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A RAND NOTE

A System for Allocating Selective Reenlistment Bonuses

Judith C. Fernandez

March 1989

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A RAND NOTE

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A System for Allocating Selective Reenlistment Bonuses

**Judith C. Fernandez
with Jennifer Kawata**

March 1989

**Prepared for
The Office of the Assistant Secretary of Defense
for Force Management and Personnel**

RAND

PREFACE

This Note explores the conceptual basis for a cost-minimizing approach for allocating Selective Reenlistment Bonuses among military occupational specialties that are of varying degrees of criticality to the defense mission. It further presents an operational methodology for implementing that approach in the face of the data and computational limitations that characterize the environment in which bonuses are allocated. The whole is designed to support a personal-computer-based program that yields a recommended allocation of bonuses. The program has been transmitted to the Office of the Assistant Secretary of Defense (Force Management and Personnel) separately, and is described in some detail in the appendices to this Note. This work was completed in July 1987.

Judith Fernandez was project leader for the research reported here, and developed the conceptual framework and the basic operational methodology. Jennifer Kawata helped refine the methodology, and designed the code for the personal-computer-based model. Any questions concerning changes in the code should therefore be addressed to Kawata. Queries or comments on broader modelling issues, and questions about appropriate data availability and usage, should be directed to Fernandez.

The conceptual and operational tenents described in this study should be of interest to manpower policy decisionmakers within the Department of Defense, especially those concerned with enlisted personnel management. The research was sponsored by the OASD(FM&P) as part of RAND's National Defense Research Institute, a Federally Funded Research and Development Center sponsored by the Office of the Secretary of Defense. It was conducted by the Selective Reenlistment Bonus Allocation project within RAND's Defense Manpower Research Center.



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SUMMARY

Personnel planners within the Department of Defense are faced with the task of managing an enlisted force composed of hundreds of individual specialties, some with several thousand members and others with only a few dozen. Within every specialty new recruits and experienced careerists must be managed so that every year there are appropriate numbers of each. One tool available to the manpower manager who attempts to meet specialty and skill-level targets is the Selective Reenlistment Bonus (SRB). Awarded to reenlistees in chosen specialties, it is a financial incentive whose magnitude varies among specialties, within certain statutory and policy constraints.

The allocation of a limited SRB budget among numerous shortage specialties is guided by general instructions from the Office the Secretary of Defense (OSD), which are implemented by bonus managers within each Service. Historically the implementation has not always been either consistent with the OSD guidelines or entirely appropriate.

The research reported here suggests an operational methodology that can be implemented by all four Services and that will effectively combine the diverse criteria suggested by previous OSD guidance. Specifically, it provides a set of step-by-step guidelines, and a personal-computer-based program embodying those guidelines, joining the twin criteria of cost and importance of a specialty to the defense mission. (S) p-

An ideal allocation system for bonuses would allocate bonuses across specialties based on a comparison of bonus-related costs for additional reenlistees in each specialty, replacement costs if bonuses are not used and the training pipeline expanded instead, and penalty functions quantifying the damage done to the defense mission if a specialty's grade-specific targets are not met. Incorporated in this framework would be substitution possibilities among enlistees with different but related specialties, and among enlistees at different skill levels within each specialty. Also incorporated would be a time

dimension, capturing the effect on the penalty functions of varying time-paths of filling shortages.

Currently neither the data nor the computational resources available to manpower planners in the military will realistically support such an idealized approach to the allocation of bonuses. We suggest as an immediately available alternative a set of short-cuts and rules of thumb that capture the essential elements of an idealized methodology, and at the same time make transparent important judgments and tradeoffs that are now made implicitly and invisibly by bonus managers in each Service.

The operational methodology essentially consists of eight steps:

1. Determine expected shortages in each specialty.
2. Determine correctly computed replacement cost per additional reenlistee.
3. Determine the change in total bonus cost that will occur, if the bonus multiple were changed for the specialty being considered.
4. Assign each occupational specialty to a priority group.
5. Assign a minimum acceptable fill rate to each occupational specialty.
6. Within each priority group, rank occupations by the size of the difference between replacement cost and incremental SRB cost. Priority groups should then be stacked from highest to lowest, creating a master ranking by priority group and cost difference.
7. Work down the master ranking, assigning increased bonuses to each specialty in turn, until the minimum acceptable manning level is reached, or until a legal or practical constraint is encountered.
8. If the bonus budget is not exhausted by meeting minimum fill rates in all specialties, repeat step 7 using a 100 percent fill rate until the budget limit is reached.

To use this operational methodology, a planner requires information on statutory and policy limits on the maximum allowable bonus and maximum change in bonus level, and the following basic--and currently available--data inputs: current and target manpower levels in each specialty; predicted manpower levels with no change in bonus; estimates of first-term pay, accession costs, and training costs; current reenlistment rates; the change in reenlistment rates expected to occur if the bonus level changes; average basic pay of a reenlistee; and the expected distribution of reenlistments by term of reenlistment (i.e., the percentage of total reenlistments that are for three, four, and six years).

To implement the operational methodology, the planner also needs two inputs that, because they are treated only implicitly in current practice, are not now available in documented form: the relative priorities of different specialties (i.e., specialties categorized into three or four groups based on their importance to the defense mission), and a minimum acceptable percentage of the target manpower level in each specialty. Judgments on these two pieces of information are currently made on an ad hoc basis within each Service as bonus levels are assigned to specialties, but are neither systematic nor visible to OSD.

The operational methodology represented by steps 1 through 8 above has a number of shortcomings, which are discussed in the text. Most derive from imperfect short-cuts necessitated by a lack of certain key data, particularly data on (1) the retention behavior of bonus-induced reenlistees in later terms, (2) relative productivity of soldiers in different year groups, and (3) quantitative information about the importance of any particular shortage to the defense mission.

As better data become available, the methodology described in the body of this Note can be modified to provide improved results (details appear in App. A). In the meantime, the model as currently constructed should noticeably increase the rationality and consistency of the method by which bonuses are assigned to specialties. In addition, total expenditure on training and bonuses may be reduced. Finally, by making the allocation of the bonus budget more visible and more defensible, the

model will provide an improved means of choosing and justifying the bonus budget annually requested of Congress.

ACKNOWLEDGMENTS

This research benefited from the continuing support and encouragement of LTC Steven Strobbridge, Officer and Enlisted Personnel Management, OASD (FM&P), and his predecessor, COL Chris Somers. LTC William Carr of the same office provided invaluable advice and council, and he, as well as a succession of Selective Reenlistment Bonus managers in the Services, patiently answered numerous questions about bonus allocation policies and procedures. RAND colleagues Glenn Gotz, James Hosek, and David Grissmer provided many useful comments in the course of the research. Adele Palmer provided a full and thoughtful review of the final draft of this document. Preparation of the Note was handled by Linda Tanner and Barbara Thurston.

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I. INTRODUCTION

The active military trains and utilizes enlisted personnel in a wide variety of occupational specialties, ranging from relatively unskilled to highly skilled, from large specialties to small. As this Note is written, for example, almost 50,000 Army enlistees are Infantrymen (Military Occupational Specialty 11B), whereas fewer than 150 are Nike Radar Repairers or Terrain Intelligence Analysts. The supply of personnel in each specialty must be managed so as to avoid either shortages or surpluses. The task is complicated by the need to match not only the total requirement for enlistees in a specialty, but also a desired grade or skill-level profile. In some specialties, there may be a large demand for enlistees in the lower grade or skill levels, but sharply lower requirements for senior personnel. At the other extreme, some specialties are open only to senior Non-Commissioned Officers (NCOs).

The Department of Defense and the individual Services have developed an extensive set of tools for managing the distribution of the enlisted force among specialties and over time. Promotions, reenlistment opportunities, and various financial incentives differ among specialties in ways designed, in part, to channel appropriate numbers of personnel at each grade level into each specialty.

The purpose of the research reported here is to provide a conceptual and operational model for allocating among specialties one particular financial incentive, the Selective Reenlistment Bonus (SRB). Due to shortcomings and gaps in available data, the operational model of necessity includes some rough-and-ready procedures and embodies a number of assumptions. We have incorporated the model in software designed to be run on a mini-computer and transmitted this software to OSD. To put the computer model in context, we discuss both the ways in which it represents improvement over current procedures and ways in which it falls short of perfection. We therefore direct a fair amount of attention to current Service practices, and to an ideal methodology. We

also discuss the reasons the ideal cannot be implemented, and suggest ways the software that embodies the operational methodology can be modified as improved data become available.

BACKGROUND

SRBs were instituted specifically as a means of dealing with second-term-and-beyond shortages in particular occupational categories. Trained personnel who reenlist in designated specialties receive bonuses of varying amounts. In some cases there are long-standing retention difficulties in the specialty, while in others shortages result from unexpected changes in requirements or retention. The SRB program aims at alleviating shortages by influencing the reenlistment rates and terms of reenlistment of personnel already in the designated specialties, and by inducing personnel in other specialties to retrain into bonus-eligible specialties when they reenlist.

Funded annually by Congress, the SRB budget must stretch over numerous specialties short of personnel, and over three separate reenlistment points (although historically most bonuses have been allocated to the first reenlistment point). The Department of Defense Instruction governing the allocation of bonus levels to specialties (DODI 1304.22, issued in April 1983) lists several criteria to be considered by the Services when they recommend bonus levels for different specialties. These criteria include:

- Serious undermanning in three or more year groups
- Chronic and persistent shortages in the specialty
- High replacement costs for personnel in the specialty
- The specialty is arduous or unattractive
- The specialty is essential to the defense mission
- There is a reasonable prospect that the bonus will improve manning enough to justify the cost of the bonus

DODI 1304.22 then directs the Services to use a "balanced evaluation" of these criteria to assign bonus levels to specialties. In the absence of more specific guidance, each Service currently interprets

the DODI somewhat differently--their practices are discussed in some detail in the next chapter. At heart, however, the approaches of all four Services consider systematically only (1) whether a specialty is essential to the defense mission (and very few specialties are judged inessential), (2) the degree of undermanning, and (3) the expected increase in the reenlistment rate that would result from a bonus increase. The remaining DoD criteria, including "replacement cost" and "enough improvement to justify cost," are considered only in an ad hoc manner when modulating down from a bonus schedule that will enable all specialties to meet their authorized levels to a schedule that will fit the bonus budget likely to be available.

Initial recommendations for bonus levels are developed annually by the day-to-day managers of the SRB program. An extensive review process occurs before bonus levels are approved and a budget for them presented to Congress by the Office of the Secretary of Defense.¹ At many steps in that process all of the DoD criteria are used as justification for particular bonus levels, and replacement costs are frequently cited in support of bonuses in this or that specialty. As with the initial recommendations, however, costs are considered only on a sporadic basis in the review process, and are not systematically compared across all specialties potentially in need of bonuses.

¹Day to day management of the SRB program generally is done by manpower managers in each Service who also have responsibility for other monetary and nonmonetary incentives designed to attract and shape the career enlisted force (e.g., promotion policies, Pro-Pay). Recommendations from this level may be reviewed and modified at several levels, including the Office of the Deputy Chief of Staff for Personnel of each Service, and the Directorate of Officer and Enlisted Personnel Management in the Office of the Assistant Secretary of Defense (Force Management and Personnel). After the final bonus levels are approved, the appropriate budget is requested from Congress as part of the Military Personnel Appropriation. During the fiscal year, bonus levels may be changed as long as the total budget is not exceeded; changes for occupational specialties of particular importance are reviewed by OASD(FM&P).

ISSUES

In the process of choosing an SRB budget and allocating it among specialties, bonus managers attempt to meet both short-run and long-run goals. Sometimes the major consideration is an "immediate" shortage in a specialty--i.e., current shortages or ones that will appear before new personnel could be recruited and trained. In such decisions replacement costs are irrelevant, and thus properly ignored by SRB managers. Money expended in the past on training enlistees in the specialty should have no bearing on the current decision, because current decisions cannot change past expenditures. The cost of training future recruits is equally irrelevant, because they cannot be trained in time to solve the current problem. (The costs of retraining an enlistee from another specialty into the shortage one may be relevant, however.)

SRB managers consider not just immediate shortages when recommending bonus levels, but also potential shortages 18-24 months in the future. In addition, they recognize that "immediate" shortages may be chronic in some specialties. For these longer-run decisions, training costs are relevant because in the medium and long run there is a tradeoff between accession-plus-training expenditures and bonus expenditures. This tradeoff is not systematically considered in current procedures for assigned SRBs, in part no doubt because the Services lack a framework in which to balance short- and long-run uses of SRBs.

