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A RAND NOTE

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ATTRITION DURING TRAINING IN THE ARMY  
RESERVE AND ARMY NATIONAL GUARD

David W. Grissmer, Sheila Nataraj Kirby

August 1984

N-2079-RA

Prepared for

The Office of the Deputy Assistant Secretary  
of Defense, Reserve Affairs

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## SUMMARY

This Note examines attrition prior to the completion of training among nonprior-service accessions in the Army National Guard and Army Reserve. The analysis uses the FY77 and FY78 accession cohorts to develop a quantitative model that assigns attrition probabilities to recruits with different characteristics.

The analysis identifies characteristics that discriminate between reservists who do and do not finish training, and it develops equations that can estimate attrition for an accession cohort of varying composition. This information can be used to improve recruit screening standards when supply exceeds demand, to help establish the proper trade-off between the level of recruiting resources and training costs, and to improve attrition forecasting for more accurate control of manpower budgets and end strength.

The analysis shows that over one-half of nonprior-service Army Reserve accessions in FY77 and FY78 left prior to the end of their third year of service. For the Army National Guard, 61 percent of the FY77 and 47 percent of the FY78 cohort left prior to the completion of their third year. On average, probably only about one in five nonprior-service accessions will finish his or her six-year term.

Attrition prior to the completion of training was an important but varying component of total attrition. The Army National Guard apparently used stringent screening criteria during training in FY77, and 46 percent of enlistees separated prior to the completion of training. In the FY78 cohort, less stringent criteria produced a separation of only 19 percent of accessions prior to the completion of training. As a result of the more stringent criteria, subsequent attrition in the FY77 cohort was apparently lower than in the FY78 cohort. However, stricter criteria appear also to have separated a number of individuals who would have completed at least three years.

The Army Reserve had overall lower training attrition--only one in six in FY77 and one in 12 in FY78. This was due partially to the higher quality of accessions. However, posttraining attrition was higher in

the Army Reserve than in the National Guard, leading again to the hypothesis of a trade-off between stringent screening criteria in training and lower posttraining attrition. Since the primary focus of this Note is training attrition, further investigation of this phenomenon is left to future modeling of both pre- and posttraining attrition.

Level of education and mental category are the characteristics that best discriminate between those who do and do not finish training. Other things equal, large and statistically significant differences in training attrition exist between those with different levels of educational attainment and mental category groups.

Much smaller, but statistically significant, differences in attrition exist between men and women, blacks and nonblacks, and older and younger reservists. Other things equal, blacks have slightly lower attrition rates than nonblacks and women have somewhat higher attrition than men. Reservists over 20 years of age have higher attrition than those from 18 to 20. Other characteristics, such as region, marital status, and dependents showed either insignificant or conflicting trends by component and year.

Education levels are a better predictor of attrition than mental category, but a combination of the two measures is probably best for setting recruit standards. The results showed--not surprisingly--that nonhigh school graduates in mental categories III and IV had the highest attrition rates and high school graduates in mental categories I, II, and III had the lowest.

The analysis cannot distinguish consistently between Category IV/high school, Category I/nonhigh school, and Category II/nonhigh school groups in attrition risks. Thus, if lowering attrition during training is an objective, recruit standards would screen out nonhigh school graduates in mental categories III and IV first, and then move to category IV high school graduates and categories I and II nonhigh school graduates.

Future work will concentrate on posttraining attrition and attrition among prior-service reservists. In addition, it will develop models that discriminate between reservists who return to civilian life as opposed to entering another component or the active service. Also,

attrition models will be combined with cost to evaluate more thoroughly different recruit and training screening criteria and a different mix of prior-service and nonprior-service reservists.

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## I. INTRODUCTION

Individuals without prior military service entering the Selected Reserve are sent to full-time training to qualify them in a military occupational specialty (MOS). This training ranges from a minimum of 90 days for low-aptitude skills to more than six months for higher-aptitude skills. The cost of training nonprior-service personnel varies by skill, but simple cost estimates that include recruiting and training costs and military pay during training range from \$4,000 to \$10,000 per individual. In FY81, the Selected Reserve enlisted 103,000 nonprior-service recruits, 85 percent of whom went to the two Army components-- the Army National Guard and Army Reserve. If all of these recruits finish training, the total cost will range from \$.4 to \$1.0 billion.

The return from this training investment comes as individuals serve their term of service and are available for mobilization. For the Selected Reserve, almost all nonprior-service enlistees enlist for six years; a smaller number choose three-year terms. Of course, selected reservists work only part-time and are usually required to work on the reserve job 28 days per year (14 days of annual training and 24 days of drill). A typical nonprior-service reservist who enlists for six years and serves a complete term would serve 228 days at a maximum. However, the return from training for a reservist cannot be measured strictly by days served, since the reservist is also liable for full-time mobilization call-up at any time during the six-year period.

Unfortunately, the return on training investment for nonprior-service reservists is often not fully realized because many reservists leave before the end of their term of service; among those who stay, attendance at drills and annual training is not perfect, nor is it certain that all reservists would report during a mobilization. These three factors can substantially reduce the return from training investment. This Note focuses on the first of these factors--attrition among nonprior-service reservists.

Data from reservists who enlisted in FY75 show that fewer than one in five reservists completed their initial six-year commitment. This high level of attrition indicates either that many people are recruited for the reserves who cannot meet performance standards and are separated, or that many who do meet performance standards leave before the end of their contract. If separation occurs during the initial full-time training period--usually lasting three months--it is likely the result of performance. However, separation after training, i.e., during the remainder of the six-year term, is more likely to involve adequate performers.

It is important to distinguish between these two problems since different policies will be required to remedy each. High levels of attrition during training can perhaps be remedied by improved recruitment and selection of enlistees or different training policies. High levels of attrition after training might be remedied partly by recruit selection, but may depend more on other factors operating in the civilian life of reservists.

Posttraining attrition can be high for reservists because the reserve job--being part-time--often cannot compete in priority with the demands of a full-time civilian job or family priorities. Thus, reservists often drop out due to the relocation necessary to obtain or hold a civilian job, or simply in response to conflicting work hours between the military and civilian job, or conflicts with family. Policy remedies for posttraining attrition might include family and employer support and improved tracking of relocating reservists. The current study focuses on attrition during training. A future study will address posttraining attrition.

If more potentially satisfactory nonprior-service reservists could be recruited or induced to complete their term, then fewer reservists would have to be recruited and trained, resulting in lower recruiting and training budgets. If, on the other hand, ways cannot be found to reduce these levels of attrition, serious consideration should be given to substituting prior-service personnel for nonprior-service personnel. Prior-service personnel do not usually require new full-time training, thereby saving training costs. In FY81, the Selected Reserve enlisted

126,000 prior-service personnel, which was 55 percent of total enlistments.

Although prior-service personnel have lower training costs, their effectiveness as a substitute for nonprior-service personnel depends on their useful service life. Since prior-service personnel can enlist for a single year, their average length of stay may be even shorter than that of nonprior-service personnel. One policy problem, then, is to determine the optimal mix of prior-service and nonprior-service personnel; this determination requires estimates of useful service life of each type, as well as estimates of various costs and differences in productivity. The purpose of this study is to begin to address this question by developing quantitative estimates of attrition rates for nonprior-service reservists.

Besides being useful eventually in determining an optimal prior-service nonprior-service mix, these pretraining attrition estimates are useful in two other policy areas: recruiting selection criteria for nonprior-service personnel and force-level planning. Individuals who leave prior to the completion of training cause the service to incur training cost, but they provide no useful service.

If the characteristics of those who leave differ from the characteristics of those who stay, recruiters may be able to enlist personnel who have a higher propensity to stay. Equations developed here describe the major characteristics that separate stayers and leavers; the equations can be used to estimate the decrease in loss rates during training if recruiters were able to enlist higher-quality personnel. This information can also be used to balance the increased recruiting resources necessary to obtain higher-quality personnel with the associated decreased training costs.

This model is also useful in controlling the total force size when the components attempt to meet Congress-imposed or budget-imposed end strength. To meet these constraints requires accurate forecasting of losses. Significant losses occur during training, and these loss rates depend on the composition and size of the enlistment cohort. The methodology used in this study can be used to forecast loss rates during training for cohorts with different compositions, thus allowing improved overall force size control and budgeting.

Analysis in this study contains estimates for only two of the six Selected Reserve components--the Army National Guard and Army Reserve. These components not only account for 85 percent of all nonprior-service accessions, but have higher loss rates than other components except the Marine Reserve. Focusing on these two components simplified data gathering and analysis while still addressing the major part of the problem.

This study uses Army Reserve and Army National Guard FY77-78 enlistment cohort files constructed by the Defense Manpower Data Center. This file provides attrition statistics through the first four years of service and allows estimates of the probability of attrition of enlistees of differing characteristics. The data showed that the level of attrition during training varied considerably, depending on the entrance year and the reserve component.

In FY77, the training attrition rate was 46.3 percent for Army National Guard enlistees, but only 7.7 percent for Army Reserve enlistees in FY78. These differences may reflect the differing quality composition of the cohorts or different training standards. This study addresses this question and concludes that different training standards were in effect for the two components during each fiscal year. It also concludes that (1) educational attainment and aptitude category are the most important predictions of training attrition and (2) the race and sex of the individual make smaller, but statistically significant differences.

