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A Report prepared for

UNITED STATES AIR FORCE PROJECT RAND

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PREFACE

This report was prepared as part of The Rand Corporation's Manpower Personnel and Training Program, sponsored by the U.S. Air Force; it presents work done under the Supply and Retention of Air Force Officers project. The work was initiated at the request of the Deputy Chief of Staff/Personnel, Headquarters U.S. Air Force, and is designed to assist the Air Force in achieving stable accession and training rates, smooth career progression, and control of officer inventory by year group. This report is part of a series examining the mutual impact of changes in personnel policy and in the supply and retention of officers, as well as the number and flow of officers by component, years of service, source of commission, and aeronautical rating.

The ability to manage U.S. Air Force personnel in general and officers in particular is important because people are the most critical resource in the Air Force. "People costs" have increased until they now constitute more than half of each annual Air Force or Department of Defense budget. Moreover, newer and more sophisticated weapon systems make essential the attraction and retention of qualified officers. The discontinuation of the draft and the transition to an all-volunteer force have changed the value, and hence the use, of traditional personnel planning factors.

The set of computer-based models of which the Officer Force Progression Model* described here is a part is designed to provide personnel planners with both broadly based aggregated data and detailed officer inventories and flows reflecting the effects of policies and conditions under investigation.

In addition to the present report, the above-mentioned series of Rand publications includes the following (in preparation):

- R-1606-PR, *A System of U.S. Air Force Officer Personnel Planning Models: An Overview.*

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*The actual computer program for the model is available from The Rand Corporation on request.

- *The Constrained Officer Force Progression Model: A Steady-State Mathematical Model of the U.S. Air Force Officer Structure.*
- R-1632-PR, *The Officer Grade Limitations Model: A Steady-State Mathematical Model of the U.S. Air Force Officer Structure.*
- *The Retention of U.S. Air Force Officers.*

SUMMARY

The Officer Force Progression Model (OFPM) is designed to supplement TOPLINE* long-term or steady-state computer models in a way that permits the personnel planner to examine the effect of changes in personnel policy on the structure and flows of the officer force.

Air Force personnel planners often face policy alternatives that lead to changes in accessions, training rates, loss rates, promotion policies, or augmentation opportunities (the acceptance of reserve officers into the regular force). The personnel planner may input these changes into the OFPM in terms of such common characteristics as component, grade, aeronautical rating, source of commission, and year of service; the OFPM then computes the effects of the changes on the number of officers with these characteristics who are lost, promoted, augmented, or otherwise changing from one state to another.

If, for example, the user wishes to specify that there will be 100 Academy-graduated accessions to the officer force, the OFPM will compute the number of Academy graduates that will reach any state or flow from any state per 100 accessions. This information is useful in developing long-term steady-state planning factors such as the number of promotions from captain to major per 100 accessions, or the number of pilots of lieutenant colonel or lower grade with less than 25 years of service per 100 accessions, and so forth. The same is true for ROTC or Officer Training School accessions.

Thus, the personnel planner has a tool that enables him to measure the effects of policies imposed on him (i.e., those beyond his control) and to select from alternative policies when he does have a choice. The OFPM provides this tool by computing the long-range effects of these changes in terms of promotion opportunities, promotion phase points, augmentations, force cuts or expansions, and the inventory of officers by component, grade, aeronautical rating, source of commission, and years of service.

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*Department of the Air Force, *The USAF Personnel Plan*, Volume 2, *Officer Structure (TOPLINE)*, Washington, D.C., May 1971 (For Official Use Only).

CONTENTS

I. INTRODUCTION

The Air Force has consistently been innovative in its development of officer force structure policy planning and implementation by means of computer models using a systems approach to personnel management, the basic concepts of which are contained in the several volumes of the *USAF Personnel Plan*.(1) Volume Two, *Officer Structure (TOPLINE) 1971*,* describes the philosophy and computer models that apply to the officer force structure. The TOPLINE static personnel planning model is used by Headquarters USAF to develop its long-term officer structure goals, using the assumption that for long-term planning purposes ideal and steady-state conditions will apply. Steady-state conditions are hypothetical; they apply only when loss rates and other planning factors do not change from year to year (that is, when the system is in equilibrium, gains exactly equal losses, and the inventory of officers and their characteristics do not change from year to year).

The Rand Corporation has developed a system or family of officer force personnel planning models to supplement and extend the TOPLINE static personnel planning model. These "second-generation" planning models provide increased capability to analyze the long-term effects on the officer force structure of changes in policy or various external or environmental influences. This system of officer force planning models, described in this and companion reports, includes the following:

- Unconstrained officer force progression model (short title: progression model).
- Constrained officer force progression model (short title: constraints model).
- Officer grade limitations model (short title: grade limitations model).

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*TOPLINE is a short title for "total officer personnel objective structure for the line officer force."

- o Officer force behavioral model (short title: behavioral model).

The use of these models provides increased capabilities in the following ways:

- o Expansion of inputs and outputs.
- o Allowance for interaction of changes in policies, officer behavior, and the officer structure.
- o Provision for the impact of grade limitations.

