of the distribution of flight hours.<br><br>Analyses show that the rate of pilot error mishaps tends to decrease as pilots' flight experience increase. These data suggest, therefore, that as the experience levels of naval aviators decline, the mishap rate will increase. The experience levels of Training Command/Fleet Readiness Squadron instructor pilots would also tend to decrease, thereby contributing both directly and indirectly to an increased mishap rate. The total effect will, of course, also depend upon aggregate flight hour reductions as well as pilot retention rates. |       |                                        |                                                                                             |                                                       |                           |
| 20. DISTRIBUTION/AVAILABILITY OF ABSTRACT<br><input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |                                        | 21. ABSTRACT SECURITY CLASSIFICATION<br>Unclassified                                        |                                                       |                           |
| 22a. NAME OF RESPONSIBLE INDIVIDUAL<br>Mr. David Soulsby                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |                                        | 22b. TELEPHONE (Include Area Code)<br>(804) 444-4240                                        |                                                       | 22c. OFFICE SYMBOL<br>053 |

**Block 9. Procurement Instrument Identification Number:** For a contractor grantee report, enter the complete contract or grant number(s) under which the work was accomplished. Leave this block blank for in-house reports.

**Block 10. Source of Funding (Program Element, Project, Task Area, and Work Unit Number(s):** These four data elements relate to the DoD budget structure and provide program and/or administrative identification of the source of support for the work being carried on. Enter the program element, project, task area, work unit accession number, or their equivalents which identify the principal source of funding for the work required. These codes may be obtained from the applicable DoD forms such as the DD Form 1498 (Research and Technology Work Unit Summary) or from the fund citation of the funding instrument. If this information is not available to the authoring activity, these blocks should be filled in by the responsible DoD Official designated in Block 22. If the report is funded from multiple sources, identify only the Program Element and the Project, Task Area, and Work Unit Numbers of the principal contributor.

**Block 11. Title:** Enter the title in Block 11 in initial capital letters exactly as it appears on the report. Titles on all classified reports, whether classified or unclassified, must be immediately followed by the security classification of the title enclosed in parentheses. A report with a classified title should be provided with an unclassified version if it is possible to do so without changing the meaning or obscuring the contents of the report. Use specific, meaningful words that describe the content of the report so that when the title is machine-indexed, the words will contribute useful retrieval terms.

If the report is in a foreign language and the title is given in both English and a foreign language, list the foreign language title first, followed by the English title enclosed in parentheses. If part of the text is in English, list the English title first followed by the foreign language title enclosed in parentheses. If the title is given in more than one foreign language, use a title that reflects the language of the text. If both the text and titles are in a foreign language, the title should be translated, if possible, unless the title is also the name of a foreign periodical. Transliterations of often used foreign alphabets (see Appendix A of MIL-STD-847B) are available from DTIC in document AD-A080 800.

**Block 12. Personal Author(s):** Give the complete name(s) of the author(s) in this order: last name, first name, and middle name. In addition, list the affiliation of the authors if it differs from that of the performing organization.

List all authors. If the document is a compilation of papers, it may be more useful to list the authors with the titles of their papers as a contents note in the abstract in Block 19. If appropriate, the names of editors and compilers may be entered in this block.

**Block 13a. Type of Report:** Indicate whether the report is summary, final, annual, progress, interim, etc.

**Block 13b. Time Covered:** Enter the inclusive dates (year, month, day) of the period covered, such as the life of a contract in a final contractor report.

**Block 14. Date of Report:** Enter the year, month, and day, or the year and the month the report was issued as shown on the cover.

**Block 15. Page Count:** Enter the total number of pages in the report that contain information, including cover, preface, table of contents, distribution lists, partial pages, etc. A chart in the body of the report is counted even if it is unnumbered.

**Block 16. Supplementary Notation:** Enter useful information about the report in hand, such as: "Prepared in cooperation with...", "Translation at (or by)..." "Symposium..." If there are report numbers for the report which are not noted elsewhere on the form (such as internal series numbers or participating organization report numbers) enter in this block.

