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# USAF Enlisted Air Traffic Controller Selection: Examination of the Predictive Validity of the FAA Air Traffic Selection and Training Battery Versus Training Performance

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16. Abstract

**Introduction:** Over the past decade, the U.S. military has conducted several studies to evaluate determinants of enlisted air traffic controller (ATC) performance. Research has focused on validation of the Armed Services Vocational Aptitude Battery (ASVAB) and has shown it to be a good predictor of training performance. Despite these efforts, enlisted ATC training and post-training attrition is higher than desirable, prompting interest in alternate selection methods to augment current procedures. The current study examined the utility of the FAA Air Traffic Selection and Training (AT-SAT) battery for incrementing the predictiveness of the ASVAB versus several enlisted ATC training criteria. **Method:** Subjects were 448 USAF enlisted ATC students who were administered the ASVAB and FAA AT-SAT subtests and subsequently graduated or were eliminated from apprentice-level training. Training criteria were a dichotomous graduation/elimination training score, average ATC fundamentals course score, and FAA certified tower operator test score. **Results:** Results confirmed the predictive validity of the ASVAB and showed that one of the AT-SAT subtests resembling a low-fidelity ATC work sample significantly improved prediction of training performance beyond the ASVAB alone. **Discussion:** Results suggest training attrition could be reduced by raising the current ASVAB minimum qualifying score. However, this approach may make it difficult to identify sufficient numbers of trainees and lead to adverse impact. Although the AT-SAT ATC work sample subtest showed incremental validity to the ASVAB, its length (95 minutes) may be problematic in operational testing. Recommendations are made for additional studies to address issues affecting operational implementation.

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## CONTENTS

# USAF Enlisted Air Traffic Controller Selection: Examination of the Predictive Validity of the FAA Air Traffic Selection and Training Battery Versus Training Performance

Over the past decade, the US military has conducted several studies to evaluate determinants of enlisted air traffic controller (ATC) performance (Carretta & Siem, 1999; Held, 2006a, 2006b; Held & Johns, 2002). These studies focused on validating the Armed Services Vocational Aptitude Battery (ASVAB; Defense Manpower Data Center, 2006) and have shown it to be a strong predictor of training performance. Despite its predictive utility, enlisted air traffic control training and post-training attrition are higher than desirable, prompting an interest in operational personnel in evaluating alternate selection methods to augment current procedures.

Under an arrangement between the Federal Aviation Administration (FAA) and the military services, enlisted ATC trainees were administered subtests from the FAA Air Traffic Selection and Training (AT-SAT) test battery (King, Manning, & Drechsler, 2006; Ramos, Heil, & Manning, 2001a, 2001b) as part of an equating study evaluating alternate forms (Tsacoumis, Anderson, & King, 2006) due to concerns over practice and coaching efforts (Heil et al., 2002). The AT-SAT battery was approved in May 2002 as the Civil Service selection tool for FAA air traffic control specialist (ATCS) applicants without previous air traffic control experience. A side benefit of the equating study allowed for an evaluation of the utility of the AT-SAT subtests as an adjunct to the method used to select enlisted USAF air traffic control trainees.

The purpose of the current study was to evaluate the predictive utility of the subtests of the FAA AT-SAT test battery against US Air Force (USAF) enlisted air traffic controller training performance. The current USAF selection test, the ASVAB, was used to establish a baseline and to determine whether the AT-SAT could improve prediction of training success beyond that provided by the ASVAB.

## METHOD

### *Participants*

Participants were 448 USAF enlisted air traffic controller students who were administered the ASVAB and subtests from the FAA Air Traffic Selection and Training (AT-SAT) battery and subsequently graduated or were eliminated from apprentice-level training. The average age was about 21 years. The sample was mostly male (76.2%) and was ethnically diverse. All participants had obtained at least a high school diploma or its equivalent.

### *Measures*

*Armed Services Vocational Aptitude Battery (ASVAB).* The ASVAB is a cognitive aptitude battery used by all US military services for enlistment qualification and job classification. The current form (Defense Manpower Data Center, 2006) has nine subtests: General Science (GS), Arithmetic Reasoning (AR), Word Knowledge (WK), Paragraph Comprehension (PC), Math Knowledge (MK), Electronics Information (EI), Auto and Shop Information (AS), Mechanical Comprehension (MC), and Assembling Objects (AO). All services use the Armed Forces Qualification Test (AFQT), which is a composite of the verbal and math subtests (WK, PC, AR, MK) for enlistment qualification. AFQT minimum qualifying scores vary by branch of service. The USAF minimum AFQT is the $36^{th}$ percentile. Each service develops its own composites for job classification. The USAF uses four broad job categories: Mechanical (M), Administrative (A), General (G), and Electronics (E). The minimum qualifying score for enlisted USAF ATC training is the $55^{th}$ percentile on the General composite. Table 1 summarizes the subtest content and USAF composite composition. As shown in Table 1, there is substantial overlap among the composites. The verbal subtests (WK and PC) contribute to the AFQT and three (M, A, and G) of the four USAF composites. AR also contributes to the AFQT and three (M, G, and E) of the four USAF composites.

*FAA Air Traffic Selection and Training (AT-SAT) battery.* The Air Traffic Selection and Training (AT-SAT) battery was developed on the basis of a job task analysis (Separation and Control Hiring Assessment, SACHA; Nickles, et al., 1995) of the FAA ATCS career field. It replaced the Office of Personnel Management written test and a nine-week screening program (King, Manning, Schroeder, Carretta, Rathje, & Myhr, 2007). The FAA AT-SAT battery consists of eight subtests that assess cognitive and perceptual abilities and self-reported life experiences. The subtests are: Dials (DI), Applied Math (AM), Scan (SC), Angles (AN), Letter Factory (LF), Air Traffic Scenarios (AT), Analogies (AY), and Experience Questionnaire (EQ). The battery includes two dynamic subtests (AT and LF) that require examinees to apply complex rules to manage resources. Five of the eight AT-SAT subtests are scored for number correct. The remaining subtests produce composite scores based on multiple sub-scores. Table 2 summarizes the AT-SAT subtest content.

*Enlisted air traffic controller training criteria.* As shown in Figure 1, US Air Force enlisted air traffic controller training requires about 8 weeks. All students complete an ATC Fundamentals course and take the FAA Certified Tower Operator test. Following Fundamentals training, students enter one of two specialized training tracks: Radar Approach Control Operations or Control Tower Operations. Upon graduation from training, enlisted air traffic controllers stay in their specialty throughout their first term of enlistment.

Training performance criteria include a dichotomous graduation/elimination training score, final average grade for written tests from the ATC Fundamentals course, and the FAA Certified Tower Operator (CTO) test score. For the dichotomous criterion, only those eliminees who failed for academic or performance reasons were included. Neither the ASVAB nor the AT-SAT subtests are designed to screen applicants for disciplinary, medical (including psychiatric/psychological), or other non-ability factors that may be related to failure.