Section II offers a theoretical framework for analyzing reserve attrition. Section III presents the descriptive statistics on attrition from the FY77-78 enlistment cohort files. The estimation results from the multivariate model of pretraining and training attrition are discussed in Section IV. The final section summarizes the results and indicates plans for future work.

## II. THEORETICAL FRAMEWORK FOR ANALYZING RESERVE ATTRITION

At the time of enlistment, the reservist and the reserve component enter into a contract. Presumably, the enlistment decision is deemed in the best interests of both parties, based on a calculus of perceived costs and benefits relevant to each. At the time of attrition, this calculus clearly has changed for at least one of the involved parties, and separation is regarded as the best course of action. The calculus might change either because one party is better able to evaluate costs and benefits of alternatives based on new information obtained after enlistment and/or because changed circumstances affect the relative attractiveness of the alternatives.

From the Army's point of view, the decision calculus essentially includes the benefits of retaining the individual--i.e., contributions to unit readiness--versus the costs--i.e., wages and benefits, and the costs of dismissing him. These costs of dismissal include the relative wages and productivity of replacement personnel, costs of obtaining replacement personnel, costs of having the position vacant for a time, and routine separation costs.

From the individual's point of view, the original enlistment calculus includes the benefits of reserve service--i.e., earnings over the period of service, training opportunities, reserve benefits--versus the costs--i.e., the commitment to attend reserve drills and annual training, the possibility of mobilization, and the opportunity costs of forgone work and leisure time. The latter includes forgone earnings from additional hours spent on a primary job or another moonlighting job or the forgone utility from additional leisure time.

The first step in explaining reserve attrition decisions requires identifying the changes that can occur to tip the decision calculus for either the individual or the reserve component from an original enlistment decision to a separation decision. The second step is to estimate the frequency of occurrence of these changes for different types of enlistees. The third step is to estimate the degree of

sensitivity of separation to each occurrence of change. While theoretically straightforward, the data to support efforts of this kind do not currently exist.

In this section, we will indicate the broad categories of changes that could lead to a separation decision either by the individual or the service. Next, we will comment on the likelihood that such changes will take place and on the sensitivity of a separation decision if changes occur. Finally, we will describe the data available for the current analysis and develop some hypotheses that can be tested with the available data.

We will focus here on two types of changes that might occur during the enlistment term and hypothetically lead to separation. The first type of change involves the accumulation of new information and its reevaluation by both the enlistee and the reserve component early in the term. The second type of change involves major changes in the external circumstances of the individual's life--changes in the marital status, primary employer or geographical location of the individual.

The first type of change probably is more important during training as information is acquired by both parties regarding the suitability of the match between the reserve job and the recruit. Once the initial adjustment period is over, the reason for separation is likely to shift to changes of the second type, where the environment in which the original decision was made itself changes.

#### **ACCUMULATION AND REEVALUATION OF INFORMATION AFTER ENLISTMENT**

The Army and the enlistee enter the initial contract with limited information about each other, but partly due to the costs of further search for each, decide on enlistment. As perceptions change, either about each other or about other alternatives, each may decide that an alternative other than reserve service offers greater utility: for the reserve components, replacement with another individual; for the reservist, another moonlighting job or not working a moonlighting job.

The recent literature in labor market theory attempts to include quitting behavior, based on an information-theoretic approach or some

variant. Wilde's<sup>1</sup> information-theoretic model is particularly appropriate here. His model formalizes Pencavel's observation that "the taking on of a job for a trial period may be the optimum method for an individual to discover whether that employment suits him."<sup>2</sup>

Wilde's model describes jobs in terms of general (or search) characteristics, which can be observed directly or without actually consuming the "good," and specific (or experience) characteristics, which are specific to the job and can be learned only by working the job. The acceptance of any job is conditional; if the jobholder finds the value of the experience attribute (about which he was imperfectly informed) below some critical level, he will quit and look for another job.

A simple extension of the model would posit two types of employee attributes--screening attributes, which can be observed by the employer prior to employment, and performance attributes, observed by the employer only after the individual works on the job. The attrition process can then be viewed as the consequence of rational decisionmaking in which belated information regarding the various attributes of the moonlighting job and the employee is received and reevaluated by both the worker and employer.

Critical levels exist for both the employee and the employer. Separation will occur if either employee performance on the moonlighting job does not exceed the critical performance level for the employer, or "moonlighting job experience attributes" do not exceed some threshold set by the employee.

Several aspects of holding a reserve job may be classified as experience attributes for a typical enlistee. The experience of a typical enlistee may encompass holding a part-time or full-time civilian job, but will not likely include a military job or military environment or a moonlighting job.

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<sup>1</sup>See L. L. Wilde, "An Information-Theoretic Approach to Job Quits," in S. A. Lippmann and J. J. McCall (eds.), *Studies in the Economics of Search*, 1979; and L. L. Wilde, "On the Formal Theory of Inspection and Evaluation in Product Markets," *Econometrica*, July 1980.

<sup>2</sup>See J. Pencavel, "Wages, Specific Training and Labor Turnover in U.S. Manufacturing Industries," *International Economic Review* (13) 1972, 53-64.

The experience attributes of military training can include being away from home, regimentation and competition of military life, group living, intense physical conditioning, and even receiving a full-time paycheck. Similarly, the experience attributes of holding the reserve moonlighting job after training can include various aspects of the military job and on-the-job training, attitudes of fellow reservists, forgone leisure time with a family, and certain aspects of reserve compensation.

One aspect of reserve compensation that may be an experience attribute is the large difference between reserve gross and net pay. Although an average first-term reservist will receive approximately \$1500 annually in reserve pay after completion of training, his net gain in after-tax annual income will only be approximately \$780.<sup>3</sup> The recruit is unlikely to know about this large difference at enlistment; it becomes obvious only during the first term. An associated point is that taxes are often not withheld from reserve pay; finding themselves owing disproportionately high taxes on reserve income may well prove unpalatable to many reservists.

For the Army, several performance attributes cannot be observed or predicted accurately from preenlistment observation or testing. The Armed Services Vocational Aptitude Battery (ASVAB) is partly designed to predict cognitive trainability, and physical examinations are used to screen for physical trainability. However, both of these entrance tests are imperfect and do not screen for the important dimension of psychological adjustment to the military environment.

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<sup>3</sup>The difference between gross and net pay is large for reservists for three reasons. First, approximately 30 percent of a reservist's annual pay is earned at annual training, during two full-time weeks in the summer. During this period, a majority of reservists do not receive civilian income; thus, reserve pay simply substitutes for civilian income and may not contribute to net annual income. Second, reserve pay will be taxed at a higher marginal tax rate than civilian income, further reducing the contribution to net income. Third, transportation costs to and from drills must also be subtracted from net income. Taking these factors into account, the average reservist's first-term net reserve income will amount to approximately 55 percent of gross reserve income. See Burke K. Burright, David W. Grissmer, and Zahava D. Doering, *A Model of Reenlistment Decisions of Army National Guardsmen*, The Rand Corporation, R-2866-MRAL, October 1982.

The Army uses the basic and advanced training process partly to discover the experience attributes that cannot be foreseen, and to make separation decisions based on actual performance. During the 1977-1978 period, when reserve strength was low, the tendency was to set less stringent preenlistment screens and to allow actual performance data during training to determine suitability for military service.

To this point, we have used the simple Wilde model developed for separations from full-time jobs and applied it in a straightforward way to moonlighting jobs. However, the model requires two extensions when it is applied to moonlighting job separation rather than full-time job separation. Moonlighters may quit their moonlighting jobs not only because of experience attributes on their moonlighting jobs, but also because of specific experience attributes on their full-time job which arise because of their moonlighting job. These experience attributes may include scheduling conflicts between the two jobs or lower performance and promotion on the primary job because of the moonlighting job.

Essentially, conflicts between the primary and moonlighting jobs can occur which are not foreseen by the enlistee or the full-time employer. Thus, even though the enlistee performs well on the moonlighting job and the job meets the enlistee's criteria, separation may occur because of conflicts with the full-time employer.

Participation in the reserve may cause more conflict than even the ordinary moonlighting job, owing to an unusual work schedule (16 hours per month, typically on a single weekend) and periods of full-time demand (annual training for two weeks during the summer and an initial period of training of at least three months). This work schedule makes the reservists particularly vulnerable to conflicts between reserve obligations and employers, who must provide leave so that the reservist may fulfill full-time reserve obligations.

Schedule conflicts may be particularly difficult for young persons who have only recently adjusted to civilian full-time or part-time jobs. Conflicts with the civilian employer have been shown to be one of the two leading causes for reservists' leaving at their end of term.<sup>4</sup> One

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<sup>4</sup>See *ibid.*

would expect that these tensions could appear also during the first term of service and cause attrition.

A second extension is necessary to explain separation from the reserve to the active force. The normal theory posits that experience attributes of the reserve job that result in a lower taste for military service will cause attrition. However, another possibility exists. The moonlighter can actually develop a higher taste for the moonlighting job and decide to turn to his moonlighting occupation full-time. He may quit his moonlighting job when he finds a full-time job in the new occupation.