**Block 17. COSATI Codes:** This block provides the subject coverage of the report for announcement and distribution purposes. The categories are to be taken from the "COSATI Subject Category List" (DoD Modified), Oct 65, AD-624 000. A copy is available on request to any organization generating reports for DoD. At least one entry is required as follows:

**Field** - to indicate subject coverage of report.

**Group** - to indicate greater subject specificity of information in the report.

**Sub-Group** - if specificity greater than that shown by Group is required, use further designation as the numbers after the period (.) in the Group breakdown. Use only the designation provided by AD-624 000.

**Example:** The subject "Solid Rocket Motors" is Field 21, Group 08, Subgroup 2 (page 32, AD-624 000).

**Block 18. Subject Terms:** These may be descriptors, keywords, posting terms, identifiers, open-ended terms, subject headings, acronyms, code words, or any words or phrases that identify the principal subjects covered in the report, and that conform to standard terminology and are exact enough to be used as subject index entries. Certain acronyms or "buzz words" may be used if they are recognized by specialists in the field and have a potential for becoming accepted terms. "Laser" and "Reverse Osmosis" were once such terms.

If possible, this set of terms should be selected so that the terms individually and as a group will remain UNCLASSIFIED without losing meaning. However, priority must be given to specifying proper subject terms rather than making the set of terms appear "UNCLASSIFIED." Each term on classified reports must be immediately followed by its security classification, enclosed in parentheses.

For reference on standard terminology the "DTIC Retrieval and Indexing Terminology" DRIT-1979, AD-A068 500, and the DoD "Thesaurus of Engineering and Scientific Terms (TEST) 1968, AD-672 000, may be useful.

**Block 19. Abstract:** The abstract should be a pithy, brief (preferably not to exceed 300 words), factual summary of the most significant information contained in the report. However, since the abstract may be machine-searched, all specific and meaningful words and phrases which express the subject content of the report should be included, even if the word limit is exceeded.

If possible, the abstract of a classified report should be unclassified and consist of publicly releasable information (Unlimited), but in no instance should the report content description be sacrificed for the security classification.

**NOTE:** An unclassified abstract describing a classified document may appear separately from the document in an unclassified context e.g., in DTIC announcement or bibliographic products. This must be considered in the preparation and marking of unclassified abstracts.

For further information on preparing abstracts, employing scientific symbols, verbalizing, etc., see paragraphs 2.1(n) and 2.3(b) in MIL-STD-847B.

**Block 20. Distribution / Availability of Abstract:** This block must be completed for all reports. Check the applicable statement: "unclassified / unlimited," "same as report," or, if the report is available to DTIC registered users "DTIC users."

**Block 21. Abstract Security Classification:** To ensure proper safeguarding of information, this block must be completed for all reports to designate the classification level of the entire abstract. For CLASSIFIED abstracts, each paragraph must be preceded by its security classification code in parentheses.

**Block 22a,b,c. Name, Telephone and Office Symbol of Responsible Individual:** Give name, telephone number, and office symbol of DoD person responsible for the accuracy of the completion of this form.

# INSTRUCTIONS FOR PREPARATION OF REPORT DOCUMENTATION PAGE

## GENERAL INFORMATION

The accuracy and completeness of all information provided in the DD Form 1473, especially classification and distribution limitation markings, are the responsibility of the authoring or monitoring DoD activity.

Because the data input on this form will be what others will retrieve from DTIC's bibliographic data base or may determine how the document can be accessed by future users, care should be taken to have the form completed by knowledgeable personnel. For better communication and to facilitate more complete and accurate input from the originators of the form to those processing the data, space has been provided in Block 22 for the name, telephone number, and office symbol of the DoD person responsible for the input cited on the form.

All information on the DD Form 1473 should be typed.

Only information appearing on or in the report, or applying specifically to the report in hand, should be reported. If there is any doubt, the block should be left blank.

Some of the information on the forms (e.g., title, abstract) will be machine indexed. The terminology used should describe the content of the report or identify it as precisely as possible for future identification and retrieval.

**NOTE:** Unclassified abstracts and titles describing classified documents may appear separately from the documents in an unclassified context, e.g., in DTIC announcement bulletins and bibliographies. This must be considered in the preparation and marking of unclassified abstracts and titles.

