NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

AN ARMY RESERVE MANPOWER PLANNING MODEL

by

Ward E. Litzenberg

June 2001

Thesis Advisor:	Siriphong Lawphongpanich
Second Reader	Eugene P. Paulo

Approved for public release; distribution is unlimited.

Form SF298 Citation Data

Report Date *("DD MON YYYY")* 15 Jun 2001	**Report Type** N/A	**Dates Covered (from... to)** *("DD MON YYYY")*

Title and Subtitle AN ARMY RESERVE MANPOWER PLANNING MODEL	**Contract or Grant Number**
	Program Element Number
Authors	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Naval Postgraduate School Monterey, CA 93943-5138	**Performing Organization Number(s)**
Sponsoring/Monitoring Agency Name(s) and Address(es)	**Monitoring Agency Acronym**
	Monitoring Agency Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes	
Abstract	
Subject Terms	
Document Classification unclassified	**Classification of SF298** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** unlimited
Number of Pages 80	

AN ARMY RESERVE MANPOWER PLANNING MODEL

Ward E. Litzenberg-Major, United States Army Reserve
B.S., Pennsylvania State University, 1985
Master of Science in Administration, Central Michigan University, 1997
Master of Science in Operations Research, June 2001
Advisor: Siriphong Lawphongpanich, Department of Operations Research
Second Reader: Eugene P. Paulo, LTC, Department of Operations Research

Because of the expected shortages in its Active Guard and Reserve (AGR) program, the Army Reserve is considering two manpower policy changes. One is the use of Position Vacancy Promotions (PVP) and the other is to allow more officers to serve beyond 20 years of Active Federal Service (AFS). To evaluate the impact of these policy changes, either individually or in combination, on alleviating the shortages, this thesis develops the Army Reserve Manpower Planning model (ARMP). ARMP is an optimization model that determines the annual numbers of accessions, promotions, and separations that best meet the authorized inventory targets. Results from ARMP suggests that a combination of extension of the AFS requirement and allowing PVP can nearly eliminate the shortage in the near future if implemented immediately. ARMP is also useful for managing the AGR officer force.

DoD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training, Modeling and Simulation

KEYWORDS: Manpower Planning, Personnel, Optimization, Army Reserve, Active Guard and Reserve

REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY ***(Leave blank)***	**2. REPORT DATE** June 2001	**3. REPORT TYPE AND DATES COVERED** Master's Thesis	
4. TITLE AND SUBTITLE: Title (Mix case letters) An Army Reserve Manpower Planning Model			**5. FUNDING NUMBERS**
6. AUTHOR(S) Ward E. Ltizenberg			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			**12b. DISTRIBUTION CODE**

13. ABSTRACT

Because of the expected shortages in its Active Guard and Reserve (AGR) program, the Army Reserve is considering two manpower policy changes. One is the use of Position Vacancy Promotions (PVP) and the other is to allow more officers to serve beyond 20 years of Active Federal Service (AFS). To evaluate the impact of these policy changes, either individually or in combination, on alleviating the shortages, this thesis develops the Army Reserve Manpower Planning model (ARMP). ARMP is an optimization model that determines the annual numbers of accessions, promotions, and separations that best meet the authorized inventory targets. Results from ARMP suggests that a combination of extension of the AFS requirement and allowing PVP can nearly eliminate the shortage in the near future if implemented immediately. ARMP is also useful for managing the AGR officer force.

14. SUBJECT TERMS Manpower Planning, Personnel, Optimization, Army Reserve, Active Guard and Reserve			**15. NUMBER OF PAGES**
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UL

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

AN ARMY RESERVE MANPOWER PLANNING MODEL

Ward E. Litzenberg
Major, United States Army Reserve
B.S., Pennsylvania State University, 1985
M.S. Central Michigan University, 1997

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
June 2001

Author: ______________________________
Ward E. Litzenberg

Approved by: ______________________________
Siriphong Lawphongpanich, Thesis Advisor

____
Eugene P. Paulo, Second Reader

____
James N. Eagle, Chairman
Department of Operations Research

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

Because of the expected shortages in its Active Guard and Reserve (AGR) program, the Army Reserve is considering two manpower policy changes. One is the use of Position Vacancy Promotions (PVP) and the other is to allow more officers to serve beyond 20 years of Active Federal Service (AFS). To evaluate the impact of these policy changes, either individually or in combination, on alleviating the shortages, this thesis develops the Army Reserve Manpower Planning model (ARMP). ARMP is an optimization model that determines the annual numbers of accessions, promotions, and separations that best meet the authorized inventory targets. Results from ARMP suggests that a combination of extension of the AFS requirement and allowing PVP can nearly eliminate the shortage in the near future if implemented immediately. ARMP is also useful for managing the AGR officer force.

THIS PAGE INTENTIONALLY LEFT BLANK

DISCLAIMER

The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

The reader is cautioned that computer programs developed in this research may not have been exercised for all cases of interest. While every effort has been made, within the time available, to ensure that the programs are free of computational and logic errors, they cannot be considered validated. Any application of these programs without additional verification is at the risk of the user.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS

1LT	First Lieutenant
2LT	Second Lieutenant
AFS	Active Federal Service
AGR	Active Guard and Reserve
ARMP	Army Reserve Manpower Planning
ARNG	Army National Guard
ASA(M&RA)	Assistant Secretary of the Army for Manpower and Reserve Affairs
CAR	Chief, Army Reserve
CNGB	Chief, National Guard Bureau
COA	Course(s) of Action
COL	Colonel
CPT	Captain
FTS	Full Time Support
FY	Fiscal Year
IMA	Individual Mobilization Augmentee
IRR	Individual Ready Reserve
LTC	Lieutenant Colonel
MAJ	Major
OCAR	Office of the Chief, Army Reserve
OCAR-PE	Office of the Chief, Army Reserve – Personnel Division
PML	Programmed or Managed Loss
POM	Program Objective Memorandum
PVP	Position Vacancy Promotion
RC	Reserve Component
ROPMA	Reserve Officer Personnel Management Act
TIG	Time in Grade
TPU	Troop Program Unit
USAR	United States Army Reserve

THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

With the downsizing of the U.S. Army over the past ten years, an increasing reliance has been placed on its two Reserve Components (RC), the Army Reserve and National Guard, when responding to crises. With this increasing reliance, the capability and readiness of RC units and their members become critical. One essential factor in maintaining and further enhancing this capability and readiness is the RC Full Time Support (FTS). One component of FTS that has been receiving much attention recently is the Army Reserve's Active Guard and Reserve (AGR) officer force, which is the focus of this thesis.

At the end of fiscal year 2000 the number of company grade officers in the AGR program is 42% above the authorized strength, whereas the number of field grade officers is 10% under strength. When examined more closely, the numbers of Colonels (COL) and Majors (MAJ) appear to be relatively healthy at approximately 2% below their authorized strength. However, the shortage of Lieutenant Colonels (LTC) is rather severe at 26% below authorized. The distribution of the years of Active Federal Service (AFS) for AGR officers indicates that over 82% of LTC and 93% of COL are eligible for retirement or will be eligible to retire within the next five years. Combining these figures with the current shortage of LTC foretells an unhealthy future for this component of FTS.

To alleviate the potential shortage of field grade officers, the Chief, Army Reserve (CAR) is considering several alternatives. The recent passage of the Reserve Officer Personnel Management Act (ROPMA) in 1995 offers several major changes in the management of AGR officers, which includes, among others, allowing position

vacancy promotions (PVP) for officers in the AGR program. Another regulatory requirement that can contribute to the current shortage of field grade officers is the Army's policy that AGR officers with 20 years and one month of qualified AFS must retire unless granted an exception. Recently, the Assistant Secretary of the Army for Manpower and Reserve Affairs [ASA(M&RA)] granted the CAR and Chief, National Guard Bureau (CNGB) the authority to allow officers to serve up to 24 years of AFS. However, this authority expires in January 2002. (McCloskey, 2001)

To evaluate courses of action for reducing the field grade officer shortfall in the AGR program, this thesis develops an optimization model called the Army Reserve Manpower Planning (ARMP) model. This model determines the annual number of officers by rank or grade, years of time in grade (TIG) and years of AFS to recruit, promote, and extend beyond the mandatory requirement for retirement in order to maintain an AGR officer force that best meets its strength targets. This thesis considers four courses of action (COA). One uses the current personnel management policies. The remaining three COA consider two alternative management policies, individually and in combination. One alternative policy is to allow officers to serve beyond 20 years of AFS and the other is to implement PVP.

Using the current policies, ARMP forecasts an average shortfall of 18.7% in field grade officers over the seven years horizon, a time period typically considered in the Program Objective Memorandum (or the POM years). Over a 25-year horizon, the average shortfall decreases to 14.9%. On the other hand, results from ARMP show each of the alternative policies lead to a reduction in the field grade officer shortfall when compared with the results of the current policies. Individually, relaxing the AFS requirement and utilizing PVP both reduce the average shortfall in field grade officers to 12.1% over the POM years. Over a 25-year horizon, the average shortfalls are 7.4% and 5.2% for relaxing AFS requirement and utilizing PVP, respectively. When combined, the average shortfalls under the two alternatives are 5.8% and 2.1% over the POM years and a 25-year horizon, respectively. These results certainly support the Chief, Army Reserve's consideration for relaxing the AFS requirement and utilizing PVP and, hopefully, would also serve as a justification for approval of the alternatives as well.

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

First I would like to express my appreciation to the Office of the Chief, Army Reserve staff for their full support during my thesis experience. Specifically I would like to thank: COL Terry Lerch who recommended this topic to me as well as for his inspiration, support and mentoring; Mr. Bill McCloskey of SyTech, Inc. for his invaluable insight into the AGR officer program and his excellent review of my final draft; and LTC Frank Willingham for his encouraging words and his excellent review of my final draft.

I would be remiss if I did not thank my wife, Melody, whose love, support and dedication, not to mention weekly reminders to complete my thesis, led to the successful completion of this project. To my two children, Chase and Taylor, I thank you for reminding me each day about the really important things in life.

Finally, I would like to extend my sincerest thanks to my advisor, Professor Siriphong Lawphongpanich, for his patience, dedication, insight and constant mentoring throughout the entire thesis research effort.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

With the downsizing effort of its active component over the past ten years, the U.S. Army has had to place an increasing reliance on its two Reserve Components (RC), the Army Reserve and National Guard, when responding to crises. With this increasing reliance, the capability and readiness of RC units and their members become critical. One essential factor in maintaining and further enhancing this capability and readiness is the Full Time Support (FTS) consisting of Active Guard and Reserve (AGR) members, military technicians, Active component members, and civilian personnel. (U.S. Army, 1999) One component of FTS that has been receiving much attention recently is the Army Reserve's AGR officer force, which is the focus of this thesis.

At the end of Fiscal Year (FY) 2000, the number of company grade officers in the AGR program is 42% above the authorized strength. On the other hand, the number of field grade officers is 10% under strength. When examined more closely, the numbers of Colonels (COL) and Majors (MAJ) are approximately 2% short of their authorized strength. However, the shortage of Lieutenant Colonels (LTC) is rather severe, falling 26% short of authorized. The distribution of the years of Active Federal Service (AFS) for AGR officers, shown in Figure 1.1, is also alarming. The figure indicates that over 82% of LTC and 93% of COL are currently retirement eligible or will be retirement eligible within the next five years. Combining these numbers with the current shortage of LTC foretells an unhealthy future for this component of FTS.

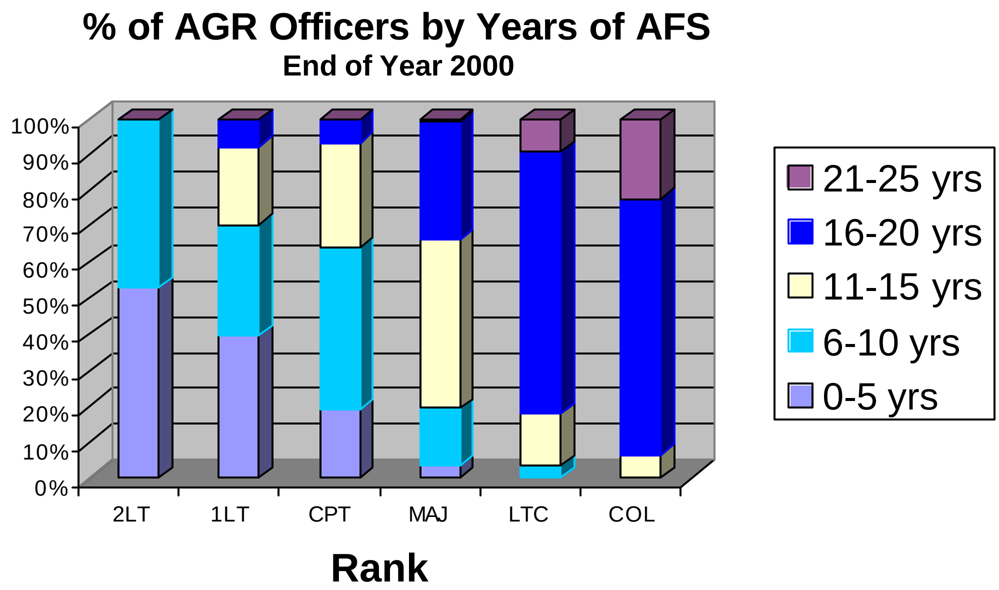

Figure 1.1. The distribution of the years of AFS for AGR officers. The composition of the AGR officer force by years of AFS is depicted. Of note is the high proportion of LTCs and COLs, 82% and 93.0% respectively, who are retirement eligible or will be retirement eligible in the next five years.

