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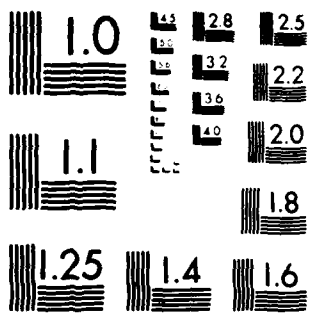
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THREE STUDIES OF BIOGRAPHICAL FACTORS ASSOCIATED WITH SUCCESS
IN AIR TRAFFIC CONTROL SPECIALIST SCREENING/TRAINING AT THE FAA ACADEMY

Allan D. VanDeventer, Deborah K. Taylor,
William E. Collins, and James O. Boone

Civil Aeromedical Institute
Federal Aviation Administration
Oklahoma City, Oklahoma 73125

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16. Abstract The current Air Traffic Control Specialist (ATCS) selection procedure requires that all applicants pass the Office of Personnel Management (OPM) air traffic control aptitude test. In addition to the test scores, applicants may also receive points for certain types of aviation-related prior experience or substitute college-level education in lieu of general experience requirements. The Civil Aeromedical Institute (CAMI) has had a long-standing involvement in efforts to update and improve ATCS selection procedures. As part of this continuing task, all incoming ATCS students are given an opportunity to voluntarily take a battery of research tests upon arrival at the FAA Academy for basic training. Included in this battery is a Biographical Questionnaire (BQ) designed to elicit responses about background experiences, including high school education and activities, college education, military experience, and pre-FAA ATC experience. After a new pass/fail training program was implemented at the Academy in 1976, biographical data on trainees were examined to determine the relationship between biographical variables and Academy success rates. A new set of 21 questions was added to the BQ in May 1980, and responses to the revised BQ were analyzed to determine the underlying factor structure of the questionnaire and the relationship of those factors to success or failure at the Academy. Further research examined the relationship between various types of military experience and performance at the Academy.			
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BIOGRAPHICAL PROFILES OF SUCCESSFUL AND UNSUCCESSFUL
AIR TRAFFIC CONTROL SPECIALIST TRAINEES

Allan D. VanDeventer

Introduction.

The Federal Aviation Administration (FAA) instituted a new centralized pass/fail air traffic control (ATC) training program at the FAA Academy in Oklahoma City, Oklahoma, on January 13, 1976. This training is mandatory for all air traffic control specialist (ATCS) trainees and starts approximately 1 week after their acceptance into the ATCS developmental program. The purposes of the program are (i) to provide the trainee with the knowledge necessary to progress in later field phases of training and (ii) to screen the trainees such that only those demonstrating aptitude for ATCS work are passed on to the field phase of training. The pass/fail determination is made on the basis of a composite of measures of academic knowledge, assessed performance on simulated nonradar ATC problems, and scores on an objective Controller Skills Test.

Historically, eligibility for ATCS training has been based in part on an applicant's preemployment experience, educational background, and aptitude test measurement. The majority of those with pre-FAA ATC experience have had that experience in the military. Cobb (1), after an analysis of biographical data from ATCS trainees who entered training in 1969, concluded that pre-FAA ATC experience was significantly related to success in training at the FAA Academy. He also concluded that educational level showed no relationship to training success (2). Since that time, a new pass/fail training program has been implemented, and changes may possibly have occurred in the characteristics of applicants (biographical data) as they relate to success. The purpose of this study was to examine biographical data on trainees entering the Academy between June 1977 and June 1979 to determine relationships with success or failure at the end of Academy training. This information permits a comparison with the results of the previous study on 1969 trainees.

Method.

Subjects. Of the 3,016 trainees who entered Academy training between June 1977 and June 1979 and were administered the short version of the biographical questionnaire, complete responses to all of the items analyzed were obtained from 2,371 trainees. Subjects thus comprised 1,291 En Route and 1,080 Terminal trainees.

Questionnaire. During the first week at the Academy, students are given experimental tests and questionnaires for research purposes. Between June 1977 and June 1979, students in the En Route and Terminal options were administered a short biographical questionnaire.

The biographical questionnaire used in the study consisted of 60 items taken in part from Owens' Biographical Questionnaire (3) covering high school education, education beyond high school, and prior experience. Experience items were combined into two summary items. Some items which were not at least ordinally scaled were rescaled or dropped from the analysis, resulting in 21 items for analysis. The success criterion was the student's pass/fail status at the end of Academy training.