Hence, in the theory, an upper level threshold must exist for the moonlighting job experience attributes which, if exceeded, initiate a job search for a full-time job in an occupation similar to the moonlighting job. Upon finding the new full-time job, the individual quits his moonlighting job. Thus, reserve enlistment may be essentially a stepping-stone to active force enlistment. Survey data<sup>5</sup> on nonprior-service reservists show that a strong motivation for joining the reserve rather than the active force is to try out military service. Reservists who join the active force from the reserve must enter the active force as prior-service enlistees. Data developed in this study show that over the first two years of reserve enlistment 5 to 15 percent of a reserve cohort join the active force.

#### CHANGE IN MARITAL STATUS, EMPLOYMENT STATUS, OR RESIDENCE DURING ENLISTMENT

While the previous subsection modeled the effects of a change in information, this section describes the other change in the reservist's life that might lead to separation. The reservist makes the decision to enlist based on information, labor market, marital status, and home at the time of enlistment. Presumably, major conflicts with employers or spouses that might prevent enlistment do not then exist.

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<sup>5</sup>Unpublished printouts from the 1979 Reserve Forces Study. For a description of the survey, see Zahava D. Doering, David W. Grissmer, Jennifer A. Hawes, *1979 Reserve Force Studies Surveys: Survey Design, Sample Design and Administrative Procedures*, N-1749-MRAL, August 1981. See also Zahava D. Doering, David W. Grissmer, Jennifer A. Hawes, *1979 Reserve Force Studies Surveys: User's Manual and Codebooks*, N-1755-MRAL, September 1981, and Jennifer A. Hawes, *1979 Reserve Force*

During the six-year period of enlistment, a change is likely to occur in the enlistee's marital status, employer, or geographical location of home; any one of these changes means the individual will have to reevaluate his commitment to the reserve job in light of his new circumstances. The likelihood of separation will depend on (1) the probability of these changes occurring and (2) the probability that a given change will actually lead to separation. For young enlistees, these changes occur frequently.

For example, approximately one in two individuals will marry between age 19 and 25.<sup>6</sup> At age 19, only 7.1 percent of males and 22.4 percent of females are married. By age 25, 54.1 percent of males and 71.4 percent of females have married. Employer changes are also frequent during this period. Data show that annual full-time job turnover rates are 36.4 percent for the 18- to 24-year-old group.<sup>7</sup>

Migration data<sup>8</sup> show approximately four in ten 23-year olds move annually. While only 36 percent move outside the original county of residence, even intracounty moves may considerably lengthen the travel time to reserve units.<sup>9</sup> Migration data<sup>10</sup> over longer periods show that 71.2 percent of 23-year olds move over a four-year period, with 30.4 percent moving to a different county.

Moving outside the home area of a reserve unit does not automatically mean separation or the end of the commitment. Transfer to another unit in the new place of residence--if one exists--is possible. However, the new unit may not have a vacancy and will nearly always have a different mission and require a different set of military skills, making retraining or separation mandatory.

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*Studies Surveys: Description and Evaluation of Survey Procedures*, N-1750-MRAL, September 1981.

<sup>6</sup>U.S. Bureau of the Census, *Marital Status and Living Arrangements: March 1982*, Current Population Reports, Series P-20, No. 380.

<sup>7</sup>See S. E. Haber, E. L. Lamas, and G. Green, "A New Method for Estimating Job Separations by Sex and Race," *Monthly Labor Review*, Vol. 106, No. 6, June 1983, Bureau of the Census.

<sup>8</sup>See U.S. Bureau of the Census, *Geographical Mobility: March 1980 to March 1981*, Current Population Reports, Series P-20, No. 377.

<sup>9</sup>Survey data show the average one-way travel time to reserve units to be 31 minutes.

<sup>10</sup>See U.S. Bureau of the Census, *Geographical Mobility: March 1975 to March 1979*, Current Population Reports, Series P-20, No. 353, May 1981.

Not every change in employer or marital status will mandate a separation. The probability of separation, given the occurrence of a particular event, depends on whether the change causes a conflict with continued reserve service and whether the conflict is seen as best resolved through some sort of an adjustment (with employer, spouse, or new unit) or through separation.

If the reservist marries or changes employers, separation will depend on the attitude of the spouse or employer toward reserve service and perhaps on the work schedule of a new job. No direct data exist on spousal or employer attitudes on reserve service during the first term, but some rough inferences can be made from data collected at reenlistment.<sup>11</sup>

Survey data collected from reservists with between 3 and 8 years of service who were making reenlistment decisions show that about one-third of those not reenlisting (60 percent of sample) cited spouse conflict and another one-third cited employer conflict as the main reason for not reenlisting. If we assume that these proportions hold for first-term enlistees as well (i.e., about 40 percent of the incoming cohort will face potentially serious conflicts with either a spouse or an employer), it is clear that such conflicts could be a significant cause of separation. Given the much higher proportion of *new* spouses and *new* employers among this group, it is plausible that these numbers may well be higher.

Geographical relocation poses a slightly different analytical problem. Here the probability of separating depends on the existence of a reserve unit near the new home and the chances of acceptance into this unit, given the previous military training received. The chances of not having a reserve unit within reasonable driving distance of a new home is probably less than 10 percent. A National Guard or Army Reserve unit exists in nearly every community with a population over 25,000 in the nation. Since approximately three-fourths of the population live in communities of over 50,000 and since some proportion of the population in smaller towns is within driving distance of reserve units, the chances of finding a new unit are good.

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<sup>11</sup>See Burright et al. (1982).

However, acceptance into the new unit depends on the availability of a vacancy and being accepted to fill that vacancy. An existing vacancy is likely to require a different skill and, thus, either normal retraining (full-time training at an Army school) or on-the-job training. Acceptance may depend on the willingness to attend full-time training or perhaps the transferability of the previously learned skill to the current job. It may also depend on a match between the grade level of the individuals and the vacancy.

If a serious conflict exists with employer or spouse, it is more likely to be resolved by separating from the reserve job than by adjusting to the employer or spouse. The reserve commitment is tenuous partly because reserve income is a relatively minor portion of total family income. Although data are not available on relative civilian and military wages during the first term, data collected from individuals at the end of their first term show that after-tax net reserve income is approximately 7 percent of total family income.<sup>12</sup> The relatively small contribution of reserve pay to family income implies that an enlistee can fairly easily make up for the loss of reserve income upon separation. It also means that serious conflicts with employer or spouse can easily outweigh the relatively small monetary benefits of reserve service.

The above discussion provides a general framework within which to view reserve attrition. It is, however, more difficult to develop hypotheses about specific variables that can be empirically tested. The available variables are those collected at entrance, and include demographic variables and results of aptitude tests. Missing variables probably affecting attrition include data on changing circumstances in an individual's life, characteristics and status of civilian employment, civilian wages, and employer and spouse attitudes.

We restrict ourselves in this Note to attrition during the training period. We would expect that for training attrition, the new information available to the Army and the recruit during training is likely to be the dominant factor in separation. Changes in employer, marital status, and location are likely to occur not during training,

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<sup>12</sup>See Burreight et al. (1982).

but after return to the home unit. Basically, we posit that a better job search process and an informed enlistment decision will result in fewer experience attributes--i.e., fewer surprises once on the job.

Individuals with higher educational attainment and mental category will likely search for a job and evaluate alternatives at enlistment more capably than those having lower attainment and mental category. Other things equal, older enlistees should also make better enlistment decisions and have fewer experience attributes. A priori, we would expect that, other things equal, there would be no differences by family status, race, and sex.

Military training has two components--boot camp and advanced individual training (AIT). Meeting the requirements probably involves physical, cognitive, and psychological components. Other things equal, meeting the cognitive requirements would be more likely for those testing higher on aptitude tests, those having more education, and those who are older. Other things equal, there should be no a priori difference by race, sex, or marital status. Hypotheses concerning psychological adaptation to Army training are more speculative. Those finishing more years of education have shown a group and institutional adaptation that probably bodes well for adaptation to certain aspects of Army training.

While no strong hypothesis emerges regarding differences by race, age, or marital status, women may find the group adaptation more difficult both because they are a small minority and because they probably have fewer previous competitive experiences common to military training. Adaptation to the physical aspects of training seems to favor certain groups. Available data seem to show that, other things equal, those who can more easily meet the physical conditioning of training would be male, younger, and more educated than their counterparts.

The following hypotheses emerge from the above framework:

- Enlistees who have higher aptitudes and educational attainment should have lower attrition rates because they make better enlistment decisions and have better chances of meeting the cognitive, psychological, and physical demands of training.

- Other things equal, older enlistees may have either higher or lower attrition rates. They should be able to make better enlistment decisions, but may fare more poorly in meeting the physical requirements of Army training.
- Other things equal, races should not affect attrition rates.
- Other things equal, women may be expected to have higher attrition rates because they may have more difficulty than men in meeting physical requirements and in adapting psychologically to a military environment, given their minority status.
- Other things equal, the marital status of the individual at enlistment should not affect attrition rates.