To alleviate the potential shortage of field grade officers, the Chief, Army Reserve (CAR) is considering several alternatives. The recent passage of the Reserve Officer Personnel Management Act (ROPMA) in 1995 offers several major changes in the management of AGR officers, which include, among others, removing the time in service requirement for promotion and allowing position vacancy promotions for officers in the AGR (U.S. Congress, 1994). Another regulatory requirement that can contribute to the current shortage of field grade officers is the Army's policy that AGR officers with 20 years and one month of qualified AFS must retire unless granted an exception. (U.S. Army, 1996) The Assistant Secretary of the Army for Manpower and Reserve Affairs [ASA (M&RA)] is authorized to grant extensions to those officers subjected to the mandatory requirement to retire. Recently, the ASA (M&RA) has authorized the CAR and Chief, National Guard Bureau (CNGB) to selectively allow AGR officers to serve beyond 20 years of AFS, if their skills are critical, in two-year increments up to 24 years. This authority is temporary and expires in January 2002. (McCloskey, 2001)

A. PROBLEM STATEMENT

To evaluate courses of action for reducing the field grade officer shortfall in the AGR program, this thesis develops an optimization model called the Army Reserve Manpower Planning (ARMP) model. This model determines the annual number of officers by rank or grade, years of time in grade (TIG) and years of AFS to recruit, promote, and extend beyond the mandatory requirement for retirement in order to maintain an AGR officer force that best meets its strength targets.

B. THESIS OUTLINE

Chapter II describes how the Army Reserve manages its AGR officer inventory. Chapter III formulates ARMP as a linear optimization problem. Chapter IV uses ARMP to assess the impact of alternative policies on the AGR officer inventory. Finally, Chapter V provides conclusions and recommendations for future research.

THIS PAGE INTENTIONALLY LEFT BLANK

II. AGR OFFICER MANAGEMENT

The US Army Reserve (USAR) consists of three components: Ready, Standby and Retired Reserve. Table 2.1 displays the strength of each component at the end of FY 2000. (Saltarelli, 2000b)

Ready Reserve	368,514
Standby Reserve	701
Retired Reserve	687,237
Total US Army Reserve	1,056,452

Table 2.1. Composition of the Army Reserve at the end of FY 2000.

The Ready Reserve consists of reservists in the Selected and Individual Ready Reserve (IRR). The AGR is a subcomponent of the Selected Reserve. At the end of FY 2000, only 1.5% of the reservists in the Selected Reserve are AGR officers. Although small in number, these officers play an important role because they work full time and are responsible for maintaining and further enhancing the capabilities and readiness of the Army Reserve. Table 2.2 displays the composition of the Ready Reserve at the end of FY 2000 (Saltarelli, 2000b).

Selected Reserve	206,892
Troop Program Units	*188,330*
Active/Guard Reserve	*12,855*
Individual Mobilization Augmentee	*5,700*
Individual Ready Reserve	161,622
Total Ready Reserve	**368,514**

Table 2.2. Composition of the Ready Reserve at the end of FY 2000. One subcomponent of the Selected Reserve is the Active and Guard Reserve, the focus of this thesis.

Table 2.3 displays the current AGR officer inventory and authorizations for each rank (Saltarelli, 2000a). Approximately 80% of the authorizations are for field grade officers, i.e., MAJ, LTC and COL, and the remaining ones are for company grade officers that consist of Second Lieutenants (2LT), First Lieutenants (1LT) and Captains (CPT). Note that there is no individual authorization for 2LT. The authorization for LT in Table 2.3 is for both 2LT and 1LT. Observe that the current AGR officer inventory does not match the authorized strength very well. As stated in Chapter 1, the current shortage in LTC is a major concern.

	LT	CPT	MAJ	LTC	COL
Authorization	29	558	1396	853	187
Current Inventory	201	632	1376	634	183
Deviation (%)	593%	13%	-1%	-26%	-2%

Table 2.3. AGR officer inventory and authorizations at the end of FY 2000.

To maintain its own capabilities and readiness, the goal in managing AGR officer inventory is to minimize the deviation from the authorized strength in each rank. The sections below discuss the current policies for the management of AGR officers and two alternative policies for alleviating the shortages in the field grade officers.

A. AGR OFFICER MANAGEMENT

This section describes how the USAR accesses, promotes, and separates officers from the AGR program. The description reflects the changes in policies due to the passage of ROPMA. (U.S. Congress, 1994)

1. Accessions

The main sources of new officers for the AGR program consist of officers from the other subcomponents of the Ready Reserve, such as Troop Program Units (TPU) and the IRR or from officers who leave the Active Component. New officers can join the

AGR program at any of rank between 2LT and COL, however, most officers join the program at the rank of MAJ and below because they are less likely to have established civilian occupations.

To join the AGR program, candidates submit an application to the Department of the Army Accessions Board that the CAR convenes at least annually. (U.S. Army, 1994) Only the best qualified candidates with the skills needed by the CAR are accepted into the program. By Army regulation (U.S. Army, 1996), these candidates must have less than 13 years of AFS and must not have been denied promotion to the next higher rank by the previous promotion board for their rank.

2. Promotions

Officers are eligible for promotion to the next higher rank after they have served in their current rank for some predetermined number of years. The number of years an officer serves in the same rank is commonly known as 'Time in Grade' or TIG. Although ROPMA provides the minimum and maximum TIG at which an officer can be promoted to the next higher rank, Table 2.4 provides the typical TIG when officers are considered for promotion to the next higher rank for the first time. In general, officers with TIG shown in Table 2.4 are said to be 'in the zone' for promotion. If officers are not selected for promotion, they are considered for promotion again the following year. These officers will have accumulated one more year of TIG when they are being considered for promotion for the second time and they are said to be 'above the zone' for promotion. (Although permitted by ROPMA, promotion below the zone, i.e., promotion of officers with less TIG, is not currently being considered in the AGR program.)

	TIG (years)
2LT	2
1LT	5
CPT	7
MAJ	7
LTC	5

Table 2.4. Time in grade for promotion to the next higher rank.

Except for 2LT, promotion boards select officers for promotion to the next higher rank. No board approves or reviews the promotions from 2LT to 1LT. All eligible 2LT are promoted to 1LT. By regulation, those ineligible may be retained and later promoted if the reason for ineligibility is removed. (U.S. Army, 1998) There is a selection board for each of the remaining ranks. These boards review records of all AGR officers who are eligible for promotion in and above the zone. Officers up to the rank of MAJ who are eligible and are above the zone but not selected for promotion to the next grade will not be considered for promotion again. (U.S. Army, 1998)

3. Separation

Officers separate from the AGR program for many reasons and some are listed below.

a) Upon entering the program, each new officer is obligated for three years. (U.S. Army, 1996) Officer Continuation Boards are convened annually to consider officers in the third year of their initial three-year tour for continuation in the AGR program. Officers not recommended for continuation by this board are released from active duty.

b) Officers must retire from the AGR program when they reach 20 years and one month of qualifying AFS (U.S. Army 1996) or their Mandatory Release Date (MRD) (U.S. Army, 1994), unless granted an exception.

c) Officers may be released from the AGR program due to a reduction in force initiatives, known as programmed or managed loss (PML).

d) Officers below the rank of LTC, may be released from the AGR program when they are not selected for promotion above the zone.

e) Officers may be released from the AGR program for medical and administrative reasons.

f) Officers may decide to leave the AGR program on their own accord.

B. ALTERNATIVE POLICIES

Although they may not have reached their MRD, AGR officers with 20 years and one month of AFS must retire. The CNGB and the CAR believe that AGR officers with 20 years of AFS represent an enormous Army investment and releasing these officers while they are at their prime of their career does not make good business sense. In a joint memorandum, the CNGB and the CAR have requested authority to selectively extend AGR officers beyond 20 years AFS up to, if required, their MRD. (NGB, 2000) Recently, the ASA (M&RA) granted the CAR and CNBG the authority to allow officers to serve up to 24 years of AFS. However, this authority expires in January 2002. (McCloskey, 2001)

In a normal promotion, an AGR officer would be considered for promotion when the individual has accumulated the required TIG in his or her current rank. (See Table 2.4.) However, normal promotions may not generate sufficient inventory to meet the authorized strength. Under ROPMA, it is possible to promote an officer to the next higher rank with less than the maximum TIG if there is a position for which there is no eligible officer to fill. For example, if there are LTC positions that cannot be filled because of the shortage in LTC, then the CAR, under ROPMA, can convene a position vacancy promotion board to consider promoting MAJ up to two years below the zone in order to fill those LTC positions. Use of position vacancy boards must however be approved by the Secretary of the Army.

The next chapter presents an optimization model that is useful in evaluating different courses of action (COA) for reducing shortages in field grade officer inventory. One COA is to continue using the current personnel management policies described in the previous section. The others include, individually and in combination, the two policies described above, i.e., (i) allowing officers to serve beyond 20 years of AFS and (ii) implementing PVP.

III. ARMY RESERVE MANPOWER PLANNING MODEL

This chapter presents an optimization model called the Army Reserve Manpower Planning (ARMP) model. This model determines the annual number of officers by grade, years of time in grade and years of AFS to recruit, promote, and extend beyond the mandatory requirement for retirement in order to maintain an AGR officer force that minimizes the total deviation from its strength targets. The first three sections in this chapter list the necessary assumptions, describe the model and formulate it mathematically. The fourth section reviews similar models in the literature.

A. MODEL ASSUMPTIONS

To make ARMP tractable, the following assumptions are necessary.

1. Accounting for Officer Inventory

In practice, the number and composition of officers in the AGR program can change daily. Every day there may be new officers joining the AGR program, current officers being promoted to higher ranks, and older (in tenure or otherwise) officers retiring from the program. However, it is neither practical nor beneficial to keep account of the number and composition of officers in the AGR program at the end of each day. Instead, ARMP accounts for them at the end of each fiscal year in the planning horizon.

2. Officer Classification

ARMP groups or classifies officers according to their ranks, TIG and years of AFS (or, more simply, AFS). Table 3.1 lists possible values of TIG and AFS for each rank. Although values outside the ranges in the table are possible, they occur infrequently and the benefits of modeling them explicitly are minimal. Although it may not seem possible to have a combination or classification in which TIG is more than AFS, e.g., (2LT, 3, 1), this is a perfectly feasible combination for the AGR program. The preceding combination could represent an officer currently in his or her first year in the AGR program after spending two years in a Troop Program Unit.

Rank	Time in Grade	Years of AFS
2LT	$1 \leq g \leq 3$	$1 \leq y \leq 10$
1LT	$1 \leq g \leq 7$	$1 \leq y \leq 20$
CPT	$1 \leq g \leq 9$	$1 \leq y \leq 21$
MAJ	$1 \leq g \leq 9$	$3 \leq y \leq 25$
LTC	$1 \leq g \leq 7$	$6 \leq y \leq 25$
COL	$1 \leq g \leq 7$	$11 \leq y \leq 25$

Table 3.1. Valid officer classifications or combinations of rank, TIG and AFS.

From the end of one fiscal year to the next, officers transition from one classification to another. For example, officers with classification (1LT, 2, 5) at the end of year *t* become officers with classification (1LT, 3, 6) at the end of year (*t*+1). This is to represent the fact that these officers have provided one additional year of service, in both TIG and AFS, at the end of year (*t*+1).

For MAJ, LTC, and COL, classifications with TIG or AFS at their maximum values, or 'classifications at the boundary', have slightly different meanings. For example, (MAJ, 7, 25) represents a MAJ with 7 years TIG and 25 or more years of AFS. Therefore, officers with classification (MAJ, 7, 25) at the end of year *t* become officers with classification (MAJ, 8, 25) at the end of year (*t*+1). Note that AFS in the new classification is unchanged because an AFS of 25 in this classification scheme means 25 or more years of AFS. Similarly, a classification with a TIG of 9 also means 9 or more years of TIG. So, officers with classification (MAJ, 9, 25) would remain in the same classification from the end of one year to the next assuming that their extensions were approved.

3. Accessions

As explained in Chapter II, new officers can join the AGR program in different classifications depending on their previous experience in the Active component or other subcomponents of the Ready Reserve. Table 3.2 lists the ranges of TIG and AFS that are valid for ARMP. Although Army regulations may allow AGR officers to access outside these ranges, they are unlikely in practice.

Rank	Time in Grade	Years of AFS
2LT	$1 \leq g \leq 2$	$1 \leq y \leq 10$
1LT	$1 \leq g \leq 5$	$1 \leq y \leq 12$
CPT	$1 \leq g \leq 7$	$1 \leq y \leq 12$
MAJ	$1 \leq g \leq 7$	$3 \leq y \leq 12$
LTC	$1 \leq g \leq 5$	$6 \leq y \leq 12$
COL	$1 \leq g \leq 5$	$11 \leq y \leq 12$

Table 3.2. Valid combinations of Rank, TIG and AFS for accessions.