**Table 1.** ASVAB Subtest Content and USAF Composite Composition

| | | | ASVAB Composite | | | | |
|---|---|---|---|---|---|---|---|
| Subtest | Abbr. | AFQT | M | A | G | E | Subtest Description |
| General Science | GS | | | | | X | Knowledge of biological & physical sciences |
| Arithmetic Reasoning | AR | X | X | | X | X | Ability to solve arithmetic word problems |
| Word Knowledge | WK | X | X | X | X | | Ability to select the correct meaning of words presented in context & identify the best synonym |
| Paragraph Comprehension | PC | X | X | X | X | | Ability to extract information from written passages |
| Math Knowledge | MK | X | | X | | X | Knowledge of high school mathematical principles |
| Electronics Information | EI | | | | | X | Knowledge of electricity & electronics |
| Auto & Shop Information | AS | | X | | | | Knowledge of auto, tools & shop terms, technology, & practices |
| Mechanical Comprehension | MC | | X | | | | Knowledge of mechanical & physical principles |
| Assembling Objects | AO | | | | | | Ability to determine how an object will look when its parts are put together |

**Table 2.** FAA AT-SAT Subtest Content

| Subtest | Abbr. | Score | Subtest Description |
|---|---|---|---|
| Dials | DI | Number correct | Scan & interpret meanings from a cluster of analogue instruments |
| Applied Math | AM | Number correct | Solve basic math problems as applied to distance, rate, & time |
| Scan | SC | Number correct | Scan dynamic digital displays to detect targets that change regularly |
| Angles | AN | Number correct | Determine the angle formed by intersecting lines |
| Letter Factory | LF | Weighted composite (awareness & planning) | Apply complex rules to categorize letters on 4 dynamic “assembly lines” – requires rule learning, memory, & prioritization |
| Air Traffic Scenarios | AT | Weighted composite (efficiency, safety, & accuracy) | Control air traffic in an interactive, dynamic, low-fidelity air traffic simulation; requires rule-learning, memory, & prioritization |
| Analogies | AY | Weighted composite (reasoning & windows) | Solve verbal & non-verbal analogies requiring the ability to conceptualize relationships |
| Experience Questionnaire | EQ | Composite score (combines subscales) | Respond to Likert scale questions regarding life experiences |

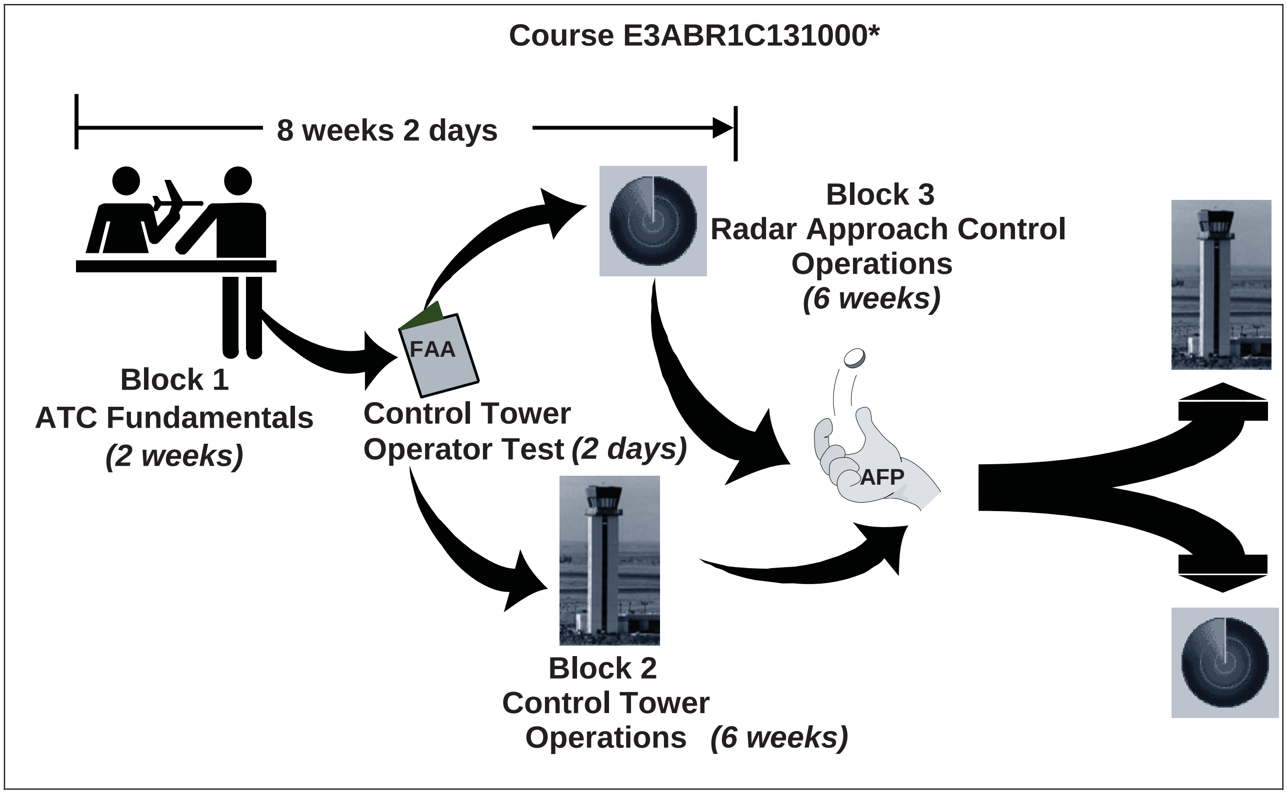


**Figure 1.** USAF enlisted air traffic controller apprentice-level training and initial assignment (Source: POI E3ABR1C131 000, dated 22 Apr 96).

*Procedures*

Participants completed the ASVAB as part of their enlistment qualification. The minimum AFQT percentile score for USAF enlistment qualification was 36. Qualification requirements for enlisted air traffic controller training were a minimum ASVAB General (G) composite score of 55, passing a Class III flight physical and a reading aloud test,[1] and visual acuity correctable to 20/20. Voluntary participants were administered the FAA AT-SAT battery at Keesler AFB, MS, at the beginning of enlisted ATC training. AT-SAT and ATC training data collection occurred between late 2003 and early 2006. The entire AT-SAT test battery requires about 6 ½ hours to complete, with a maximum of 8 hours including breaks and lunch. Due to time constraints, participants were not able to complete the entire AT-SAT battery. Instead, each participant provided demographic information (age, gender, educational level, and race/national origin), then completed one of three overlapping subtest blocks (see Table 3).

*Analyses*

As previously noted, due to the length of the FAA AT-SAT battery, participants were not able to complete the entire test battery. Instead, each participant completed one of three overlapping test blocks. Separate analyses were performed for each AT-SAT subtest in order to maximize the sample size by subtest.

The participants represented a range-restricted sample as they already had been selected for military entrance and ATC training based on their ASVAB scores. The data were corrected for range restriction using the multivariate method (Lawley, 1943; Ree, Carretta, Earles, & Albert, 1994) to provide a better estimate of the relations among the scores. Correlations involving the ATC graduation/elimination training criterion were corrected for both range restriction and dichotomization (Cohen 1983).

The validity of the USAF ASVAB composites was examined using correlational analyses to provide an estimate of the validity of the current selection test. Validity and incremental validity of the AT-SAT subtests was examined in a series of regression analyses. The ASVAB General (G) composite was used as a baseline in all of the regression analyses with the FAA AT-SAT subtest scores. The ASVAB General composite was entered first, followed by the AT-SAT subtest score. All analyses used a .05 Type I error rate.