Section II presents an overview of the models, describing each model briefly and familiarizing the reader with the concepts and vocabulary employed. The concept of an officer's state as his *status* at a given point in time is discussed first. For example, one element of an officer's state is his rating: Is he a pilot, navigator, or non-rated? Then we describe the movement (or flow) between states; non-rated officers might, for instance, become pilots. Next, several promotion concepts are introduced, followed by a rigorous definition of what is meant by a steady-state or static model. Finally, each of the four computer models is described in nonmathematical terms.

Section III presents the mathematical basis of the progression model, further refining and making mathematically rigorous the officer flow concepts introduced in Section II. Sections IV and V describe the model's inputs and outputs. Appendixes A and B describe the development of the detailed mathematical formulas used in the progression model. Readers not interested in the mathematical details may omit Section III and the appendixes without great loss of understanding.

II. OVERVIEW OF OFFICER FORCE PERSONNEL PLANNING MODELS

The progression model, constraints model, and grade limitations model are steady-state, Markovian, mathematical simulations of flow. The Air Force officer force is a hierarchical system with the following characteristics that make it suitable for analysis by Markovian models:

> 1) entries into military systems are made at specific low-level entry points in the hierarchy; 2) recruits (either officer or enlisted) are essentially undifferentiated, with specialization occurring as a result of training and experience that takes place after entry into military life; and 3) because breaks in service are rarely allowed, the process of movement through the military personnel system becomes a close analogy to an actuarial, life-death, model of life expectancy.(2)

As observed elsewhere in Ref. 2,

> The "flow" of personnel through a system may be thought of as movement from state (e.g., grade, year of service, occupational specialty) to state. The utility of the concept depends upon the definition of meaningful subsets of the population under consideration whose members are differentiated from all other members of the population. Each member of the population must be a member of one, and only one, state of the system.

(Note that a basic assumption of Markovian models is that movement depends only on where an individual is located in the system, not where he has been.)

STATES

The following characteristics are used to group Air Force line officers into states (or "cells" or "nodes") that form subsets of the officer force.

- Component (C)*
    - (1) Reserve*
    - (2) Regular
- Grade (G)
    - (1) Lieutenant (first or second)
    - (2) Captain
    - (3) Major
    - (4) Lieutenant colonel
    - (5) Colonel and higher grades combined
- Aeronautical rating (R)
    - (1) Pilot
    - (2) Navigator
    - (3) Non-rated
- Source of commission (IS)
    - (1) Academy (Air Force, military or naval)
    - (2) ROTC
    - (3) Officer Training School (OTS) and all other
- Year of service (Y)
    - (1) First
    - (2) Second
    - .
    - .
    - .
    - (35) Thirty-fifth†

The variable name S(C,G,R,IS,Y) is used to represent the count of officers in state (C,G,R,IS,Y). Thus, S(2,1,1,1,2) = 1000 indicates a count of 1000 Academy-graduated (IS = 1) lieutenants (G = 1) who are in the regular component (C = 2), are pilots (R = 1), and have completed one but not two years of total active federal commissioned service (Y = 2).‡

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*Symbol in parenthesis denotes characteristic. Number in parenthesis is the code for a given subdivision.

†"Years of service" (YOS) is synonymous with the number of years of total active federal commissioned service (TAFCS). An officer is in his i-th YOS when he has completed i-1 but not i years of total active federal commissioned service. The time unit in the OFPM is one year. Inputs and outputs are also in terms of yearly units.

‡A convenient way to remember subscript positions is to note that they appear in alphabetical order, namely, component, grade, rating, source of commision, and year of service, or (C,G,R,IS,Y).

UNDERLYING ASSUMPTIONS

The next subsection discusses the flows through the Air Force officer system that are computed in the progression, constraints, and grade limitations models. However, it is useful first to list and discuss the assumptions used in the development of the models:

- Academy graduates are regular officers throughout their active career. It is possible for Academy-graduated officers to give up their regular status by separating, joining a reserve unit, and being recalled to active duty, for example, but the unlikely possibility of an Academy graduate being other than a regular officer is not considered in these models.
- Net suspensions or grounding of pilots or navigators is considered to be zero, i.e., it is assumed that pilots (or navigators) leaving flight status exactly equal those returning to flight status after having been grounded or suspended.
- Production of pilots or navigators, i.e., undergraduate pilot or navigator training, is completed prior to the first year of service in which lieutenants may be promoted to the grade of captain. Therefore, in the models, only lieutenants are assigned to undergraduate pilot or navigator training.
- All officers enter the Air Force as non-rated officers; approximately one year is necessary to obtain an aeronautical rating of pilot or navigator. From this and the prior assumption, the models permits neither officers in their first year of service nor captains or higher grade non-rated officers to become pilots or navigators.
- ROTC, OTS, and other non-Academy graduates who become officers enter the Air Force as reserve lieutenants in their first year of service. In the past, distinguished military graduates have been awarded regular commissions and have entered active Air Force duty as regular officers in their first year of service. However, this policy has been discontinued, and the models are constructed accordingly. Also, lateral entries of officers in their first year of active service with grade higher than lieutenant are not considered by the models.