Because shortages in many specialties are chronic, and because bonuses tend to be assigned to many of the same specialties year after year, we address our model primarily to the use of SRBs as a longer term solution to filling the career-force needs of specialties with persistent retention problems.² Although the model we ultimately suggest allows an exogenous selection of some set of specialties that receive bonuses regardless of cost considerations, the major focus of the research reported here is to develop an approach appropriate to long-

²Consideration of bonuses solely as an "emergency" response to unexpected shortages requires a different model--ideally one which would use quantitative information, currently unavailable, on the importance to the defense mission of each separate military specialty at each point in time. This issue is discussed in more detail in Chapter III.

term SRB management that can be used to combine cost considerations with the other criteria listed in the DoD guidelines.

We also suggest that the DoD criteria be modified--"chronic and persistent shortages" and "undermanning in three or more year groups" are somewhat redundant, and whether a specialty faces personnel shortages because it is "arduous or unattractive" rather than for some other reason is not directly relevant to bonus assignment. In addition, we suggest that the costs of bonus-induced reenlistments should include any retraining costs for personnel attracted from another specialty by the bonus.

The following chapter describes in more detail the current DoD guidelines and Service practices briefly discussed above. The theoretic considerations that guide us in suggesting criteria and methodology for allocating bonuses are then reviewed in Chapter III. Details of guidelines and practices that can be implemented consistently in all four Services, and that will systematically incorporate the criteria appropriate to the allocation of SRBs, are the subject of Chapter IV. We conclude with a brief discussion of suggested changes in the DODI governing SRB allocation, and a survey of the limitations of the allocation system we have developed. Finally, the appendices describe the details of the personal-computer-based program that we have developed to implement the operational model described in Chapter IV.

II. CURRENT PRACTICES

Each individual in every occupational specialty in the military fulfills two functions simultaneously: he or she provides current labor input to the military (e.g., performs needed repairs, processes personnel records, provides combat readiness), while at the same time gaining experience and additional formal training in order to be ready in the future to provide labor input of a more skilled kind. Because the active duty components of the U.S. armed forces rely very little on lateral entrants, the second function must be managed simultaneously with the first.

The Services thus face constraints not usually confronted by other employers. Military personnel requirements can be met using one of several manning strategies, but any strategy must explicitly take into account requirements both for the current job and for future ones to be filled from the same group of soldiers. One possible manning strategy would be to determine initial accessions based solely on the need for first-term personnel, and to use bonus or selection policies that vary by specialty to increase or decrease the reenlistment rate to achieve the desired second-term strength. For soldiers induced to change specialties by such policies, retraining would be provided. Bonus/selection policies would be similarly used again at each subsequent reenlistment point to achieve the desired profile over all years of service.

As long as we ignore possibilities for substitution between junior and senior personnel within a specialty, and among skilled personnel formally classified into different specialties, the above strategy is the only one open to the Services, given that they continue to eschew lateral entry from the civilian labor force into shortage specialties. Any other strategy will run afoul of the need to meet the fixed levels of personnel at each pay grade in each specialty.¹

¹We abstract from substitution possibilities here because such substitution is not formally recognized in military personnel requirements. We revisit this subject from time to time throughout the rest of this Note, however.

In practice, the active military seldom exactly meets all of its specialty- and grade-specific requirements. Responses to personnel policies are not known with enough precision to make such a goal practical, and total requirements may exceed total authorizations as well.²

A modified approach, then, might be the following: Regard the requirements as flexible, rather than rigid and precise targets. Search for the accession/reenlistment mix that achieves a reasonable approximation to requirements within the limits set by recruiting, training, and bonus budgets. By "reasonable approximation," we mean that minimum targets for the number of personnel in each grade and specialty are met, but that in some grades and specialties there will be more than the minimum. The minimum acceptable number of personnel may be less than the formal requirement--and indeed it must be less in at least some specialties and grades if overall authorized manpower levels are below total requirements.

It is this latter approach to managing the force that is implicit in current Service practices on assigning Selective Reenlistment Bonuses to occupational specialties. The details of current practices are somewhat *ad hoc*, however, and at times inappropriate to the logic of this strategy. Our recommendations for changes in current practices are essentially changes that incorporate the tenets of the current strategy in a more consistent and appropriate way. Before we turn to that topic, however, we review in more detail the current approach to assigning bonuses.

²In this Note, "requirements" refer to the number of personnel a Service considers necessary, given desired manning ratios. "Authorizations" refer to the (usually smaller) number of personnel allowed within the end-strength and other constraints mandated by Congress.

OSD GUIDANCE

Guidelines published by the Office of the Secretary of Defense regarding the assignment of Selective Reenlistment Bonus levels to specialties, and the administration of the SRB program, are contained in Department of Defense Instruction (DODI) 1304.22. It lists several criteria to be considered by the Services when they recommend bonus multiples for different specialties. The bonus multiple may range in value from 0 (no bonus) to 6, and may take on fractional values. The dollar value of the reenlistment bonus for any individual is determined by the bonus multiple, the basic monthly pay of the individual, and the reenlistment term.

The specific criteria that DODI 1304.22 directs the Services to consider, listed in Chapter I, relate to several distinct aspects of a specialty:

- The level and persistence of shortages in the specialty
- Replacement and bonus costs for personnel in the specialty
- The criticality of the specialty to the defense mission

The DODI decrees the Services will use a "balanced evaluation" of these criteria to assign bonus levels to specialties. In the absence of more specific guidance, each Service currently interprets the DODI somewhat differently.

SERVICE PRACTICES

We describe here the procedures used to assign Zone A bonus levels (bonuses for enlistees who have 21 months to six years of active duty service--basically, bonuses granted at the first reenlistment point). The process is similar for the assignment of the less-commonly-used Zone B (second reenlistment point, six to ten years of service) and Zone C (third reenlistment point, 10 to 14 years of service) bonus levels.

The implementation of the OSD guidelines differs from Service to Service and year to year. Although OSD has requested that Operating Instructions be written specifying the implementation of the DODI as it

applies to assignment of bonus multiples, only the Air Force has produced such a document (Department of the Air Force HQ Operating Instruction 39-4, *Designation of Military Specialties for the Selective Reenlistment Bonus and Enlistment Bonus*).³ With or without written Service-level guidance, as the situation changes and SRB managers come and go, the details of the decisionmaking process change. In general, the practice has been to consider systematically only the degree of undermanning in the skill in comparison with improvement expected from an increased bonus. The remaining OSD criteria, in particular replacement cost, are then considered in an *ad hoc* manner when modulating down from a bonus schedule that will enable all specialties to meet their requirements to a schedule that will fit the bonus budget.

All four Services begin with a comparison of current and projected inventories (up to three years into the future) of enlistees in each specialty, with target manpower levels. The comparison is made separately for each specialty and year of service. This process involves, on the inventory side, a projection of loss and reenlistment rates for each specialty. The projection is usually done by manpower planners within each Service, and transmitted annually to the SRB managers. The modelling and data underlying the projections vary among Services in the number of factors that are assumed to influence decisions to stay in the military (e.g., civilian unemployment, military salaries relative to civilian ones), and also in the extent to which reenlistment rates are in fact estimated separately for different specialties.

On the requirements side, specialty-specific requirements or authorizations initially stated in terms of pay grade are translated into targets expressed by years of service. (SRBs affect reenlistment decisions that occur at a specified year-of-service (YOS) point, not at a particular pay grade.)

³All four Services have Operating Instructions covering the details of the administration and actual payment of SRB bonuses. What is lacking (except in the Air Force) is an explanation of how the bonus multiples are assigned.

In specialties where the projected inventory is approximately in balance with future expected authorizations, the propensity is to leave existing bonus levels unchanged. For specialties where there are projected shortages, the bonus managers calculate the increase in bonus multiple necessary to induce sufficient reenlistments to meet requirements or authorizations. The estimated increase is based on the "bonus improvement factor," which is the increase in the reenlistment rate thought to result from a one-level increase in the bonus multiple.

Bonus managers in each Service usually rely on bonus improvement factors that have been previously estimated by a Service laboratory or outside contractor, modified by the manager's own judgment and recent experience. The same bonus improvement factor may be used for all specialties, or, more often, specialties will be grouped together in a handful of categories, with factors varying among categories but not within them.

Identifying the bonus multiple needed to ensure full manning of each specialty focuses attention on the number of enlistees who will be induced to begin their second term of enlistment in the shortage specialty. The length of time the person will spend there, and whether the person is continuing in the specialty or joining it after retraining, are factors the managers recognize as important, but are considered at a different stage in the process, if at all.⁴

⁴Enlistees changing specialties at reenlistment (either in response to a bonus or for some other reason) normally extend their first term of service for a length of time sufficient for retraining. Once qualified in the new specialty, they reenlist. All four Services recognize that bonus-induced retraining is costly, but tend to address this problem as part of a broader issue of the appropriate amount of retraining rather than as part of bonus management. Similarly, all Services recognize that bonuses induce longer terms of reenlistment because the dollar value of a bonus increases with the amount of additional obligated service, up to the maximum allowable bonus payment (limited by Congress to \$30,000, but sometimes limited to less than that by Service policy). The inferences drawn from this latter knowledge differ across Services, and affect general bonus policy. For example, the Air Force favors lower bonus multiples in part because of a feeling that the effects of higher multiples on reenlistment term will be blunted by the bonus payment ceiling.

Having developed a schedule of bonus levels that will erase the shortage in each specialty (or the bonus level will be the maximum allowed), the bonus manager computes the budget implied by the schedule. Usually this budget is very much greater than the budget likely to be available. (The likely budget may be defined by guidelines from above, or by last year's bonus budget plus some increment.) Then begins the process of modulating down to a schedule of bonus levels that will fit within the likely budget.

At this point in the process the criteria listed in DODI 1304.22 enter. Service bonus managers consider undermanning in adjacent year groups, the degree to which the defense mission would be jeopardized by a shortage in a particular specialty, the costs of training new personnel in the specialty, and so forth. The judgment of the bonus manager becomes crucial, because the manager has no framework for considering these factors quantitatively or systematically.

Faced with multiple criteria but no guidance on how to weigh or combine them, each manager thus uses his or her best judgment. That judgment is based on a general knowledge of cost levels, and other relevant items, but specific information is seldom incorporated. Rather, it is marshalled after the decisions are made, to support whatever parts of the bonus schedule are challenged. What quantitative data there are--e.g., degree of undermanning, replacement cost--tend to be used *ex post* to justify decisions, rather than *ex ante* to inform or guide.

In a similar fashion, those charged with oversight of the bonus managers, and with responsibility for approving the bonus schedules, use their own general knowledge and judgment to challenge or support the bonus levels recommended for individual specialties. They, too, have no easy access to either data or models that would allow for more systematic approaches.

Given the difficulty of quantifying many of the considerations that influence bonus decisions (e.g., importance of a specialty to the defense mission), and the inherent complexity of the tradeoffs being made (is a 5 percent shortage of radio repairmen more or less important

than a 5 percent shortage of infantrymen?), no "system" will replace experienced judgment. But a system can allow the judgment to be more fully informed, and can make the judgment more visible.

III. AN IMPROVED SYSTEM: CONCEPTUAL FRAMEWORK

Current Service practices in the assignment of SRBs to occupational specialties suffer from the lack of a framework with which to combine the multiple relevant criteria into a single decision. We next suggest such a framework, and develop from that framework an idealized system for bonus allocation. Compromises imposed by data and computational constraints are then discussed in Chapter IV. The discussion here is intended both to provide the rationale for the operational system for bonus allocation that follows, and to suggest how that system might be improved if better data were to become available.

ASSUMPTIONS AND SIMPLIFICATIONS

Because we are examining the allocation of reenlistment bonuses in isolation from the remainder of the personnel management system, we need to make assumptions about what will happen in the rest of the system as bonuses are raised or lowered.¹ The two major assumptions embodied in the conceptual framework described here are:

1. The Services will make an effort to increase accessions into specialties that experience chronic shortages. Thus over a medium-to-long-term time horizon, shortages not corrected using bonuses will tend to be corrected by inducing higher levels of accessions.
2. The Services will not always be successful in correcting all shortages even when using both accession policy and bonuses. There will thus continue to be shortages, whose distribution across specialties is influenced by bonus and accession policies.

¹In a fully developed general model of personnel management these topics would be treated explicitly as policy variables or parameters, and would be subject to sensitivity analysis.

The first assumption arguably does some injustice to reality. Increases in the number of trained personnel in a specialty can be induced by methods other than bonuses or increased accessions--more rechanneling from overmanned to shortage specialties as a condition for remaining in the military, for example. But the costs of other policies, and their ramifications, are quite difficult to identify and quantify, and hence difficult to compare with bonuses. If these other policies are not significant influences, or if they are exploited as fully as possible before either bonuses or increased accessions are considered, then assumption 1 may be considered acceptable.