[1]The reading aloud test assessed the ability to speak English clearly.

**Table 3.** FAA AT-SAT Equating Study Subtest Blocks

| Subtest | Abbr. | Length (minutes) | Block 1 | Block 2 | Block 3 |
|---|---|---|---|---|---|
| Background | ---- | 5 | X | X | X |
| Dials | DI | 12 | X | X | |
| Applied Math | AM | 30 | X | | X |
| Scan | SC | 18 | X | X | |
| Angles | AN | 10 | X | X | |
| Letter Factory | LF | 91 | | X | X |
| Air Traffic Scenarios | AT | 95 | X | | X |
| Analogies | AY | 45 | X | X | |
| Experience Questionnaire | EQ | 36 | | X | |

## RESULTS AND DISCUSSION

***Validity of the ASVAB Composites Versus Enlisted ATC Training Performance***

Examination of the means and standard deviations for the ASVAB subtests indicated that the means were elevated on average about 0.55 standard deviations above the military applicant population means, and the variances were about 40.6% of the population variances. Clearly, the data reflected the effects of range restriction due to prior selection on the ASVAB. The effects of range restriction were even stronger for the three subtests that contribute to the General composite (AR, WK, and PC) where the means were elevated by about 0.67 standard deviations and the variances were about 22.0% of the population value.

*ATC graduation/elimination training criterion.* Four hundred seventy four enlisted ATC students had ASVAB scores and graduated/eliminated from training (362 graduates, 112 eliminees; 76.4% graduation rate). Eighty-four of the 112 eliminees failed for poor academic or poor performance. The remaining 28 eliminees failed for non-performance reasons, including medical, disciplinary, prerequisite deficiencies, and unsuitability. Neither the ASVAB nor the AT-SAT batteries are designed to screen for these non-performance factors related to training elimination. As a result, these eliminees were removed from subsequent analyses. The resulting sample of 446 trainees consisted of 362 graduates and 84 eliminees for an 81.1% graduation rate. A distribution of the graduates and categories of eliminees is provided in Table 4.

Table 5 summarizes the correlations between the ASVAB composites and the dichotomous ATC graduation/elimination training criterion. Each of the ASVAB MAGE composites and the AFQT composite were related significantly to the ATC graduation/elimination training criterion at the .01 level of significance. The effects of range restriction on the correlations between the ASVAB composites and ATC training criteria were clear. The observed correlation between the ASVAB General composite and the dichotomous ATC graduation/elimination training score was 0.197. After correction for the effects of range restriction, the correlation increased to 0.477; after correcting for both range restriction and dichotomization of the criterion, the correlation increased to 0.610. Similar results were observed for the other ASVAB composites.

As expected, the training failure rate declined as the ASVAB General composite increased. The numbers at the top of each bar in Figure 2 indicate the number of enlisted USAF ATC students that had General composite scores in that range. For example, 77 students had General composite scores between 55 and 59 and their training failure rate was 29.9%. Twenty-two students had General composite scores of 95 or higher and had a 4.5% failure rate.

**Table 4.** Enlisted ATC Graduation/Elimination Distribution

| Training Outcome | N | |
|---|---|---|
| Graduates | 362 | |
| Eliminees | 112 | |
| Academic | 50 | Focused on Academic & Performance eliminees |
| Performance | 34 | |
| Medical | 17 | |
| Conduct/Misconduct | 2 | |
| Disciplinary | 2 | |
| Prerequisite Deficiency | 2 | |
| Unsuitability | 4 | |
| Unsuitability (language) | 1 | |

*Note.* Medical eliminees included students who reported anxiety, fear of controlling, and sleep disorders.

**Table 5.** Correlations Between USAF ASVAB Composites and ATC Graduation/ Elimination Training Criterion

| Score | Observed | Range-Restriction Corrected | Fully Corrected |
|---|---|---|---|
| Mechanical | 0.199** | 0.460 | 0.587 |
| Administrative | 0.212** | 0.487 | 0.622 |
| General | 0.197** | 0.477 | 0.610 |
| Electronic | 0.222** | 0.485 | 0.620 |
| AFQT | 0.226** | 0.493 | 0.630 |

*Notes.* No statistical tests were done using the corrected data. "Fully corrected" correlations were corrected for range restriction and dichotomization of the criterion.
N = 448; ** $p < .01$

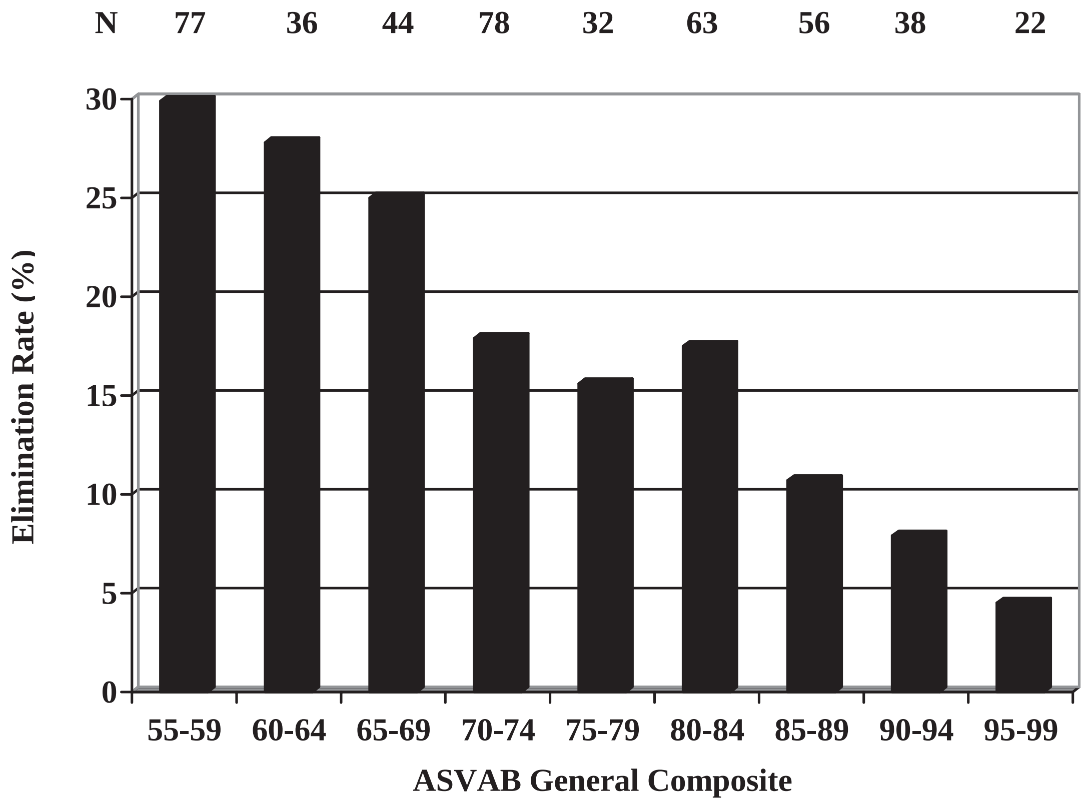


**Figure 2.** ATC training elimination rate by ASVAB General Composite score.

**Table 6.** Correlations Between USAF ASVAB Composites and ATC Fundamentals Average and FAA CTO Test Scores

| | ATC Fundamentals Average | | FAA CTO Test Score | |
|---|---|---|---|---|
| Score | Observed | Range-Restriction Corrected | Observed | Range-Restriction Corrected |
| Mechanical | 0.379** | 0.711 | 0.225** | 0.550 |
| Administrative | 0.387** | 0.746 | 0.272** | 0.596 |
| General | 0.423** | 0.757 | 0.278** | 0.596 |
| Electronic | 0.433** | 0.751 | 0.279** | 0.590 |
| AFQT | 0.442** | 0.766 | 0.298** | 0.608 |