### III. PATTERNS OF PRETRAINING AND TRAINING ATTRITION IN THE 1977 AND 1978 COHORTS

This section presents a preliminary analysis of the attrition data contained in the 1977 and 1978 cohorts, giving, first, a demographic profile of the 1977 and 1978 nonprior-service accessions. Second, it discusses differences in attrition rates for the 1977 and 1978 cohorts over time and other factors. These unconditional rates do not control for other variables correlated with the attrition process. Section IV presents a multivariate model that controls for these effects simultaneously.

#### DATA BASE

The primary data source for reserve personnel information is the Reserve Components Common Personnel Data System (RCCPDS), maintained in the Office of the Assistant Secretary of Defense (Reserve Affairs)--OASD (KA)--by the Defense Manpower Data Center (DMDC). This system, begun in March 1973, became the official source of inventory figures for the reserve forces in July 1974.

DMDC has developed files for four cohorts encompassing fiscal years 1975 to 1978.<sup>1</sup> The cohort file for each fiscal year contains the records for all individuals who were identified as gains during that fiscal year. The files have been updated to reflect information available on any particular reservist through September 1981. Thus, the master file record is attached for each year the individual is present in the reserve, and the loss record is attached whenever an individual leaves the reserve.

In addition, for those who separated, the Active Master File is searched from the date of separation through FY81. If a former reservist joined the active force, his active force enlistment record is added to the file. This effectively gives us four years of data for the FY77 cohort and three years of data for the FY78 cohort. Since

<sup>1</sup>Examination of these data revealed severe problems with the 1975 and 1976 cohorts. As a result, we omitted them from the subsequent analysis.

reservists generally enlist for three- or six-year terms, this means we do not have complete attrition profiles on recruits who choose to serve in the reserve for the full period of enlistment.

In this analysis, we make a distinction between pretraining and training losses and losses during posttraining. The timing of attrition is based on the training pay category of reservists as reported by the components on loss records. As is evident, the validity of our analysis and conclusions, therefore, depends heavily on the accuracy and timeliness of the data generated in the field.

The analysis reported here and in the subsequent section is based on a data file that was constructed by extracting a subset of variables from the original DMDC cohort files. The files include only the Army Reserve and Army National Guard.

#### **DEMOGRAPHIC PROFILE OF THE 1977 AND 1978 COHORTS**

The FY77 and FY78 cohorts are a good place to start attrition analysis because they fully reflect the demographic shifts that started with the transition to an all volunteer force in FY73-FY74. Besides being among the first cohorts to reflect these shifts, these cohorts also will soon allow longitudinal tracking for 4 to 6 years--nearly the entire first term of the enlistee.

The enlistment of higher-quality--often college-educated--draft-motivated reserve personnel typical of the draft era ended in FY74, causing a marked demographic shift in reserve accessions. In subsequent years, personnel with lower educational attainment and a greater proportion of women and minority personnel enlisted.

Between FY73 and FY78, for example, the proportion of women in the nonprior-service accession group rose from 1.9 percent to 15.8 percent. In the same period, the proportion of blacks rose from 11.3 to 27.5, and the proportion of accessions in Mental Categories I and II dropped from 41.0 to 19.9 percent. Analyzing the FY77 and FY78 cohorts provides the first opportunity to evaluate the attrition behavior of the more heterogeneous mix of reserve accessions.

### **Army National Guard**

Table 1 presents a profile of the 80,400 nonprior-service accessions entering in the 1977 and 1978 cohorts from the DNDC Reconstructed Attrition files.

The Guard enlistees tend to be young, with over 60 percent of each cohort being 19 years or younger but with a significant number (about 8 percent) 25 or older. The number of women enlisting in the Army National Guard, around 9 percent of total Guard enlistment, is constrained by the large number of occupational specialties from which women are currently excluded. Single enlistees without dependents account for some 81 or 82 percent of the cohorts; however, the sample of individuals who are married with or without dependents, or single with dependents is large enough for analysis. Blacks constitute about 30 percent of the cohorts.

Mental test ability is measured by the Armed Forces Qualifying Test (AFQT); mental categories are based on test scores. Categories I and II together represent roughly 19 or 20 percent of the total; Category IV, about 13 to 15 percent. The size of the latter group is important, since mental category often is used as a basis for setting recruit quality standards. The size of the sample will allow us to test a basis for those standards. Almost 60 percent of enlistees during FY77 and FY78 were nonhigh school graduates, while the percentage of college graduates dropped from 5.9 in FY77 to less than 1 percent in FY78.

The sample also contains large samples of enlistees from each region of the country. Only the FY77 file contains data on regions.

### **Army Reserve**

Table 2 presents a demographic breakdown for 25,600 nonprior reserve accessions entering in the 1977 and 1978 Army Reserve cohorts. The Army Reserve attracts somewhat older reservists than the National Guard, with a significant proportion (15 to 17 percent) 25 years and older. The proportion of women is higher for the Army Reserve (26.0 percent in 1978) than for the Army National Guard (9.0 percent) because Army Reserve occupational specialties tend to be in combat support categories which are open to women. The marital status of both

Table 1

SIZE AND DEMOGRAPHIC COMPOSITION OF 1977 AND 1978  
NONPRIOR-SERVICE COHORTS, ARMY NATIONAL GUARD  
(Based on DMDC Attrition Files)

Variable:	1977	1978
Size of Cohort		
DMDC Reconstructed Attrition Files	42,281	38,128
<i>Age at enlistment</i>		
17 years	20.9	24.7
18 years	24.9	24.1
19 years	17.0	15.7
20-24 years	28.8	27.7
25-29 years	6.1	5.9
30+ years	2.3	1.9
<i>Sex</i>		
Male	90.7	91.0
Female	9.3	9.0
<i>Marital Status</i>		
Single, no dependents	80.8	82.1
Single, with dependents	5.2	5.2
Married, no dependents	5.8	5.2
Married, with dependents	8.2	7.4
<i>Race</i>		
Black	30.3	29.4
Nonblack	69.7	70.6
<i>Mental Category</i>		
Mental category I	2.9	2.8
Mental category II	17.9	17.0
Mental category III	63.9	66.7
Mental category IV	15.3	13.5
<i>Education</i>		
Nonhigh school graduate	57.1	60.7
High school graduate	37.2	38.4
College graduate	5.7	1.9
<i>Region</i>		
Northeast	20.2	*
North Central	26.4	*
South	35.9	*
West	15.7	*
Other	1.8	*

\*Data not available.

Table 2

SIZE AND DEMOGRAPHIC COMPOSITION OF 1977 AND 1978  
NONPRIOR-SERVICE COHORTS, ARMY RESERVE  
(Based on DMDC Attrition Files)

Variable:	1977	1978
Size of Cohort		
DMDC Reconstructed Attrition Files	9,562	12,717
<i>Age at Enlistment</i>		
17 years	10.6	21.6
18 years	20.9	20.9
19 years	16.9	13.5
20-24 years	34.3	29.0
25-29 years	12.0	10.0
30+ years	5.3	5.0
<i>Sex</i>		
Male	67.6	74.5
Female	32.4	25.5
<i>Marital Status</i>		
Single, no dependents	80.2	81.7
Single, with dependents	1.2	1.0
Married, no dependents	8.5	7.5
Married, with dependents	10.1	9.8
<i>Race</i>		
Black	35.4	32.1
Nonblack	64.6	67.9
<i>Mental Category</i>		
Mental category I	6.9	5.1
Mental category II	30.7	22.1
Mental category III	54.1	62.6
Mental category IV	8.3	10.2
<i>Education</i>		
Nonhigh school graduate	33.2	56.1
High school graduate	49.3	40.2
College graduate	17.5	3.7
<i>Region</i>		
Northeast	28.2	*
North Central	22.7	*
South	32.8	*
West	13.9	*
Other	2.4	*

\*Data not available.

components is roughly similar. Blacks account for a slightly higher proportion of the Army Reserve cohorts than the National Guard cohorts.

Army Reserve accessions score higher, on average, on the AFQT test than Army National Guardsmen and have higher educational attainment. However, there is a marked disparity between FY77 and FY78 educational profiles in the Army Reserve. In FY77, only 33.2 percent were nonhigh school graduates; this percentage jumped to 56.1 percent in FY78.

The regional composition of the enlistment cohorts are similar for the Guard and Reserve, except that the Army Reserve has a somewhat higher proportion from the Northeast.

### **ATTRITION IN THE ARMY NATIONAL GUARD AND ARMY RESERVE**

Reserve attrition may be either programmed or unprogrammed. A reservist generally signs up for a six-year term of service, although three-year terms have always been available to women enlistees and to men during experimental periods. Programmed losses occur at the end of the enlistment term, whereas unprogrammed losses occur before completion of the committed term.

A recruit may leave the reserve unit for many reasons. Computerized records identify losses to active duty, to another reserve component, to another reserve category (Individual Ready Reserve [IRR], Standby Reserve, or Retired Reserve), to officer from enlisted status, and to discharge to civilian life. In the context of total force planning, a loss from the reserve to the active force may be considered differently from a loss to civilian life.

Because any loss to a reserve component means replacement of that individual and the associated costs, we include here all losses to the reserve component. Later studies will distinguish between losses to the active force, other reserve components, and civilian life.