THE TRADEOFF

The system described here thus is based on the notion that more enlisted people of a given skill level in a given specialty can be obtained in one of two basic ways. First, more people may be sent through the training pipeline, so that even though nothing else changes, more skilled or trained people will appear in the second or subsequent terms because more untrained people have started through the process. Second, there may be the same number of people starting through the pipeline, but with more of them choosing to stay.

This strategy recognizes that one additional enlistee at the four-year point (for example), can be obtained through (a) an increased number of new accessions with an unchanged reenlistment bonus, thus leaving the reenlistment rate unchanged, or (b) an unchanged number of new recruits coupled with an increased reenlistment bonus that retains more of them. The alternatives will have different implications for the years-of-service profile of the force, but both will provide the same number of second-term personnel. Which alternative is preferable will in part depend on the marginal costs of increased reenlistments compared with the marginal costs of increased recruitment-plus-training. Thus, if cost-effectiveness is taken as the sole criteria, bonuses are warranted in those specialties where a trained person-year of service can be obtained more cheaply through a reenlistment bonus (or an increase in the reenlistment bonus) than through new recruits. Paying

bonuses whenever this criterion is fulfilled will allow the smallest possible training-plus-bonus expenditure, given the occupation-specific requirements for trained personnel in all grades.

A better idea of the tradeoff that is the heart of the cost-effectiveness strategy can be obtained with the help of Fig. 1, which gives a stylized picture of the training process in a specialty in the first enlistment term. The width of each bar corresponds to the cost of each step of the pipeline in order while the height corresponds to the number of additional enlistees needed at each step to produce one additional enlistee at the beginning of the second term of service. The total area enclosed by the bars indicates the cost to get one additional enlistee out of the pipeline.

Similar figures could be drawn for later reenlistment points as well. With no bonus payments at earlier reenlistment points, the figures would differ from Fig. 1 in the height of each bar, because for later years of service, more enlistees are needed at each of the earlier steps due to attrition between the first reenlistment point and whatever year is being considered. If bonus payments at earlier reenlistment points are allowed, there will be a different variant of Fig. 1 corresponding to each bonus pattern. If one is considering one additional reenlistment at, say, the third reenlistment point, then the appropriate comparison is between the cost of a reenlistment bonus at that point and the costs of getting one additional enlistee at the same point via a different combination of new accessions and second- and third-term bonuses.

The general point to be noted here is that, at a given level of bonuses and reenlistment rates, it will take more new recruits in order to have one additional person remaining at, say, the 15th year of service than it will to get one additional person at the 7th year of service; the difference will depend on attrition between the earlier point and the later point. The difference will be reflected in additional costs in the training pipeline--corresponding to an increased height of the bars in Fig. 1.

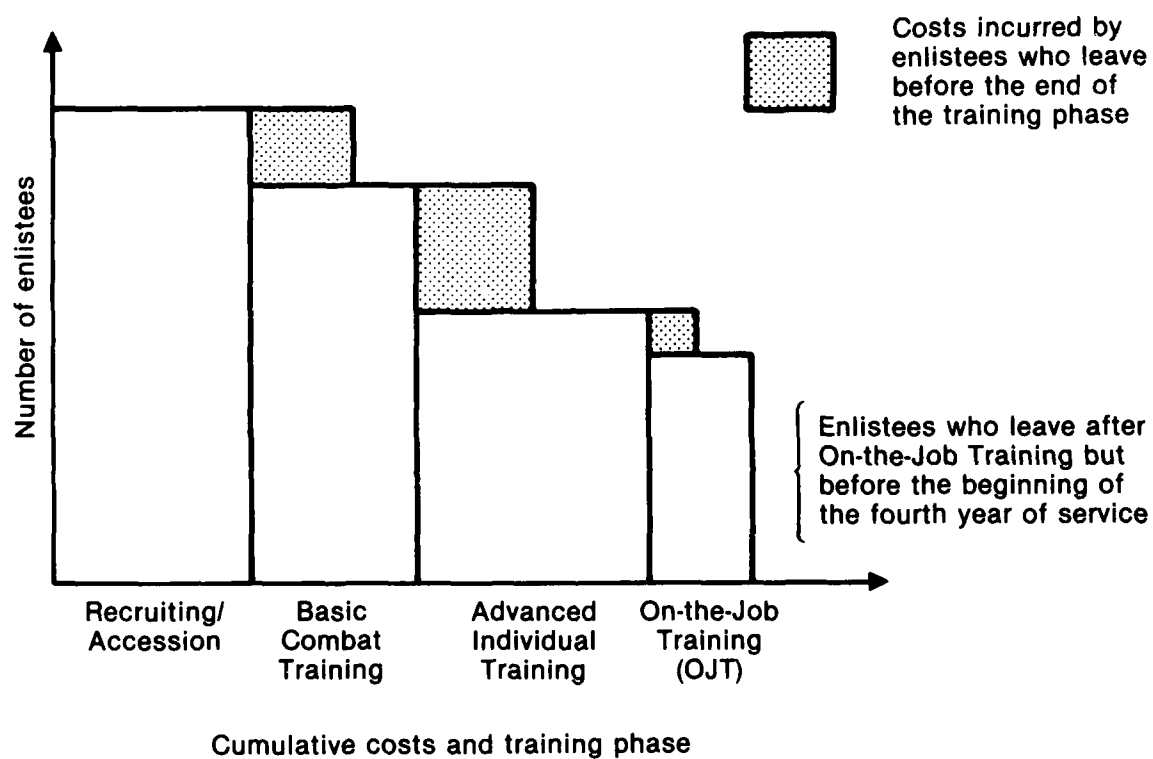


Fig. 1—Stylized enlistee training path

The relevant comparison for manpower managers is the cost associated with getting an additional person at any given point via bonuses, as opposed to the cost to get an additional person out the end of the pipeline shown in Fig. 1. More precisely, the comparison should be between the cost of getting an additional person-month (or person-year) of trained labor from bonuses versus the cost of expanding the training pipeline. The measurement of cost would include total manpower costs (recruitment, pay, bonuses, retirement accrual, in-kind benefits, etc.) associated with two alternative force profiles, one utilizing increased accessions and unchanged bonuses, the other unchanged accessions and increased bonuses. The amount of labor provided also should be measured over the full life cycle of a cohort--i.e., it should include months of labor provided in the first term after the end of training, and in post-bonus terms of enlistment.²

When trained personnel with different experience levels provide significantly different kinds of service, or have different levels of productivity, then in an ideal system a "trained person-month (or person-year)" should be adjusted for productivity differences among different years-of-service or experience levels as well.³

²First-term person-months of trained labor should be included because increasing the accessions pipeline not only increases the number of reenlistments, but also increases the amount of first-term labor supplied. Months or years of labor provided in reenlistment terms after the one for which the bonus is granted need to be included if the loss rate of an entering cohort depends on its size, or if the bonus has a prolonged (rather than one-term) effect on attrition behavior.

³A cost-minimization model of this type, using rudimentary productivity data estimated for a few specialties, is discussed by Ellen Balis, *Balancing Accession and Retention: Cost and Productivity Tradeoffs*, Center for Naval Analyses, Professional Paper 380, March 1980. A simulation-based model incorporating cost and productivity considerations for a few broad groups of specialties, using user-specified productivity information, has been developed by C. Peter Rydell and documented in *ALEC: A Model for Analyzing the Cost-Effectiveness of Air Force Enlisted Personnel Policies*, N-2629/1-AF (Theory and Results) and N-2629/2-AF (User's Guide), The RAND Corporation, August 1987.

WITH A REQUIREMENTS CONSTRAINT

In a system with an unconstrained budget, the appropriate manpower strategy is to regard the requirements or authorizations at each pay grade as minimum acceptable levels. A model which minimizes total manpower costs per (productivity-adjusted) trained-year-of-service-provided, subject to the constraint that the minimum manning levels be met or exceeded in each specialty, would then solve the management problem of meeting requirements at least cost. The solution to this cost-minimization problem yields optimal levels for recruiting, training, and bonus budgets. Some specialties and grades would have "excess" personnel but, in view of requirements in later years, "carrying" these personnel in the meantime would be less costly than the alternatives.

WITH A BUDGET CONSTRAINT

The military, however, is not free to set its recruiting or bonus budgets by the use of a cost-minimizing model such as described here. It may be in a situation where all requirements cannot be met within the budget it is allocated by Congress. The cost-minimization process thus proceeds (to the extent that cost-minimization is one of many goals in managing the enlisted force) in the context of decisions about which requirements will be met.

The systematic treatment of cost-minimization in a context where budget and other considerations dictate that attaining all personnel targets is not possible requires the addition of another consideration to the modelling: penalty functions. In general, what is required is information on the relative importance of meeting different targets at each point in time. In the context of specialty-specific manpower management, there are two valuations that need to be made: the relative importance of meeting requirements of different grades, and the relative importance of meeting requirements in different specialties. The basis of the former comparison should be differences in productivity of people at different grade levels within a specialty, whereas the latter comparison ideally should be based on the marginal contributions of different specialties to the defense mission.

OTHER CONSTRAINTS

Up to this point, our conceptual approach ignores certain real world facts, in particular statutory limits on total enlisted end-strength. End-strength constraints may be binding for at least two reasons: (1) target manpower levels may aggregate to more than the allowable total end-strength, if requirements, rather than authorizations, are used as the targets; or (2) the "excess" manpower in one term of service (needed as a least-cost way of generating sufficient labor in a later term of service) may cause total manpower levels to exceed end-strength constraints. Incorporating end-strength limits is relatively straightforward conceptually, although it may result in an overdetermined system. (This may in reality be the situation the Services face.) But adding end-strength constraints and possible other policies introduces considerable complexity.⁴ At the same time they cannot be incorporated in operational models, because of data gaps.⁵

Therefore, for the remainder of this chapter, and for the discussion of the operational model in Chapter IV, we will ignore end-strength constraints. This simplifies the discussion, at some injustice to reality. But the injustice will be minimal if in the context of the issues discussed here (i.e., the accessions versus bonuses tradeoff) bonus budgets are more likely to be a binding constraint than are end-strength limits.

⁴An approach very similar to the one described here, but incorporating constraints on end-strength (and constraints on accession levels), is described in mathematical terms in David Grissmer and Judith Fernandez, "Meeting Occupational and Total Manpower Requirements at Least Cost: A Nonlinear Programming Approach," in Curtis Gilroy (ed.), *Army Manpower Economics*, Westview Press, 1986, pp. 361-384. That presentation also posits two quality subgroups within each specialty and term-of-service group.

⁵In addition to the data discussed later in the text with reference to bonus budget constraints, incorporating end-strength constraints and other tools requires data on such issues as (1) the contribution to the defense mission of "excess" soldiers in overmanned specialties and (2) costs of using other available tools to channel soldiers from overmanned to shortage specialties.

Binding bonus budget constraints are specifically incorporated in our conceptual and operational models, along with limits on individual bonuses prescribed by policy or statute. With such constraints, the military faces a situation where even after the full bonus budget has been spent, shortages may remain in some specialties.

AN IDEALIZED ALLOCATION ALGORITHM

Based on the above conceptualization of the tradeoff between increased new recruits and improved retention of already-trained enlistees, we can put together the outline of an idealized approach to the allocation of reenlistment bonuses among specialties. That is, we can describe an optimization approach that would be appropriate if sufficient data and computational capacity were available.

The idealized approach would simultaneously consider the possibility of bonuses at all reenlistment points (i.e., Zone A, B, and C Selective Reenlistment Bonuses). It would use as a baseline starting point not current shortages and current bonus levels, but all possible combinations of accessions and retention that would meet or exceed predetermined target manning levels by occupation and skill level. The algorithm would then select from all possible combinations the accession and bonus at each reenlistment point that produced at minimum cost the desired force profile within each specialty, given policy and budget constraints on bonus payments.

This idealized algorithm would require the following inputs:

- Replacement cost for an enlistee at each skill level in each specialty, expressed in terms of cost per trained man-year of labor provided by the enlistee
- Cost for bonus-induced increases in retention, also expressed as cost per trained year of service obtained, and including not only bonus payments but also any retraining costs incurred when reenlistees change specialties

- Institutional and statutory constraints on bonuses (e.g., legal maximums, preferred maximum increases in bonus multiples)

Costs should be measured as marginal or incremental cost--the increase in total cost occurring when one additional trained-person-year of service is obtained. Normally both replacement and bonus costs would be increasing functions of trained person-years; incremental cost per soldier may well increase as more and more new recruits are obtained, and as larger numbers of reenlistments are sought.