*Note.* No statistical tests were done using the range-restriction corrected data.
N = 448; ** p < .01

*ATC Fundamentals average score and Certified Tower Operator (CTO) test score.* Table 6 summarizes the correlations between the ASVAB composites and the ATC Fundamentals average score and FAA CTO test score. As with the ATC graduation/elimination training score, the ASVAB composites demonstrated acceptable validity versus both criteria. The observed correlation between the ASVAB General composite and the ATC Fundamentals average score was 0.423. Correcting for the effects of range restriction increased the correlation to 0.757. Similar results were observed for the other ASVAB composites and for the FAA CTO test score. Clearly, the ASVAB is a good predictor of USAF enlisted ATC training performance. The strong relationship between ASVAB scores and training performance based on written tests (ATC Fundamentals average and CTO test score) was consistent with previous results showing the ASVAB to be a good predictor of academic performance during training (Ree, Carretta, & Doub, 1998/1999; Ree & Earles, 1991).

As shown in Figures 3 and 4, mean scores on both the ATC Fundamentals average score and the FAA CTO test increased as the ASVAB General composite score increased. Once again, the numbers at the top of each column indicate the number of students with ASVAB General composite scores in that range.

*Validity and Incremental Validity of the FAA AT-SAT Battery Versus Enlisted ATC Performance.* As previously noted, study participants did not complete all subtests of the AT-SAT battery due to its length. As a result, the sample sizes for examining their validity and incremental validity varied by AT-SAT subtest from 154 (EQ) to 326 (DI). The validity and incremental validity of each FAA AT-SAT subtest was examined separately to maximize the validation sample size. The ASVAB General composite was used as a baseline in all of the regression analyses with each of the FAA AT-SAT subtest scores. The General composite was entered first, followed by the AT-SAT subtest score. All analyses used a .05 Type I error rate.

*ATC graduation/elimination training criterion.* The ATC training graduation rate varied among the subsamples for the FAA AT-SAT subtest analyses from 78% to 82%. Table 7 summarizes the results of the regressions using the observed (uncorrected) data. The validity of the ASVAB General composite varied across the subsamples from .143 to .227 but was significantly related to the dichotomous graduation/elimination criterion in each subsample.

Only the AT-SAT Air Traffic Scenarios (AT) subtest demonstrated *incremental validity* over the ASVAB General composite in predicting graduation/elimination status. The Experience Questionnaire demonstrated the next largest increment, but the increment was not significant at the .05 Type I error rate. It should be noted, however, that the Experience Questionnaire analyses were conducted on a small sample, as it appeared in only one of the three AT-SAT test blocks described earlier.

Figure 5 shows the training elimination rate by aptitude test score. The numbers at the top of each bar in Figure 5 indicate the number of enlisted USAF ATC students that had General composite scores in that range. For example, 49 students had General composite scores between 55 and 59, and their training failure rate was 26.5%. Thirteen students had General composite scores of 95 or higher with a 4.5% failure rate. We then used the regression weights from the equation using both the ASVAB General composite and the AT-SAT AT subtest score to create predicted training outcome scores for the ATC students. Students were rank-ordered based on their predicted score, sorted into subgroups of the same size

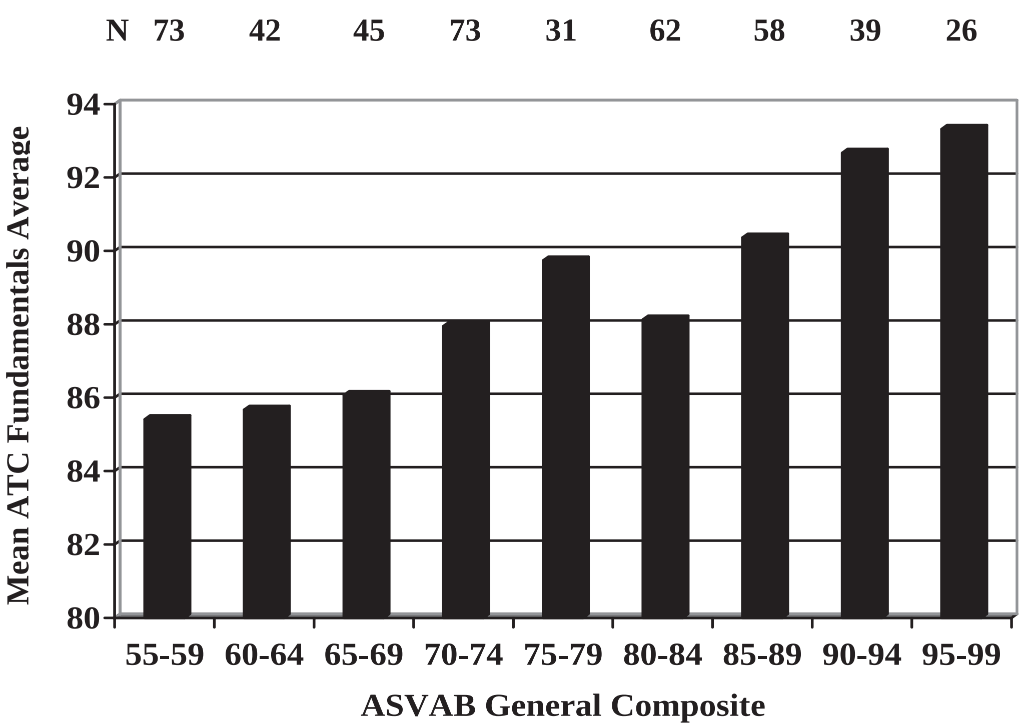


**Figure 3.** Mean ATC Fundamentals Score by ASVAB General Composite Score.
*Note.* N = 448; Mean ATC Fundamentals score = 88.3