In examining the timing of separation, the differences between reserve procedures and the better known procedures of the active force must be kept in mind. Participation in the active force is a full-time occupation and there is close accountability of personnel. This includes a nondiscretionary daily reporting system of absences; when an individual does not attend, he is reported as absent. A separation decision usually follows shortly--perhaps after some investigation.

In contrast, reserve participation is a part-time job, with most members having a full-time civilian occupation. The accounting system is based on monthly rather than daily reporting. A member can be absent from monthly drills for many reasons, some of which are excused and some of which are not. For example, he may claim that he is ill or out of town for his primary civilian job.

If a member misses two consecutive drills without an excused absence, the unit commander must decide at what point to drop the member from the unit. Although there are some guidelines, commanders have considerable discretion in deciding whether the individual is no longer a functioning member of the unit. This discretion results in substantial variability among units on when and how the separation decision is made. During recent years, however, attempts have been made to establish and enforce uniform standards for discharge.

We have three years of comparable history for both cohorts. Table 3 presents the status of the FY77 and FY78 cohorts as of September 1981. As can be seen, the Army Reserve lost approximately one-half of their entering FY77 and FY78 cohorts to unprogrammed attrition during the first three years. In the Army National Guard, the FY77 cohort lost a significantly higher proportion (61.4 percent) than the FY78 cohort (46.7 percent).

Pretraining and training attrition together accounted for widely varying proportions of total attrition: approximately 19 to 46 percent of the accession cohorts in the Army National Guard and approximately 8 to 16 percent in the Army Reserve. This may reflect a difference in the composition of the accession cohorts or a difference in the methods of detecting and dismissing *potentially* unproductive recruits.

If the component succeeds in weeding out nonproductive recruits prior to or during training, then the training dismissal policy should reduce posttraining attrition. This appears to be the case; second-year and third-year attrition rates were much lower when training attrition was high. While more stringent training standards can reduce posttraining attrition--a desirable outcome--it can also eliminate recruits who would later stay and make productive soldiers. We will

investigate this phenomenon in conjunction with analyzing posttraining attrition.

### FACTORS ASSOCIATED WITH UNPROGRAMMED PRETRAINING AND TRAINING ATTRITION

This subsection examines the relationship between unprogrammed attrition prior to training completion in the Army National Guard and Army Reserve and various factors that could be associated with early attrition. The variables hypothesized to influence attrition included age, sex, marital status, race, education, and mental category. The following rates are unconditional in the sense we are not controlling for other variables that may be correlated with the attrition process.

Table 3

UNPROGRAMMED ATTRITION RATES OF 1977 AND 1978 NONPRIOR-SERVICE COHORTS, BY TIMING OF SEPARATION AND TYPE OF ATTRITION, ARMY NATIONAL GUARD AND ARMY RESERVE

	Army National Guard		Army Reserve	
	1977	1978	1977	1978
<i>Percent of Total Cohort Loss</i>				
During training or pre-training	46.3	19.3	16.4	7.7
During remainder of first year	1.5	4.3	5.4	8.8
During second year	7.0	12.6	16.5	23.3
During third year	7.7	10.8	13.6	12.6
<i>Total Percent Lost Through Three Years</i>	61.4	46.9	51.2	51.9
(N)	(42,281)	(38,128)	(9,562)	(12,717)

Table 4 reports attrition rates by age and region for the services, by cohort year. Notice that these rates can be interpreted as the propensity of a given subgroup to separate during pretraining and training. The bivariate relationship between propensity to separate during training and age shows no consistent trend. Recruits from the South and West tend to have somewhat lower attrition rates.

Table 5 presents attrition rates by sex, race, and marital status. Again, no consistent trend emerges. Table 6 presents attrition rates by mental category and level of education; these rates depict a monotonically decreasing relationship with years of education. Nonhigh school graduates have the highest propensity to leave during this period; recruits with college education, the lowest. We get almost the

Table 4

PRETRAINING AND TRAINING ATTRITION RATES OF ARMY RESERVE  
AND ARMY NATIONAL GUARD 1977 AND 1978 NONPRIOR-SERVICE  
COHORTS, BY AGE AND REGION

	Army National Guard		Army Reserve	
	1977	1978	1977	1978
<i>Age at Enlistment</i>				
< 18 years	54.1	16.8	23.6	8.0
18-20 years	44.5	18.8	18.0	8.3
21-25 years	43.0	22.3	17.0	7.4
26+ years	47.6	25.8	15.7	7.6
<i>Total</i>	46.4	19.4	18.1	8.0
<i>Region of Origin</i>				
Northeast	46.9	*	21.1	*
North Central	52.3	*	17.5	*
South	43.9	*	16.4	*
West	43.4	*	16.7	*
<i>Total</i>	46.4	*	18.1	*

\*Data not available.

Table 5

PRETRAINING AND TRAINING ATTRITION RATES OF ARMY RESERVE  
AND ARMY NATIONAL GUARD 1977 AND 1978 NONPRIOR-SERVICE  
COHORTS, BY SEX, RACE, AND MARITAL STATUS

	Army National Guard		Army Reserve	
	1977	1978	1977	1978
<i>Sex</i>				
Male	46.3	19.3	19.7	8.1
Female	47.7	21.0	13.4	7.7
<i>Total</i>	46.4	19.4	18.1	8.0
<i>Race</i>				
Black	45.5	19.8	16.9	6.9
Nonblack	46.8	19.3	18.8	8.4
<i>Total</i>	46.4	19.4	18.1	8.0
<i>Marital Status</i>				
Single, no dependents	45.3	18.8	16.5	7.6
Single, with dependents	44.8	17.6	17.8	11.3
Married, no dependents	44.9	23.5	16.0	8.4
Married, with dependents	45.6	22.8	15.8	8.6
<i>Total</i>	45.3	19.2	16.4	7.7

same pattern with the mental category variable; Mental Category I recruits have the lowest propensity to leave and Mental Category III and IV recruits have the highest.

Since more years of education probably also mean higher aptitude scores, we have also provided attrition rates by education and mental category in Table 7. The pattern is fairly consistent--both across cohorts and years--with some exceptions. Within each mental category, the attrition probabilities for high school and nonhigh school graduates differ markedly, with nonhigh school graduates being much more likely to leave the reserve during training. Within an educational group, however, a general, but somewhat weaker pattern emerges of lower attrition with higher aptitude.

Table 6

PRETRAINING AND TRAINING ATTRITION RATES OF ARMY RESERVE  
AND ARMY NATIONAL GUARD 1977 AND 1978 NONPRIOR-SERVICE  
COHORTS, BY EDUCATION LEVEL AND MENTAL CATEGORY

	Army National Guard		Army Reserve	
	1977	1978	1977	1978
<i>Education Level</i>				
College graduate	27.3	13.9	10.0	3.2
High school graduate	31.8	16.2	12.7	7.7
Nonhigh school graduate	57.3	21.5	28.5	8.4
<i>Total</i>	46.4	19.4	18.1	8.0
<i>Mental Category</i>				
Mental category I	29.5	10.5	8.2	5.6
Mental category II	36.9	14.8	13.4	7.1
Mental category III	48.3	19.8	21.1	8.5
Mental category IV	51.4	25.5	19.8	7.5
<i>Total</i>	46.3	19.5	18.1	8.0

This section has confirmed that pretraining and training attrition rates vary substantially by characteristics like education and mental category in expected patterns. Certain other characteristics, contrary to expectation, show little or no variation. However, recall that these are unconditional attrition rates: We have looked at the relationship between attrition and each variable in isolation, without controlling for the effect of the other variables. Since there is likely to be correlation between certain of the tested variables, we need a multivariate analysis. The next section presents an empirical model of attrition.

Table 7

PRETRAINING AND TRAINING ATTRITION RATES OF ARMY RESERVE  
AND ARMY NATIONAL GUARD 1977 AND 1978 NONPRIOR-SERVICE  
COHORTS, BY MENTAL CATEGORY AND EDUCATION LEVEL

	Army National Guard		Army Reserve	
	1977	1978	1977	1978
Mental category I, high school graduate	26.5	9.7	7.5	5.1
Mental category II, high school graduate	29.3	15.0	11.6	6.6
Mental category III, high school graduate	31.4	16.5	13.3	8.5
Mental category IV, high school graduate	33.3	21.7	11.8	8.5
Mental category I, nonhigh school graduate	49.7	15.7	21.7	9.8
Mental category II, nonhigh school graduate	52.5	14.4	27.0	9.1
Mental category III, nonhigh school graduate	57.5	21.3	29.0	8.5
Mental category IV, nonhigh school graduate	59.5	26.9	26.7	7.0
<i>Total</i>	<i>46.4</i>	<i>19.4</i>	<i>18.1</i>	<i>8.0</i>

#### IV. A MULTIVARIATE ANALYSIS OF PRETRAINING AND TRAINING ATTRITION

This section develops a multivariate attrition model to assess the separate contribution of factors that, as seen in Section II, appear to strongly correlate with pretraining and training attrition. From the standpoint of setting recruit standards, the multivariate model can be used to estimate the probability of attrition for individuals with specific characteristics and, thus, to determine the best criteria (e.g., education versus mental category) for minimizing attrition.