The Defense Technical Information Center (DTIC) is ready to offer assistance to anyone who needs and requests it. Call Data Base Input Division, Autovon 284-7044 or Commercial (202) 274-7044.

## SECURITY CLASSIFICATION OF THE FORM

In accordance with DoD 5200.1-R, Information Security Program Regulation, Chapter IV Section 2, paragraph 4-200, classification markings are to be stamped, printed, or written at the top and bottom of the form in capital letters that are larger than those used in the text of the document. See also DoD 5220.22-M, Industrial Security Manual for Safeguarding Classified Information, Section II, paragraph 11a(2). This form should be unclassified, if possible.

## SPECIFIC BLOCKS

**Block 1a** Report Security Classification: Designate the highest security classification of the report. (See DoD 5220.1-R, Chapters I, IV, VII, XI, Appendix A.)

**Block 1b** Restricted Marking: Enter the restricted marking or warning notice of the report (e.g., CNWDI, RD, NATO).

**Block 2a** Security Classification Authority: Enter the commonly used markings in accordance with DoD 5200.1-R, Chapter IV, Section 4, paragraph 4-400 and 4-402. Indicate classification authority.

**Block 2b** Declassification / Downgrading Schedule: Indicate specific date or event for declassification or the notation, "Originating Agency Determination Required" or "OADR." Also insert (when applicable) downgrade to \_\_\_\_\_ on \_\_\_\_\_ (e.g., Downgrade to Confidential on 6 July 1983). (See also DoD 5220.22-M, Industrial Security Manual for Safeguarding Classified Information, Appendix II.)

**NOTE:** Entry must be made in Blocks 2a and 2b except when the original report is unclassified and has never been upgraded.

**Block 3** Distribution/Availability Statement of Report: Insert the statement as it appears on the report. If a limited distribution statement is used, the reason must be one of those given by DoD Directive 5200.20, Distribution Statements on Technical Documents, as supplemented by the 18 OCT 1983 SECDEF Memo, "Control of Unclassified Technology with Military Application." The Distribution Statement should provide for the broadest distribution possible within limits of security and controlling office limitations.

**Block 4** Performing Organization Report Number(s): Enter the unique alphanumeric report number(s) assigned by the organization originating or generating the report from its research and whose name appears in Block 6. These numbers should be in accordance with ANSI STD 239.23-74, "American National Standard Technical Report Number." If the Performing Organization is also the Monitoring Agency, enter the report number in Block 4.

**Block 5** Monitoring Organization Report Number(s): Enter the unique alphanumeric report number(s) assigned by the Monitoring Agency. This should be a number assigned by a DoD or other government agency and should be in accordance with ANSI STD 239.23-74. If the Monitoring Agency is the same as the Performing Organization, enter the report number in Block 4 and leave Block 5 blank.

**Block 6a** Name of Performing Organization: For in-house reports, enter the name of the performing activity. For reports prepared under contract or grant, enter the contractor or the grantee who generated the report and identify the appropriate corporate division, school, laboratory, etc., of the author.

**Block 6b** Office Symbol: Enter the office symbol of the Performing Organization.

**Block 6c** Address: Enter the address of the Performing Organization. List city, state, and ZIP code.

**Block 7a** Name of Monitoring Organization: This is the agency responsible for administering or monitoring a project, contract, or grant. If the monitor is also the Performing Organization, leave Block 7a blank. In the case of joint sponsorship, the Monitoring Organization is determined by advance agreement. It can be either an office, a group, or a committee representing more than one activity, service, or agency.

**Block 7b** Address: Enter the address of the Monitoring Organization. Include city, state, and ZIP code.

**Block 8a** Name of Funding/Sponsoring Organization: Enter the full official name of the organization under whose immediate funding the document was generated, whether the work was done in-house or by contract. If the Monitoring Organization is the same as the Funding Organization, leave 8a blank.