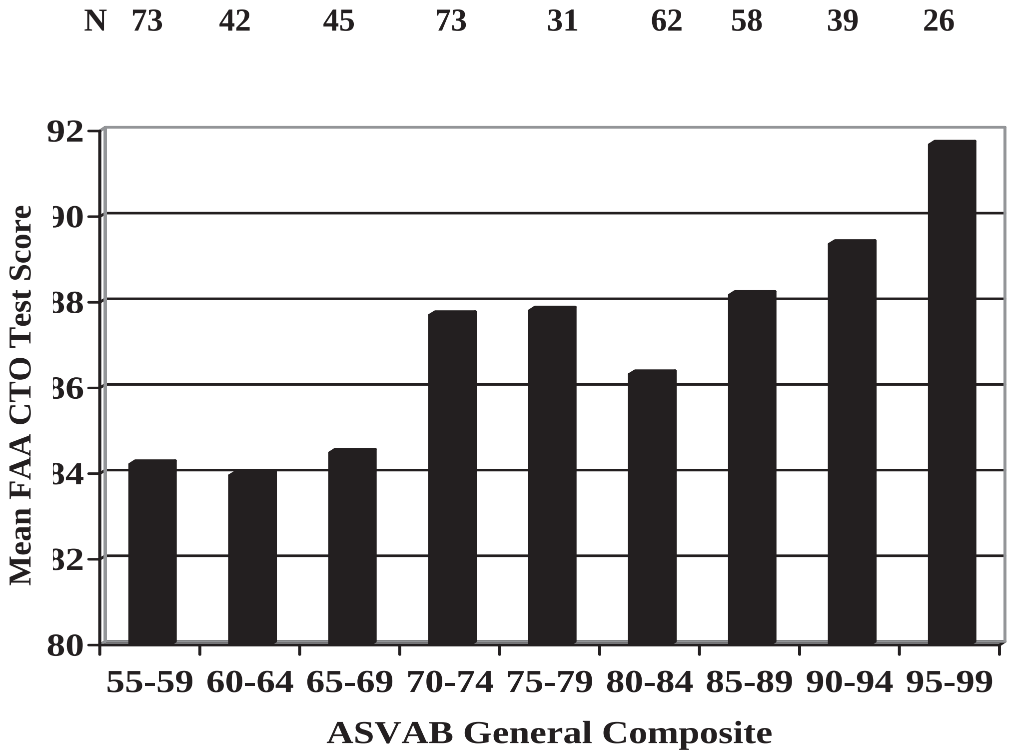


**Figure 4.** Mean FAA CTO test score by ASVAB General composite score.
*Note.* N = 448; Mean CTO test score = 86.4

**Table 7.** ATC Graduation/Elimination Training Regressions Using the ASVAB General Composite and FAA AT-SAT Subtest Scores: Observed Correlations

| AT-SAT Subtest | | ASVAB General Composite | | AT-SAT Score | | ASVAB General Composite + AT-SAT Score | | |
|---|---|---|---|---|---|---|---|---|
| | N | R | $R^2$ | R | $R^2$ | R | $R^2$ | $R^2$ Change |
| DI | 326 | .175** | .031 | -.033 | .001 | .179** | .032 | .001 |
| AM | 303 | .191** | .036 | -.063 | .004 | .203** | .041 | .005 |
| SC | 319 | .169** | .028 | .060 | .004 | .175** | .031 | .003 |
| AN | 307 | .170** | .029 | .012 | .000 | .172** | .029 | .000 |
| LF | 284 | .227** | .051 | .024 | .001 | .227** | .051 | .000 |
| AT | 290 | .158** | .025 | .362** | .131 | .363** | .131 | .106** |
| AY | 324 | .158** | .025 | -.003 | .000 | .159** | .025 | .000 |
| EQ | 154 | .143** | .020 | .167* | .028 | .210* | .044 | .024 |

*Note*. Sample sizes (N) varied by AT-SAT subtest.
*p < .05; ** p < .01

as the ASVAB-based subgroups, and the training failure rate was computed for the subgroups. The black bars in Figure 5 indicate the ATC training failure rate based on ASVAB General composite group. The white bars indicate the ATC training failure rate for the combined ASVAB/FAA Air Traffic Scenarios regression-based composite. The combined ASVAB/AT equation was much better at sorting the failures into the bottom subgroups than the ASVAB alone. The bottom subgroup (N = 49) had an ATC failure rate of 46.9% for the students sorted on the ASVAB/AT composite (as opposed to 26.5% when the ASVAB General composite was used alone).

The correlations then were corrected for range restriction (Lawley, 1943), and the regression analyses were repeated. Results for the range-restriction corrected data are summarized in Table 8. Correcting for range restriction slightly reduced the amount of incremental validity for the AT-SAT subtests. This is a consequence of the correction for range restriction.

Next, the range-restriction corrected correlations with the criterion were corrected for dichotomization of the graduation/elimination criterion (Cohen, 1983). Results for the fully-corrected data are summarized in Table 9. The multiple correlation for the combined regression model with the ASVAB General composite and the FAA Air Traffic Scenarios test score was 0.363 for the observed data, 0.517 after correction for range restriction, and 0.672 after correction for both range restriction and dichotomization of the criterion.

*ATC Fundamentals average score and Certified Tower Operator (CTO) test score.* The ASVAB General composite was related significantly to the ATC Fundamentals average in each of the AT-SAT sub-samples where its validity ranged from .410 (AT) to .492 (EQ). See Table 10 for a summary of the sub-sample regressions using the observed data. Three of the 8 AT-SAT subtests demonstrated incremental validity when the ASVAB General composite was used as a baseline – Angles, Letter Factory, and Air Traffic Scenarios. The Angles subtest measures an aspect of spatial ability, specifically appreciation of angles, which is not included in the ASVAB General composite. Letter Factors and Air Traffic Scenarios are dynamic tests that require monitoring and controlling multiple objects based on complex rules.

Table 11 summarizes the regression results for the range-restriction corrected data. After correction for range restriction, the amount of incremental validity for the FAA subtests was reduced. For example, the Air Traffic Scenarios subtest incremented ASVAB predictability by an $R^2$ of .034 in the observed data but only by .020 in the corrected data. This is not surprising, as the students had been selected directly on the basis of their ASVAB scores, and the multivariate correction for range restriction corrected for this.

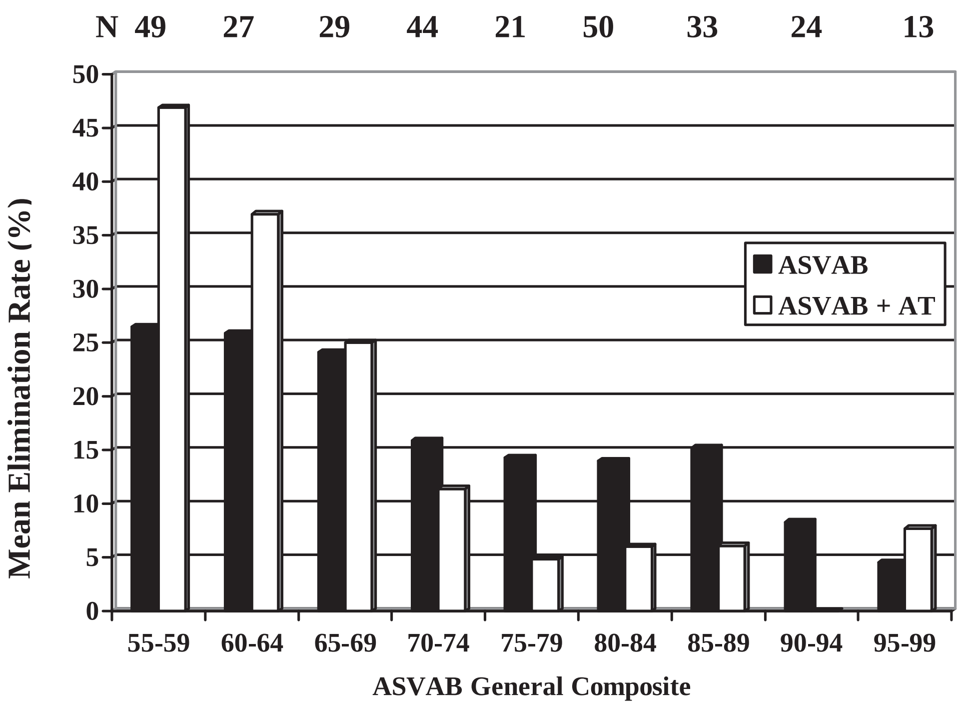


**Figure 5.** ATC training elimination rate by ASVAB General composite score and by ASVAB/AT-SAT AT Scenarios regression-weighted composite.