Groups. A priori considerations, preliminary analyses, and previous research prompted an analysis of the data across three groups. Some trainees are selected in a noncompetitive manner and are placed in a special pretraining program prior to entry into the Academy (called the Predevelopmental Program) in an effort to increase the numbers of disadvantaged and minority people entering the ATCS work force. Since this group probably constitutes a sample from a population different from those selected competitively, the group was treated separately. Of the remaining trainees, two groups tend to stand out: (i) those with previous ATC experience and (ii) those without such prior experience. Since previous research (1) has shown this kind of experience to be significantly related to Academy and field success, the three groups were first compared relative to Academy success and then the remaining biographical items were examined separately by group.

Table I shows the number entering and percent passing for each group. The difference between the Experience group and the No Experience group in proportions passing was significant ($\chi^2=8.99$, $df=1$, $p < .005$).

TABLE I. RELATIVE SUCCESS OF ATCS TRAINEES

Group	Number	Percent Passing
Experience	1,257	75.3
No Experience	951	69.6
Predevelopmental	163	73.6

Results.

Experience Group. A factor analysis with orthogonal varimax rotation on the 20 biographical items (the experience item was not included) yielded 12 factors. Pass/fail status loaded heavily on one factor only (variance accounted for = 5.19%) and no other variables loaded significantly with the success factor. The only other variable that loaded more than 0.200 was high school grades in mathematics or arithmetic (factor loading = 0.3102). Of those reporting A or B grade average in high school math, 78.3% passed, while 71.2% of those reporting a grade of C or lower passed. While this difference was significant ($\chi^2=8.36$, $df=1$, $p < .005$), the correlation between math/arithmetic grades and success was very low ($r=0.082$).

No Experience Group. A factor analysis on the scores of this group was performed in the same manner as for the Experience group. The first factor (variance accounted for = 8.46%) loaded heavily on pass/fail status (factor loading = 0.7915), on high school grades in math/arithmetic (loading = 0.501), and on overall high school average (loading = 0.434). High grades on each of the variables were associated with a higher probability of passing the Academy program (see Table II). Passing proportions were significantly different both for math/arithmetic grades ($\chi^2=23.18$, $df=1$, $p < .001$) and for high school average $\chi^2=18.64$, $df=1$, $p < .001$). The multiple regression of the two items with pass/fail yielded $R = 0.175$ (Beta Weights: Math = 0.117, H.S. Avg. = 0.088).

TABLE II. VARIABLES ASSOCIATED WITH SUCCESS FOR THE NO EXPERIENCE GROUP

Percent Passing	N	H.S. Grades	
		Math	H.S. Avg.
75.3	579	High*	High
67.2	125	High	Low
64.0	89	Low	High
53.8	158	Low	Low

*High = 'A' or 'B' grades; Low = grades of 'C' or below

Predevelopmental Group. Again, the factor analysis yielded one factor (variance accounted for = 6.23%) on which pass/fail loaded heavily (loading = 0.846) with little loading on other factors. Only one other variable, pre-FAA ATC experience, loaded to any other appreciable degree on this factor (factor loading = 0.544). Of the 85 predevelopmental trainees with pre-FAA ATC experience, 82.4% passed, while only 64.1% of the 78 nonexperienced predevelopmental trainees passed the Academy program. The difference in proportions was significant ($\chi^2=6.97$, $df=1$, $p < .01$). While analysis of the two groups (experienced and nonexperienced) of predevelopmental trainees was based on samples too small for generalization, the experienced predevelopmental group appeared to exhibit the same correlations as the No Experience group (see above). Nonexperienced predevelopmental trainees did not show such relationships.

Discussion.