##### THE EMPIRICAL MODEL

Empirically, the attrition process is summarized by a dichotomous dependent variable that categorizes individuals as stayers or leavers. The outcome variable is defined as:

- $$Y_i = \begin{cases} 0, & \text{if individual } i \text{ stayed through the pretraining} \\ & \text{training periods.} \\ 1, & \text{if individual } i \text{ separated either during the pretraining} \\ & \text{or training periods.} \end{cases}$$

Thus, for the  $i$ th individual, the outcome ( $Y_i$ ) is defined to be zero or one according to whether the individual stayed at time  $t$  or separated.

The conditional logistic regression (logit) model is an appropriate choice for the functional form since it restricts the value of the dependent variable to zero and one. This model relates the separation decision of the  $i$ th individual,  $Y_i$ , to a vector of characteristics for that individual,  $x_i$ . The assumed relationship is:

$$Y_i = P(x_i) + \epsilon$$

where 
$$P(x_i) = \frac{1}{1 + \exp[-(a + \sum_{j=1}^k b_j x_{ij})]}$$

k = number of characteristics measured for individual i  
a, b<sub>1</sub>, ..., b<sub>k</sub> = parameters of the model to be estimated.

Two estimation methods are commonly used to estimate the parameters in studies of this type: conditional maximum likelihood estimation and discriminant function analysis. Since several empirical studies<sup>1</sup> report similar estimates with both methods, we chose the cheaper, discriminant function method.<sup>2</sup>

The variables used in the empirical model are defined in Table 8. Means of variables for the different cohorts and service are given in Table 9. The basic probability function was fit to each service and each accessions cohort separately. We then tested for the stability of the coefficients across the years for a given component. Finally, the predicted attrition rates for different demographic groups are calculated for specific groups for each year and component.

<sup>1</sup>See Winston K. Chow and J. Michael Polich, *Models of the First-Term Reenlistment Decision*, The Rand Corporation, R-2468-MRAL, September 1980; G. W. Haggstrom, "Discriminant Analysis and Logistic Regression," unpublished notes, 1974; and M. Halperin, W. C. Blackwelder, and J. I. Vorter, "Estimation of the Multivariate Logistic Risk Function: A Comparison of the Discriminant Function and Maximum Likelihood Approaches," *Journal of Chronic Diseases*, Vol. 24, 1971, pp. 125-158.

<sup>2</sup>The linear discriminant specification of a logistic attrition model is  $\ln[P(Y_1)/(1 - P(Y_1))] = x\beta$ , i.e., the natural logarithm of the odds ratio is a linear function of x. The estimated coefficients are derived by rescaling the least squares coefficients relating Y and x. In other words, one simply computes a linear probability function by regressing Y<sub>1</sub> on x<sub>1</sub>, using OLS. Then one can obtain the discriminant function estimates  $\alpha$  and  $\hat{\beta}$  as (Haggstrom, 1974):  $\hat{\beta} = (n/SSE) * \beta$  and  $\alpha = \log(P_1/P_2) + [(n/SSE)(\alpha - 0.5)] + [n(n_1^{-1} - n_2^{-1})/2]$  where  $\alpha$ ,  $\beta$  = the OLS intercept and estimated coefficient; n = number of observations; SSE = residual sum of squares from the OLS regression; n<sub>1</sub> = number of observations for which the dependent variable has the value 1; n<sub>2</sub> = n - n<sub>1</sub>; P<sub>1</sub> = proportion of individuals in the target population for which Y has the value 1 (if observations are drawn at random from the target population, one can estimate P<sub>1</sub> using n<sub>1</sub>/n); and P<sub>2</sub> = 1 - P<sub>1</sub>.

Table 8  
DEFINITIONS OF DISCRIMINANT VARIABLES

Variable Name	Variable (Indicator) Definition*
<i>Dependent Variable</i>	
BOTHATT	If reservist separated either prior to or during training
<i>Independent Variables</i>	
NE**	Census Division of Origin--Northeast
NC	Census Division of Origin--North Central
SOUTH	Census Division of Origin--South
WEST	Census Division of Origin--West
FEMALE	Female
BLACK	Black
SINGLE**	Single, no dependents
SINGDEP	Single, with dependents
MARRIED	Married, no dependents
MARRDEP	Married, with dependents
MCAT1HSG	AFQT group I, high school graduate
MCAT2HSG	AFQT group II, high school graduate
MCAT1,2NHS	AFQT group I and II, nonhigh school graduate
MCAT3HSG**	AFQT group III, high school graduate
MCAT3NHS	AFQT group III, nonhigh school graduate
MCAT4HSG	AFQT group IV, high school graduate
MCAT4NHS	AFQT group IV, nonhigh school graduate
COLL	Some college education
AGELT18	Age at entry less than 18 years
AGE18-20**	Age at entry between 18-20 years
AGE21-25	Age at entry between 21-25 years
AGE26	Age at entry 26 years or older

\* Each variable is dichotomous and equals one if the individual has the defining characteristic and is zero otherwise.

\*\* Omitted category used as reference group.

## EMPIRICAL RESULTS

Tables 10 and 11 present the discriminant function regression coefficients. The effects discussed below are *ceteris paribus* effects; they show the effect on attrition of the variable, *holding constant all other variables*.

Table 9

MEANS OF VARIABLES USED IN THE ATTRITION MODEL\*

<i>Dependent Variable</i>	<i>Army Reserve</i>		<i>Army National Guard</i>	
	1977	1978	1977	1978
BOTHATT	.16	.08	.45	.19
<i>Independent Variables</i>				
NE**	.28	***	.20	***
NC	.23	***	.26	***
SOUTH	.33	***	.36	***
WEST	.14	***	.16	***
FEMALE	.32	.26	.09	.09
BLACK	.35	.32	.30	.29
SINGLE**	.81	.82	.81	.83
SINGDEF	.01	.01	.05	.05
MARRIED	.08	.07	.06	.05
MARRDEF	.10	.10	.08	.07
MCAT1HSG	.07	.05	.02	.02
MCA12HSG	.28	.18	.12	.11
MCAT1,2NHS	.03	.04	.06	.06
MCAT3HSG**	.29	.18	.23	.22
MCAT3NHS	.25	.44	.40	.45
MCAT4HSG	.04	.03	.05	.04
MCAT4NHS	.04	.07	.10	.10
COLL	.17	.04	.06	.01
AGELT18	.11	.22	.20	.24
AGE18-20**	.48	.44	.53	.50
AGE21-25	.27	.22	.20	.19
AGE26	.14	.12	.06	.06

\* Since all variables are dichotomous, the means are the proportion of enlistees having the given characteristic. For instance, in 1977, 28 percent of Army Reserve enlistees were from the Northeast, while 32 percent were female.

\*\* Omitted category used as reference group in regression analysis.

\*\*\* Data not available.

Table 10

REGRESSION RESULTS ON PRETRAINING AND TRAINING ATTRITION  
FOR THE ARMY RESERVE 1977 AND 1978 COHORTS\*

Dependent Variable: BOTHATT				
Independent Variable	1977	L- statistic	1978	t- statistic
<i>Constant</i>	-1.914		-2.361	
<i>Region of Origin</i>				
North Central	-.29	3.70**	***	***
South	-.27	3.72**	***	***
West	-.24	2.63**	***	***
F-value****	3.29**		***	
<i>Sex: Female</i>	.07	.92	.20	1.86
<i>Race: Black</i>	-.19	2.93**	-.26	3.46**
<i>Family Status</i>				
SINGDEP	.17	.66	.61	1.72
MARRIED	-.25	1.35	.21	.83
MARRDEP	.12	1.36	.26	2.50**
F-value****	1.51		2.91**	
<i>Mental Scores/Education</i>				
MCAT1HSG	-.47	6.58**	-.63	6.77**
MCAT2HSG	-.31	8.22**	-.20	4.03**
MCAT1,2NHS	.85	17.67**	.06	.92
MCAT3NHS	1.16	41.83**	.54	14.01**
MCAT4HSG	.15	2.85**	.40	5.35**
MCAT4NHS	1.28	33.14**	.82	15.95**
COLLEGE	-.22	4.54**	-.31	2.12**
F-value****	466.51**		80.30**	
<i>Age</i>				
AGELT18	.12	4.27**	-.23	6.83**
AGE21-25	.10	3.56**	.28	7.69**
AGE26	.28	5.95**	.48	7.70**
F-value****	16.92**		58.54**	

\* The coefficients reported here are the discriminant function estimates of the logistic regression coefficients.

\*\* Significant at 5 percent level of significance.

\*\*\* Data not available.

\*\*\*\* For significance of variables as a group.