If the reenlistment bonus budget is unconstrained, then cost-minimization, taken in conjunction with institutional constraints, is sufficient to produce bonus recommendations for manning the active force. Considerations other than dollar costs also may be incorporated as long as they can be quantified and expressed either as a dollar-denominated value or as a minimum or maximum acceptable manning level for an occupational or skill-level group (or an aggregation of such groups).

If, however, the bonus budget is constrained, additional information is needed to inform the choice as to which manning targets are to be left unmet. Specifically, the importance of shortages in each occupation and skill level should be measured, based on the effect of each shortage on the overall accomplishment of the defense mission. Presumably this will depend on

- The criticality of the specialty as a whole to the defense mission
- Substitutability among skill levels within a specialty, and whether shortages exist in other skill levels
- Substitutability among occupations, and whether shortages exist in substitute occupations

In the presence of this information, an idealized algorithm could proceed in one of two ways. If the importance of shortages to the defense mission can be quantified in terms of dollar-denominated penalty

functions, then the algorithm will be designed to minimize, not costs, but costs net of penalties, given the bonus budget constraint.

The use of penalty functions, however, requires absolute measures of the effect of potential shortages. If all we know is the relative importance of shortages in different specialties, an allocation algorithm might proceed as follows:

1. Compute the difference between total manpower costs using increased accessions and using increased bonuses, with each total prorated over expected years of service. This difference in cost per trained year of service is the cost savings attributable to using reenlistment bonuses to alleviate a particular shortage.
2. Weight the cost savings based on the relative importance of the shortage.
3. Assign the top-ranked shortage group a bonus multiple of one (or increase its bonus by one step).
4. If costs are nonlinear, repeat step 1 using new figures, based on the points on the training and bonus cost functions that have been affected by the changes implicit in step 3.
5. Repeat steps 1 through 4 until the bonus budget is exhausted, or until bonus costs exceed replacement costs in all remaining occupations and skill groups.

In view of the large number of specialties and skill groups in the armed forces (the Army has over 500 Military Occupational Specialties, each of which contains four skill levels), implementing such an algorithm would be computationally quite demanding. More importantly, it requires information on (a) substitutability among and within occupations, (b) the criticality of each specialty to the defense mission, and (c) the shape of cost functions. Quantitative information on all points is difficult to come by. However, the appropriate way of allocating reenlistment bonuses across specialties relies on them. And all are currently taken into account in bonus decisions, albeit in an *ad hoc* manner.

The objective of this research is not to replace these decisions with a large-scale numeric model; with the current state of information this would not be possible. Rather, we use the above idealized approach to guide us toward rules-of-thumb and procedures that will more closely approximate the ideal than the current system does.

IV. AN IMPLEMENTABLE METHODOLOGY

In view of the difficulty of obtaining the data necessary to apply the idealized methodology of Chapter III, a much simplified allocation approach is required if the reenlistment bonus program is to incorporate a systematic approach to assigning bonus levels to specialties. In this chapter we describe such an approach, and present operational guidelines for its implementation. This approach and the guidelines also have been embodied in a software package based on the commercially available spreadsheet program Lotus 1-2-3; the software is described in the appendices to this document.

ASSUMPTIONS AND SIMPLIFICATIONS

The operational methodology is based on the same two basic assumptions that underlie the conceptual framework (see the beginning of Chapter III), plus two behavioral assumptions. We also employ a number of simplifications to reduce computational complexity and deal with data deficiencies.

The first additional assumption we introduce is: increased manning in a particular specialty induced by a bonus comes from one of three sources: (a) personnel already in the specialty who would otherwise leave the military; (b) personnel retraining into the specialty who would otherwise leave the military, or (c) personnel who would stay in the military regardless of the bonus, but who retrain from an overmanned specialty. The one group excluded by this assumption is personnel who would reenlist regardless of bonuses, but who move from one shortage specialty to another because of a bonus.

This additional assumption is introduced because of data gaps and considerations of computational tractability. If bonuses in one shortage specialty attract people from other shortage specialties, then full information is needed about patterns of in- and out-migration for each specialty, and how the patterns are affected by bonuses, before bonuses can be allocated cost-effectively. Such data generally are not

available. Computationally, the assumption allows us to model bonuses as though the additional people attracted by the bonus represent pure improvements in the aggregate level of shortages, rather than as the direct cause of a shortage elsewhere that then needs to be filled-- at some cost that must be considered.¹ The assumption is reasonable unless there are frequent movements among shortage specialties by personnel already committed to a military career.

The second behavioral assumption we introduce into the operational methodology is embodied in the use of the number of reenlistees in each specialty as our unit of measure. Thus we implicitly assume that the same number of man-years in later terms of service will be generated by either new accessions or increased bonuses. This assumption is unlikely to be precisely true; we do not know the degree to which it approximates reality because we simply do not know the out-year effects of bonuses for individual specialties. If such data ever become available,² they can be readily incorporated in the operational model, as discussed in the final section of App. A.

In addition to the above assumptions, the operational methodology incorporates a number of simplifications to deal with data deficiencies and avoid computational complexities:

1. The allocation algorithm begins with current bonus levels and shortages, rather than *de novo*. This simplification both greatly reduces the computational capacity needed to run the model and allows easy incorporation of Service or OSD policies proscribing large year-to-year changes in any specialty's bonus level.

¹The basic conceptual approach remains unchanged if we allow migration among shortage specialties of personnel who would reenlist anyway. Much complex detail, and a system of simultaneous equations, however, is required to incorporate the tracking and costing of all possible sources of personnel retraining for each bonus specialty.

²Because of lack of historical variability in bonus levels in many specialties, it may not be possible to empirically estimate specialty-specific out-year effects using current data.

2. Currently available estimates of accession and training costs are used. If better estimates become available, they can be directly used as input into the operational model (again, see the final section of App. A).
3. Both bonus and replacement costs are assumed constant in the neighborhood where changes occur, specifically, within two steps of a specialty's starting-point bonus level. (The operational model is not easily adaptable to nonlinear cost functions.)
4. Specialties are grouped within a relatively few groups based on the criticality of the specialty to the defense mission, and criticality is not necessarily based on shortages in related specialties or skill levels.
5. The allocation is based on current and/or near-term future shortages; bonuses justified by projected shortages in the subsequent enlisted terms are allowed, but not explicitly incorporated in the allocation process.

Of the simplifications introduced to meet the data and computational limitations of tools available to the typical SRB manager in each Service, the last is arguably the most important. The cost tradeoff that is the conceptual basis of the idealized allocation system is medium to long term (a tradeoff of accessions and reenlistments implies at least a one term-of-enlistment time horizon), yet we do not explicitly incorporate projections of shortages in later years in the operational model. This choice is based on two considerations.

First, incorporating time in an integral fashion in the allocation methodology would require an inventory-projection or force-aging model. Although all four military Services now support at least one version of such a model, incorporating them into bonus-allocation guidelines for SRB managers would require data, modelling, and computational capabilities that are difficult and expensive to support. More importantly, currently supported inventory projection models used by the Services generally are weak on specialty-specific detail--and it is

precisely in the longer-term aspects of specialty-specific retention rates and behavioral responses that they are weakest. Although long-term tradeoffs provide the ultimate justification of the cost trade-off aspects of bonus allocation, long-term projections of shortages and overmanning would impose large support and computational burdens on SRB managers and overseers, without much prospect of accuracy.

Second, the introduction of a full inventory projection scheme into bonus allocation would require as a concomitant a fully developed, quantitative description of the time-criticality of shortages in any given year (i.e., can the Army wait to "grow" new skilled personnel). As we shall see below, this aspect of bonuses is handled in our suggested allocation scheme by incorporating expert judgment and knowledge of the current situation into the assignment of a specialty to one of a small number of priority groups each time reenlistment bonuses are reconsidered (generally once a year, as part of the POM [Program Objectives Memorandum] cycle).³

Thus for basically practical reasons the allocation methodology described in the remainder of this chapter relies primarily on a measurement of shortages that looks only a short distance into the future. This approach assumes there is no substitutability among enlistees several years apart in experience levels, and assumes that the time-criticality of shortages is best handled by exogenous judgments on priority rankings for specialties. It also assumes--as does the idealized methodology--that either (1) most shortages are chronic, rather than a result of one-time-only special circumstances,⁴ or (2) most shortages are not extremely time-critical to fill. If neither is true, the justification for considering replacement cost in any way is weak; we are back to a need to use only penalty functions (as discussed in the introduction).

³A theoretic exposition of the approach needed to incorporate a time-criticality function into a personnel planning model is presented in Patricia Munch, *A Dynamic Model for Optimum Bonus Management*, The RAND Corporation, R-1940-ARPA, January 1977.

⁴James Hosek and Christine Peterson note the extent to which shortages--and bonuses--tend to persist year-to-year; see *Reenlistment Bonuses and Retention Behavior*, The RAND Corporation, R-3199-MIL, March 1985.

One other important point should be noted here. The procedure described below is at heart based on a *ranking* of the difference between the replacement cost and the bonus cost associated with an additional enlistee in each speciality. Due to the simplifications discussed above, the *absolute magnitude* of the difference is unlikely to be accurate; for our purposes, *relative magnitude* (the rank ordering of the difference across specialties) is used instead. Specifically, we may well be overestimating the amount of cost savings when bonuses are used instead of increased accessions.⁵ As long as the degree of overestimate does not vary systematically across specialties, this does not concern us here. It does mean, however, that replacement costs computed as described below should be used with extreme caution in situations where the value, rather than the rank ordering, of cost savings is important.

GENERAL PROCEDURE

In general terms, then, the implementable methodology we have designed to allocate a constrained bonus budget among military occupational specialties provides an operational way to combine three criteria:

- Minimum acceptable manning level in each specialty
- The difference between replacement cost and bonus cost per additional reenlistee
- Criticality of the specialty to the defense mission

⁵We include in our estimate of replacement costs the first-term pay of the recruits. But since we abstract in the operational model from years of labor provided, we have no way of accounting for the labor these recruits contribute. If we could compute "net pay" of recruits in their first term--i.e., pay less the value of labor provided--our replacement cost figure would be more accurate in absolute terms. The greater the value of labor provided, the greater our overestimate of net replacement cost. If the value of first-term labor equals the pay rate during the first term, the true measure of replacement costs collapses to accession plus training cost (both adjusted for attrition) only.

The methodology begins, not with a baseline level of no bonuses, but with current bonus levels and shortages. It also incorporates a rough correction so that currently reported accession and training costs more nearly approximate the "replacement cost" that is needed for appropriate cost comparisons.

Much of the data needed for the operational methodology to be applied is available to Service bonus managers. Two pieces of information, however, need to be developed--minimum manning levels and priority groupings. Decisions on these aspects of shortage specialties, made implicitly now by Service bonus managers and those who oversee them, become explicit in the operational methodology suggested here.

STEP-BY-STEP GUIDELINES

In each Service there are a number of bonus-receiving specialties that have few enlistees. These specialties, although they may be important in themselves, will not consume a very large portion of the total bonus budget. They will also quite likely be treated best by an *ad hoc* approach--information on "usual" reenlistment rates and estimated responses to bonuses may be less useful than knowledge of who is coming up to the reenlistment point and what their intentions are. In other words, these small specialties have so few members that systematic and statistical treatment of them probably leads to less valid projections of shortages and bonus needs than does an approach based purely on judgment.

For all other specialties, the following systematic procedure is suggested:

1. **Determine expected shortages in each specialty**, given current bonus levels and reenlistment rates. This process will be the same as the current first step by Service bonus managers. Data on inventory and expected reenlistments in each specialty by year-of-service group (YOS) are needed, and generally are available from manpower planners within each Service. "Shortages" are the difference between expected manning and target manning levels, and may be defined either as shortages next year, or as average shortages over the next few years.

2. **Determine replacement cost per additional reenlistee.** The figure needed here, as discussed in Chapter III above, is the total increase in accession, first-term pay, and training costs that occurs when a sufficient number of new recruits enter the pipeline so that, given current attrition and reenlistment rates, one additional enlistee will survive to begin the second term. Generally speaking, such cost figures are not now available to the Service bonus manager.⁶ A reasonable approximation to it can be achieved by taking accession, pay, and training costs as currently reported for basic training and skill-specific training for one person, and dividing it by the survival rate of enlistees in the specialty between the end of specialty-specific training and the start of the second terms.

Thus if Basic Training costs \$4000 per enlistee, and the specialty-specific training that follows costs \$3000, total training costs as currently reported by the training commands will be \$7000. However, if only one of three enlistees who finish specialty training goes on to finish the first term and reenlist, it will require training costs of $\$7000 / .33333 = \$21,000$ to get one additional reenlistee. Similarly, the total increase in accession costs attributable to getting one additional soldier to the second term can be estimated using cost per enlistee divided by the survival rate.