The results of this study are consistent with the previous research (1) based on a 1969 sample of ATCS trainees. In that study, 46% of 1,684 En Route and Terminal option trainees under 30 years of age had pre-FAA ATC experience. Their Academy attrition rate was significantly lower than that of trainees without any ATC experience. Pre-FAA ATC experience is reported by 53% of the current sample. This experience is not only related to

success for competitively entering trainees, but also for those entering through the predevelopmental program. Thus, the present study confirms that, approximately 10 years later, pre-FAA ATC experience is still a significant factor in success in Academy ATCS training. Present results are also consistent with previous research (2) that concluded that level of education (i.e., high school vs. college) does not relate to Academy success. With respect to the latter, in this study, level of education failed to load on the factor with pass/fail status for either the Experience, No Experience, or Predevelopmental groups. The derived Beta Weights in the multiple regressions to predict success in the respective groups were only -0.032, 0.034, and 0.059 for level of education.

Other interesting findings were that high school achievement overall and in math/arithmetic in particular appear to be related to pass/fail probabilities, especially for persons entering competitively with no prior ATC experience. The math grade finding is somewhat surprising in light of the fact that one component of the ATCS Aptitude Screening Battery is a test of Arithmetic Reasoning, and a restriction in variance among Academy trainees would be expected. A possible explanation could be that the aptitude test and the high school grades in math/arithmetic are measures of somewhat different abilities.

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SOME BIOGRAPHICAL FACTORS ASSOCIATED WITH SUCCESS OF
AIR TRAFFIC CONTROL SPECIALIST TRAINEES AT THE FAA ACADEMY DURING 1980

Deborah K. Taylor
Allan D. VanDeventer
William E. Collins
James O. Boone

Introduction.

The current Air Traffic Control Specialist (ATCS) selection procedure requires that all applicants take the Office of Personnel Management (OPM) Air Traffic Control Aptitude Test. In addition to the test scores, applicants may also receive points for certain types of aviation-related prior experience or substitute college-level education in lieu of required general work experience. The Civil Aeromedical Institute (CAMI) has had a long-standing involvement in efforts to update and improve ATCS selection procedures. As part of this continuing task, all incoming ATCS students are given an opportunity to voluntarily take a battery of research tests upon arrival at the Federal Aviation Administration (FAA) Academy for basic training. Included in this battery are tests measuring controller aptitudes and knowledge; various psychological tests measuring achievement needs, motivation, interests, and perceptions; and a Biographical Questionnaire (BQ) designed to elicit responses about background experiences, including high school education and activities, college education, military experience, and pre-FAA ATC experience. These tests are designed to identify the factors that may predict success or failure in ATCS training.

Previous research (1) analyzing biographical data from incoming ATCS students recruited in 1969, concluded that pre-FAA ATC experience was significantly related to success at the Academy. In other studies, Cobb also concluded that neither educational level (2) nor sex (3) was related to Academy pass/fail rates. A new pass/fail training program was implemented at the Academy in 1976, leading VanDeventer (4) to examine biographical data on trainees who entered the Academy from June 1977 to June 1979 to determine if any changes had occurred in the relationship between biographical variables and Academy success rates. His results were consistent with previous research. In addition, he found that (self-reported) overall high school grades in general and high school math grades in particular were also somewhat related to Academy pass/fail rates.

A new set of 21 questions was added to the Biographical Questionnaire in May 1980, including inquiries about marital status, the number of times the ATC Aptitude Test was taken, types of previous FAA experience, reasons for wanting to become an ATCS, and attitudes about air traffic control as a career. In the present study, responses to the revised BQ were analyzed to determine the underlying factor structure of the Biographical Questionnaire and the relationship of these factors to success or failure at the Academy.

Method.

The present sample comprised 567 incoming ATCS students (286 Terminal and 281 En Route) who began training between June and December 1980. A battery of experimental tests, including the revised Biographical Questionnaire was administered to students upon their arrival at the FAA Academy. The BQ consisted of 81 items which inquired about areas such as types of previous experience, high school and college education, degree of interest in aviation, number of times the ATC Aptitude Test was taken, reason for wanting to become an ATCS, and approach to ATCS career.

Relationships of pass/fail rates with demographic variables (such as age, sex, etc.) and responses on the BQ were initially analyzed using chi-square tests. Subsequently, a series of multivariate analyses were performed. Due to multicollinearity among some of the independent variables, certain items were removed on an a priori basis before performing multivariate analyses (these items were overlapping, detailed descriptions of prior experience and were combined into one summary item). After removing these highly duplicative variables, the remaining items were regressed on the criterion variable, pass/fail status, using forward (stepwise) inclusion. In order to determine the underlying orthogonal patterns of relationships in the data, a factor analysis with varimax rotation was performed, yielding 19 factors. Factor scores for each subject on these 19 factors were then entered into a multiple regression equation with pass/fail as the dependent variable.