**Block 8b** Office Symbol: Enter the office symbol of the Funding/Sponsoring Organization.

**Block 8c** Address: Enter the address of the Funding/Sponsoring Organization. Include city, state and ZIP code.

READINESS AND RETENTION:  
PILOT FLIGHT EXPERIENCE  
AND  
AIRCRAFT MISHAPS  
DR. MICHAEL S. BOROWSKY  
U.S. NAVAL SAFETY CENTER  
STATISTICS AND MATHEMATICS DEPARTMENT



|                    |                                            |
|--------------------|--------------------------------------------|
| Accession For      |                                            |
| NTIS CRA&I         | <input checked="checked" type="checkbox"/> |
| DTIC TAB           | <input type="checkbox"/>                   |
| Unannounced        | <input type="checkbox"/>                   |
| Justification      |                                            |
| By                 |                                            |
| Distribution       |                                            |
| Availability Codes |                                            |
| Dist               | Avail and/or Special                       |
| A-1                |                                            |

"Approved for public release; distribution is unlimited."

June 24, 1986

## ABSTRACT

Budget constraints which yield reductions in flight hours per pilot imply an eventual shifting of the distribution of flight hours.

Analyses show that the rate of pilot error mishaps tends to decrease as pilots' flight experience increase. These data suggest, therefore, that as the experience levels of naval aviators decline, the mishap rate will increase. The experience levels of Training Command/Fleet Readiness Squadron instructor pilots would also tend to decrease, thereby contributing both directly and indirectly to an increased mishap rate. The total effect will, of course, also depend upon aggregate flight hour reductions as well as pilot retention rates.

## INTRODUCTION

Pilot error mishaps in Naval Aviation during the calendar years 1977-1985 cost \$1.7 billion- not including "indirect" items such as survivors' benefits, litigation, and full aircraft replacement costs. In addition, there were 400 fatalities, including 173 pilots in these mishaps.

Analyses of aircraft mishaps, pilot flight experience, and exposure data showed that in general, more experienced aviators had a lower probability of pilot error mishaps than those aviators with little flight experience. In particular, pilots with extensive experience--both in model and total hours--had a low pilot error mishap rate, while inexperienced pilots in the fleet readiness squadrons and during the initial half of their first tour had a particularly high rate.

These results imply a strong relationship between aviation safety and flight experience, and therefore, readiness and retention. Higher retention rates likely imply an increased distribution of flight hours for experienced aviators and, therefore, lower mishap rates and increased operational readiness--if mission and flight tempo parameters are not modified.

Previous studies (References 1-3) have shown the existence of relationships between pilot error mishaps and the experience levels of the pilots. Updated results are provided in this analysis.

The high risk levels for pilots were:

### Hours in Model/Total Hours

|                     |                 |
|---------------------|-----------------|
| Fighter:            | 300- / 750-     |
| Attack:             | 300- / 450-1500 |
| Single-seat TACAIR: | 300- / 450-750  |
| Multi-seat TACAIR:  | 300- / 750-     |
| Helo:               | 300- / 450-750  |

(e.g., fighter pilots with 300- hours in model and simultaneously 750-total hours had a high pilot error mishap rate. On the other hand, pilots with extensive experience--both in model and total hours--had a low pilot error mishap rate.)

Analysis pertaining to the Training Command (4) showed that the pilot error mishap rate for instructor pilots (while flying with students) significantly decreased as hours flown in training aircraft increased. The rates were particularly high for instructors with less than 300 hours in trainers--regardless of whether these new instructors were "SERGRADS" or fleet experienced aviators.

The effects of certain variables were not quantified. Therefore, absence or presence of specific statistical relationships may be partially the result of command attention such as increased safety emphasis by commanders during high tempo periods, special scheduling for pilots with minimal experience in model, and mission profile differences as a function of flight experience.

## SUMMARY RESULTS

### Fighter

FRS: The rate was extremely high\*.

First tour-initial portion: The rate was extremely high\*.

Transition/SERGRAD: The rate was low--relative to pilots with 750- total hours\* and relative to pilots with more extensive hours in model.

### Attack

FRS: The rate was low relative to pilots in the initial portion of their first tour and was high relative to pilots with more extensive hours in model.

First tour-initial portion: The rate was extremely high\*.

Transition/SERGRAD: The rate did not differ substantially from the FRS but was low relative to pilots in the initial portion of their first tour and high\* relative to pilots with more extensive hours in model.