First-term pay should be treated this way as well, except that first-term pay should *exclude* pay during the period the soldier is in training. Trainee pay is included by DoD and the Services in training cost in all currently available estimates.

⁶Navy training cost figures are an exception. In recent years, they have embodied the type of correction for attrition suggested here. Navy costs thus are much higher than training costs used for SRB management in the other Services. For a fuller discussion of the basis of the costs used by the Navy, see Deborah Clay-Mendez, Ellen Balis, Kurt Driscoll, Bruce Angier, and Robert Lockman, *Balancing Accession and Retention*, Final Report of the Navy Comprehensive Compensation Study, Center for Naval Analyses, CNS 1176, September 1982. For a comparison of training costs as defined by each of the Services for use in SRB management, see Judith C. Fernandez, "Selective Reenlistment Bonuses and the Cost of Training by Military Specialty," mimeo.

Accession plus training plus first-term pay costs, with each component adjusted using survival rates, together yield an approximation of replacement cost for a second-term soldier.⁷ Frequently, however, Service bonus managers may not know survival rates from end-of-training to the beginning of the second term. They may know reenlistment rates for those that complete the first term of service, and it is possible to use this as a proxy for survival rate.

Using the reenlistment rate in place of the survival rate in the computation of replacement cost will lead to an underestimate. It will nonetheless be an improvement over the direct use of cost as reported by the training commands, and should be used if specialty-specific survival rates are not available to the bonus manager.⁸

3. Determine the change in total bonus cost that will occur, if the bonus were increased (or decreased) in the specialty being considered. This cost should be expressed as a cost per each additional reenlistee. As with step 1 above, this is generally a figure available to (or computed by) the Service bonus managers. It normally is based on estimates of the dollar value of an SRB paid to the average reenlistee in the specialty, and on the "bonus improvement factor" for the specialty. The bonus improvement factor is the percentage by which the reenlistment rate will change if the bonus multiple for the specialty changes by one.⁹ Bonus improvement factors, current reenlistment rates,

⁷Accession cost will be different for different specialties (because of enlistment bonuses in some specialties, or different quality standards across specialties), but reliable data on specialty-specific costs are not available at this time. A single accession cost per recruit in all specialties will therefore have to be used.

⁸Specialty-specific survival rates for recent enlisted cohorts can be obtained from the Defense Manpower Data Center if the Service can provide information on the time it takes a recruit in the specialty to complete training.

⁹As discussed in Chapter III, ideally such bonus improvement factors would be based, not on the reenlistment rate, but on the man-years-of-service provided by reenlistees. In this fashion the bonus improvement factors could incorporate such aspects of enlistee responses to bonuses as increased terms of reenlistment, decreased reenlistment rates at subsequent reenlistment points, and pre-end-of-term effects on attrition. Analytically, however, estimating years-of-service effects have proven difficult. See Daniel Kohler, *Using Survivor Functions to Estimate Occupation-Specific Bonus Effects*, The RAND Corporation, R-3348-FMP, March 1988.

and current inventory together determine the additional number of reenlistees attracted by an increase in bonus level.

The increase in total bonus cost can be estimated using the difference between:

$$\begin{aligned} \text{Current bonus cost} &= \text{Current number of reenlistees} \times \\ &\quad \text{current average bonus payment per reenlistee} \end{aligned}$$

and:

$$\begin{aligned} \text{New bonus cost} &= \text{New number of reenlistees} \times \\ &\quad \text{new average bonus payment per reenlistee} \end{aligned}$$

Increase in total bonus cost divided by *additional* reenlistees gives the cost per added reenlistee. Note that this cost is equal to the cost of bonuses paid to the additional reenlistees attracted by the increase in bonuses, plus the cost of an increased bonus paid to those reenlistees who would have reenlisted anyway at the old bonus level.

4. Assign each occupational specialty to a priority group. We envision a small number of priority groups--three or four--for all specialties. The priority group to which a specialty is assigned indicates its criticality to the defense mission. Specialties in higher priority groups will be allocated bonuses before lower priority groups, fostering quicker (and possibly surer) filling of more critical specialties.

The criticality of the specialty will be a matter of expert judgment. For some Services, this may be judgment that is developed and approved for other manpower planning purposes; for other Services no such general judgment will have been made, and the Service bonus managers will have to make their own judgments. All bonus managers currently incorporate some such judgment in their decisions, if only in the form of choosing which shortage specialties to consider for bonuses. The operational methodology described here seeks to make these judgments explicit.

If the Services are unwilling to make such judgments explicit, then the operational model essentially will provide bonus recommendations based on cost considerations alone. In general, the fewer the priority groups, the greater the role of the cost criterion. The larger the number of priority groups, the greater the role of noncost considerations that influence the assignment of priorities to specialties.

5. Assign a minimum acceptable fill rate to each occupational specialty. The projection of shortages that is part of step 1 above implicitly assumes a level of requirements or authorizations for second-term personnel in each specialty. It may be, however, that authorizations for some specialties have more slack in them than others. Or some specialties may be more able than others to endure a shortage, because a second-term shortage may be partially overcome by sufficient manning in related specialties, or in the first-term ranks of the same specialty. For this reason, it is useful to specify not only the target number of reenlistees that ideally would be added to each specialty, but also a minimum acceptable manning level. This becomes particularly important if requirements are used to determine shortages in step 1, and end-strength is below requirements. In this case, regardless of bonus levels it will be impossible to reach requirements in all specialties. If requirements (rather than authorizations) are used to define target manpower levels, minimum fill rates can be uniform, but less than 100 percent, in all specialties,¹⁰ or they can vary across specialties. As with priority groups, expert judgment is the basis for minimum fill rate decisions.

The difference between the priority grouping and minimum acceptable fill rates is both conceptual and practical. Conceptually, priority groups relate to the importance of each specialty to the defense mission. Minimum fill rates relate to the amount of slippage from a

¹⁰Recent bonus managers in the Air Force have explicitly taken this approach, defining a specialty to have a shortage if its projected manning level falls short of requirements by more than the average for all specialties.

specialty's grade-specific authorization that is considered in some sense manageable. Thus infantry as a group may be of critical importance to the defense mission, while simultaneously the Army might be able to make do with only 90 percent of the target manning level of infantry in YOS 4. Practically speaking, given the structure of the operational methodology described here, priority groups provide the primary means of ranking the overall importance of a shortage, with fill rates a secondary ranking criterion. That is, minimum fill rates, unless they vary widely (e.g., are set at 50 percent for some specialties and 100 percent for others), will affect bonus allocation only within a priority group.

6. Within each priority group, rank occupations by the size of the difference between replacement costs and SRB cost. This ranking will order specialties by the cost savings realized if the shortage is filled using bonuses instead of increased accessions. Priority groups should then be stacked from highest to lowest, creating a master ranking by priority group and cost difference.

7. Work down the master ranking, assigning increased bonuses to each specialty in turn. The bonus level for the highest-ranking specialty should be increased until either the minimum fill rate is reached or a constraint is encountered (e.g., the bonus level reaches 6, or the reenlistment rate is at 100 percent). Then the next-ranking specialty is addressed, and so on down through the ranking.

8. If the bonus budget is not exhausted by meeting minimum fill rates in all specialties, repeat step 7 using 100 percent fill rates as target levels, until the budget limit is reached.

Starting Point with the Software

The above steps imply a starting point which takes current bonus levels as given, and projects shortages based on those bonuses. A correct allocation of reenlistment bonuses, however, would recognize that specialties receiving bonuses, but having no projected shortages, should be considered for bonus reductions. Even in the absence of overmanning (which is *prima facie* evidence that a bonus should be reduced), it may be true that a bonus reduction is appropriate. A

specialty should have its bonus reduced even though such reduction results in a shortage, if the specialty ranks below other shortage specialties on the master ranking created in step 6 above.

This complication can be treated in a straightforward way, by beginning the allocation process described in steps 1 through 8 not with current bonus levels, but at the largest reduction in those levels allowed by current policy--a two-multiple reduction as of this writing. This procedure has been programmed into the software designed to accompany this document. If, however, the (modest) computing resources necessary to use this software are not available to the bonus manager, two options exist.

Starting Point without the Software

As one option, the bonus manager without access to the software can follow steps 1 through 8 based on baseline reenlistments and shortages as they would exist at bonus levels two multiples below current ones. This approach, although admirable, would entail a level of computational effort that almost certainly is beyond the enthusiasm and time of a bonus manager.

Alternatively, steps 1 through 6 may first be followed *only* for those specialties with projected shortages at current bonus levels. Overmanned specialties now receiving bonuses should then be considered separately. Their bonuses should be reduced by two multiples (or to zero, whichever occurs first). If any projected shortage appears, those specialties should be included in the master-ranking of step 6. Otherwise they should be recommended for two-multiple bonus reductions.

Specialties that currently receive bonuses, but are not overmanned, are also candidates for bonus reduction. Reduction would be expected to create a shortage in such specialties, however, and their bonus levels then might be raised again by following steps 1 through 6. To avoid these extra computations when the final bonus recommendation is likely to be "no change," these specialties may be simply left at their old bonus levels from the outset unless there is a specific reason to believe that they would rank fairly low on the master ranking--because of an exceptionally low training cost, for example, or a priority rating that puts the specialty in the lowest priority group.

Once the augmented master ranking is determined, the manager should proceed to steps 7 and 8.

CURRENT PRACTICE VERSUS RECOMMENDED CHANGES

The proposed operational guidelines for allocating SRBs do not introduce new criteria to the decision process, but rather make systematic and visible the application of criteria that are now generally regarded as appropriate. It also introduces a more appropriate measurement of replacement cost than has heretofore been available to Service bonus managers, and makes explicit the cost comparison that is implicit in current OSD guidance--the comparison of marginal replacement cost with marginal bonus cost.

The conceptual basis of the recommended changes, as discussed earlier, makes clear where improvements in the proposed operational methodology can be made as better data become available. The areas where improvements may come in the near future are:

- Appropriately computed replacement costs,
- Bonus costs that include retraining costs for reenlistees persuaded to change specialties under the reenlistment bonus structure, and
- More accurate bonus improvement factors--that recognize the increased term of reenlistment effects of bonuses and the likelihood that the improvement factor shrinks as the bonus level approaches its legal maximum.

Other data improvements would have greater effect on bonus allocation than the above, but are unlikely to occur in the near future. These include:

- Information on substitutability among occupational specialties, and among adjacent year-groups within the same specialty

- Penalty functions quantifying the impact on the defense mission of shortages in each occupational specialty.

V. CONCLUDING REMARKS

The conceptual framework, idealized allocation system, and operational methodology described in this Note suggest that some of the criteria now specified in OSD guidance on SRB allocation may be unnecessary, and others may be better phrased. Specifically, we would recommend the following changes in the six criteria now listed in DODI 1304.22.

- Serious undermanning in three or more year groups
 - Retain
- Chronic and persistent shortages in the specialty
 - Retain
- High replacement costs for personnel in the specialty
 - Replace with "The amount by which incremental replacement cost exceeds incremental bonus cost." The discussion of this criterion should make clear that "incremental replacement cost" includes costs associated with as many enlistees as necessary to secure one additional second-term person. Also "incremental costs due to bonuses" should include any retraining costs incurred by bonus-induced transfers among specialties--or at least this cost should be included as soon as the necessary data are developed.
- The specialty is arduous or unattractive
 - Remove. The reason for the projected shortage is immaterial.
- The specialty is essential to the defense mission.
 - Replace with "The degree of importance of the specialty to the defense mission."
- There is a reasonable prospect that the bonus will improve manning enough to justify the cost of the bonus

-- Remove. Now included in the third criterion above.

More importantly, guidelines such as those in steps 1 through 8 in Chapter IV should be added to the OSD guidance, to provide information on the appropriate approach for fulfilling the general stricture that the Services base bonus allocations on a balanced evaluation of the multiple criteria.

Any procedural approach recommended to the Services should change as improved data and modelling techniques become available to the bonus managers. The guidelines we suggest emphasize longer-run aspects of skill-specific management, and in many ways reflect rules of thumb rather than a fully articulated force-management optimizing process. They also rely on expert judgments that may at some future date be replaceable with analytic conclusions. Our approach is also clearly narrowly focused on one decision point and one or two policy options; a fully developed force-management model may indicate refinements and tradeoffs that are not incorporated in any look at a single retention tool such as reenlistment bonuses.

Nonetheless, given the limitations of current data and modelling techniques, and the limited access to large-scale models that will likely be a permanent aspect of the work environment of a Service bonus manager, we recommend the procedures described in Chapter IV (and incorporated in the personal-computer-based software described in the appendices), as a significant improvement over current practices. If implemented, they will noticeably increase the rationality with which bonuses are assigned to specialties and reduce the total amount spent by the Services on training and bonuses combined. By making more visible and more defensible the allocation of the bonus budget, they may also provide a better means of explaining and justifying bonus budgets.