Results.

Chi-square tests yielded 13 items, which were significantly related to pass/fail rates at the Academy. Aspects associated with passing included: younger age, pre-FAA ATC experience, nonminority status, higher grades in high school math and biology, higher overall high school grades, more amount of time spent around airports, a tendency to help friends with problems, how interest in ATC work began, the fewer number of times the ATC Aptitude Test was taken, the greater self-assessed chances of staying in FAA ATC work less than 3 or more than 5 years, and better self-prediction of future performance compared to all other ATCS's.

The biographical items were then regressed on pass/fail status, yielding five variables (see Table I) which were significant in accounting for variance in the criterion variable ($R=.385$). Table I also includes success rates for respondents on these variables.

TABLE I. REGRESSION OF BIOGRAPHICAL VARIABLES ON ACADEMY PASS/FAIL STATUS

R=.385

VARIABLES	CATEGORIES	% PASSING	BETA
Overall H.S. Grade	A	83.1	-0.261
	B	69.4	
	C	55.7	
Pre-FAA ATC Experience	Yes	72.3	-0.2146
	No	54.	
Repetitions of ATC Aptitude Test	1	73.1	-0.1351
	2	57.5	
	3	42.9	
Age	22 or less	85.7	-0.1662
	23 thru 27	68.1	
	28 or more	57.1	
Of all ATCS's where do you feel you'll perform	Top 10 %	73.6	-0.0789
	Upper half	62.6	
	Average	44.0	

Regression Constant = 5.7603

*Categories with N less than 10 were not listed.

In order to identify the orthogonal factor structure of the questionnaire relative to Academy success, a factor analysis with varimax rotation was performed on the BQ items and pass/fail status. This analysis produced 19 orthogonal factors. Factor scores for each subject were then regressed on pass/fail status. Six factors made significant contributions in the prediction of the criterion variable. The resulting multiple R of .592 was inflated beyond the actual R of .385 (obtained in the previous multiple regression) due to the inclusion of pass/fail status in the factor scores (see Table II).

Discussion.

Results of this study indicate that several biographical variables are related to performance in FAA Academy training. Findings from previous research on earlier Academy inputs (1,2,3) were validated with the present sample of ATCS students. Pre-FAA ATC experience was shown to be significantly related to Academy success. Seventy-two percent of students with experience passed Academy training, while only 55% of those with no experience were successful. VanDeventer's findings (4) that overall high school grades and math grades were associated with pass/fail status were also confirmed. As in previous investigations, sex and educational level were not significant. A series of CAMI reports on the effects of age on

training and job performance led to Congressional legislation in 1972 permitting the FAA to set an upper age limit of 30 for entry into ATCS training. Even with this restriction, the present sample shows that age is still related to Academy pass/fail rates. As shown in Table I, the percentage of students passing Academy training decreases with increasing age.

Table II. REGRESSION OF FACTOR SCORES ON ACADEMY PASS/FAIL STATUS

FACTORS	DESCRIPTION	BETA
13	Pass/fail status, and the number of times the ATC aptitude test was taken	-0.5057
7	Subjective estimates of the likelihood of remaining in FAA ATC work, and self-ratings of future performance	-0.1223
9	Age	-0.1123
18	Number of books around the home while growing up, and participation in scientific experiments in high school	0.1343
5	Types and length of FAA experience before entry into the Academy	0.1113
14	How initial interest in ATC work began	-0.0878

R=.592*
Regression Constant = 3.5339

*Multiple R is inflated beyond actual R due to inclusion of pass/fail in the factor scores

In addition to age, prior ATC experience, and high school grades, two new items on the revised BQ were related to Academy success--the number of times the ATC Aptitude Test was taken, and a self-evaluation of future performance in relation to all ATCS's. As shown in Table I, success rates declined as the number of test repetitions increased. Self-ratings of expected performance are also closely related to Academy success rates.