### Single seat TACAIR

FRS: The rate was low\* relative to pilots in the initial portion of their first tour but did not differ substantially from pilots with more extensive experience.

First tour-initial portion: The rate was extremely high\*.

Transition/SERGRAD: The rate did not differ substantially from the and from pilots with more extensive hours in model but was low\* relative to pilots in the initial portion of their first tour.

### Multi-seat TACAIR

FRS: The rate was extremely high.

First tour-initial portion: The rate was low relative to pilots in the FRS but was high relative to pilots with more extensive experience.

Transition/SERGRAD: The rate was low relative to pilots in the FRS through the initial portion of their first tour but--if total hours were 1500- --was high relative to pilots with more extensive hours in model. The rate--if total hours were 1500+--did not differ substantially from pilots with more extensive hours in model.

## Helicopter

FRS: The rate was low relative to pilots with 451-1000 total hours but did not differ substantially from pilots who had 1000+ total hours.

First tour-initial portion: The rate was extremely high\*

Transition/SERGRAD: The rate was low relative to pilots in the initial portion of their first tour but was high relative to FRS pilots and pilots with more extensive hours in model.

\*Denotes statistically significant result at  $<.05$ .

Definitions: FRS: 300- hours in model and 450- total hours.

First tour-initial portion: 300- hours in model and 451-750 total hours.

Transition/SERGRAD: 300- hours in model and 750+ total hours.

Notation: "-" by itself denotes "less than", e.g., 300- means less than 300.



## DETAILED RESULTS

### Fighter:

The pilot factor mishap rate was significantly ( $\alpha = .005$ ) related to total hours (Table I). Pilots with 450- hours had the highest rate followed by those who had 451-750 hours. The mishap rate was not significantly ( $\alpha = .218$ ) related to hours in model in themselves. Pilots with 300- hours in model had the highest rate, while those with 1000+ hours had the lowest rate, however. Interactions showed an extremely high rate for pilots who had 300- hours in model and simultaneously 750- total hours. In fact, for pilots with 300- hours in model, the rate significantly ( $\alpha = .012$ ) decreased as total hours increased. There was no statistical evidence, however, that maximizing hours in model relative to total hours yielded reduced mishap rates. For each total hour category, the mishap rate was not significantly associated with hours in model ( $\alpha = .229, .646, .327$  for the 451-750, 751-1500, and 1500+ total hour categories, respectively). Though the rate decreased as hours in model increased for pilots who had 451-750 total hours, this was not the case for pilots in the 750+ total hour categories.

### Attack:

The pilot factor mishap rate significantly decreased as total hours ( $\alpha=.035$ ) and hours in model increased ( $\alpha<.001$ ) (Table II). Interactions showed an extremely high rate for pilots who had 300- hours in model and simultaneously 451-1500 total hours. In fact, for pilots with 300- hours in model, the rate increased as total hours increased from 450- to 451-750, but then decreased as total hours increased beyond 750. This relationship was not statistically significant, however ( $\alpha=.130$ ). In addition, career patterns which maximized hours in model relative to total hours yielded lower pilot factor mishap rates than patterns for which hours in model were severely limited. Specifically, for each total hour level, the rate for pilots who had 300- hours in model (e.g., SERGRAD, transition pilots) was higher than the rates for pilots who had 301-500, 501-1000, or 1000+ hours in model. These associations between mishap rate and hours in model, in fact, were significant for pilots who had 451-750 or 751-1500 total hours ( $\alpha=.004$ ,  $.008$ , respectively) but was not significant for pilots who had 1500+ total hours ( $\alpha=.191$ ).

Single seat TACAIR:

The pilot factor mishap rate was significantly related to total hours ( $\alpha = .010$ ) and hours in model ( $\alpha < .001$ ) (Table III). The rate decreased as hours in model increased and, with respect to total hours, was highest at the 451-750 level. Interactions showed an extremely high rate for pilots who had 300- hours in model and simultaneously 451-750 total hours. Furthermore, for pilots with 300- hours in model, the rate increased as total hours increased from 450- to 451-750 and then decreased as total hours increased beyond 750. This association was statistically significant ( $\alpha = .002$ ). The rate (for pilots with 451-750 total hours) significantly decreased ( $\alpha < .001$ ) as hours in model increased to 300+. There was no significant evidence, however, that maximizing hours in model relative to total hours yielded reduced mishap rates for pilots with 750+ total hours ( $\alpha = .120$ , .287 for rate vs. hours in model for pilots who had 751-1500 and 1500+ total hours, respectively).