4. Attrition

In this thesis, attrition for MAJ or below refers to officers leaving the AGR program due to reasons other than being released under PML. In order to allow ARMP to relax the mandatory retirement at 20 year of AFS, attrition for LTC and COL also excludes those who have to leave because of this mandatory retirement.

To simplify the model, ARMP assumes that attrition occurs prior to any other personnel actions such as promotions and PML. In addition, newly accessed officers do not attrite during the year in which they join the AGR program.

In general, attrition rates, or the percentage of officers who decide to leave, depend on ranks, TIG, AFS, unemployment rates, cost of living, the state of the economy, etc. However, it is beyond the scope of this thesis to develop a model, statistical or otherwise, to estimate attrition rates for various classifications of AGR officers. It is assumed instead that attrition rates depend only on ranks, TIG and AFS. (Due to insufficient data, the implementation in Chapter IV assumes that attrition rates depend on ranks and TIG and they are constant during the planning horizon.)

B. MODEL DESCRIPTION

The problem in managing the AGR officer inventory is to determine the number of officers to access, promote, release under PML, and, when necessary, retire after reaching 20 years of AFS so that the resulting officer inventory deviates the least from the strength targets at the end of each fiscal year. For each rank, one measure of deviation is the absolute difference between the target and the number of officers in that rank. Using this measure, the objective of the model is to minimize the total deviation, i.e., the sum of absolute deviations from each rank at the end of each fiscal year in the planning horizon. While minimizing deviations, the model must ensure that officers transition from one classification to another in a logical manner. Figure 3.1 graphically displays a partial set of logical transitions as a network of nodes (or circles) and arcs (or arrows). Each node and arc represents a valid officer classification (or a combination of ranks, TIG, and AFS) and transition between two classifications, respectively. Dotted arcs or 'retention arcs' represent officers remaining in the rank from the end of year t to the end of year (t+1). Solid arcs or 'promotion arcs' represent officers being promoted to the next rank during year (t+1). Observe that there are three different promotion arcs emanating from the CPT nodes at the end of year t, to the (MAJ,1,y+1) node at the end of year (t+1). These three arcs represent Position Vacancy (from TIG 6), in-the-zone (from TIG 7) and above-the-zone (from TIG 8) promotions. Because PVP is not allowed for 2LT and 1LT, there are only two promotion arcs emanating from each rank (one for in-the-zone promotions and the other for above-the-zone promotions).

In general, the classifications or nodes at the head and tail of each retention arc have a different TIG and AFS to indicate the fact that officers have accumulated one additional year of service that counts toward TIG and AFS. In Figure 3.1, there are two arcs that do not follow this general rule. To reflect current practices, the arc from (2LT,3,y) to (2LT,3,y+1) is a retention arc that allows a small fraction of 2LT to stay in the AGR program after being denied promotion. In this case, a TIG of 3 refers to officers in the same rank for three or more years. The similar is also true for the arc from (CPT,9,y) to (CPT,9,y+1). The classification or node at the head of each promotion arc always has a TIG of one because officers have just been promoted and they must have one year of TIG at the end of year (t+1).

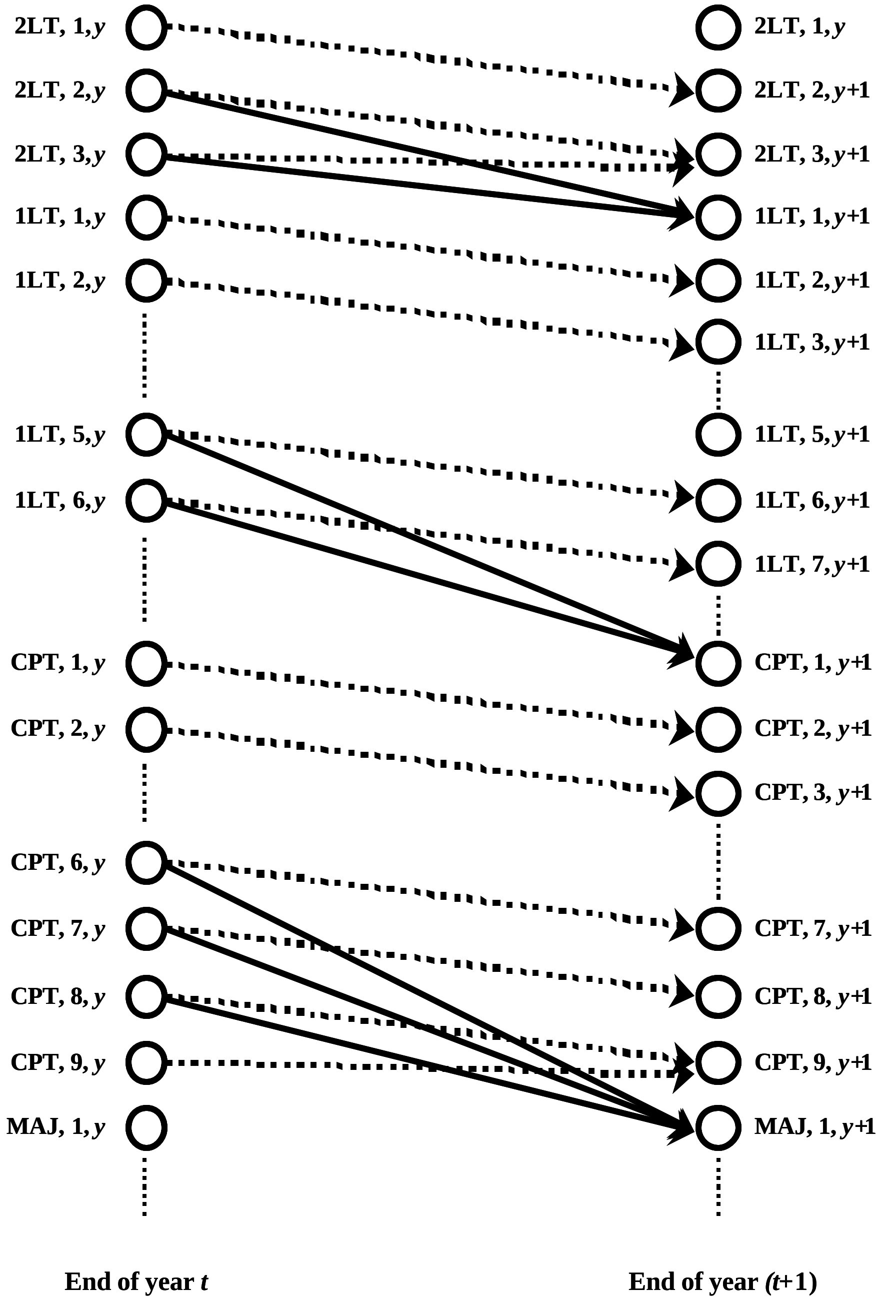

Figure 3.1. A transition network for AGR officers. Each node represents a valid classification (combination of rank, TIG and AFS) at the end of the year. Arcs represent the movement, or flow, of officers from one year to the next. Dotted arcs, or 'retention' arcs, represent officers remaining in the rank from the end of year *t* to the end of year (*t*+1). Solid arcs or 'promotion arcs' represent officers being promoted to the next rank during year (*t*+1).

C. MODEL FORMULATION

Below is a formulation of the Army Reserve Manpower Planning problem.

Indices:

t	year of the planning horizon, $t = 1, 2, 3, \ldots T$
r	rank, r = 2LT, 1LT, CPT, MAJ, LTC, COL
g	years in time in grade (TIG), $g = 1,2,3,\ldots 9$
y	years of Active Federal Service (AFS), $y = 1, 2, 3, \ldots 25$

To make the problem structure more evident, assume when unspecified that data, variables and summation indices apply only to combinations of (r, g, y) listed in the Tables 3.1 and 3.2.

Data:

a	discount factor, i.e., $0 < \alpha < 1$
plb_t^r	minimum proportion of officers who must be promoted in zone to rank r during year t of the planning horizon
paub_t^r	maximum proportion of officers who can be promoted above zone to rank r during year t of the planning horizon
pvub_t^r	maximum proportion of officers who can be promoted by position vacancy board to rank r during year t of the planning horizon
PMLrate_t^r	maximum proportion of officers in rank r who are forced to separate during year t of the planning horizon

AFSrate_t^r maximum proportion of officers with rank *r* and 20 or more years of AFS who can be selected for an extension at the end year *t* of the planning horizon

target_t^r targeted number of officers in rank *r* at the end of year *t* of the planning horizon where $r \geq$ 1LT. (Recall that targets for 2LT and 1LT are combined and it is more convenient to let target_t^{1LT} represent this combined target.)

$\text{Attrit}^{r,g}$ proportion of officers with rank *r* and TIG *g* who attrite during each year of the planning horizon

$\text{ma}_t^{r,g,y}$ maximum number of officers with rank *r*, TIG *g* and AFS *y* to access in year *t* of the planning horizon.

w^r weight for deviation from targets by rank *r*.

ca penalty for exceeding the AFS limit

cp penalty for exceeding the PML limit

Nonnegative Variables:

$X_t^{r,g,y}$ number of officers with rank *r*, TIG *g* and AFS *y* in the AGR officer inventory at the end of year *t* of the planning horizon. $X_1^{r,g,y}$ represents the initial number of officers with rank *r*, TIG *g* and AFS *y*.

$A_t^{r,g,y}$ number of officers with rank *r*, TIG *g* and AFS *y* to join the AGR program during year *t* of the planning horizon.

$P_t^{r,y}$ number of officers with AFS (*y* – 1) to be promoted in the zone to rank *r* during year *t* of the planning horizon. (Observe that these officers will have *y* years of AFS and a TIG of 1 at the end of year *t*.)

$PA_t^{r,y}$ number of officers with AFS (*y* – 1) to be promoted above the zone to rank *r* during year *t* of the planning horizon. (The above observation applies here.)

$PV_t^{r,y}$ number of officers with AFS (y – 1) to be promoted by position vacancy board to rank r during year t of the planning horizon. (The above observation applies here.)

$PML_t^{r,g,y}$ number of officers with rank r, TIG g and AFS y who are forced to separate from the AGR program during year t of the planning horizon. When $y \geq 20$, $PML_t^{r,g,y}$ includes those who must retire because of the AFS requirement.

$OAFS_t^r$ number of officers in rank r with more than 20 years of AFS over the maximum allowed by $\mathrm{AFSrate}_t^r$ during year t of the planning horizon.

$OPML_t^r$ number of officers in rank r forced to separate over the maximum allowed by $\mathrm{PMLrate}_t^r$ during year t of the planning horizon.

EX_t^r number of officers in rank r in excess of the target during year t of the planning horizon.

SH_t^r number of officers in rank r short of the target during year t of the planning horizon

Army Reserve Manpower Planning Model

Formulation:

$$\text{Min} \sum_{t\geq 2}\sum_{r\geq 1\text{LT}} a^{t-1} w^r (EX_t^r + SH_t^r) + \sum_{t\geq 2}\sum_{r\geq 1\text{LT}} a^{t-1}(\text{ca}\cdot OAFS_t^r + \text{cp}\cdot OPML_t^r) \tag{3.1}$$

Subject to

$$X_t^{2LT,g,y} - (1-\text{Attrit}^{2LT,g})\cdot X_{t-1}^{2LT,g-1,y-1} - A_t^{2LT,g,y}\,|_{g\leq 2 \text{ and } y\leq 10} + P_t^{1LT,y}\,|_{g=3} + PA_t^{1LT,1,y}\,|_{g=3} + PML_t^{2LT,g,y} = 0 \quad \forall\, g, y, t\geq 2 \tag{3.2a}$$

$$X_t^{1LT,g,y} - (1-\text{Attrit}^{1LT,g})\cdot X_{t-1}^{1LT,g-1,y-1} - A_t^{1LT,g,y}\,|_{g\leq 5 \text{ and } y\leq 12} - P_t^{1LT,y}\,|_{g=1} - PA_t^{1LT,y}\,|_{g=1} + P_t^{CPT,y}\,|_{g=6} + PA_t^{CPT,y}\,|_{g=7} + PML_t^{1LT,g,y}\,|_{y\leq 17} = 0 \quad \forall\, g, y, t\geq 2 \tag{3.2b}$$

$$X_t^{CPT,g,y} - (1-\text{Attrit}^{CPT,g})\cdot X_{t-1}^{CPT,g-1,y-1} - A_t^{CPT,g,y}\,|_{g\leq 7 \text{ and } y\leq 12} - P_t^{CPT,y}\,|_{g=1} - PA_t^{CPT,y}\,|_{g=1} + P_t^{MAJ,y}\,|_{g=8} + PA_t^{MAJ,y}\,|_{g=9} + PV_t^{MAJ,y}\,|_{g=7} + PML_t^{CPT,g,y}\,|_{y\leq 17} = 0 \quad \forall\, g, y, t\geq 2 \tag{3.2c}$$

$$X_t^{MAJ,g,y} - (1-\text{Attrit}^{MAJ,g})\cdot X_{t-1}^{MAJ,g-1,y-1} - A_t^{MAJ,g,y}\,|_{g\leq 7 \text{ and } y\leq 12} - P_t^{MAJ,y}\,|_{g=1} - PA_t^{MAJ,y}\,|_{g=1} - PV_t^{MAJ,y}\,|_{g=1} + P_t^{LTC,y}\,|_{g=8} + PA_t^{LTC,y}\,|_{g=9} + PV_t^{LTC,y}\,|_{g=7} + PML_t^{MAJ,g,y} = 0 \quad \forall\, g, y, t\geq 2 \tag{3.2d}$$

$$X_t^{LTC,g,y} - (1-\text{Attrit}^{LTC,g})\cdot X_{t-1}^{LTC,g-1,y-1} - A_t^{LTC,g,y}\,|_{g\leq 5 \text{ and } y\leq 12} - P_t^{LTC,y}\,|_{g=1} - PA_t^{LTC,y}\,|_{g=1} - PV_t^{COL,y}\,|_{g=1} + P_t^{COL,y}\,|_{g=6} + PA_t^{COL,y}\,|_{g=7 \text{ or } g=8} + PV_t^{COL,y}\,|_{g=5} + PML_t^{LTC,g,y} = 0 \quad \forall\, g, y, t\geq 2 \tag{3.2e}$$

$$X_t^{COL,g,y} - (1-\text{Attrit}^{COL,g})\cdot X_{t-1}^{COL,g-1,y-1} - A_t^{COL,g,y}\,|_{g\leq 5 \text{ and } y\leq 12} - P_t^{COL,y}\,|_{g=1} - PA_t^{COL,y}\,|_{g=1} - PV_t^{COL,y}\,|_{g=1} + PML_t^{COL,g,y} = 0 \quad \forall\, g, y, t\geq 2 \tag{3.2f}$$