Four of the six factors relating to pass/fail rates comprised items that were significant in the previous chi-square and regression analyses; however, Factors 5 and 18 contain previously unrelated items. Factor 5 is

composed of three items relating to previous FAA experience (including prior ATC training, length of time in the ATC option, and length of time as an FAA employee). Factor 18 includes two questions which may be related to overall academic achievement--the number of books around the home while growing up, and participation in scientific experiments in high school. A possible explanation for significance on these factors may be that while the individual items were not significantly related to Academy success, combinations of these items produced factors that were.

Results of this study indicate that several biographical variables are related to successful performance in FAA ATC Academy training. Actions such as limiting the number of times the ATC Aptitude Test may be taken could possibly lead to reductions in Academy failure rates. Concentrating recruitment efforts on persons who evidence high levels of academic achievement in high school, especially in the areas of math and science, may also improve success rates. Attitudes of potential applicants regarding the likelihood of remaining in FAA ATC work and self-evaluation of future performance also appear to be related. Questionnaires assessing these attitudes could be used during recruitment to evaluate potential job candidates.

In addition to new aptitude assessment techniques to select ATCS students, some improvements in future Academy training success rates may result from concentrating trainee recruitment efforts on individuals whose biographical profiles are most similar to those of successful ATCS students. Such an approach might have significant cost benefits since the cost per student for Academy training is approximately \$14,000 (based on 1981 estimates). If, for example, the percentage of students passing had increased by 5% during the 6-month period evaluated in this report, a savings of approximately \$392,000 would have resulted.

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MILITARY AIR TRAFFIC CONTROL EXPERIENCE AND
PERFORMANCE IN FAA ACADEMY AIR TRAFFIC CONTROL TRAINING

Allan D. VanDeventer

Introduction.

Previous research on the relationship between pre-FAA experience in Air Traffic Control (ATC) and performance in FAA Air Traffic Control Specialist (ATCS) training has led to the suggestion that, after aptitude screening, only Instrument Flight Rules (IFR) operations experience should be considered as a factor in ranking applicants for selection while Visual Flight Rules (VFR) operations experience should not be considered (1). However, that research was based on ATCS's entering training before 1970. Since that time, two conditions have changed which may have had an impact on the relationship between military ATC experience and FAA ATCS training performance: (i) the FAA has implemented a rigorous nonradar control aptitude screening phase that must be passed soon after entry into the FAA, and, (ii) the military services have all become voluntary (and therefore ex-military controllers who enter the FAA are a changing population with characteristics potentially different than those of trainees previously studied). The purposes of the present study were (i) to examine the relationship between various types of military ATC experience and performance at the FAA Academy based on a more recent sample, and (ii) to evaluate factors such as military branch and type of facility in which experience was gained.

Method.

Subjects. A Biographical Questionnaire was administered at the beginning of training to ATCS trainees who entered the FAA Academy between June 1977 and May 1981. Responses regarding pre-FAA military ATC experience were available for 4,254 of those who entered through the usual competitive selection process.

Results.

In response to questions regarding pre-FAA experience, 2,021 (48%) claimed to have air traffic control operations experience and/or ratings (those holding ratings did not always have operations experience) in the military. Of those who claimed military ATC experience or ratings, 1,015 (50%) were from the Air Force, 392 (19%) from the Navy, 163 (8%) from the Marines, and 422 (21%) from the Army. Five were from the Coast Guard and 24 were from unknown branches of the military. The success rate of the 2,201 students with no pre-FAA ATC experience was 61.15%. Table I shows the Academy success rates of students with military ATC experience by experience type and by military branch.

TABLE I. ACADEMY SUCCESS RATES OF ATCS STUDENTS WITH MILITARY ATC EXPERIENCE

MILITARY BRANCH	MILITARY ATC EXPERIENCE				ROW TOTAL
	RATING ONLY	VFR EXPER	IFR EXPER	VFR+IFR EXPER	
U.S. AIR FORCE	46 58.70%	170 64.71%	260 74.23%	539 76.62%	1015 73.20%
U.S. NAVY	13 76.92%	39 69.23%	34 70.59%	306 74.18%	392 73.47%
U.S. MARINE CORPS	10 80.00%	26 73.08%	14 92.86%	113 76.99%	163 77.91%
U.S. ARMY	26 61.54%	119 61.34%	31 58.06%	246 61.79%	422 61.37%
U.S. COAST GUARD	3 33.33%	0 0.00%	1 100.00%	1 100.00%	5 60.00%
COLUMN TOTAL	98 63.27%	354 64.69%	340 73.24%	1205 73.03%	1997 71.11%