*Note.* N = 290; Elimination rate = 17.9%

**Table 8.** ATC Graduation/Elimination Training Regressions Using the ASVAB General Composite and FAA AT-SAT Subtest Scores: Range-Restriction Corrected Correlations

| AT-SAT Subtest | N | ASVAB General Composite R | ASVAB General Composite $R^2$ | AT-SAT Score R | AT-SAT Score $R^2$ | ASVAB General Composite + AT-SAT Score R | ASVAB General Composite + AT-SAT Score $R^2$ | ASVAB General Composite + AT-SAT Score $R^2$ Change |
|---|---|---|---|---|---|---|---|---|
| DI | 326 | .418 | .175 | -.016 | .000 | .420 | .176 | .001 |
| AM | 303 | .452 | .205 | .009 | .000 | .456 | .208 | .003 |
| SC | 319 | .410 | .168 | .143 | .020 | .412 | .170 | .002 |
| AN | 307 | .415 | .172 | .065 | .004 | .415 | .172 | .000 |
| LF | 284 | .507 | .257 | .080 | .006 | .507 | .257 | .000 |
| AT | 290 | .418 | .175 | .509 | .259 | .517 | .267 | .092 |
| AY | 324 | .396 | .157 | .025 | .001 | .396 | .157 | .000 |
| EQ | 154 | .322 | .104 | .209 | .044 | .355 | .126 | .022 |

*Notes.* Sample sizes (N) varied by AT-SAT subtest. No significance tests were performed on the corrected data.

**Table 9.** ATC Graduation/Elimination Training Regressions Using the ASVAB General Composite and FAA AT-SAT Subtest Scores: Fully-Corrected Correlations

| AT-SAT Subtest | N | ASVAB General Composite R | ASVAB General Composite $R^2$ | AT-SAT Score R | AT-SAT Score $R^2$ | ASVAB General Composite + AT-SAT Score R | ASVAB General Composite + AT-SAT Score $R^2$ | ASVAB General Composite + AT-SAT Score $R^2$ Change |
|---|---|---|---|---|---|---|---|---|
| DI | 326 | .543 | .295 | -.021 | .000 | .545 | .297 | .002 |
| AM | 303 | .579 | .335 | .012 | .000 | .585 | .342 | .007 |
| SC | 319 | .531 | .282 | .185 | .034 | .534 | .285 | .003 |
| AN | 307 | .534 | .285 | .084 | .007 | .534 | .285 | .000 |
| LF | 284 | .643 | .413 | .101 | .010 | .643 | .413 | .000 |
| AT | 290 | .543 | .295 | .661 | .437 | .672 | .451 | .156 |
| AY | 324 | .517 | .267 | .033 | .001 | .517 | .267 | .000 |
| EQ | 154 | .420 | .176 | .273 | .074 | .463 | .214 | .038 |

*Notes.* Sample sizes (N) varied by AT-SAT subtest. No significance tests were performed on the corrected data.

**Table 10.** ATC Fundamentals Average Regressions Using the ASVAB General Composite and FAA AT-SAT Subtest Scores: Observed Correlations

| AT-SAT Subtest | N | ASVAB General Composite R | ASVAB General Composite $R^2$ | AT-SAT Score R | AT-SAT Score $R^2$ | ASVAB General Composite + AT-SAT Score R | ASVAB General Composite + AT-SAT Score $R^2$ | $R^2$ Change |
|---|---|---|---|---|---|---|---|---|
| DI | 329 | .441** | .194 | .037 | .001 | .441** | .194 | .000 |
| AM | 306 | .419** | .175 | .028 | .001 | .419** | .175 | .000 |
| SC | 318 | .417** | .174 | .132** | .017 | .427** | .182 | .008 |
| AN | 311 | .419** | .175 | .138** | .019 | .436** | .190 | .015* |
| LF | 279 | .418** | .174 | .134* | .018 | .434** | .188 | .014* |
| AT | 297 | .410** | .168 | .305** | .093 | .450** | .202 | .034* |
| AY | 329 | .429** | .184 | .092 | .008 | .440** | .193 | .009 |
| EQ | 152 | .492** | .242 | .064 | .004 | .492** | .242 | .000 |

*Note.* Sample sizes (N) varied by AT-SAT subtest.
*$p < .05$; ** $p < .01$

**Table 11.** ATC Fundamentals Average Regressions Using the ASVAB General Composite and FAA AT-SAT Subtest Scores: Range-Restriction Corrected Correlations

| AT-SAT Subtest | N | ASVAB General Composite R | ASVAB General Composite $R^2$ | AT-SAT Score R | AT-SAT Score $R^2$ | ASVAB General Composite + AT-SAT Score R | ASVAB General Composite + AT-SAT Score $R^2$ | $R^2$ Change |
|---|---|---|---|---|---|---|---|---|
| DI | 329 | .784 | .614 | .093 | .008 | .784 | .614 | .000 |
| AM | 306 | .733 | .537 | .140 | .019 | .733 | .537 | .000 |
| SC | 318 | .764 | .583 | .238 | .056 | .767 | .588 | .005 |
| AN | 311 | .741 | .549 | .172 | .029 | .747 | .558 | .009 |
| LF | 279 | .752 | .565 | .168 | .028 | .757 | .572 | .007 |
| AT | 297 | .774 | .599 | .579 | .335 | .787 | .619 | .020 |
| AY | 329 | .778 | .605 | .125 | .015 | .781 | .610 | .005 |
| EQ | 152 | .826 | .682 | .187 | .035 | .826 | .682 | .000 |

*Notes.* Sample sizes (N) varied by AT-SAT subtest. No significance tests were performed on the corrected data.

Figure 6 shows the ATC Fundamentals average by ASVAB General composite score and by the combined ASVAB/AT regression-weighted composite. The numbers at the top of each bar in Figure 6 indicate the number of enlisted USAF ATC students that had General composite scores in that range. For example, 49 students had General composite scores between 55 and 59, and their average ATC Fundamentals score was 85.43. On the high end, 15 students had General composite scores of 95 or higher with an average ATC Fundamentals score of 92.93. We then used the regression weights from the equation using both the ASVAB General composite and the AT-SAT AT subtest score to create predicted training outcome scores for the ATC students. Students were rank-ordered based on their predicted score, sorted into subgroups of the same size as the ASVAB-based subgroups, and the average ATC Fundamentals score was computed for the subgroups. The black bars in Figure 6 indicate the average ATC Fundamentals score based on ASVAB General composite group. The white bars indicate the average ATC Fundamentals score for the combined ASVAB/FAA Air Traffic Scenarios regression-based composite. As the ASVAB General composite score increased, so did the mean ATC Fundamentals score. Although the FAA Air Traffic Scenarios test showed incremental validity over the ASVAB General composite, the amount of improvement for the combined ASVAB/FAA Air Traffic Scenarios model was not as dramatic as was observed for the ATC graduation/elimination criterion.