In-the-Zone Promotion Eligibility Constraints

$$P_t^{1LT,y} - (1 - \text{Attrit}^{\,2LT,2}) \cdot X_{t-1}^{2LT,2,y-1} \leq 0 \qquad \forall\, y,\ t \geq 2 \quad (3.3a)$$

$$P_t^{CPT,y} - (1 - \text{Attrit}^{\,1LT,5}) \cdot X_{t-1}^{1LT,5,y-1} \leq 0 \qquad \forall\, y,\ t \geq 2 \quad (3.3b)$$

$$P_t^{MAJ,y} - (1 - \text{Attrit}^{\,CPT,7}) \cdot X_{t-1}^{CPT,7,y-1} \leq 0 \qquad \forall\, y,\ t \geq 2 \quad (3.3c)$$

$$P_t^{LTC,y} - (1 - \text{Attrit}^{\,MAJ,7}) \cdot X_{t-1}^{MAJ,7,y-1} \leq 0 \qquad \forall\, y,\ t \geq 2 \quad (3.3d)$$

$$P_t^{COL,y} - (1 - \text{Attrit}^{\,LTC,5}) \cdot X_{t-1}^{LTC,5,y-1} \leq 0 \qquad \forall\, y,\ t \geq 2 \quad (3.3e)$$

In-the-Zone Promotion Lower Bound Constraints

$$\sum_y P_t^{1LT,y} - \text{plb}_t^{1LT} \cdot \sum_y (1 - \text{Attrit}^{\,2LT,2}) \cdot X_{t-1}^{2LT,2,y} \geq 0 \qquad \forall\, t \geq 2 \quad (3.4a)$$

$$\sum_y P_t^{CPT,y} - \text{plb}_t^{CPT} \cdot \sum_y (1 - \text{Attrit}^{\,1LT,5}) \cdot X_{t-1}^{1LT,5,y} \geq 0 \qquad \forall\, t \geq 2 \quad (3.4b)$$

$$\sum_y P_t^{MAJ,y} - \text{plb}_t^{MAJ} \cdot \sum_y (1 - \text{Attrit}^{\,CPT,7}) \cdot X_{t-1}^{CPT,7,y} \geq 0 \qquad \forall\, t \geq 2 \quad (3.4c)$$

$$\sum_y P_t^{LTC,y} - \text{plb}_t^{LTC} \cdot \sum_y (1 - \text{Attrit}^{\,MAJ,7}) \cdot X_{t-1}^{MAJ,7,y} \geq 0 \qquad \forall\, t \geq 2 \quad (3.4d)$$

$$\sum_y P_t^{COL,y} - \text{plb}_t^{COL} \cdot \sum_y (1 - \text{Attrit}^{\,LTC,5}) \cdot X_{t-1}^{LTC,5,y} \geq 0 \qquad \forall\, t \geq 2 \quad (3.4e)$$

Position Vacancy Promotion Eligibility Constraints

$$PV_t^{MAJ,y} - (1 - \text{Attrit}^{\,CPT,6}) \cdot X_{t-1}^{CPT,6,y-1} \leq 0 \qquad \forall\, y,\ t \geq 2 \quad (3.5a)$$

$$PV_t^{LTC,y} - (1 - \text{Attrit}^{\,MAJ,6}) \cdot X_{t-1}^{MAJ,6,y-1} \leq 0 \qquad \forall\, y,\ t \geq 2 \quad (3.5b)$$

$$PV_t^{COL,y} - (1 - \text{Attrit}^{\,LTC,4}) \cdot X_{t-1}^{LTC,4,y-1} \leq 0 \qquad \forall\, y,\ t \geq 2 \quad (3.5c)$$

Position Vacancy Promotion Upper Bound Constraints

$$\sum_y PV_t^{MAJ,y} - \text{pvub}_t^{MAJ} \cdot \sum_y (1 - \text{Attrit}^{CPT,6}) \cdot X_{t-1}^{CPT,6,y} \le 0 \qquad \forall\, t \ge 2 \quad (3.6a)$$

$$\sum_y PV_t^{LTC,y} - \text{pvub}_t^{LTC} \cdot \sum_y (1 - \text{Attrit}^{MAJ,6}) \cdot X_{t-1}^{MAJ,6,y} \le 0 \qquad \forall\, t \ge 2 \quad (3.6b)$$

$$\sum_y PV_t^{COL,y} - \text{pvub}_t^{COL} \cdot \sum_y (1 - \text{Attrit}^{LTC,4}) \cdot X_{t-1}^{LTC,4,y} \le 0 \qquad \forall\, t \ge 2 \quad (3.6c)$$

Above-the-Zone promotion Eligibility constraints

$$PA_t^{1LT,y} - (1 - \text{Attrit}^{2LT,3}) \cdot X_{t-1}^{2LT,3,y-1} \le 0 \qquad \forall\, y,\, t \ge 2 \quad (3.7a)$$

$$PA_t^{CPT,y} - (1 - \text{Attrit}^{1LT,6}) \cdot X_{t-1}^{1LT,6,y-1} \le 0 \qquad \forall\, y,\, t \ge 2 \quad (3.7b)$$

$$PA_t^{MAJ,y} - (1 - \text{Attrit}^{CPT,8}) \cdot X_{t-1}^{CPT,8,y-1} \le 0 \qquad \forall\, y,\, t \ge 2 \quad (3.7c)$$

$$PA_t^{LTC,y} - (1 - \text{Attrit}^{MAJ,8}) \cdot X_{t-1}^{MAJ,8,y-1} \le 0 \qquad \forall\, y,\, t \ge 2 \quad (3.7d)$$

$$PA_t^{COL,y} - \sum_{g=6}^{7} (1 - \text{Attrit}^{LTC,g}) \cdot X_{t-1}^{LTC,g,y-1} \le 0 \qquad \forall\, y,\, t \ge 2 \quad (3.7e)$$

Above-the-Zone Promotion Upper Bound Constraints

$$\sum_y PA_t^{1LT,y} - \text{paub}_t^{1LT} \cdot \sum_y (1 - \text{Attrit}^{2LT,3}) \cdot X_{t-1}^{2LT,3,y} \le 0 \qquad \forall\, t \ge 2 \quad (3.8a)$$

$$\sum_y PA_t^{CPT,y} - \text{paub}_t^{CPT} \cdot \sum_y (1 - \text{Attrit}^{1LT,6}) \cdot X_{t-1}^{1LT,6,y} \le 0 \qquad \forall\, t \ge 2 \quad (3.8b)$$

$$\sum_y PA_t^{MAJ,y} - \text{paub}_t^{MAJ} \cdot \sum_y (1 - \text{Attrit}^{CPT,8}) \cdot X_{t-1}^{CPT,8,y} \le 0 \qquad \forall\, t \ge 2 \quad (3.8c)$$

$$\sum_y PA_t^{LTC,y} - \text{paub}_t^{LTC} \cdot \sum_y (1 - \text{Attrit}^{MAJ,8}) \cdot X_{t-1}^{MAJ,8,y} \le 0 \qquad \forall\, t \ge 2 \quad (3.8d)$$

$$\sum_y PA_t^{COL,y} - \text{paub}_t^{COL} \cdot \sum_y \sum_{g=6}^{7} (1 - \text{Attrit}^{LTC,g}) \cdot X_{t-1}^{LTC,g,y} \le 0 \qquad \forall\, t \ge 2 \quad (3.8e)$$

Target constraints

$$\sum_{y}\sum_{g} X_t^{r,g,y} \quad \le \quad \text{target}_t^r \qquad \forall\, r \ge \text{ MAJ, } t \ge 2 \quad (3.9a)$$

$$\sum_{y}\sum_{g} X_t^{r,g,y} - EX_t^r + SH_t^r = \text{ target}_t^r \qquad \forall\, r \ge \text{ CPT, } t \ge 2 \quad (3.9b)$$

$$\sum_{y}\sum_{g} (X_t^{2LT,g,y} + X_t^{1LT,g,y}) - EX_t^{1LT} + SH_t^{1LT} \quad = \quad \text{target}_t^{1LT} \qquad \forall\, t \ge 2 \quad (3.9c)$$

Programmed or Managed Loss constraints

$$PML_t^{r,g,y} - (1 - \text{Attrit}^{\,r,g}) \cdot X_{t-1}^{\,r,g,y-1} \le 0 \qquad \forall\, r, g, y, t \ge 2 \quad (3.10a)$$

$$\sum_{g}\sum_{y} PML_t^{r,g,y} - overPML_t^r - \text{PMLRate}_t^r \cdot \sum_{g}\sum_{y} X_t^{r,g,y} \le 0 \qquad \forall\, r, t \ge 2 \quad (3.10b)$$

Maximum Active Federal Service constraints

$$\sum_{g}\sum_{y=21}^{y=25} X_t^{r,g,y} - overAFS_t^r \quad \le \quad \text{AFSRate}_t^r \cdot \text{target}_t^r \qquad \forall\, r \ge \text{CPT, } t \ge 2 \quad (3.11)$$

Accession constraints

$$A_t^{r,g,y} \le \text{ma}_t^{r,g,y} \qquad \forall\, (r, g, y) \text{(see Table 3.2), } t \ge 2 \quad (3.12)$$

Nonnegativity constraints

$$X_t^{r,g,y},\ A_t^{r,g,y},\ P_t^{r,g,y},\ PA_t^{r,g,y},\ PV_t^{r,g,y},\ PML_t^{r,g,y},$$
$$OAFS_t^r,\ OPML_t^r,\ EX_t^r,\ SH_t^r \ge 0 \qquad \forall\, r, g, y, t \quad (3.13)$$

In Equation (3.1), the objective function is linear and represents the present value of a combination of weighted deviations from inventory targets and penalties for having too many officers with more than 20 years of AFS and for forcing too many officers to leave the AGR program. The present value is based on the discount factor a, where $0 < a < 1$. When t is sufficiently large, a^{t-1} is essentially zero, making the deviations and penalties in year t and later irrelevant to the optimization process.

The inventory balance constraints, Equations (3.2a) to (3.2f), relate the officer inventory from the end of one year to the end of the next. In general, these constraints state that the number of officers with rank r, TIG g, and AFS y at the end of year t is equal to the number of officers with rank r, TIG (g–1), and AFS (y–1) who survive from the end of year (t–1) plus the number of officers who are promoted to rank r (to TIG 1) during year t and minus the number of officers who are either promoted to the next rank (r+1) or separated from the AGR during year t.

Constraints in Equations (3.3a) to (3.3e), (3.5a) to (3.5c), and (3.7a) to (3.7e) ensure that the number of officers who will have accumulated y years of AFS and are promoted to rank r in the zone, above the zone, and via PVP, respectively, during year t is no larger than the number of eligible officers. On the other hand, constraints in Equations (3.4a) to (3.4e) force the number of officers promoted in the zone to rank r to be no smaller than the lower bound defined by plb_t^r and those in Equations (3.6a) to (3.6c) and (3.8a) to (3.8e) limit number of officers promoted above the zone and via PVP to rank r to be no larger that their respective upper bounds.

Constraints in Equation (3.9a) guarantee that numbers of MAJ, LTC and COL in the inventory do not exceed their respective targets. Equation (3.9b) calculates the numbers of officers in excess or short of the CPT, MAJ, LTC and COL targets. In light of Equation (3.9a), $EX_t^r = 0$ for $r \geq$ MAJ. Equation (3.9c) does the same for the 2LT and 1LT. Recall that there are no separate targets for 2LT and 1LT.

Constraints in Equation (3.10a) ensure that the number of PML for each valid combination of (*r*, g, *y*) does not exceed the number of officers who will remain with the AGR program until the end of year *t*. Then, constraints in Equations (3.10b) and (3.11) compute the numbers of officers who are forced to separate and extended beyond 20 years of AFS, respectively, that exceed the maximum allowed during year *t*.