An analysis of variance of type of military ATC experience, military branch (the Coast Guard students were omitted due to the small number) and ATCS option (en route and terminal), with the Academy nonradar score as the dependent measure, yielded no significant interactions while all main effects were significant. Since no interactions were present, ATCS option and military branch were dropped from further analysis and the significant effect of type of ATC experience ($F=14.53$; $df=4,2697$; $p < .001$) was examined. Post hoc tests indicated no significant differences between the no experience, rating only, and VFR groups; and no significant differences between the IFR and the IFR plus VFR experience groups. The nonradar scores for the IFR groups were significantly higher than for the non-IFR groups ($p < .05$). Identical results were obtained for Academy pass rates. While pass/fail status correlated 0.12 with IFR experience, it did not correlate with VFR experience (0.02). Table II gives the mean Academy nonradar final scores and the pass rates for the experience groups. The results indicate that those with military IFR experience show approximately 12% higher pass rates than those with no military ATC experience.

TABLE II. MEAN FAA ACADEMY SCORES AND PASS RATES BY TYPE OF MILITARY ATC EXPERIENCE

MILITARY ATC EXPERIENCE	MEAN SCORE	PASS RATE
NONE	72.24	61.15%
RATING ONLY	71.78	63.27%
VFR EXPERIENCE	72.52	64.69%
IFR EXPERIENCE	74.35	73.24%
VFR+IFR EXPERIENCE	74.40	73.03%
TOTAL	73.06	71.11%

Academy success rates by type of facility where military ATC experience occurred are presented in Table III. The results generally conform to the results obtained above; i.e., experience in IFR facilities such as Radar Approach Control (RAPCON), Radar Ground Controlled Approach (RGCA), Radar Tower (RTOWER), Radar Air Traffic Control Facility (RATCF) and Air Route Traffic Control Center (ARTCC) is related to higher success rates. The success rate of those with Nonradar Tower (NRTOWER) experience is higher than expected; however, 975 (70%) of those with NRTOWER experience also had IFR experience in other facilities. Similarly, 100 (33%) of those with Flight Service Station (FSS) experience also had IFR experience in other facilities. Radar Ground Controlled Intercept (RGCI), Nonradar Ground Controlled Intercept (NRGCI), and Army Radar Approach Control (ARAC) experienced students showed no difference in pass rates than students with no ATC experience at all.

TABLE III. MILITARY ATC EXPERIENCE AT VARIOUS FACILITIES AND ACADEMY SUCCESS RATES

TYPE OF FACILITY	N	PASS RATE
RAPCON	711	76.93%
RGCA	1055	72.51%
RTOWER	931	71.97%
RATCF	260	71.92%
NRTOWER	1392	71.91%
ARTCC	166	69.88%
FSS	301	69.44%
RGCI	134	63.43%
NRGCI	90	61.11%
ARAC	61	59.02%

Discussion.

The results yield the conclusion that the only military ATC experience that has validity for predicting Academy success in ATCS training is IFR operations experience and that such experience is equally valid for the En Route and Terminal options. This is essentially the same conclusion that Cobb and Nelson (1) arrived at in their study of pre-1970 Academy entrants and the magnitude of the effect is similar. However, the effect of military VFR experience on Academy success is even less evident with this current group than in their study.

The FAA implemented a new selection procedure in October 1981 that, in addition to utilizing a new aptitude test for establishing qualification, uses a test of ATC operations knowledge--the Occupational Knowledge Test--to award extra credit for pre-FAA ATC experience. This replaces the older procedure of rating the applicant's experience to award extra credit. During the FAA's recovery from the August 1981 Professional Air Traffic Controllers' union strike, 2 years of pre-FAA IFR-ATC experience is being used in addition to the new qualification procedures to qualify a limited number of applicants for hire directly into field training, beginning January 1982. These findings support limiting such a procedure to those with IFR experience and not considering those with VFR experience. In an emergency, such as the strike recovery effort, direct field hire of those with IFR-ATC experience may be justified; however, given that about 27% of those trainees would have attrited during Academy training, field attrition rates are likely to be higher for that group than for Academy graduates (2).

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