Table 11

REGRESSION RESULTS ON PRETRAINING AND TRAINING ATTRITION  
FOR THE ARMY NATIONAL GUARD 1977 AND 1978 COHORTS\*

Dependent Variable: BOTHATT				
Independent Variable	1977	t- statistic	1978	t- statistic
<i>Constant</i>	- .957		-1.792	
<i>Region of Origin</i>				
North Central	.28	9.43**	***	***
South	.002	.09	***	***
West	-.07	2.16**	***	***
F-value****	63.40***		***	
<i>Sex: Female</i>	.50	12.93**	.36	7.07**
<i>Race: Black</i>	-.08	3.30**	-.10	3.25**
<i>Family Status</i>				
SINGDEP	.05	1.03	-.12	2.00**
MARRIED	-.18	1.09	-.21	.97
MARRDEP	.04	1.14	.11	2.43**
F-value****	1.16		4.07**	
<i>Mental Scores/Education</i>				
NCAT1HSG	-.42	3.12**	-.59	3.12**
NCAT2HSG	-.22	2.60**	-.38	3.12**
NCAT1,2NHS	1.04	6.14**	.06	.33
NCAT3NHS	1.32	15.78**	.06	.61
NCAT4HSG	-.05	.31	.07	.34
NCAT4NHS	1.10	7.40**	-.14	.91
COLLEGE	-.23	2.62**	-.44	2.30**
F-value****	56.12**		4.19**	
<i>Age</i>				
AGELT18	-.05	.46	-.12	1.28
AGE21-25	.21	2.82**	.11	1.18
AGE26	.11	1.07	-.19	1.44
F-value****	2.95**		1.19	

\* The coefficients reported here are the discriminant function estimates of the logistic regression coefficients.

\*\* Significant at 5 percent level of significance.

\*\*\* Data not available.

\*\*\*\* For significance of variables as a group.

The variables measuring mental category and education level have the highest level of statistical significance as a group, show the largest variation in attrition levels, and generally have the most consistency across years and components. For three of the four cohorts analyzed, there is a high degree of consistency for these variables in the pattern of statistical significance and the sign and magnitude of effects. Only the 1978 Army Reserve cohort shows a somewhat different pattern. The difference in the 1978 Army Reserve may be attributable to the significantly lower level of attrition (.08) experienced by this cohort making sample sizes within some groups somewhat small.

The results for all four cohorts show that, other things equal, CAT1HS have the lowest attrition followed by CAT2HS and CAT3HS enlistees. For three of the four cohorts, CAT3NHS and CAT4NHS have the highest attrition probability. The results are somewhat more ambiguous in distinguishing between CAT3HS, CAT4HS and CAT1,2NHS. In two of the four cohorts, the results show statistically significant higher attrition in CAT4HS and CAT1,2NHS groups than in the CAT3HS group.

Overall, the results show that, other things equal, within a mental category those finishing high school always have lower attrition than those not finishing high school. For those finishing high school, higher mental categories have lower attrition than lower mental categories. For those not finishing high school, a somewhat weaker pattern of lower attrition with higher mental category is present. College was entered separately and proved significant in all four regressions. Other things equal, having some college education decreases the probability of early attrition over and above the effect of the mental category/education variable.

Race appears to have a consistent and statistically significant influence on pretraining and training attrition across all four regressions. Other things equal, blacks have lower attrition rates than nonblacks, but the differences, although statistically significant, are relatively small. For both the National Guard and Army Reserve, other things equal, women have higher attrition rates than men. However, only for the Guard are the differences large and statistically significant.

For the Army Reserve, the age variables were generally insignificant, although the pattern generally shows a higher attrition for those over 20. For the Guard, other things equal, the results show statistically significant higher attrition for those over 20, compared to the 18-20 group, with those over 25 having even higher attrition rates. The results for both components generally show inconsistent results for the 17-year-old group.

The effect of region appeared to be quite important for the 1977 cohorts, although not consistent across the components. As mentioned earlier, no data on region were available for the 1978 cohorts. Other things equal, recruits from the west have significantly lower attrition rates than recruits from the northeast. The effect of the north central variable is inconsistent across the two components, being negative in the Army Reserve model and positive in the Army National Guard model, although strongly significant in both.

A convenient way of summarizing the results and easing the interpretation of the regression coefficients is to estimate the pretraining and training attrition probabilities for any specific group. These probabilities are calculated using

$$P(x_i) = \frac{1}{1 + \exp[-(a + \sum_{j=1}^k b_j x_{ij})]}$$

where  $P(x_i)$  = probability of attrition of a specific reservist  $i$

$x_{ij}$  = values of the explanatory variable  $j$  for reservist  $i$

$b_j$  = estimated coefficients for the  $x_j$ .

To illustrate this, we have estimated attrition rates from the model for individuals with differing characteristics. The reference group chosen is a white male reservist, who was single, from the northeast region, aged 18-20 years, and a category III high school graduate. His attrition rate was then calculated for each cohort and component. The attrition probability for an individual identical in all respects except one characteristic is then calculated.

For instance, Table 12 shows that in 1977 for the Army Reserve our reference individual had a predicted probability of 12.9 percent, while an individual alike in all respects except for being female would have an attrition probability of 13.7 percent.

The results show the largest differences in attrition occur among different mental category and education groups. For instance, in 1977 for the National Guard, changing the reference individual from CAT1HS to CAT4NHS would change the attrition probability from 19.4 percent to 58.0 percent. These are reported in Table 12 and should be of interest to policymakers in that they provide a convenient way of summarizing the regression model effects.

These comparisons could of course be made with a different reference group in question. For instance, if one wanted to look in particular at standards for women enlistees, a set of regression estimates and a reference group of women with changing characteristics could be generated.

For purposes of recruit selection, consistency of the results across years is important. It is also important to distinguish whether different standards might be more successful in reducing attrition in the Army Guard and Army Reserve. Since the Army Guard is predominantly combat skills, while the Reserve is support skills, the differences in training may favor different selection criteria. To analyze these questions, we have made statistical tests to determine

1. Whether the set of model coefficients for different years are statistically equivalent
2. Whether the coefficients for mental category and education variables as a set are equivalent across years
3. Whether individual coefficients for each mental category and education group are statistically different from all others within the same model.

The hypothesis of the equivalence of the sets of model coefficients across years was rejected for both the Guard and Reserve.<sup>3</sup> The more

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<sup>3</sup>See the Appendix for the results. While these tests imply that the coefficients computed for the 1977 cohorts differ significantly from

Table 12

PRETRAINING AND TRAINING ATTRITION PROBABILITIES FOR  
SPECIFIC RESERVIST GROUPS

	Army Reserve		Army National Guard	
	1977	1978	1977	1978
"Average" attrition probability	.129	.086	.277	.143
<i>Region of Origin</i>				
Northeast	.129	*	.277	*
North Central	.099	*	.337	*
South	.101	*	.278	*
West	.104	*	.264	*
<i>Sex</i>				
Male	.129	.086	.277	.143
Female	.137	.103	.388	.193
<i>Race</i>				
Black	.109	.068	.262	.131
Nonblack	.129	.086	.277	.143
<i>Family Status</i>				
Single	.129	.086	.277	.143
Single, with dependents	.149	.148	.288	.129
Married	.103	.104	.243	.119
Married, with dependents	.143	.109	.286	.157
<i>Mental Category/Education</i>				
Category I/high school graduate	.088	.050	.194	.082
Category II/high school graduate	.106	.061	.220	.120
Category III/high school graduate	.129	.086	.277	.143
Category IV/high school graduate	.123	.092	.309	.199
Category I or II/nonhigh school graduate	.294	.091	.473	.150
Category III/nonhigh school graduate	.356	.091	.551	.222
Category IV/nonhigh school graduate	.307	.076	.580	.274
College	.105	.057	.236	.109
No college	.129	.086	.277	.143
<i>Age</i>				
Less than 18 years	.123	.077	.302	.117
18-20 years	.129	.086	.277	.143
21-25 years	.154	.078	.298	.181
26 years or older	.141	.072	.337	.212

\* Data not available.

limited test across the mental category/education coefficient across years was also rejected. These results imply that patterns of attrition relationships for both the Guard and Reserve changed more than expected on a purely statistical basis from 1977 to 1978. It implies that other nonrandom factors were present in at least one year which changed the attrition pattern. However, it should be noted that the relatively large sample sizes involved in the analysis make the statistical tests extremely stringent.

Given that attrition relationships change from year to year, a further question arises as to whether these changes are large enough to actually affect the standard-setting process. To analyze this, we have tested the differences in coefficients between individual mental category/educational group for each set for each model. Table 13 summarizes the directional effect and the significance of mental category/level of education variables (the most important, by far, of all the regressors) with respect to each other. We attempted to answer three questions in this summary table:

1. Is the predicted attrition rate for a particular subgroup (for example, Mental Category I, high school graduate) higher or lower than other subgroups, *holding everything else constant*?
2. Do these rates differ significantly from each other?
3. How consistent are these patterns (i.e., one rate higher or lower than another) over time and across components?

The table compares predicted attrition rates across groups. Reading across the row, a "+" indicates that the attrition rate for the *row* subgroup is lower (or better) than the attrition rate for the *column* subgroup and, further, that this difference is statistically significant; a "-" indicates the opposite (i.e., the *row* subgroup is statistically worse with respect to attrition than the *column* subgroup); and "?" indicates that the attrition rates do not differ significantly between the subgroups.

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those estimated for the 1978 cohorts with respect to magnitude, our findings as to the direction and significance of the effect of the independent variables on attrition still hold.