Multi-seat TACAIR:

The pilot factor mishap rate was significantly associated with total hours ( $\alpha = .006$ ) and hours in model ( $\alpha = .008$ ) (Table IV). The rate decreased as hours in model increased and, with respect to total hours, was highest for pilots with 750- --particularly if 450-. Interactions showed that for pilots with 300- hours in model, the rate decreased as total hours increased. In addition, for pilots with 1500- total hours, career patterns which maximized hours in model relative to total hours yielded reduced mishap rates. This, however, was not the case for pilots who had 1500+ total hours. The results for these interactions were not statistically significant, however. ( $\alpha = .176$  for rate vs. total hours for pilots with 300- hours in model,  $\alpha = .554$ ,  $.209$ ,  $.131$  for rate vs. hours in model for pilots with 451-750, 751-1500, 1500+ total hours, respectively)

### Helicopters:

The pilot factor mishap rate was significantly ( $\alpha = .004$ ) related to total hours (Table V). Pilots with 451-750 total hours had the highest rate, while those with 2000+ had the lowest rate. The mishap rate was not significantly ( $\alpha = .647$ ) related to hours in model in themselves. Pilots with 1000+ hours in model had the lowest rate, however. Interactions showed that pilots with 451-750 total hours who also had 300- hours in model possessed an extremely high rate. For pilots with 300- hours in model, the rate was significantly ( $\alpha = .003$ ) related to total hours--increasing as total hours increased from 450- to 451-750 and decreasing as total hours increased further. Moreover, pilots who had 2000+ total hours and also 1000+ hours in model possessed a very low rate. Career patterns which maximized hours in model relative to total hours generally yielded lower pilot factor mishap rates than patterns for which hours in model were severely limited (e.g., SERGRAD, transition pilots). Specifically, for each total hour level, the rate for pilots who had 300- hours in model was higher than the rate for pilots who had 500+ hours in model. These relationships were significant, however, only for the 451-750 total hour level ( $\alpha = .011$ ); for the 751-1000, 1001-2000, 2000+ levels,  $\alpha = .617, .447, .210$ , respectively).

### References

1. "Fighter Aircraft Class A F/FRM Rates vs. Pilot Experience CY 77-83," APPROACH Magazine, January 1985
2. "Attack Aircraft Class A F/FRM Rates vs. Pilot Experience CY 77-83," APPROACH Magazine, November 1984
3. "Helicopter Class A F/FRM Rates vs. Pilot Experience CY 77-83," APPROACH Magazine, March 1985
4. "Naval Training Command Mishaps and Instructor Experience," Aviat., Space Environ. Med. 57: 65-70, 1986 (Jan), by M. S. Borowsky, Ph.D.

TABLE I - FIGHTER

HOURS IN MODEL

|                | 300-       | 301-500    | 501-1000   | 1000+      | Total      |
|----------------|------------|------------|------------|------------|------------|
| TOTAL<br>HOURS | 17         | —          | —          | —          | 17         |
| 450-           | 9.99       |            |            |            | 9.99       |
| 451-750        | 10<br>9.62 | 5<br>4.41  | —          | —          | 15<br>6.75 |
| 751-1500       | 4<br>3.94  | 3<br>4.20  | 11<br>4.07 | 0<br>0.00  | 18<br>3.72 |
| 1500+          | 4<br>2.27  | 5<br>5.04  | 14<br>5.78 | 12<br>3.65 | 35<br>4.14 |
| Total          | 35<br>6.35 | 13<br>4.54 | 25<br>4.82 | 12<br>3.26 | 85<br>4.95 |

The figures denote class A flight/flight-related pilot error mishaps and rate per 100,000 flight hours.