Constraints in Equation (3.12) impose an upper bound on the number of accessions for each valid combination of (*r*, g, *y*) during each year *t*. Finally, constraints in Equation (3.13) ensure all decision variables are nonnegative.

D. RELATED WORK

Although there are articles in the open literature that describe personnel models specifically for the military, our search uncovers only one article that addresses the Army Reserve. Shukiar (1996) develops a Markov model for determining enlisted inventory for the Army Reserve and National Guard, called the Readiness Enhancement Model. Outside the open literature, the Career Management Decision Support Model (CMDSM) developed by the Army Reserve – Personnel Command (AR-PERSCOM) in 1998 uses the personnel assignment problem (e.g., Ahuja et al., 1993) to simulate assignments, promotions and accessions for officers in the AGR program. CMDSM produces highly detailed solutions and uses a large amount of CPU time (Marmorstein, 2000).

For other branches of the military, models in the open literature address either finite or infinite planning horizons. Those with a finite planning horizon include, e.g., the Enlisted Loss Inventory Model – Computation of Manpower Programs using Linear Programs (Holz and Wroth, 1980), Army Manpower Long-Range Planning System (Gass et al., 1998), and Model for Planning Officer Accessions (Bres et al., 1980). These three models are similar to ARMP in that they utilize similar ideas from Markov Chains and determine optimal personnel decisions by solving an optimization problem that minimizes total deviation from inventory targets. On the other hand, Yamada (2000) (and references cited therein) uses approximation schemes to address the infinite planning horizon.

IV. RESULTS AND APPLICATIONS

To illustrate how outputs from ARMP can be used to assess the impact of the alternative manpower policies described in Chapter II, the model is implemented in the General Algebraic Modeling System (GAMS), version 2.50D (Brooke et al. 1998) using a 333 megahertz Pentium III computer with 128 megabytes of random access memory. In order to incorporate the random accession of officers, random combinations of rank, TIG and years of AFS that an officer can be accessed during each year of the planning horizon are generated, ARMP is solved and the process is repeated 30 times in order to take advantage of the Central Limit Theorem. Depending on the solvers, the running time can be quite different. For example, version 1 of the IBM Optimization Subroutine Library (OSL) requires approximately 16 hours of CPU time to solve ARMP 30 times. On the other hand, version 6.5 of CPLEX requires less than 2 hours to do the same.

Below, Section A describes the data used in our analysis. Section B discusses outputs from ARMP using the current policies. Section C describes the impact of the alternative policies on the field grade officer inventory.

A. INPUT DATA

Data for ARMP comes from different sources. Some are user specified and some are from data files on AGR officers. The latter include the AGR Authorization File dated September 30, 2000 and two AGR Officer Rosters, one dated September 30, 1999 and the other dated September 30, 2000. Below is a summary of the data pertinent to ARMP.

1. Planning Horizon

The analysis in this chapter is based on a 25-year planning horizon that starts at the end of FY 2000 and ends at the end of FY2025. This length is chosen because it covers the length of a typical AGR officer's career, if extended, and generates minimal errors due to end effects (e.g., Yamada, 2000).

2. Strength Targets

The strength targets for every year in the planning horizon are from the AGR Authorization File and they are the same as those shown in Table 2.3.

3. Initial AGR officer Inventory

The time in grade and years of AFS for officers in the inventory at the end of FY 2000 are based on the AGR Officer Roster dated September 30, 2000. The TIG for each officer is the difference between September 30, 2000 and the date of the officer's last promotion or 'date of rank'. When the latter is not available, an average TIG is assigned to the officer. Similarly, the number of years of AFS for each officer is the difference between September 30, 2000 and the Basic Active Service Date (BASD). As before, officers without BASD are assigned an average AFS value for their rank. Tables in Appendix A summarize the number of officers in each classification at the end of FY 2000.

4. Promotion Eligibility

Table 4.1 lists the number of years an officer must serve in the same rank or grade before becoming eligible for promotion in the zone, above the zone, and via position vacancy when applicable.

	Time in Grade (years)		
From - To:	**In the Zone**	**Above the Zone**	**Position Vacancy:**
2LT - 1LT	2	3	NA
1LT - CPT	5	6	NA
CPT - MAJ	7	8	6
MAJ - LTC	7	8	6
LTC - COL	5	6 or 7	4

Table 4.1. Required years TIG for promotion: Number of years an officer must serve in the same rank or grade before becoming eligible for promotion in the zone, above the zone, and via position vacancy.

5. Bounds on Promotion Rates

OCAR analysts supply the bounds on the proportions or percentages of officers to be promoted and they are listed in Table 4.2. The model can accept different rates for any of the first seven years of the model, however the rates used within this thesis are constant for the entire 25-year horizon. Note the unconstrained proportion of officers who can be promoted via PVP when utilized.

	1LT	CPT	MAJ	LTC	COL
Minimum Proportion for Promotion In the Zone	0.80	0.80	0.80	0.70	0.50
Maximum Proportion for Promotion Above the Zone	0.05	0.05	0.05	0.05	0.05
Maximum Proportion for Position Vacancy Promotion	0.0	0.0	1.0	1.0	1.0

Table 4.2. Bounds on promotion rates.

6. Attrition Rates

Recall from Chapter III that the attrition rate, or the percentage of AGR officers who separate from the USAR, is assumed to depend only on ranks and TIG. Under this assumption, the attrition rates for officer classifications with the same TIG are the same regardless of the AFS. Table 4.3 lists the attrition rates obtained based on two AGR Officer Rosters, one dated September 30, 1999 and the other dated one year later. The attrition rates for (2LT, 3), (1LT, 7) and (CPT, 9) were supplied by OCAR analysts in order to more closely reflect the policy of releasing officers not selected above the zone. OCAR analysts also adjusted the attrition rates for LTC and COL downward in order to remove the effect of required retirements.

	Time in Grade (TIG)								
Rank	1	2	3	4	5	6	7	8	9
2LT	0.000	0.000	0.500						
1LT	0.000	0.024	0.043	0.088	0.088	0.250	0.500		
CPT	0.062	0.080	0.063	0.044	0.054	0.036	0.039	0.038	0.500
MAJ	0.000	0.027	0.035	0.037	0.006	0.044	0.035	0.045	0.556
LTC	0.075	0.075	0.075	0.075	0.075	0.075	0.500		
COL	0.100	0.100	0.100	0.100	0.100	0.100	0.500		

Table 4.3. Attrition rates by rank and TIG.

7. Accessions

New AGR officers can join the officer inventory in any classification and the collection of classifications with new officers vary randomly from year to year. The analyses in Sections B and C use two empirical distribution functions (Conover, 1999), one for TIG and the other for AFS, to generate a random collection of classifications in which new officers can be accessed into the AGR program each year. For each rank, the collection consists of at most five random combinations of TIG and AFS. The empirical distributions for TIG and AFS are constructed from the two AGR Officer Rosters (one dated September 30, 1999 and the other dated one year later) and, for simplicity, are assumed to be independent.

8. Active Federal Service Rates

For the initial officer inventory (i.e., the inventory at the end of FY 2000), the fractions of officers with more than 20 years of AFS are listed in Table 4.4 as the current policies AFS rate. It is assumed that these fractions also apply to officer inventory at the end of each year in the planning horizon when the AFS retirement policy is not relaxed. The relaxed AFS retirement policy rate is also listed.

	2LT	1LT	CPT	MAJ	LTC	COL
Current Policies AFS Rate	0.000	0.000	0.005	0.010	0.07	0.20
Relaxed AFS Policy	0.000	0.000	0.01	0.020	0.20	0.40

Table 4.4. Fractions of officers with more than 20 years of AFS.

9. Other Data

The penalties for exceeding the AFS (denoted as 'ca' in ARMP) and PML (denoted as 'cp' in ARMP) limits are 5 and 15, respectively. The weights, w^r, are $1/\text{target}_t^r$ and $10/\text{target}_t^r$ for company and field grade officers, respectively. Since there is no plan for any early retirement program in the near future, PMLrate_t^r is zero for every rank and year in the planning horizon.

The discount factor, α, is 0.9. Figure 4.1 compares the values of a^{t-1} for three values of α. Observe that α = 0.9 places more weight or importance on the first seven years of the planning horizon, a period typically included in the Program Objective Memorandum. In this thesis, it is convenient to refer to this seven-year period as the POM years. While not ideally zero, the weight at the end of the planning horizon is sufficiently small.

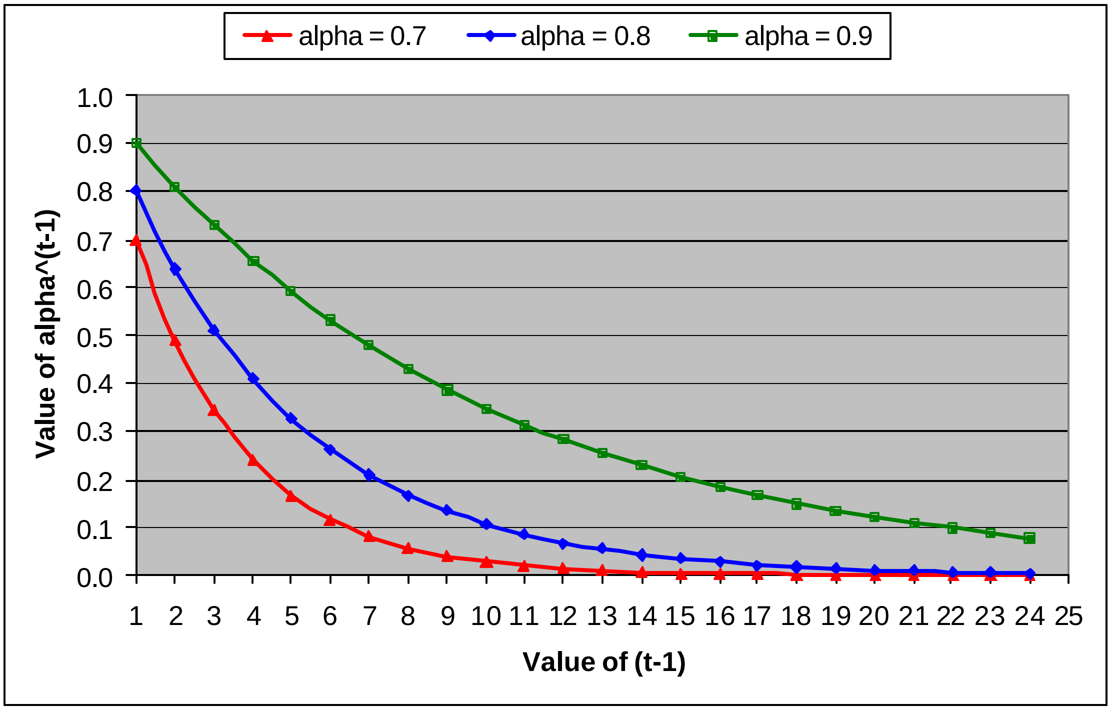

Figure 4.1. Discounting profiles for three values of α.

B. ANALYSIS OF THE CURRENT POLICIES

Below are summaries of sample outputs from solving ARMP 30 times based on the current policies.

1. Inventory

Figure 4.2 shows the average inventory, the corresponding 95 percent confidence interval and the target value at the end of each year in the planning horizon from solving ARMP 30 times. The figure includes four graphs, one for company grade officers and the other three for the three field grade officers. The company grade officer inventory starts and remains above its target value or nearly so during the entire planning horizon. On the other hand, the inventory levels for field grade officers start below their targets and remain below them until the end of the horizon.

Observe that there is little variation in the LTC and COL inventory levels during the representative POM years (FY 2001 – FY 2007) indicating that variation in officer accessions has no effect on the LTC and COL strength in the near term. Moreover, it also confirms OCAR analysts' concern regarding possible shortfalls in LTC and COL.

Table 4.5 summarizes the results shown in Figure 4.2 numerically. Observe that all field grade officer shortfalls increase over the representative POM years and the 25-year horizon (refer to Table 2.3).

	Company Grade	MAJ	LTC	COL	Field Grade
Target	587	1396	853	187	2436
Average Inventory from FY 2001 to FY 2007	714	1293	547	139	1979
Average deviation	21.56%	-7.39%	-35.86%	-25.52%	-18.75%
Average Inventory from FY 2001 to FY 2025	635	1317	606	151	2074
Average deviation	8.26%	-5.63%	-29.00%	-19.40%	-14.87%

Table 4.5: Average inventories and target deviation under the current policies.