Table 13

COMPARISON OF ATTRITION RATE DIFFERENCES AND THEIR SIGNIFICANCE  
BETWEEN MENTAL CATEGORY/LEVEL OF EDUCATION SUBGROUPS

	MCAT1, HSC ANG AR	MCAT2, HSC ANG AR	MCAT3, HSC ANG AR	MCAT4, HSC ANG AR	MCAT1&2, NHS ANG AR	MCAT3, NHS ANG AR	MCAT4, NHS ANG AR
MCAT1, HSC							
'77	+	+	+	+	+	+	+
'78	+	+	+	+	+	+	+
MCAT2, HSC							
'77	+	+	+	+	+	+	+
'78	+	+	+	+	+	+	?
MCAT3, HSC							
'77				?	+	+	+
'78				?	?	+	?
MCAT4, HSC							
'77				+	+	+	+
'78				-	?	+	?
MCAT1&2, NHS							
'77						+	+
'78						+	?
MCAT3, NHS							
'77							-
'78							?
MCAT4, NHS							
'77							+
'78							?

NOTES: (a) A "+" indicates that the attrition rate for the row subgroup is "better" (lower) than that for the column subgroup and statistically significant.

(b) A "-" indicates that the attrition rate for the row subgroup is "worse" (higher) than that for the column subgroup and statistically significant.

(c) A "?" indicates that the rates are not significantly different from each other.

To illustrate the results, the 4 plus signs under the column NCAT2,HS and row NCAT1,HS indicate that in each of the four models, NCAT1,HS always had statistically lower attrition levels than the NCAT2HS group. As can be seen in the remainder of the first row, NCAT1HS has statistically significant lower attrition than every other group in each model. The NCAT2HS group similarly dominates all other groups in each model, except for a single insignificant result for the 1978 Army Reserve model for NCAT4NHS.

The certainty of the pattern begins to change for the NCAT3HS group. It either dominates or is insignificant, but never shows a statistically significant different sign. However, comparisons between the NCAT4HS and NCAT1,2NHS group show more ambiguity as both positive and negative statistically significant signs arise.

A similar ambiguous pattern emerges for comparisons between CAT3NHS and CAT4NHS groups. The results are more consistent for the Army Guard than the Army Reserve. The Army Guard follows a perfectly consistent pattern from year to year except for the CAT4HS and CAT1&2NHS comparison. For the Army Reserve, the two samples show several inconsistent results.

## V. CONCLUSIONS AND FUTURE RESEARCH

The rudimentary theory developed to describe reserve training attrition seems to fit the results fairly well. Among all variables tested, education and mental aptitude variables are the strongest predictors of attrition behavior for both the Army Reserve and National Guard for both cohort years analyzed. This strength probably derives from both more informed and thoughtful enlistment decisions as well as better ability to meet the cognitive and psychological demands of training.

Although education and mental aptitude ranked far ahead of any other variables in our analysis in accounting for differences in attrition rates, other variables showed consistent effects. As predicted, other things equal, females had higher attrition rates than males and older enlistees had somewhat higher attrition rates than younger enlistees--although in both cases the attrition differences were markedly smaller, less significant, and less consistent than for the education/mental category variables.

Also as predicted, no consistent pattern emerged for the family status variables. Contrary to the prediction that attrition would not depend on race, blacks showed statistically lower attrition rates than whites across all four samples analyzed.

These models may be used to develop rankings for the selection of recruits according to training attrition risks. For instance, if two recruits are similar in all respects except for education and mental category, then the ordering of attrition risks--which is consistent across components and cohort years analyzed--will be as given in Table 14. In two cases, education/mental category groups cannot be distinguished consistently on the basis of attrition risks: Category IV/high school, Category I/nonhigh school, and Category I-II/nonhigh school groups are indistinguishable, as are Category III/nonhigh school and Category IV/nonhigh school groups.

Table 14

ATTRITION RISKS FOR RESERVISTS DIFFERING  
ONLY IN EDUCATION AND MENTAL CATEGORY

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<i>Lowest:</i>	1. Category I/high school
	2. Category II/high school
	3. Category III/high school
	4. Category IV/high school Category I/nonhigh school Category II/nonhigh school
<i>Highest:</i>	5. Category III/nonhigh school Category IV/nonhigh school

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While our analysis implies that education/mental category groups are the most important variables to look at in establishing attrition risks, other variables cannot be entirely ignored. In particular, in the development of recruiting screens to minimize attrition, the composition of the education/mental category groups must be considered. If different groups contain different proportions by race, sex, or age, then minimum attrition might not be achieved by following Table 14.

Some idea of whether compositional differences are important may be obtained by looking at the actual attrition rates in different education/mental category groups, shown in Table 7, above. For each cohort except the 1978 Army Reserve, the pattern of Categories I-III/high school having the lowest attrition and Categories III-IV/nonhigh school having the highest attrition generally holds. Ambiguity still remains among the middle groups. Thus, Table 14 probably reflects reasonable rules for setting general standards based on minimum training attrition.

The case of the 1978 reserve cohort raises an interesting hypothesis. When training attrition levels were only 8 percent for the Army Reserve in 1978, education and aptitude variables--while significant--distinguished only weakly between those leaving and

staying. Education and aptitude variables appear to matter less when attrition levels are low and more when attrition levels are high. This would imply that a missing variable--perhaps psychological adaptation--screens out the lowest-performing recruits and that mental aptitude and education are important only after these types of recruits are separated. A more detailed set of observations and data collection during training could begin to investigate these hypotheses.

There is also strong evidence that service attrition policy plays an important role in determining the level of attrition. Large differences in levels of attrition between FY77 and FY78 cannot be explained by shifts in the composition of the accession cohort; they are probably attributable to changes in service-directed policies in attrition. It appears that more stringent screening criteria were used during training in FY77 than in FY78 and that this change more than doubled the attrition rate in both the Army Reserve and National Guard.

One effect of this more stringent policy appears to be somewhat lower posttraining attrition, however, it also appears that a significant number of personnel in the FY77 cohort were separated who perhaps otherwise would have served much longer in their term. This hypothesis can be further tested in future work, when cohort data from 1979 and 1980 are added and posttraining attrition is analyzed in greater detail.

The above discussion has focused mainly on identifying variables which could act as screening criteria in order to minimize attrition. An alternate approach would be focus on varying training by type of recruit in order to give higher attrition risk recruits an increased chance of successfully completing the training.

Such an approach is being actively studied by the Department of Defense in its Training Data and Analysis Center (TDAC) which was created to examine these and related issues.

Future directions for attrition research involve the following:

1. Adding data from FY79 and FY80 cohorts.
2. Developing attrition models for posttraining attrition.

3. Developing more complex models that account separately for separation decisions into other reserve components, the active force, or civilian life.
4. Developing prior-service attrition estimates.
5. Incorporating attrition models and manpower costs into a model of force manning that allows testing the effects of different standards, different accession mixes (prior service, nonprior service), different recruiting resources, and different economic climates.

Adding data will allow validation testing of the results given here and, in particular, testing of hypotheses of the effects of new programs initiated in 1979-1980. These include the enlistment bonus and educational benefits, as well as increased recruiting resources. It will be important to further test the influence of service-wide attrition policies on attrition levels in FY79 and FY80.

Models of posttraining attrition are needed to develop improved recruit standards and better screening criteria during training. Evidence given in this report indicates a trade-off between more stringent training criteria and lower posttraining attrition. Models of posttraining attrition, when combined with the current pretraining models, will allow exploration of this trade-off.

The current attrition measure is simply separation from a given reserve component. However, not all separations are equally costly. Some members separate to join another reserve component or the active force. These kinds of separations need to be identified and included in a more discriminating model of reserve attrition. This discrimination is necessary, since personnel who stay within the total force return more of the training investment than those returning to civilian life.

In order to explore the proper mix of prior- and nonprior-service accession, models of attrition of prior reserve personnel are also needed. Data are available to support this analysis. Of course, these models can also be used to improve selection and recruitment of prior-service personnel.

Finally, the attrition models need to be integrated with costs incurred during recruiting, training, and reserve duty to explore how changes in various policies--such as prior service/nonprior-service service mix, recruiting standards, and incentives levels--will affect force manning and force costs.

## APPENDIX TEST OF STABILITY OF COEFFICIENTS ACROSS COHORTS

The regression model was fit to each service and each cohort year separately. Since we want to use these models to help policymakers design recruitment and screening standards to reduce attrition, the stability of the relationship estimated across the two years becomes an important question. We used the Chow test to test for the equality between the two sets of coefficients. The hypothesis that  $\beta_{1977} = \beta_{1978} = \beta$  may be tested by computing the F ratio:

$$F = \frac{(Q_1 - Q_2)/k}{Q_2/(m + n - 2k)}$$

where  $Q_2$  = total of the sums of squared residuals from the 1977, 1978 separate regressions

$Q_1$  = sum of squared residuals from the pooled regression

$k$  = number of explanatory variables

$m, n$  = number of observations in the 1977, 1978 cohorts, respectively.

For the Army Reserve, the computed F-statistic was 16.27; it was 57.88 for the Army National Guard. The null hypothesis of equality was therefore, rejected at the .01 level.

The Chow test was repeated for a restricted subset of the variables so as to examine the stability of the mental category/level of education variables, allowing all others to vary by year. Once again, the computed F-statistics caused us to reject the null hypothesis at the .01 level.

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