Appendix A

THE WORKINGS OF THE SOFTWARE

The operational methodology described in Chapter IV has been programmed for use in a personal computer using Lotus 1-2-3. This appendix describes the logic and workings of the software, the inputs needed for it, and ways to incorporate in it the improvements in data that we anticipate may occur relatively soon.

The program has its own internal documentation, which is described in App. B. That information, with its considerable detail on input format, worksheet layout, and so forth, is essential to the program. The objective of this appendix is to supplement the internal documentation and allow the potential user of the program to understand its internal workings without examining the program formula by formula and macro by macro. We also provide fuller discussion of possible alternative uses and future modifications of the model than is possible in the internal program documentation. The internal documentation can then be used as a shorthand way of reminding the user of what the variables in the model are, and, in the case of input variables, as a quick-reference guide for their format.

OVERVIEW

The program begins with a series of variables that describe the current state of the world as it relates to SRBs: bonus levels, shortages, reenlistment rates, etc. Then, using quantitative information on how the world will change if bonus levels change, the program determines the combination of increments and decrements to current bonus levels that is the "best" use of a predetermined number of dollars in the SRB budget.

In determining which changes in bonus allocations are "best," the program is designed to

- Rely on currently available data, rather than ideal data
- Incorporate statutory and OSD-imposed constraints on bonus payments
- Apply the dual criteria of cost-savings and the criticality of various specialties to the defense mission to choose the "best" use of bonus dollars.

In implementing this approach, the software relies on both cost data and priorities among occupational specialties that are provided by the user. Cost data in the form commonly provided by the Services is internally transformed in the program to a form more appropriate for use in SRB allocation; the relative importance of different specialties is used directly.

A WALK THROUGH THE PROGRAM

The program begins by prompting the user for the input needed before bonus allocation can proceed. We discuss further details below, and a list of the required input appears in Table A.1. One data element needed is a list of specialties to be considered for bonuses. Although it is possible to include up to 200 specialties in the list, the model will change bonus levels only for specialties that have bonuses or that are experiencing shortages. Thus only these specialties need be included.¹

Having received the input, the program begins by computing, for each specialty, the difference between replacement cost and bonus cost for an additional reenlistee. That is, it computes the difference between the cost of (a) bringing enough more recruits through the pipeline to increase the number of reenlistees by one, assuming unchanged attrition and reenlistment rates, and (b) increasing the number of reenlistees by one through an increased bonus at the reenlistment point. This cost difference is then used to rank all

¹For informational purposes, however, it may be useful to include more specialties, in order to inspect some of the parameters computed by the model for specialties that are not current candidates for bonuses.

specialties within the same priority group, and priority groups are stacked, highest priority first. Thus a master ranking is created, ranking all specialties with the same priority by cost difference, and then moving down to the next priority group.

The program next computes a starting point from which bonus changes will be made. The starting point is not current bonus levels, but rather minimum levels allowed by current OSD policy. The policy states that no specialty shall have its bonus reduced by more than two levels.² The program therefore begins with current bonus multiples and reduces them by two, with the constraint that a bonus multiple cannot be negative.

The program then computes the total bonus expenditure implied by this base level of bonuses. Termed the minimum bonus budget because it is the lowest level of expenditures consistent with OSD policy and current circumstances, it is compared with a total bonus budget previously provided by the user. If there are indeed bonus dollars available in excess of the minimum level, the program proceeds. If instead the entire user-provided budget and more is required just to avoid violating current policy on sudden bonus reductions, the user is prompted to reconsider the bonus budget provided as input to the program.

The program next calculates the minimum and maximum number of reenlistees needed in each specialty, based on user-provided information on target requirements and minimum and maximum fill rates. The minimum fill rate indicates that minimum percentage of stated authorizations or requirements that is acceptable to the user; the maximum indicates the percentage beyond which no more reenlistees are needed. The maximum defaults to 100 percent, but can be changed by the user.

The program then adjusts these minimum and maximum numbers of reenlistees in each specialty to conform to logical, legal, and policy constraints. Specifically, the program checks the desired minimum and maximum in each specialty to see if it is achievable given that:

²The user may specify a maximum change of greater or less than 2 if desired; two is the default option. This is discussed further in the section on inputs, below.

- No reenlistment rate can be above 100 percent
- No bonus multiple can be above 6 or below 0
- No bonus multiple can change by more than two steps
- No individual may receive a bonus in excess of \$30,000

If any of these constraints is violated, the program computes a new adjusted minimum or maximum number of reenlistees in the specialty. The adjusted numbers are as close as possible to the desired targets as it is possible to achieve given the constraints.

At this point, the program basically has four intermediate outputs-- a starting point in terms of bonus multiples that are as far below current levels as is allowed, a master ranking of all specialties in the order that shortages are to be filled, and adjusted minimum and maximum targets for each specialty. The program then proceeds down the ranking, assigning bonus increases to each specialty until the adjusted minimum number of reenlistees is reached, or one of the constraints is encountered. When the end of the list of specialties is reached, the program starts over at the top of the ranking and repeats the process using the maximum fill level. Along the way the program calculates the cumulative total cost of bonuses implied by all bonuses assigned so far (the minimum bonus levels plus all increases).

The final step is for the program to compare the user-provided budget level to the running total bonus cost, and thereby determine the point at which to stop increasing bonus multiples above their minimum base level. The program then displays the output, which reports the following items for every specialty included in the initial input list:

- Current bonus level
- New recommended bonus level
- Change in number of reenlistees resulting from the change in bonus level
- Total number of reenlistees at the new bonus level

- Incremental bonus cost per additional reenlistee, and per additional year of reenlistment
- Replacement cost per additional reenlistee
- The cost of bonuses for the specialty, and a cumulative total for all specialties

USES OF THE PROGRAM: ALLOCATION AND SENSITIVITY ANALYSIS

The program is expressly designed to produce a recommended allocation of a limited bonus budget when there are many specialties competing for scarce bonus dollars. It is a tool to combine judgments on the criticality of specialties with cost considerations, with due consideration for the rules governing the SRB program.

The model also is designed to make transparent the basis on which bonuses are assigned to specialties, while allowing as much flexibility as possible. For example, the model allows the user to choose bonuses that lead to more than 100 percent manning in some specialties, or to assign bonuses to specialties where bonus costs per reenlistee are higher than replacement costs. The program is not designed to prevent such exceptional uses of reenlistment bonuses, but rather to illuminate where and why they occur. In the context of the model, the "why" will involve either the priority assigned the specialty, or its minimum acceptable level of manning. The model is therefore designed to make judgments on these parameters visible (so they can be examined and justified--a necessary part of justifying requests for bonus dollars).

Although the primary objectives of the model involve dividing limited bonus dollars among specialties, the model can also be used for a number of other purposes. First, it can identify the bonus budget required to man all specialties to maximum desired levels. If the bonus budget that is supplied by the user at the start of the program is very large, the program will produce recommended bonus levels that come as close as possible to providing desired fill rates, given the logical and legal constraints. The cumulative total SRB cost for this bonus allocation is then the amount required to eliminate all shortages that can be eliminated, given the constraints. More generally, by entering

successively larger bonus budgets, the user can force the program to, in effect, perform a type of sensitivity analysis--the level of shortages associated with each possible bonus budget is revealed. Similarly, the program can be used to determine the consequences of relaxing one or more of the legal or policy constraints.

The program can also be used to indicate the bonus budget necessary to reach minimum acceptable manning levels in all specialties. This budget is computed internally and shown in the column "Minfill Cumulative SRB Cost." Although normally not visible as the model runs--this total is primarily used as an intermediate output within the model--it can be viewed at the command of the user.

SERVICE IDIOSYNCRASIES AND GAMING THE PROGRAM

As mentioned already, the program is specifically designed to be flexible. If the Navy decides that manning levels above 100 percent are desirable in certain grades and specialties, the program will allow it. If the Army gives a specialty a high priority, it will receive a bonus even if replacement costs are low and bonus costs high.

This flexibility is introduced because we are fully aware that our simple model cannot account for all factors affecting the importance of filling a shortage in a particular skill quickly, nor of the institutional obstacles to increasing accessions in a chronically short specialty. It takes time to obtain reenlistees by bringing more recruits through the training pipeline; bonuses work immediately. The office that manages retention is frequently different from the one that manages recruitment and training, so realizing a net savings by reducing bonuses and increasing accessions may be difficult.

Regardless of the reasons for it, however, flexibility also means that the program is easy to "game." Any user of the program can produce any allocation of bonuses that he or she chooses, by simply assigning high priorities and/or high fill rates to the specialties preselected for high bonuses.

Gaming is possible because the program ranks specialties based on cost factors only *within* a single priority group; regardless of cost, high priority specialties will receive bonuses before low priority ones.

We envision a small number of priority groups--two, three, or four--and in this circumstance cost factors will play a major role. But the program will accept as many priority groups as the user specifies. If the user specifies a different priority for each specialty, then priority alone, and not cost, will determine bonus allocation.

The advantages of flexibility are thus balanced by the disadvantage that the primary motivation of the program--incorporating priority *and* cost systematically into decisions--can be undermined by an unscrupulous user. Fortunately, should this occur it would be obvious to anyone viewing the user's inputs.

FURTHER DETAILS: INPUT

The input required by the model is listed in Table A.1. A description and desired format for each input are described in the program itself by NOTE-IT messages associated with each input, which are

Table A.1

INPUTS TO THE COMPUTER PROGRAM

Manpower Planning Variables

- Eligible MOS
- Current bonus level
- Projected requirements or authorizations
- MOS inventory
- Minimum fill rate
- Maximum fill rate
- Priorities

Cost Variables

- Monthly basic pay
- Current estimate of replacement costs

Behavioral Variables

- Current reenlistment rate
- Percent with 3, 4, and 6 year reenlistments
- Bonus improvement factor

SRB Program Constraints

- Maximum change of level
- Step

reproduced in App. B, below. We begin the discussion of each input here with a description of the variable, and then summarize the ways in which the program utilizes that input. As a corollary, we point out instances where the precise definition of the input may take one or several possible forms, as long as there is consistency among definitions of related inputs.

Manpower Planning Input

Eligible MOS. These include all specialties to be considered in SRB allocation. Here and throughout the program the term "MOS," the Army and Marine designation for an occupational specialty, will be used as a shorthand indication of military occupational specialties.

The specialties that are SRB candidates need to be identified. They normally will be those in which shortages are expected in the next planning period and those that currently receive bonuses. If desired, the list may include more specialties, up to a total of 200, but this may tax the memory of the personal computer. If a specialty neither has a bonus currently nor is projected to have a shortage, the program will recommend a zero bonus for it.

Current Bonus Levels. This is the bonus multiple in effect for each MOS. This multiple is the one existing at the time "current reenlistment rate" is measured (see below).

Projected Requirements or Authorizations. For each MOS, this should be the manning target for enlisted personnel in the time frame relevant to the model user. Either requirements or authorizations may be used, as long as it is recognized that the *apparent* severity of shortages will be greater using requirements, simply because total requirements generally exceed total authorizations.³ The time frame used to measure authorizations (or requirements) may vary depending on data availability and the planning horizon of the user. The crudest number to use would be based on authorizations or requirements in the specialty for the next period. Thus if a shortage is anticipated in the

³See the discussion of step 5 in Chapter IV for further discussion of this issue.

YOS 4 group next year, then it is next year's target for YOS 4 personnel that should be entered here.⁴ Somewhat better, from a conceptual viewpoint, would be a longer-term view--the average desired level for YOS 4 over the next several years, for example--to avoid unnecessary turbulence when authorization levels are expected to change. If, however, such a longer-term measure is used, then the same time frame must be used in measuring inventory, as well as for estimating behavioral parameters such as reenlistment rates and bonus improvement factors. This last may not impose undue data difficulties, if it is justifiable to assume that the behavioral relations are not changing rapidly over time. (The assumption may not hold, however, if the economy is turning up or down, or if the enlistees in adjacent year groups have significantly different demographic characteristics.)

Note that, ideally, the target level entered here should be adjusted for substitutability among personnel in different year groups and in closely related skills. Details appear in Chapter III. In the absence of dramatic changes in the state of the art of manpower management, such information is unlikely to be available.

Inventories Facing Decisions. For each MOS, this number should be the number of enlistees in a specialty that are potential reenlistees in the year of service (or YOS group) used to define authorizations, and that are approaching an expiration of term of service (ETS). "Potential reenlistees" can be defined in a number of ways, and for purposes of the model the precise choice is of less importance than consistency between the definition of potential reenlistees and the definitions used in measuring/estimating the behavioral relations discussed below. More specifically, "potential reenlistees" may be measured in one of the following ways:

⁴Requirements and authorizations are set, not by year-of-service group, but by pay grade. Initially, shortages are computed this way as well--shortages by grade within each specialty. Personnel managers then examine the distribution of enlistees by year of service within each pay grade, and use that distribution to transmute authorizations by pay grade into target levels of personnel, and anticipated shortages, by year-of-service group within each specialty.