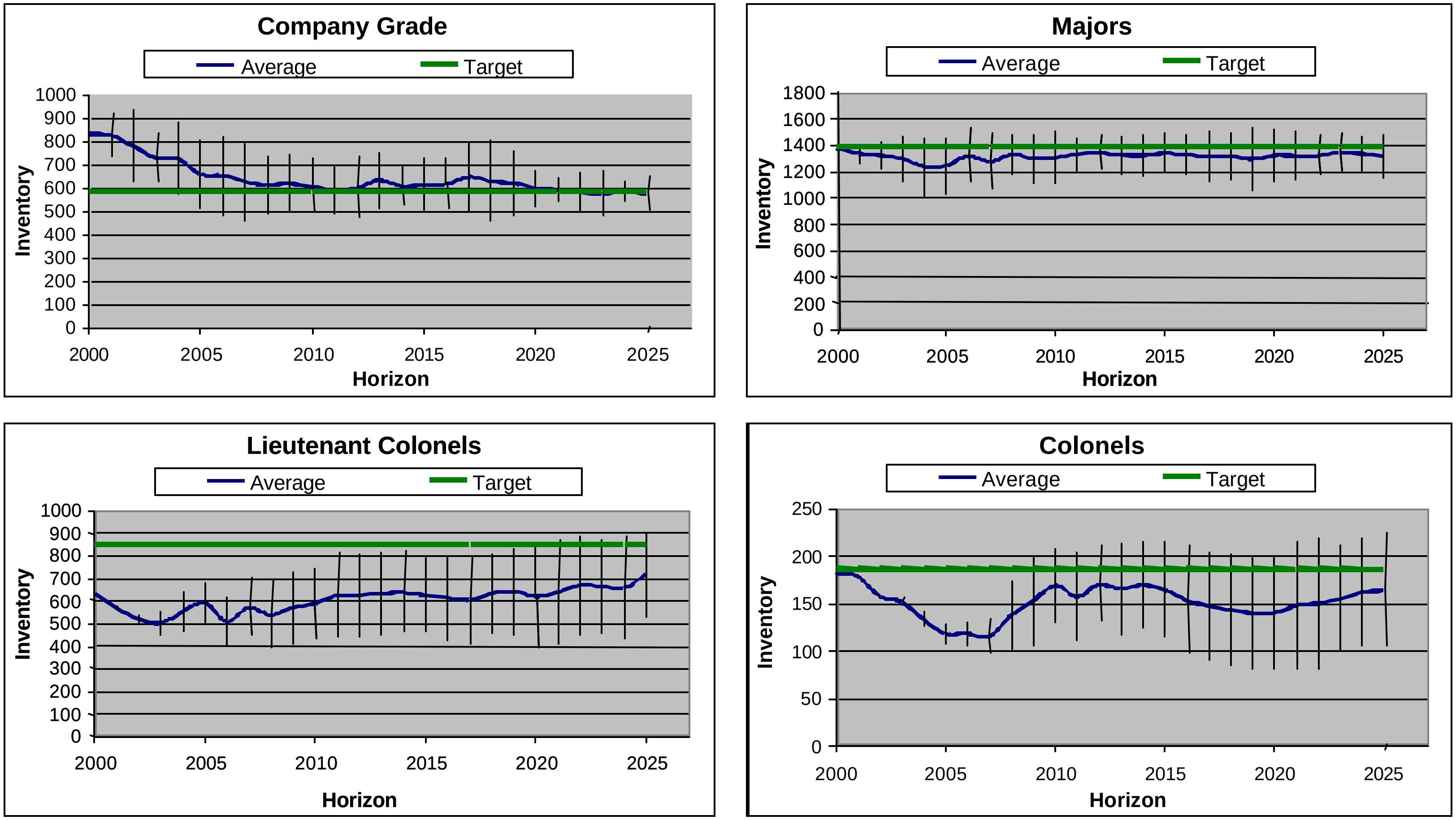

Figure 4.2. Average inventory levels and the corresponding 95% confidence intervals from 30 replications of ARMP using the current policies.

2. Accession

Table 4.6 compares historical accession numbers from FY 2000 against the outputs from ARMP over two periods, the representative POM years and the 25-year horizon. When compared to the historical numbers, ARMP accesses less Lieutenants (LT or the combination of 2LT and 1LT) and more CPT. This is due to fact that the initial number of LT (i.e., at the end of FY 2000) is over its target by nearly 600%.

	LT	CPT	MAJ	LTC
Accessions during FY2000	52	81	87	4
Average yearly accessions (FY2001-FY2007)	8	171	63	3
Average yearly accessions (FY2001-FY2025)	12	177	61	3

Table 4.6. Historical and ARMP officer accessions.

3. Promotions

Figure 4.3 shows the average number of in-the-zone promotions for company grade officers (promotions to 1LT and CPT) and the corresponding 95 percent confidence intervals during each year of the planning horizon. Observe that there is no variability in the number promoted during FY2001 to FY2003. This indicates that the only course of action to better align the officer inventory with its targets is to follow the in-the-zone promotion profile shown in Figure 4.3 during the first few years. There is also a drastic decrease in the number of in-the-zone promotions during the first four years of the planning horizon. The average number of promotions drops from 52 officers in FY 2001 to 12 in FY 2004. This drastic decrease is to eliminate the excess in the company grade officers and the shortfall in field grade officers through promotion. Once the number of company grade officers nears their desired target levels, the number of company grade promotions is relatively stable.

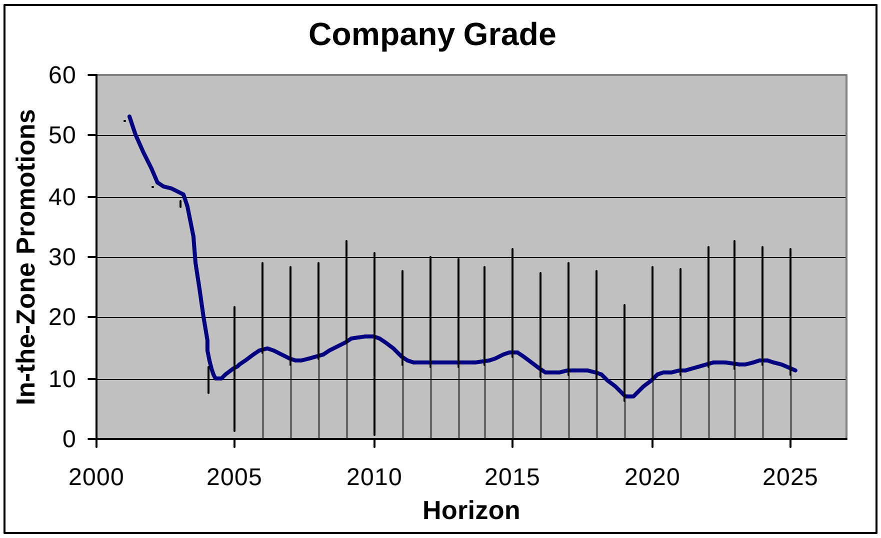

Figure 4.3. Average number of in-the-zone promotions for company grade officers.

C. ANALYSIS OF ALTERNATIVE POLICIES

Instead of providing an exhaustive list of results from ARMP, below are results selected to illustrate how the alternative policies, a relaxed AFS requirement and PVP, either individually or in combination, can impact the officer inventory and other personnel decisions.

1. New Policies Reduce Shortfalls in the Field Grade Officer Inventory

Figures 4.4 through 4.6 graphically compare the average inventory forecast under the current policies against those under three alternative policy scenarios: (i) with a relaxed AFS requirement, (ii) with PVP, and (iii) with both. Among these three alternatives, the combination of a relaxed AFS requirement and PVP yields the least shortages in the field grade officer inventory. In Figure 4.6, the combination of relaxed AFS and use of PVP eliminates almost all of the COL shortage.

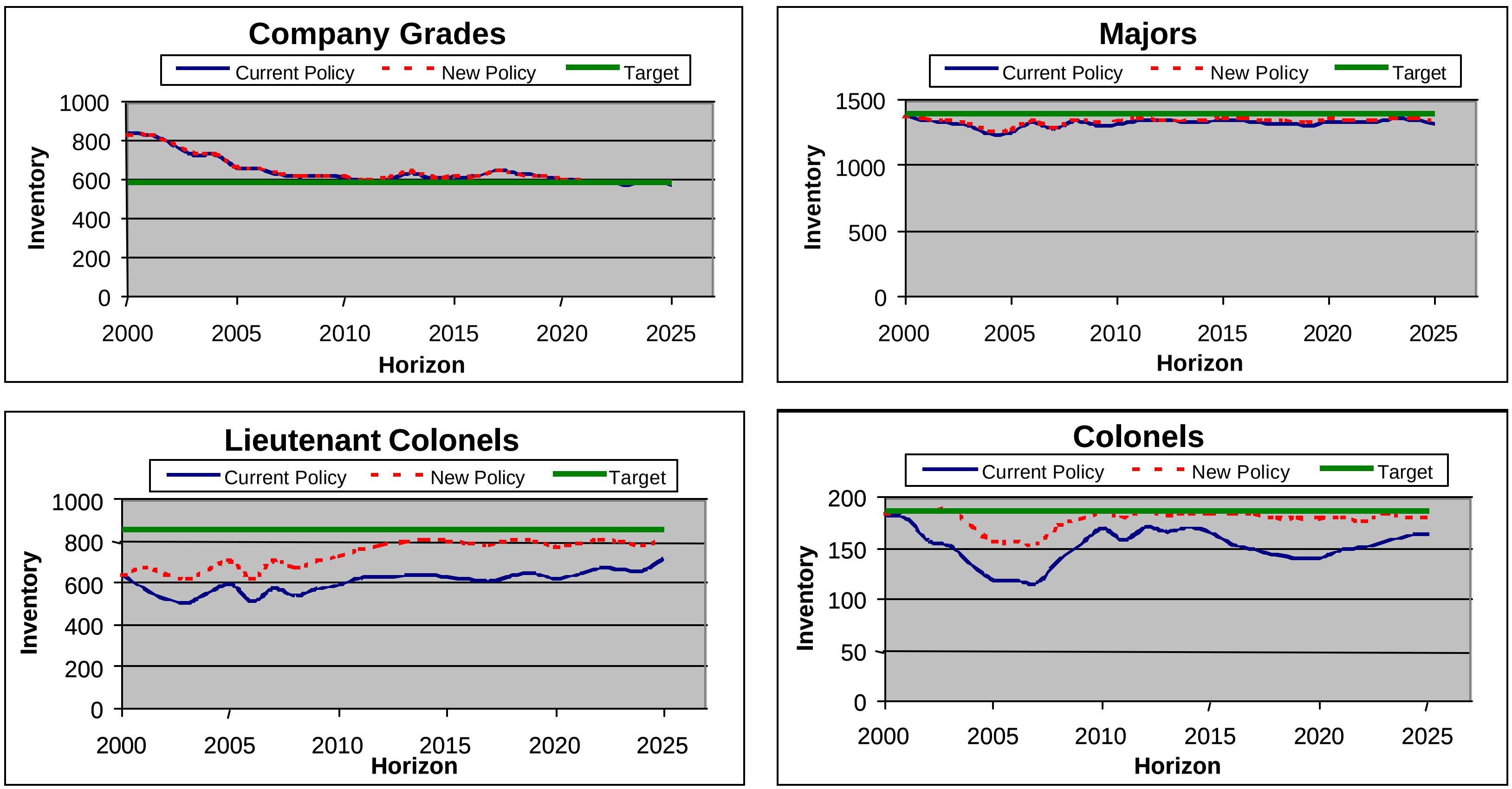

Figure 4.4. Comparison of average inventories - current policies vs. relaxing AFS requirement.

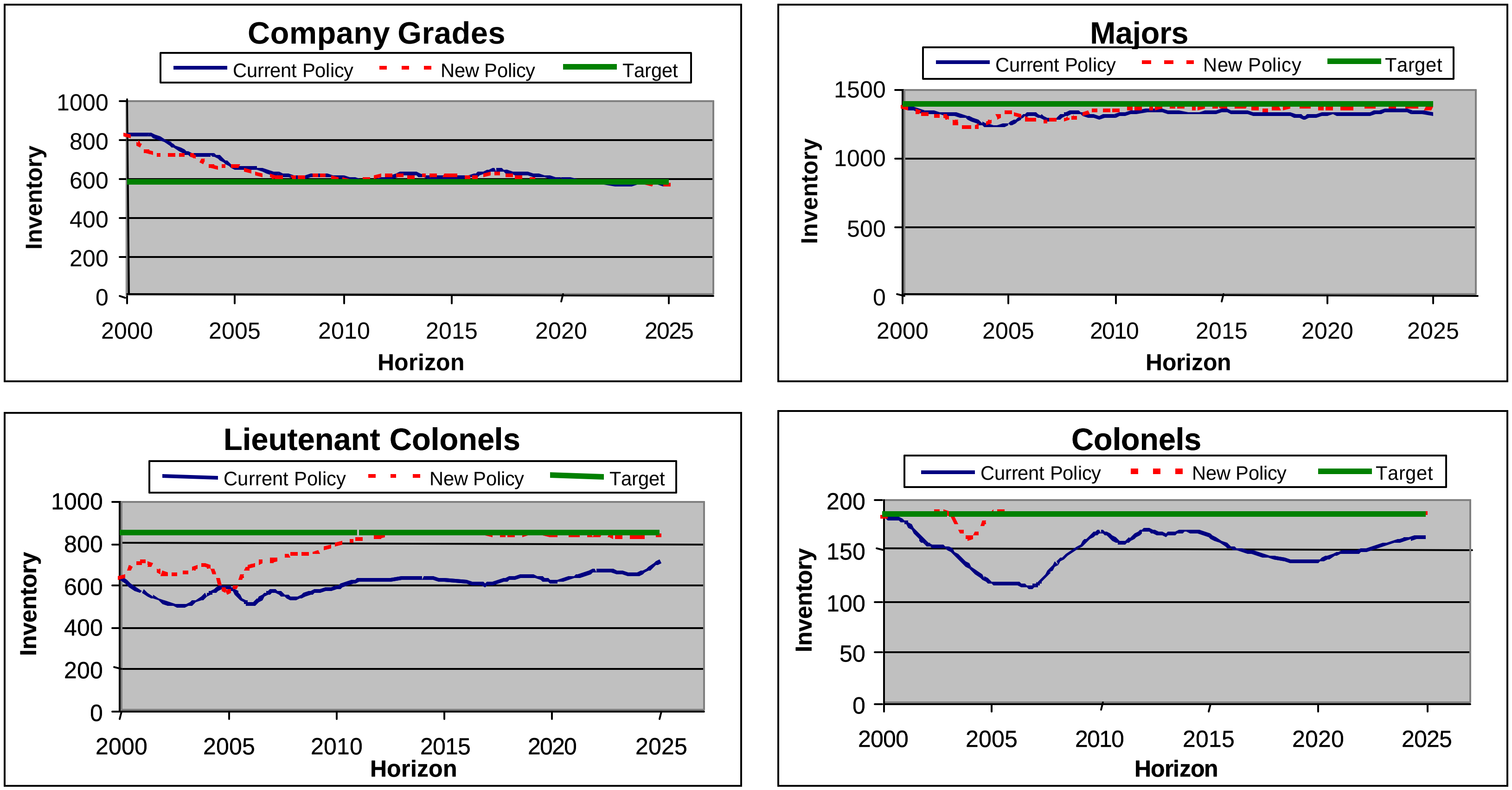

Figure 4.5. Comparison of average inventories - current policies vs. position vacancy promotion.