Similar results were observed for the FAA Certified Tower Operator test score. As with the average ATC Fundamentals score criterion, the ASVAB General composite was related significantly to the FAA CTO test score in all of the sub-samples. The validity of the ASVAB composite varied across the sub-samples from .242 (AN) to .399 (EQ). Further, the Letter Factory and Air Traffic Scenarios subtests showed incremental validity when used along with the ASVAB General composite. However, the Angles subtest was not statistically significant at the .05 level ($p = .06$). Table 12 summarizes the regression results for the observed data.

Table 13 summarizes the regression results for the CTO test score regressions using the range-restriction corrected data. After correction, the amount of incremental validity for the FAA subtests was reduced. For example the Air Traffic Scenarios subtest incremented ASVAB by an $R^2$ of .030 in the observed data but by only .016 in the corrected data. This is not surprising, as the students had been selected directly on the basis of their ASVAB scores, and the multivariate correction for range restriction corrected for this.

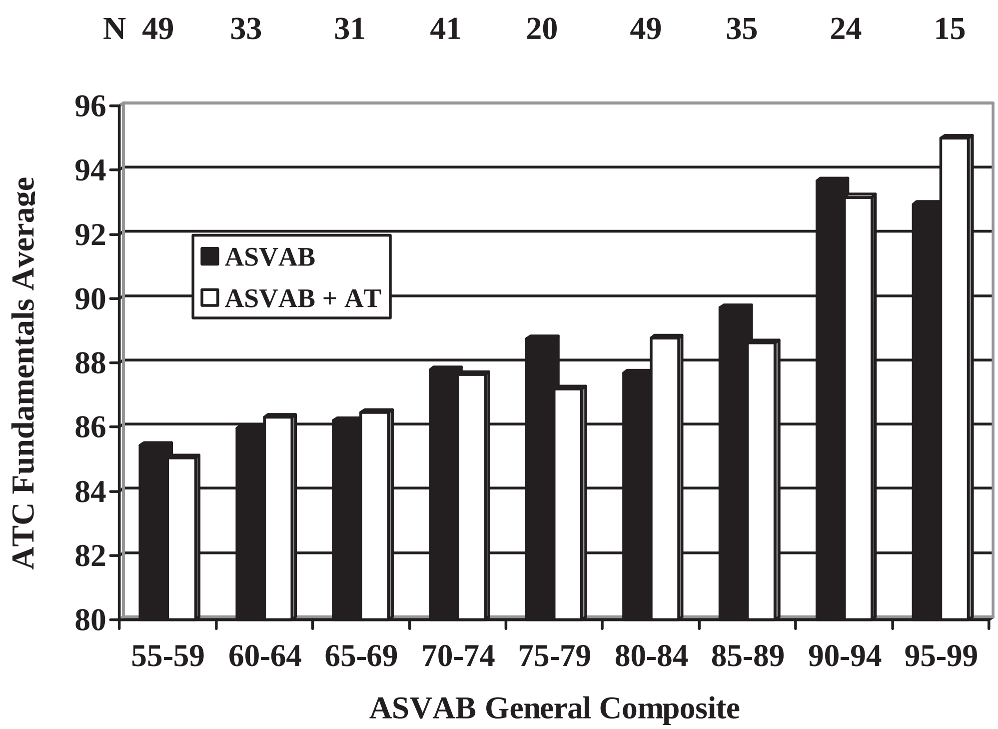


**Figure 6.** ATC Fundamentals Average by ASVAB General composite score and by ASVAB/AT-SAT AT Scenarios regression-weighted composite.

*Note.* N = 297; Mean ATC Fundamentals score = 88.0

**Table 12.** FAA Certified Tower Operator Test Score Regressions Using the ASVAB General Composite and FAA AT-SAT Subtest Scores: Observed Correlations

| AT-SAT Subtest | N | ASVAB General Composite R | ASVAB General Composite $R^2$ | AT-SAT Score R | AT-SAT Score $R^2$ | ASVAB General Composite + AT-SAT Score R | ASVAB General Composite + AT-SAT Score $R^2$ | $R^2$ Change |
|---|---|---|---|---|---|---|---|---|
| DI | 329 | .287** | .082 | .029 | .001 | .288** | .083 | .001 |
| AM | 306 | .261** | .068 | .099* | .010 | .274** | .075 | .007 |
| SC | 318 | .279** | .078 | .103* | .010 | .289** | .084 | .006 |
| AN | 311 | .242** | .059 | .116* | .013 | .264** | .070 | .011 |
| LF | 279 | .248** | .061 | .129* | .016 | .275** | .075 | .014* |
| AT | 297 | .284** | .080 | .223* | .050 | .317** | .100 | .030* |
| AY | 329 | .270** | .073 | .067 | .004 | .279** | .078 | .005 |
| EQ | 152 | .399** | .159 | .066 | .004 | .399** | .016 | .000 |

*Note.* Sample sizes (N) varied by AT-SAT subtest.
*p < .05; ** p < .01

**Table 13.** FAA Certified Tower Operator Test Score Regressions Using the ASVAB General Composite and FAA AT-SAT Subtest Scores: Range-Restriction Corrected Correlations

| AT-SAT Subtest | N | ASVAB General Composite R | ASVAB General Composite $R^2$ | AT-SAT Score R | AT-SAT Score $R^2$ | ASVAB General Composite + AT-SAT Score R | ASVAB General Composite + AT-SAT Score $R^2$ | $R^2$ Change |
|---|---|---|---|---|---|---|---|---|
| DI | 329 | .602 | .362 | .088 | .008 | .602 | .362 | .000 |
| AM | 306 | .537 | .288 | .172 | .029 | .542 | .293 | .005 |
| SC | 318 | .589 | .347 | .199 | .039 | .593 | .351 | .004 |
| AN | 311 | .539 | .290 | .154 | .024 | .548 | .300 | .010 |
| LF | 279 | .594 | .353 | .169 | .028 | .603 | .364 | .011 |
| AT | 297 | .642 | .412 | .486 | .236 | .654 | .428 | .016 |
| AY | 329 | .582 | .339 | .099 | .010 | .585 | .342 | .003 |
| EQ | 152 | .756 | .571 | .180 | .032 | .756 | .571 | .000 |

*Note.* Sample sizes (N) varied by AT-SAT subtest. No significance tests were performed on the corrected data.