1. Total number approaching the ETS point. If this definition is used, then the measure of "reenlistment rate" and "bonus improvement factor" (discussed below) must be based on the total number as well. That is, reenlistment rate must be measured as the percentage of total first-termers who reenlist, not as the percent of reenlistment-eligible personnel who reenlist.
2. That portion of the total approaching the ETS point who qualify under Service rules as eligible to reenlist--that is, the number who would be allowed to reenlist if they wanted to. In this case, "reenlistment rate," etc. also must be computed using this number as the denominator.
3. That portion of the total approaching ETS who would be allowed to reenlist and who would qualify for a bonus (i.e., who will reenlist for at least three years--not take a two-year term, if one is possible). Again, reenlistment rate and bonus improvement factors would then have to be computed based on this particular pool of potential reenlistees.

Currently, many bonus improvement factors are based on definition 1 above, while reenlistment rates frequently are cited in terms of definition 2. Because of the way in which the model internally computes replacement costs, definition 1 is preferable (see Cost Computations, below). *Any of the above definitions will do, as long as the same base is used in the estimation of the behavioral relations.* If the target authorization number is a multiyear average, then the inventory number must also be.

Minimum Fill Rate. It may be that a level below the target requirements or authorizations is acceptable in some or all specialties. If the Service is below its authorized manpower strength for the first-term pay grades, some specialties of necessity will operate below their authorized levels. Minimum fill rate is the percentage of the authorized strength in a particular specialty that reflects the lowest acceptable level of manning.

Authorizations in some specialties may have more slack in them than others. Also, tasks in certain specialties may be performed by enlistees in related specialties, while in other specialties there is no such potential for substitution. For either or both reasons, we expect that minimum fill rates will vary across specialties. The model, however, operates the same way regardless of whether minimum fill rates vary (and regardless of whether they are all set equal to 100 percent).

Minimum fill rates should *not* vary because some specialties are more important than others to the defense mission. The criticality of the specialty is explicitly incorporated separately in the model (see Priorities, below). Minimum fill rates should reflect the level of manning necessary for a specialty to function, not the importance to the defense mission of its functioning.

Maximum Fill Rate. Because authorizations presumably indicate the optimum manning level in a specialty, we would normally expect their levels to be the maximum desired manning level in each specialty. In this case, the maximum acceptable fill rate will be 100 percent, which is the default option in the program. We recognize, however, that situations may arise in which dynamic manpower planning considerations suggest a current manning level of greater than 100 percent. For instance, personnel managers may want to smooth the impact of an anticipated future jump in authorizations in a particular specialty by "starting early." Or anticipated future shortages in a specialty's senior enlisted ranks may be ameliorated by increasing the flow of junior people. In such cases the maximum fill rate may be specified as being some number greater than 100 percent.

Priorities. The criticality of each specialty to the defense mission should determine its priority. We would expect that all specialties within a Service may be combined in a few--three to five, perhaps--priority groups. This may be based on current formal policy within the Service (the Air Force, for example, explicitly identifies groups of Air Force Specialty Codes as having different importance), or it may need to be developed.

Any general grouping will likely need to be modified from year to year because the priorities in the model should reflect not only the abstract importance of the specialty to the defense mission, but also the time dimensions of a shortage in the specialty.

Cost Input

Monthly Basic Pay. For the model to estimate the budget needed to pay for an allocation of bonus levels to occupations, it must be provided with an estimate of the monthly basic pay of a reenlistee in each specialty at the time of reenlistment. This may vary among specialties, as some specialties will contain personnel with longer average first-term obligations than others. In the program, monthly basic pay is multiplied by average reenlistment term (discussed below), and bonus multiple, in order to estimate the bonus cost per enlistee for any desired bonus multiple that may be assigned to the specialty.

Current Estimate of Training Costs. In each Service there are several sources for training or replacement costs, although none is likely to be appropriate for use in assigning SRBs to specialties.⁵ Therefore the model is designed to use currently available estimates for the cost of first-term personnel and make some rough corrections to it. The cost input the model is designed to accept, then, is a estimate of the cost to produce one fully-trained specialist in each occupational specialty. This will be the sum of the cost of recruiting one soldier, plus costs of initial training (Basic Training or Recruit Training) and specialty-specific training (Advanced Individual Training or A-School), plus pay costs from end of basic training to end of first term.⁶

⁵For details, see Judith C. Fernandez, "Selective Reenlistment Bonuses and the Cost of Training by Military Specialty," mimeo.

⁶Pay costs during training are already incorporated in training costs as calculated by the Services.

Behavioral Relations

Current Reenlistment Rate. The name of this input suggests that the *current* reenlistment rate be used. Such use is a proxy of *expected* reenlistment rate in the period being examined, given an unchanged bonus level. If there is a basis for expecting reenlistment rates in the immediate future to differ from current ones, then it is expected future reenlistment rates that should be entered here.

The estimate of the current reenlistment rate in each specialty is used for two separate computations within the model. First, it is applied to current inventory as part of the calculation of projected shortages in the specialty. Second, it is used together with training costs to compute the replacement cost of a second-term enlisted person in each specialty. To be fully consistent with both uses, this variable should be based on all enlistees approaching the end of their term of service (and the measurement of inventory, above, and bonus improvement factors, below, should be consistent with this definition). As a second-best solution, this variable can be measured using only the reenlistment rate among those judged "eligible to reenlist," as long as the other related input variables are also so defined. The reason this solution is second-best is that it will lead to an underestimate of replacement cost. Replacement costs, however, will suffer from a number of problems related to accuracy, so that this underestimate may not be the source of serious additional inaccuracy unless there is a wide gap between the total number of enlistees approaching the end of their first term of service and the number eligible to reenlist.

Percent with 3, 4, and 6 Year Reenlistments. An estimate of the terms of service that reenlistees will choose in bonus specialties is needed to estimate the bonus budget, since the size of each individual's bonus depends on his or her reenlistment term. In the absence of other information, this may be a judgment based on past experience, Service regulations on allowable reenlistment terms, and, for specialties which have high bonus multiples, the term length at which the statutory maximum bonus payment is reached.⁷

⁷Since the size of the bonus increases with term length, one effect

Bonus Improvement Factor. This factor, which indicates the percentage by which the reenlistment rate in a specialty will change if the bonus multiple changes by one, has generally been estimated for each of the Services. The most common results are different factors for each of four to six groups of specialties. Before these numbers can be used in the program, there must be a determination of whether the estimation was based on (1) all enlistees approaching the end of the first term of service, or (2) only enlistees eligible to reenlist. This choice will determine the appropriate definition, for use elsewhere in the model, of MOS inventory, reenlistment rate, etc. Most estimation has been made using (1), which is preferable in this model because it implies preferable definitions for reenlistment rates.⁸

SRB Program Constraints

Maximum Change of Level. Current policy is that the Services not change the bonus multiple for any specialty by more than two in a single year. This policy aims at reducing turbulence in the administration of the SRB program, and enlistees' uncertainty when planning their futures. As a default option, the program uses two as the maximum allowable change in bonus multiple. However, this can be changed if policy changes, or if the user wants to run the model to explore the unconstrained optimal allocation of SRBs: By inputting six as the maximum change of level allowed, the model will begin by reducing all current bonuses to zero, then allocate the budget based on cost and priority criteria. It is unlikely that such "zero-based" determination of bonuses every year (or quarter) would be good manpower management--

of changing a bonus multiple may be to change the expected reenlistment term. Our model does not incorporate this effect (although it could, with the modifications described in the final section of this appendix). However, if the presence of *any* bonus, regardless of its precise magnitude, affects term length, this effect can be incorporated in the input estimates of reenlistment terms.

⁸If currently available bonus improvement factors use definition (2), it is better to use them, and define the reenlistment rate consistent with that (have a somewhat inaccurate replacement cost), than to use inconsistent definitions of bonus improvement factors and reenlistment rates.

short-term considerations would receive too much weight, and large, frequent changes in bonuses could result--but running the model in this mode could be useful to define long-term bonus targets, as well as to judge the extent to which the maximum-change policy constraint is affecting the allocation of bonuses.

Step. Bonus multiples are now defined in multiples of one-half; a bonus multiple may be 1.0, or 1.5, but not 1.25. This multiple is defined in the model as the smallest step by which a bonus may be changed. The model assumes that step is equal to .5 unless this is overridden by the user inputting a different step. Step must be the same for all specialties.

FURTHER DETAILS: INTERNAL MANIPULATIONS

Cost Computations. As implied in some of the above discussion on inputs, the model performs a number of computations on the user-supplied cost numbers to derive cost figures appropriate to use in SRB allocation. Some of the results of those manipulations are displayed in the output normally viewed by the user (SRB cost per reenlistee, for example); all results can be viewed, at the user's option. The cost computations include the following:

Marginal SRB Cost per Reenlistee. This is the marginal cost per additional reenlistee, when "marginal cost" means the change in bonus costs that occurs when the current bonus multiple changes. Marginal cost per additional reenlistee is computed as follows:

If:

current bonus cost per reenlistee = current bonus multiple × monthly
basic pay times average reenlistment term, and

new bonus cost per reenlistee = new bonus multiple × monthly basic
pay times average reenlistment term, and

current number of reenlistees = MOS inventory × current reenlistment
rate, and

new number of reenlistees = MOS inventory $\times$ current reenlistment rate
times bonus improvement factor times change in bonus multiple,

then:

current total bonus cost = current cost per reenlistee $\times$ current
number of reenlistees, and

new total bonus cost = new cost per reenlistee $\times$ new number of
reenlistees.

Furthermore:

marginal bonus cost per reenlistee = (new total bonus cost - current
total bonus cost) $\div$ (new number of reenlistees - current
number of reenlistees).

Marginal cost computed in this fashion incorporates both bonuses paid to new reenlistees and the increase in bonus costs due to the already existing reenlistees being paid more. The full increase in bonus cost, divided by additional reenlistees, gives the full additional amount the Service has to pay to gain each reenlistee attracted by the bonus increase--just as replacement cost reflects the full additional amount of training costs necessary for one additional person to appear in the second term.

Replacement Cost per Second Term Reenlistee. Ideally, this cost would be computed by Service cost experts in a manner appropriate to its use in bonus allocation. At the time of this writing, however, cost calculations are made for other purposes, and are not appropriate for use here. Therefore, as the model is currently structured, this cost figure is computed internally to get a rough approximation of a true replacement cost figure. The program divides accession, training, and first-term pay costs by the reenlistment rate, in order to compute the full replacement costs incurred in the process of obtaining a single additional enlisted person at the beginning of the second term--
"replacement cost per second term reenlistee."⁹ This cost is then appropriate for comparison with "SRB cost per reenlistee."

⁹This is only a rough approximation because an accurate translation of training costs into replacement costs would require using the

Rank: Replacement Cost - SRB Cost. Once the model has computed the two costs above, it finds the difference between the two and ranks specialties within priority groups based on the difference. This process results in specialties being ranked in order of the cost-saving incurred by the military when it obtains a second-term enlistee using a bonus instead of increasing the training pipeline in the presence of unchanged retention behavior.

Bonus Budget Costs. There are a number of budgetary cost totals computed and displayed by the model. The titles of these cost figures all have "SRB cost" in them (e.g., "Minfill cumulative SRB cost"). These costs represent the bonus budget obligation incurred given the bonus level implied by the title (e.g., "Minfill" bonus level), the average term of reenlistment, and the average basic pay rate in each specialty. Thus they are the result of a straightforward application of the rules for determining individual bonuses, using the specialty-specific average values of the determinants of those bonuses (and applying the statutory maximum of \$30,000 per individual).

FURTHER DETAILS: OTHER INTERMEDIATE OUTPUT

The remaining intermediate results computed internally in the model are not displayed unless the user chooses to examine them. They primarily describe bonus levels, bonus budget costs, and numbers of reenlistees in each specialty at intermediate points in the allocation algorithm. These points include:

1. When the desired minimum fill rate in the specialty is met--
the "Minfill" bonus

survival rate between the end of specialty-specific training and the beginning of the second term, rather than the reenlistment rate. The difference is, of course, the amount of attrition between the end of training and the end of the term of enlistment. We hope to modify the model in the near future to allow the use of this survival rate in place of reenlistment rate in cases where the specialty-specific survival rate is known.