TABLE II - ATTACK

HOURS IN MODEL

|                | 300-        | 301-500    | 501-1000   | 1000+      | Total       |
|----------------|-------------|------------|------------|------------|-------------|
| TOTAL<br>HOURS | 15          | —          | —          | —          | 15          |
| 450-           | 5.62        |            |            |            | 5.62        |
| 451-750        | 17<br>10.73 | 6<br>2.72  | —          | —          | 23<br>5.46  |
| 751-1500       | 8<br>7.32   | 6<br>5.71  | 9<br>1.70  | 3<br>3.75  | 26<br>3.15  |
| 1500+          | 9<br>4.60   | 4<br>3.10  | 17<br>4.18 | 22<br>2.33 | 52<br>3.10  |
| Total          | 49<br>6.09  | 16<br>3.44 | 26<br>2.71 | 25<br>2.45 | 116<br>3.58 |

The figures denote class A flight/flight-related pilot error mishaps and rate per 100,000 flight hours.



TABLE III - SINGLE-SEAT TACAIR

HOURS IN MODEL

|                | 300-        | 301-500   | 501-1000   | 1000+      | Total      |
|----------------|-------------|-----------|------------|------------|------------|
| TOTAL<br>HOURS | 8           | —         | —          | —          | 8          |
| 450-           | 4.36        | —         | —          | —          | 4.36       |
| 451-750        | 17<br>15.68 | 3<br>2.27 | —          | —          | 20<br>7.77 |
| 751-1500       | 5<br>5.86   | 3<br>4.25 | 6<br>1.81  | 3<br>6.65  | 17<br>3.19 |
| 1500+          | 7<br>4.72   | 3<br>3.49 | 12<br>4.69 | 14<br>2.40 | 36<br>3.36 |
| Total          | 37<br>7.04  | 9<br>3.02 | 18<br>2.98 | 17<br>2.71 | 81<br>3.94 |

The figures denote class A flight/flight-related pilot error mishaps and rate per 100,000 flight hours.

TABLE IV - MULTI-SEAT TACAIR

HOURS IN MODEL

|                | 300-       | 301-500    | 501-1000   | 1000+      | Total       |
|----------------|------------|------------|------------|------------|-------------|
| TOTAL<br>HOURS | 22         | —          | —          | —          | 22          |
| 450-           | 8.14       |            |            |            | 8.14        |
| 451-750        | 10<br>6.17 | 8<br>4.18  | —          | —          | 18<br>4.97  |
| 751-1500       | 6<br>5.75  | 5<br>5.05  | 14<br>3.18 | 0<br>.00   | 25<br>3.53  |
| 1500+          | 5<br>2.85  | 6<br>4.71  | 19<br>5.29 | 15<br>2.50 | 45<br>3.57  |
| Total          | 43<br>6.04 | 19<br>4.50 | 33<br>4.08 | 15<br>2.26 | 110<br>4.22 |

The figures denote class A flight/flight-related pilot error mishaps and rate per 100,000 flight hours.

TABLE V - HELICOPTERS

HOURS IN MODEL

|                | 300-       | 301-500    | 501-1000   | 1000+      | Total       |
|----------------|------------|------------|------------|------------|-------------|
| TOTAL<br>HOURS | 14         | 0          | --         | --         | 14          |
| 450-           | 2.16       | .00        |            |            | 2.04        |
| 451-750        | 14<br>8.30 | 14<br>2.82 | 5<br>4.30  | --         | 33<br>4.23  |
| 751-1000       | 3<br>5.06  | 2<br>6.24  | 16<br>3.39 | --         | 21<br>3.73  |
| 1001-2000      | 6<br>2.78  | 2<br>1.35  | 12<br>1.93 | 19<br>3.13 | 39<br>2.45  |
| 2000+          | 5<br>2.73  | 3<br>2.86  | 7<br>2.48  | 9<br>1.11  | 24<br>1.74  |
| Total          | 42<br>2.34 | 21<br>2.57 | 40<br>2.68 | 28<br>1.98 | 131<br>2.38 |

The figures denote class A flight/flight-related pilot error mishaps and rate per 100,000 flight hours.