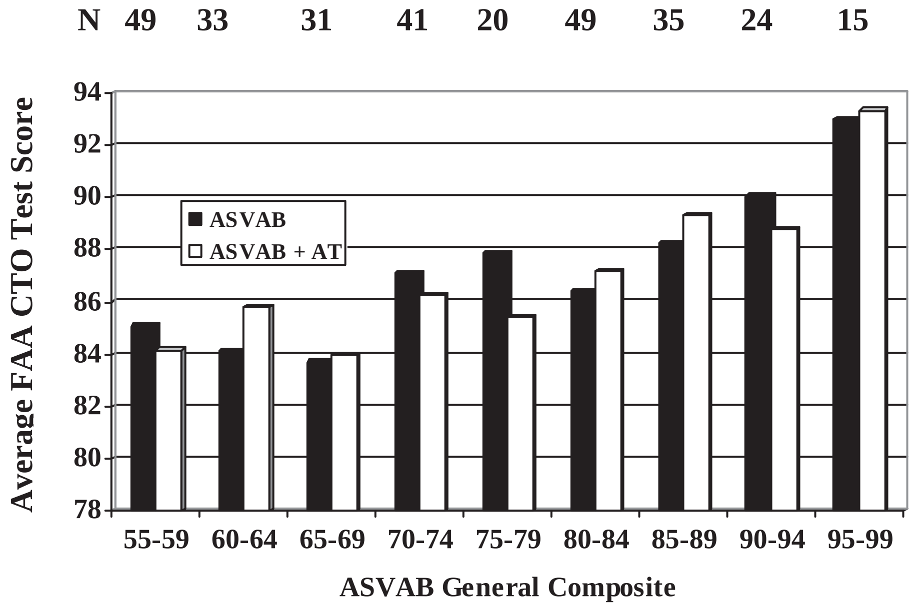


**Figure 7.** FAA CTO test score by ASVAB General Composite score and by ASVAB/AT-SAT AT Scenarios regression-weighted composite.

*Note.* N = 297; Mean CTO test score = 86.6

Figure 7 shows the average FAA CTO test score by ASVAB General composite score and by the combined ASVAB/AT regression-weighted composite. Results were similar to those observed as for the ATC Fundamentals average analyses. The black bars indicate the average FAA CTO test score based on ASVAB General composite group, and the white bars indicate the average FAA CTO test score for the combined ASVAB/FAA Air Traffic Scenarios regression-based composite. As the ASVAB General composite score increased, so did the mean FAA Certified Tower Operator test score. Although the FAA Air Traffic Scenarios subtest showed incremental validity over the ASVAB General composite, the amount of improvement for the combined ASVAB/FAA Air Traffic Scenarios model was not as dramatic as was observed for the ATC graduation/elimination criterion.

## SUMMARY AND RECOMMENDATIONS

*Armed Services Vocational Aptitude Battery*

Validation study results indicated that the current operational military enlistment qualification test, the ASVAB, demonstrated acceptable validity against several USAF enlisted air traffic controller training criteria. ASVAB validities were consistent with prior studies involving USAF (Carretta & Siem, 1999; Stoker et al., 1987) and US Navy (Held, 2006a, 2006b; Held & Johns, 2002) enlisted ATC training performance. The strong relationship between ASVAB scores and training grades based on written tests (ATC Fundamentals average and CTO test score) is consistent with previous studies of USAF enlisted training showing the ASVAB to be a strong predictor of academic performance (Ree et al., 1998/1999; Ree & Earles, 1991).

An examination of the ATC training elimination rate by ASVAB General composite score (see Figure 2) suggested that enlisted ATC training attrition could be reduced by raising the minimum training qualification score on the ASVAB General composite from the current minimum of 55 to 60. However, doing so would make it more difficult to identify sufficient numbers of enlistees for ATC training.

ASVAB validation results (see Tables 5 and 6) also showed that prediction of enlisted USAF ATC training performance could be improved by using the AFQT composite rather than the General composite for ATC training qualification. The higher validity of the AFQT, compared to the General composite, indicated that it captured more reliable variance in the training criteria. This likely is a consequence of the composition of the two composites. The General composite (AR, WK, PC) includes the two verbal and one of the math subtests, whereas the AFQT (AR, WK, PC, MK) includes both verbal and math subtests. A follow-on study to examine the impact of using alternate composites (AFQT and others) on qualification rates for sex and racial/ethnic subgroups is recommended. Ideally, an alternative composite would improve predictive validity and not lead to adverse impact. Further, it is recommended that analyses be conducted at the ASVAB subtest level to determine optimal composite composition for enhancing predictive validity, while minimizing adverse impact.

*FAA Air Traffic Selection and Training Battery*

Results from the analyses that evaluated the predictive utility of the FAA AT-SAT subtests indicated that using a composite that combined scores from the ASVAB and AT-SAT batteries provided a better estimate of training performance than ASVAB alone. Three of the 8 FAA AT-SAT subtests showed potential for improving prediction of USAF enlisted air traffic controller training performance. The small incremental validities for the AT-SAT subtests above the ASVAB General composite versus enlisted ATC training grades based on written tests (ATC Fundamentals average and CTO test score) was due to the strong relationship between the ASVAB and academic performance.

The FAA Air Traffic Scenarios subtest, which resembles a low-fidelity ATC work sample, was the most promising of the AT-SAT subtests. It demonstrated validity and incremental validity against all three ATC training criteria when the ASVAB General composite was used as a baseline. The results for the AT-SAT Air Traffic Scenarios subtest are consistent with those from a small-scale (N = 79) validation study of the AT-SAT battery conducted with US Navy enlisted ATC students (Held, 2006b). In that study, the Air Traffic Scenarios subtest demonstrated incremental validity against final school grade when used along with the ASVAB.

To be useful as an operational adjunct to the ASVAB, the FAA AT-SAT subtests may need to be shortened. Some military applicants are offered specific training assignments (e.g., air traffic controller training) based on their ASVAB scores as a condition of their enlistment. If the FAA AT-SAT subtests were to be used to determine enlisted ATC qualification, it would be necessary to administer them at the Military Enlistment Processing Stations (MEPS) as a special test for those interested in ATC training prior to any offer of a specific training assignment. Although the Angles subtest is of a reasonable length (about 10 minutes), both the Letter Factory (91 minutes) and Air Traffic Scenarios (95 minutes) subtests require substantial administration time. These three AT-SAT subtests take more time to administer than the entire ASVAB (3 hours, 15 minutes vs. 2 hours for CAT-ASVAB). AT-SAT reliability estimates suggest the subtests could be shortened without adversely affecting their reliability. A follow-on validation study is recommended where the AT-SAT Angles subtest and shortened forms of the Letter Factory and Air Traffic Scenarios subtests are used along with the ASVAB.

The burden of conducting AT-SAT testing at the MEPS and other pre-enlistment testing locations for those interested in the enlisted ATC career field could be reduced by using the ASVAB as an initial ATC training qualification test. As shown in Figure 2, applicants with high ASVAB scores (General composite of 70 or higher) had relatively low training elimination rates (failure rates). High scoring applicants could be offered an enlisted ATC training assignment prior to enlistment. AT-SAT testing could be limited to those with lower ASVAB General composite scores (e.g., between 50 and 69). Another method to reduce the testing burden at the MEPS would be to conduct AT-SAT testing during Basic Training at Lackland AFB, TX. This option would be for enlistees who had not yet received a training assignment, had appropriate ASVAB scores, and were interested in the enlisted ATC career field.

In addition to evaluation of shortened forms of the AT-SAT subtests, the follow-on validation study should expand the predictors to include non-cognitive measures, including personality (King, Retzlaff, Detwiler, Schroeder, & Broach, 2003) and improved medical assessment. Nearly 25% of the eliminations in the current study were for non-academic/non-performance reasons, including anxiety, disciplinary, fear of controlling, and loss of sleep. Neither the ASVAB nor the AT-SAT are designed to assess these non-cognitive factors.

Finally, the authors recommend follow-on validation study to examine additional training and post-training performance criteria. These include performance in the two ATC specialized training tracks (control tower operations, radar approach control operations) and measures of post-training performance (e.g., first-term attrition, supervisor ratings).

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