2. When the fill rate is as close to the minimum desired rate as is allowed, given the constraints (e.g., reenlistment rate cannot exceed 100 percent, bonus level cannot increase by more than two multiples)--the "Allowed minfill" bonus
3. When the desired maximum fill rate is met--the "Maxfill" bonus
4. When the fill rate is as close to the maximum rate as is allowed by the constraints--the "Allowed maxfill" bonus

OUTPUT

The output field normally visible when the model completes its calculations includes not only the current and recommended new bonus levels, but also, for informational purposes, the following:

- The total number of reenlistees in each specialty
- Increase or decrease in the number of reenlistees, resulting from increase or decrease in bonus level from its current level
- SRB and replacement cost per additional reenlistee, computed as discussed above
- Marginal SRB cost per man-year, computed as marginal SRB cost for the specialty divided by total man-years provided by additional reenlistees in the specialty. Total man-years is in turn derived by multiplying the average term of reenlistment by the additional number of reenlistees.
- The total number of bonus dollars that will be spent on a particular specialty at the recommended bonus multiple ("SRB cost")
- The cumulative total bonus dollars for all specialties ("Cumulative cost")

FUTURE DATA IMPROVEMENTS AND MODEL MODIFICATIONS

There are at least two data improvements that will likely occur in the relatively near future that, if incorporated in the model, will improve the bonus allocation algorithm. One is the development of true replacement costs and the other is the estimation a term-of-enlistment

effect of changing bonus levels. Neither can be handled directly by the model as it now stands, because the model was explicitly developed to use currently available data. We would like to suggest modifications needed if such improved data were to become available. Before doing so, however, we must caution the user that **no columns should be added to the Lotus worksheet to the left of column EE**, except by someone thoroughly conversant with Lotus programming who concurrently changes the existing macros to adjust for changing column locations of existing variables.

If true replacement costs for enlisted personnel in each specialty are available, the current approximation of replacement costs internal to the model becomes obsolete. In this case, the program should be modified so that the correctly calculated replacement costs are provided as input, and then used directly in the ranking of specialties by replacement cost minus bonus cost. "Current reenlistment rate" would in this case continue to be needed for the projection of shortages, but would *not* be used in cost computations internally in the model.

Modifying the program to incorporate term-of-reenlistment effects is more difficult. The model as currently configured basically takes as the unit of analysis the reenlistee, although man-years of service provided by the reenlistee is also computed. To incorporate the impact of changes in bonus multiples on the length of reenlistment terms, all cost computations would need to be recast in terms of costs per year of second-term-and-beyond service. This would entail three steps: First, bonus improvement factors would need to be cast in terms of percent improvement in years-of-service-provided as a result of increased bonuses. Presumably this would be simple, as it is precisely this effect that the new improved data would have provided. Second, replacement cost would need to be calculated in terms of replacement cost per year of second-term-and-beyond service. Finally, SRB cost would also need to be recast as bonus cost per additional second-term-and-beyond years of service, based on the newly modified bonus improvement factors.

Once this has been done, the bonus allocation can proceed as before: The difference between costs per year of service would have replaced the difference between costs per reenlistee as the basis for the ranking of specialties within each priority group.

Appendix B

NOTE-IT DOCUMENTATION

This appendix reproduces the Note-It internal documentation that is incorporated in the SRB allocation program. The entries appear exactly as they do on the screen of a personal computer, and are listed within each subsection in order of the column within the Lotus spreadsheet.

Inputs

B189 and B208:

INVENTORIES - The current inventories of people at ETS and eligible for a bonus for each MOS you are allocating bonuses for.

B190 and B209:

AUTHORIZATIONS - The projected authorization for reenlistees for the next period for each MOS.

E191 and E208:

PRIORITIES - The relative priority of any MOS over other MOSs. Although the model doesn't care if each MOS has a different priority you may wish to group MOSs in a small number of priority groups and allow the model to rank them according to priority and replacement cost.

B192:

MINFILL RATES - The percentage of the targeted requirement which is the absolute minimum an MOS must have. Keep in mind that this minimum may not be possible to meet with the current restrictions on bonus level (0-6) and bonus amount (<\$30,000).

B193:

MAXFILL RATES - The maximum percentage (of targeted requirements) for each MOS group. These rates will default to 100% if they are not input.

B194 and B211:

CURRENT RATES - The reenlistment rates for each MOS before the bonus level is changed.

B195 and B214:

AVG BASIC PAY - The average monthly basic pay for all

persons eligible for reenlistment in the coming period in each MOS group.

E188:

PROJECTED TERMS - The percent of reenlistees who will reenlist for 3, 4, or 6 year terms in the coming period. For example, in MOS 1 20% may reenlist for 3 years, 50% for 4 years, and 30% for 6 years. The three percents should add up to 100%. If not you will be prompted to adjust them.

E190 and B217:

TRAINING COSTS - The training costs of bringing a new recruit up to reenlistment for each MOS.

B191:

STEP - The fraction that is the smallest allowed change in any bonus level (other than 0).

The default value for step is .5.

E192 and E210 and BH7:

CURRENT BONUS LEVELS - The current bonus levels for each MOS.

E193 and E211:

MAX CHANGE OF LEVELS - The maximum that the bonus level for each MOS is allowed to change in one period. This has a default value of 2 for each MOS (the current rule) but may be changed.

B188:

MOS CODES - The list of codes used to distinguish one MOS from another. This will be very important after the model sorts the MOSs by priority and rank.

The default value for MOS codes is

MOS 1
MOS 2
MOS 3
etc.

E189 and B216:

BONUS IMPROV. FACTOR - The bonus improvement factor for each MOS. The bonus improvement factor should be a number and will be used to calculate new reenlistment rates by the following equation:

$$\text{curr. rate} * (1 + \text{BIF}/100 * \text{change in bonus level})$$

If the reenlistment rate will improve by 25% when

the bonus is increased by 1, enter 25.

B213:

MAXFILL RATES - The maximum percentage (of requirements) for each MOS group. These rates will default to 100% if they are not input.

B212:

MINFILL RATES - The percentage of required reenlistees which is the absolute minimum an MOS must have.

Intermediate Variables

AB7: REENLISTMENT PERCENT CHECK

The sum of the 3, 4, and 6 year reenlistment percentages. If this is not 100.0 you will be prompted to make an adjustment.

AD7: AVERAGE REENLISTMENT TERM -

(Sum of man-years provided by all reenlistees)

(Total number of reenlistees)

AP7: MARGINAL SRB COST PER REENLISTEE

The SRB cost of bringing in one additional reenlistee, assuming that the bonus improvement factor is constant for all bonus levels.

AR7: REPLACEMENT PER SECOND REENLISTEE

Training costs

Survival rates

AV7: RANK REPL COST - MARGINAL COST

Replacement cost - Marginal SRB cost per reenlist.

B210: SHORTAGES

The calculated number of reenlistees that any MOS will be short given the current reenlistment rate, current inventory, current requirement, and current bonus level.

B215: AVG. REENLIST TERMS

The average reenlistment term for reenlistees in the period that the model is being run for, calculated from the projected % of reenlistees reenlisting for 3, 4, or 6 year terms given as input.

BB7: MINIMUM BONUS LEVEL

The current bonus level minus the maximum change of bonus level allowed (provided that the resultant bonus level is ≥ 0).

BD7: REENLIST AT MINIMUM BONUS LEVEL

The total number of reenlistees that the new bonus level will attract.

BF7: EACH MOS's SRB COST AT THE MINIMUM BONUS LEVEL

The SRB cost of the reenlistees at the new bonus level.

BJ7: REENLISTS AT CURRENT BONUS LEVEL

The number of reenlistees that the current bonus level will attract.

BL7: SRB COST ABOVE MINIMUM AT THE CURRENT BONUS LEVEL

The SRB cost of the reenlistees attracted by the current bonus level that were not attracted by the minimum bonus level (current level - maximum bonus level change).

BN7: DESIRED MINFILL REENLIST -

The number of reenlistees needed to meet the minimum fill rate.

BP7: NEED AND RATE BONUS LEVEL INCREASE

This bonus level change takes into account the change needed to meet the minfill count as well as the restriction that the resultant reenlistment rate be between 0 and 1.

BR7: CHANGE < 2 BONUS LEVEL INCREASE

This bonus level change takes the previously calculated change and adjusts it to be less than or equal to the maximum allowed change.

BT7: ALLOWED MINFILL BONUS LEVEL INCREASE

This bonus level change is modified to keep the resultant bonus level within the specified range of 0 to 6.

BV7: NEW MINFILL BONUS LEVEL

The bonus level allowed to meet the minimum fill rate and stay within the current rules governing changes to bonus levels.

BX7: ALLOWED MINFILL REENLIST

The number of reenlistees attracted by the adjusted minimum fill rate bonus level.

BZ7: SRB COST ABOVE MINIMUM AT THE MINFILL BONUS LEVEL
The SRB cost of the added reenlistees attracted by the minimum fill rate bonus level but not by the minimum (current bonus level - the maximum change to bonus levels allowed) bonus level.

CB7: MINFILL CUMULATIVE SRB COST
The total SRB cost of bringing in all reenlistees attracted by the minimum (current bonus level - the maximum change to bonus levels allowed) bonus level, plus those attracted by the minimum fill rate bonus level for any given MOS and all MOSs with a higher priority and ranking.

CD7: DESIRED MAXFILL REENLIST
The number of reenlistees needed to meet the maximum fill rate.

CF7: (NEED & RATE) BONUS LEVEL INCREASE
The change to bonus level needed to attract the number of reenlistees needed to meet the maximum fill rate. The reenlistment rate cannot exceed 1.

CH7: (INCREASE <2) BONUS LEVEL INCREASE
The new change to bonus level adjusted so that it does not change by more than is allowed by the maximum change to bonus levels rule.

CJ7: ALLOWED MAXFILL BONUS LEVEL INCREASE
The new change to bonus level adjusted to be:

$$0 \leq \text{new bonus level} \leq 6$$

CL7: NEW MAXFILL BONUS LEVEL
The bonus level level needed to attract enough reenlistees to meet the maximum fill rate subject to the following rules:

- 1) maximum change to bonus level
- 2) $0 \leq \text{bonus level} \leq 6$
- 3) $0 \leq \text{continuation rate} \leq 1$

CN7: ALLOWED MAXFILL REENLIST
The number of of reenlistees attracted by the new maximum fill rate bonus level.

CP7: SRB COST ABOVE MINFILL AT THE MAXFILL BONUS LEVEL
The added SRB cost of attracting reenlistees with the maximum fill rate bonus level who would not be attracted by the minimum fill rate bonus level.

CR7: MAXFILL CUMULATIVE SRB COST

The total SRB cost for all reenlistees when (1) this MOS and all MOSs with higher priority and ranking have maximum fill rate bonus levels, and (2) all MOSs with lower priority and ranking have minimum fill rate bonus levels.

E209: RANKS

The cost factor used to rank MOSs within priorities calculated as follows:

training cost/survival rate - marginal SRB cost

E212: MARG SRB COST/REENL.

The SRB cost of bringing in one additional reenlistee, assuming that the bonus improvement factor is constant for all bonus levels.

E213: REPLACEMENT COSTS/REENL.

The cost of training enough first-term enlistees to ensure that one of them will reach the second term.

E214: MINIMUM BONUS LEVEL COSTS

The total SRB cost for all reenlistees attracted by the Minimum Bonus Level (the current bonus level - the maximum change to bonus level).

E215: MINFILL BONUS LEVEL COSTS

The addition to SRB costs for the reenlistees attracted by the Minfill Bonus Level (the bonus level needed to meet the Minimum Fill rate, adjusted by various rules) but not by the Minimum Bonus Level.

E216: MAXFILL BONUS LEVEL COSTS

The additional SRB cost for all reenlistees who were attracted by the Maxfill Bonus Level (the bonus level needed to meet the Maximum Fill Rate, adjusted by various rules) but not by the Minfill Bonus Level.

Outputs

DO7: BONUS LEVEL: CURR

The bonus level before any changes are made.

DQ7: BONUS LEVEL: NEW

The new bonus level as allocated by the model.

DS7: ADDED REENL. OVER CURR.

The number of reenlistees attracted by the change in bonus level.

DU7: SRB COST PER REENLIST.

The bonus cost of bringing in one additional reenlistee, assuming that the bonus improvement factor is constant for all bonus levels.

DW7: REPLACE. COST PER REENLIST.

The cost of training enough first-term enlistees to ensure that one of them will reach his/her second term.

EA7: SRB COST

The total bonus cost of all reenlistees brought in at the new bonus level.

EC7: CUMUL. COST

The bonus cost of all reenlistees at the new bonus level for any given MOS and all MOSs with higher rank and priority.

EE7: REENL.

The number of reenlistees brought in at the new bonus level.

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