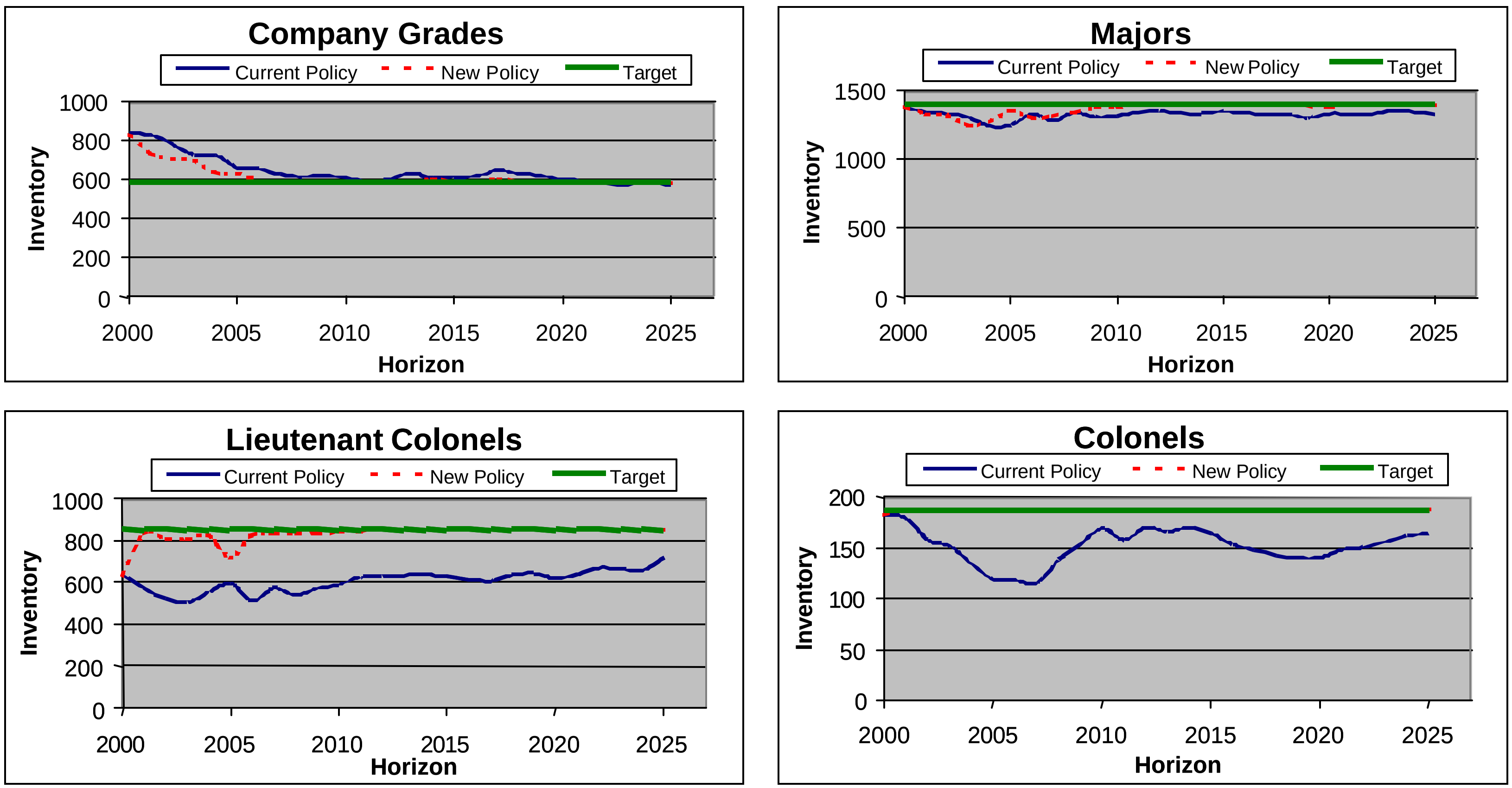

Figure 4.6. Comparison of average inventories - current policies vs. combination of relaxing the AFS requirement and position vacancy promotion.

Tables 4.7 and 4.8 summarize numerically the improvements due to the three alternative scenarios. Although all three scenarios show reduced shortfall in field grade officers, the combined alternative shows the greatest improvement over the current policies. Over the POM years, the combination of relaxing the AFS requirement and utilizing PVP reduces the shortfall in the field grade officer inventory to approximately 6%, which represents a 69% improvement over the current policies. (See Table 4.7.) Over a 25-year horizon, the improvement is slightly better (See Table 4.8.) where the combination decreases the shortfall to approximately 2%, which represents an 86% improvement over the current policies.

	Average Shortfall in Field Grade Officer Inventory	% Improvement against Current Policies
Current Policies	18.7%	
Relaxed AFS Requirement	12.1%	35.3%
Position Vacancy Promotion	12.1%	35.3%
Combination	5.8%	69.0%

Table 4.7. Average shortfall (as a percentage of the combined targets) in field grade officer inventory over the POM years.

	Average Shortfall in Field Grade Officer Inventory	% Improvement against Current Policies
Current Policies	14.9%	
Relaxed AFS Requirement	7.4%	50.3%
Position Vacancy Promotion	5.2%	65.1%
Combination	2.1%	85.9%

Table 4.8. Average shortfall (as a percentage of the combined targets) in field grade officer inventory over a 25-year planning horizon.

2. PVP Increases Company Grade Accessions.

Figure 4.7 compares the average company grade officer accessions with and without PVP. On average, PVP increases the required company grade officer accessions by about 30 per year. This is due to the fact that PVP allows LTC to be promoted into COL vacancies, MAJ to be promoted into LTC vacancies and CPT to be promoted into MAJ vacancies. Because 1LT cannot be promoted to CPT via PVP, there are additional vacant CPT positions that must be filled by increasing company grade officer accessions. Increased company grade accessions may not be feasible in practice due to the difficulty of finding qualified officers interested in the AGR program.

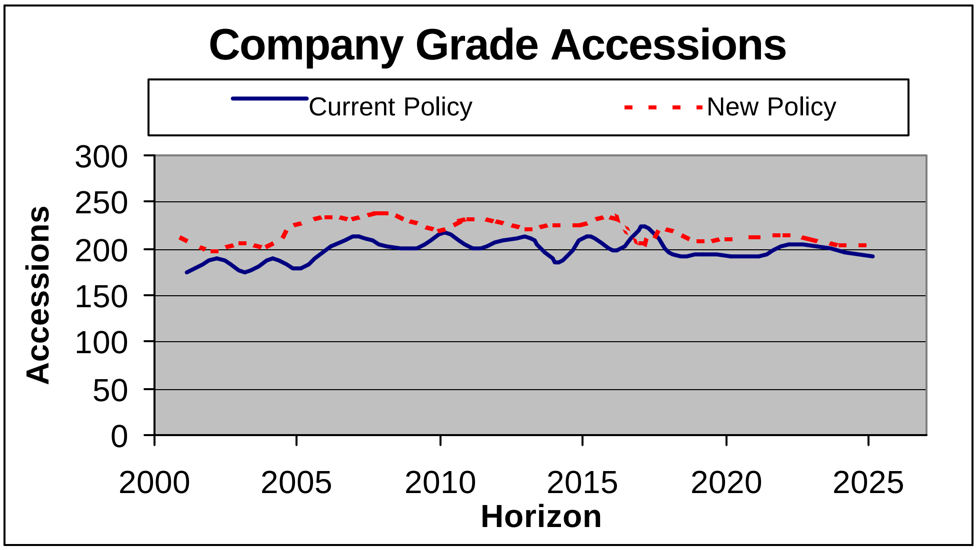

Figure 4.7. Average company grade officer accessions with and without PVP.

3. PVP Increases the Promotion Opportunities to MAJ.

Figure 4.8 shows the average number of total promotions to MAJ with and without PVP. On average, PVP increases the number of promotions to MAJ by about 32 per year. Because of PVP, more CPT are promoted to MAJ a year earlier than normal and as such, fewer CPT are subjected to attrition the following year when they are eligible to be promoted in the zone. This finding shows that the use of PVP increases the opportunity of officers to be promoted and may lead to increased retention in the future.

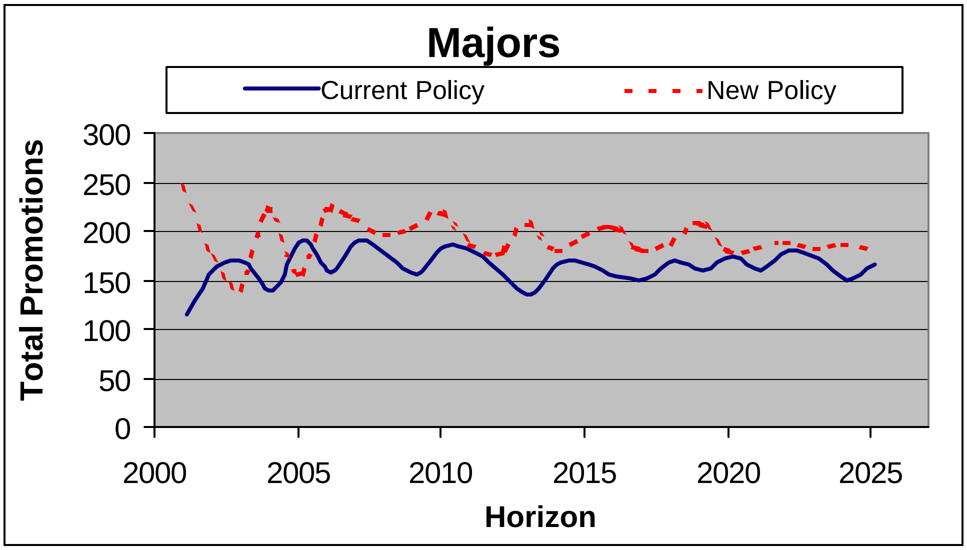

Figure 4.8. Average number of total promotions to MAJ with and without PVP.

4. Relaxing AFS Requirement Allows More Officers with Experience to Stay in the AGR Program

Figure 4.9 shows the average number of field grade officers remaining on active duty beyond 20 years of AFS with and without the relaxed AFS requirement. On average, the relaxed AFS requirement increases the number of field grade officers remaining beyond 20 years of AFS by about 163 per year. This shows that more officers with experience are allowed to remain in the AGR program beyond 20 years of AFS, helping to reduce the critical shortage of field grade officers.

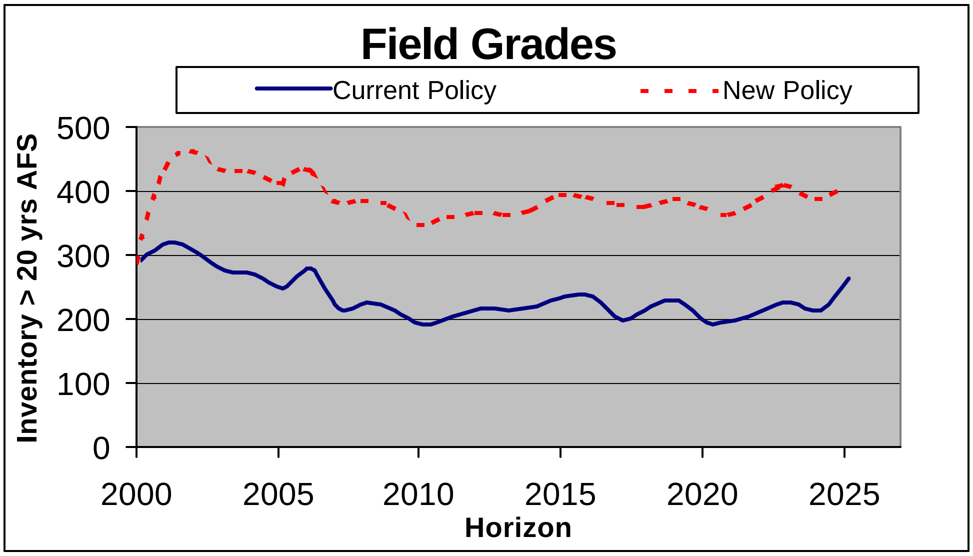

Figure 4.9. Average number of field grade officers with 20 or more years of AFS.

THIS PAGE INTENTIONALLY LEFT BLANK

V. CONCLUSIONS AND RECOMMENDATIONS

To evaluate courses of action for reducing the field grade officer shortfall in the AGR program, this thesis develops an optimization model called the Army Reserve Manpower Planning (ARMP) model. This model determines the annual number of officers by rank or grade, years of time in grade (TIG) and years of AFS to recruit, promote, and extend beyond the mandatory requirement for retirement in order to maintain an AGR officer force that best meets its strength targets.

Using the current policies, ARMP forecasts an average shortfall of 18.7% in field grade officers over the POM years. Over a 25-year horizon, the average shortfall decreases to 14.9%. On the other hand, results from ARMP show that the alternatives being considered by OCAR, relaxing the AFS requirement, utilizing PVP and a combination of the two, all lead to a reduction in the field grade officer shortfall. Individually, relaxing the AFS requirement and utilizing PVP both reduce the average shortfall in field grade officers to 12.1% over the POM years. Over a 25-year horizon, the average shortfalls are 7.4% and 5.2% for relaxing the AFS requirement and utilizing PVP, respectively. When combined, the average shortfalls under the two alternatives are 5.8% and 2.1% over the POM years and a 25-year horizon, respectively. These results certainly support the Chief, Army Reserve's consideration for relaxing the AFS requirement and utilizing PVP and, hopefully, they would also serve as a justification for approval of the two alternatives as well.

Results in this thesis also lead to several future investigations. For example, OCAR is planning to adapt ARMP to other officer populations in the Army Reserve including the TPU and IMA. In addition, models similar to ARMP are also applicable to various components of the National Guard.

APPENDIX A AGR OFFICER INVENTORY END OF FY 2000

	Time In Grade		
AFS	≤ 1	2	≥ 3
1	1	0	0
2	0	0	3
3	0	0	2
4	1	0	2
5	0	0	0
6	0	1	0
7	0	0	0
8	0	0	0
9	0	1	1
≥ 10	0	3	2

Table A.1. 2LT inventory as of the end of FY 2000

	Time In Grade					
AFS	≤ 1	2	3	4	5	≥ 6
1	1	1	1	0	0	0
2	0	2	5	3	5	0
3	0	2	1	0	1	0
4	0	3	9	11	2	0
5	1	1	11	2	10	1
6	0	0	2	7	5	1
7	0	2	3	6	2	1
8	0	1	2	2	8	0
9	1	0	3	3	1	0
10	1	0	2	0	4	0
11	1	1	2	4	0	1
12	0	0	2	2	4	0
13	1	0	0	1	2	1
14	2	0	4	2	2	0
15	1	1	2	3	1	0
16	0	0	0	0	5	0
17	0	1	2	1	1	0
18	0	1	0	1	0	0
19	0	1	0	0	0	0
20	0	0	0	1	0	0

Table A.2. 1LT inventory as of the end of FY 2000

	Time In Grade								
AFS	≤ 1	2	3	4	5	6	7	8	≥ 9
1	2	0	0	0	0	0	0	1	0
2	2	3	3	0	1	2	0	0	0
3	7	3	4	0	4	0	2	2	1
4	10	1	8	1	8	2	2	1	0
5	4	9	4	3	7	17	9	0	0
6	12	17	8	0	9	22	10	1	0
7	3	10	13	1	8	10	7	1	0
8	7	2	10	5	13	10	10	2	1
9	4	3	4	2	6	18	8	0	0
10	1	6	8	2	6	12	9	0	0
11	2	3	13	1	7	11	18	0	2
12	2	5	4	2	11	6	13	0	1
13	1	2	1	1	4	11	5	2	0
14	1	2	0	1	8	4	10	1	4
15	3	2	4	1	4	3	5	3	2
16	1	1	3	1	4	1	4	0	0
17	2	3	1	0	1	3	3	0	0
18	0	0	0	0	1	1	1	1	0
19	1	0	2	0	0	3	1	1	0
20	0	0	1	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0
22	0	1	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0
≥ 25	0	0	0	0	0	0	0	0	0

Table A.3. CPT inventory as of the end of FY 2000

	Time In Grade								
AFS	≤ 1	2	3	4	5	6	7	8	≥ 9
≤ 3	6	0	1	1	0	0	0	0	0
4	7	0	7	2	3	2	0	0	0
5	8	0	7	6	1	1	0	0	0
6	13	0	5	1	3	1	1	0	0
7	14	2	3	6	1	1	1	0	0
8	29	5	16	10	4	1	1	2	0
9	15	5	11	9	4	2	2	0	0
10	16	1	12	6	7	4	4	0	0
11	21	2	15	14	12	7	3	0	0
12	39	6	21	15	14	11	6	0	0
13	53	7	14	17	19	8	6	3	0
14	52	5	44	35	24	12	10	1	0
15	27	5	21	34	23	25	10	1	2
16	16	4	20	32	29	18	23	2	1
17	10	1	17	14	17	26	31	1	0
18	5	0	6	12	10	28	30	4	4
19	5	1	2	8	10	15	19	2	1
20	1	0	4	1	5	6	6	1	2
21	0	1	1	1	0	3	1	0	2
22	0	0	1	0	1	0	0	0	1
23	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0
≥ 25	0	0	0	0	0	0	0	0	0

Table A.4. MAJ inventory as of the end of FY 2000

	Time In Grade						
AFS	≤ 1	2	3	4	5	6	≥ 7
≤ 6	4	0	0	1	0	0	0
7	2	1	1	0	1	0	0
8	1	1	1	0	0	0	0
9	1	2	0	0	0	0	1
10	2	3	1	1	0	0	0
11	2	4	2	1	1	0	0
12	5	3	6	2	0	0	0
13	1	2	5	0	1	2	0
14	7	5	9	3	2	0	0
15	6	8	4	5	3	0	1
16	14	5	8	9	10	4	1
17	14	18	15	8	9	4	3
18	22	27	19	14	15	5	10
19	20	21	30	13	11	9	13
20	9	20	27	10	20	10	15
21	2	6	2	10	6	2	10
22	4	1	2	5	5	2	0
23	0	0	0	0	0	1	0
24	0	0	0	0	0	0	0
≥ 25	0	0	0	0	0	0	0

Table A.5. LTC inventory as of the end of FY 2000

	Time In Grade						
AFS	≤ 1	2	3	4	5	6	≥ 7
≤ 11	0	0	0	0	0	0	0
12	1	0	1	0	0	0	0
13	0	0	0	0	0	0	0
14	2	0	1	1	0	0	0
15	1	1	3	1	0	0	0
16	1	3	2	2	0	0	1
17	6	1	6	3	0	1	0
18	4	3	3	5	2	1	0
19	14	5	4	10	4	6	3
20	9	8	8	3	3	2	7
21	4	8	4	2	0	4	1
22	5	4	0	2	1	1	2
23	0	0	0	0	1	0	0
24	0	1	0	0	0	0	0
≥ 25	0	0	0	0	1	0	0

Table A.6. COL inventory as of the end of FY 2000

LIST OF REFERENCES

Ahuja, R., Magnanti, T., and Orlin, J., 1993, *Network Flows*, Prentice Hall Publishing Co., New Jersey.

Bres, E.S., Burns, D., Charnes, A., and Cooper, W.W., 1980, "A Goal Programming Model for Planning Officer Accessions," Management Science, v. 26, pp. 773-783, August 1980.

Brooke, A., Kendrick D., Meeraus, A., and Raman, R., 1998, *GAMS, Release 2.50A, Version 92, Language* Guide, Gams Development Corporation, Washington D.C.

Conover, W.J., 1999, *Practical Nonparametric Statistics*, 3d ed., John Wiley & Sons, Inc, New York.

Gass, S.I., Collins, R.W., Meinhardt, C.W., Lemon, D.M., and Gillette, M.D., 1988, "The Army Manpower Long Range Planning System," Operations Research, v. 36, pp. 5-17, January – February 1988.

Holz, B.W., and Wroth, J.M., 1980, "Improving Strength Forecasts: Support for Army Manpower Management," Interfaces, v. 10, pp. 37-52, December 1980.

Marmorstein, J, 2000, Operations Research Analyst, Army Reserve Personnel Command, Personnel Proponency Office, Electronic Mail with CMDSM Code Attached, Subject: CMDSM SAS Code, October 13, 2000.

McCloskey, B., 2001, Contractor, SyTech Inc., Office of the Chief Army Reserve, Electronic Mail, Subject: Review of Thesis, June 12, 2001.

National Guard Bureau (NGB), 1999, *Information Paper: Retention Beyond 20 Years Active Federal Service for Active Guard Reserve (AGR) Officers*, NGB-ARM-P, Washington, D.C., January 25, 1999.

National Guard Bureau (NGB), 2000, *Memorandum to the Honorable Patrick T. Henry, Assistant Secretary of the Army (Manpower and Reserve Affairs) from Major General Thomas J. Plewes, Chief, Army Reserve and Lieutenant General Russell C. Davis, Chief, National Guard Bureau, Subject: Requested change to the Active Federal Service (AFS) extension policy*, Washington, D.C., October 2000.

Saltarelli, M.A., Lieutenant Colonel, U.S. Army, 2000a, Personnel Systems Staff Officer, Office of the Chief, Army Reserve, Personnel Division, Electronic Mail, Subject: AGR Modeling., October 30, 2000.

Saltarelli, M.A., Lieutenant Colonel, U.S. Army, 2000b, Personnel Systems Staff Officer, Office of the Chief, Army Reserve, Personnel Division, Electronic Mail, Subject: General USAR Stats., November 29, 2000.

Shukiar, H.J., 1996, *The Readiness Enhancement Model, A Personnel Inventory Projection Model of the Army's Reserve Components*, RAND Rep. No. MR-659/1-A, Santa Monica, CA, RAND.

U.S. Army, 1994, *Active Duty in support of the United States Army Reserve (USAR) and Active Guard Reserve (AGR) Management Program, AR 140-30,* Headquarters, Department of the Army, U.S. Government Printing Office, September 1994.

U.S. Army, 1996, *The Active Guard Reserve (AGR) Program, AR 135-18,* Headquarters, Department of the Army, U.S. Government Printing Office, June 1996.

U.S. Army, 1998, *Promotion of Commissioned Officers and Warrant Officers Other Than General Officers, AR 135-155,* Headquarters, Department of the Army, U.S. Government Printing Office, February 1998.

U.S. Army, 1999, *How the Army Runs: A Senior Leader Reference Handbook, 1999-2000,* U.S. Army War College, U.S. Government Printing Office, April 1999.

U.S. Congress, United States Public Law 103-337 [S. 2182], 1994, *National Defense Authorization Act For Fiscal Year 1995 (containing passage of ROPMA), One Hundred Third Congress, second session,* Washington D.C., *October 5, 1994.*

Yamada, W.S., 2000, *An Infinite Horizon Army Manpower Planning Model,* M.S. Thesis, Naval Postgraduate School, Monterey, California, June, 2000.

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center..2
   8725 John J. Kingman Road, Suite 0944
   Ft. Belvoir, VA 22060-6218

2. Dudley Knox Library..2
   Naval Postgraduate School
   411 Dyer Road
   Monterey, CA 93943-5101

3. Professor S. Lawphongpanich, Code OR/Lp 1
   Department of Operations Research
   Naval Postgraduate School
   Monterey, CA 93943-5101

4. LTC Eugene P. Paulo, Code OR/Pe...1
   Department of Operations Research
   Naval Postgraduate School
   Monterey, CA 93943-5101

5. Office of the Chief, Army Reserve 1
   ATTN: DAAR-ZD, COL Lerch
   2400 Army Pentagon
   Washington, DC 20310-2400

6. Office of the Chief, Army Reserve 1
   ATTN: DAAR-PE, COL Logsdon
   2400 Army Pentagon
   Washington, DC 20310-2400

7. Office of the Chief, Army Reserve 1
   ATTN: DAAR-PAE, COL Scott
   2400 Army Pentagon
   Washington, DC 20310-2400

8. United States Army Reserve Command 1
   ATTN: AFRC-CS, BG John A. Yingling
   1401 Deshler Street SW
   Fort McPherson, GA 30330-2000

9. United States Army Reserve Personnel Command 1
   ATTN: ARPC-ZA, COL W. Bruce Pittman
   1 Reserve Way
   St. Louis, MO 63132-5200

10. United States Army Reserve Readiness Command 1
ATTN: AFRC-RRC, MG George Goldsmith, Jr.
Building 9810, Lee Road
Fort Jackson, SC 29207-6070

11. MAJ Ward Litzenberg 3
33 Burns Road
Stafford, VA 22554