- All grades of officers considered in the models are current (sometimes called temporary) rather than regular (sometimes called permanent) grades.

FLOWS

The progression, constraints, and grade limitations models provide for the following flows through the Air Force officer system:

- Losses.
- Rating transfers: Non-rated to pilot via undergraduate pilot training (UPT) or non-rated to navigator via undergraduate navigator training (UNT) are the only rating transfers considered in the officer force personnel planning models.*
- Augmentations (reserve to regular).
- Rating transfer and augmentation (both in same year).
- Promotions.
- Promotion and augmentation (both in same year).
- Lateral (officer ages one year and does not change component, grade, or aeronautical rating).

This subsection presents an overview of the types of flow, and the next section discusses the topic in detail. In the figures that follow, flows are represented by arrows, the tails of which indicate the state from which the officer came (i.e., his state sometime during YOS Y-1) and the heads of which indicate his state sometime during YOS Y.

Losses: L(C,G,R,IS,Y)

Figure 1 depicts the flow of officers in state (C,G,R,IS,Y) who separate, retire, or are otherwise lost to the Air Force in their Yth YOS, *i.e., after they have completed Y-1 but before they complete Y years of total active federal commissioned service.*

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*Suspensions or grounding of pilots or navigators are not computed either in the TOPLINE static model or the series of officer force personnel planning models.

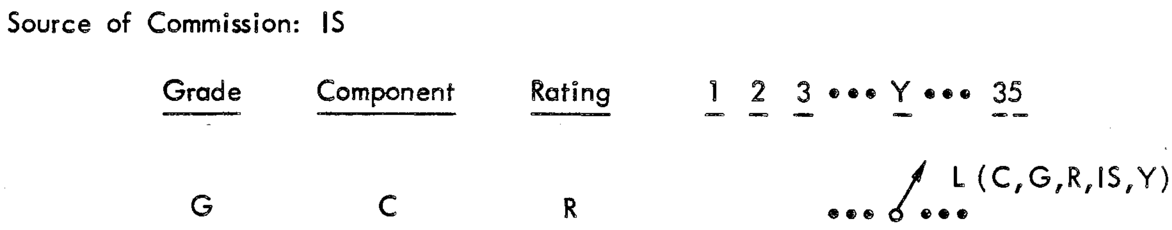

Fig. 1 — Loss flows

Rating Transfers: RT(C,G,R,IS,Y)*

The flow of officers who are non-rated in YOS Y-1 and who complete UPT (or UNT)† to achieve pilot (or navigator) status in YOS Y without changing their component or grade is illustrated in Fig. 2 for Y = 2.

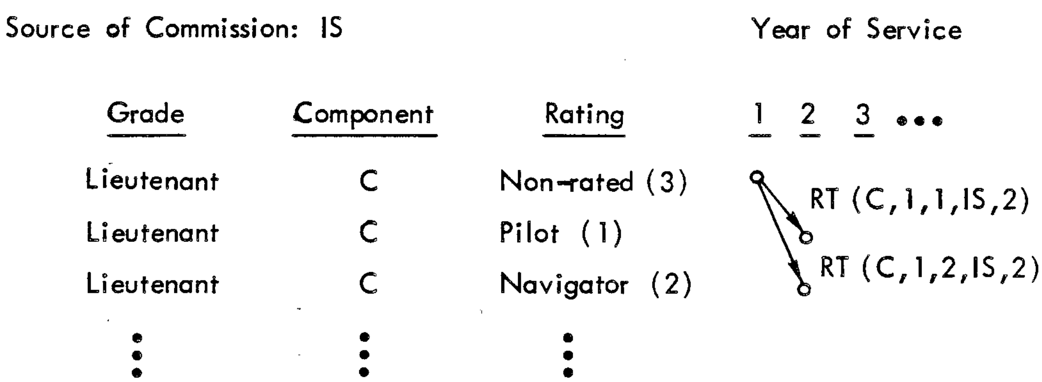

Fig. 2 — Rating transfers--non-rated to pilot RT (C,1,1,IS,2) or to navigator RT (C,1,2,IS,2) in YOS 2

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*R = 1 or 2, i.e., pilots or navigators only.

†UPT and UNT student officers are counted as non-rated.

RT(C,1,R,IS,2) contains the number of non-rated lieutenants in YOS 1 that take on rating R in YOS 2. The officer force personnel planning models assume that all rating transfers have been completed prior to the first year of service in which promotion from lieutenant to captain is permitted.*

Augmentations: AU(2,G,R,IS,Y)

The flow of officers from the reserve to the regular component is illustrated in Fig. 3, which illustrates the flow from state (1,G,R,IS,Y-1) to state (2,G,R,IS,Y) (i.e., reserve in YOS Y-1 to regular in YOS Y); the flow is equal to AU(2,G,R,IS,Y).

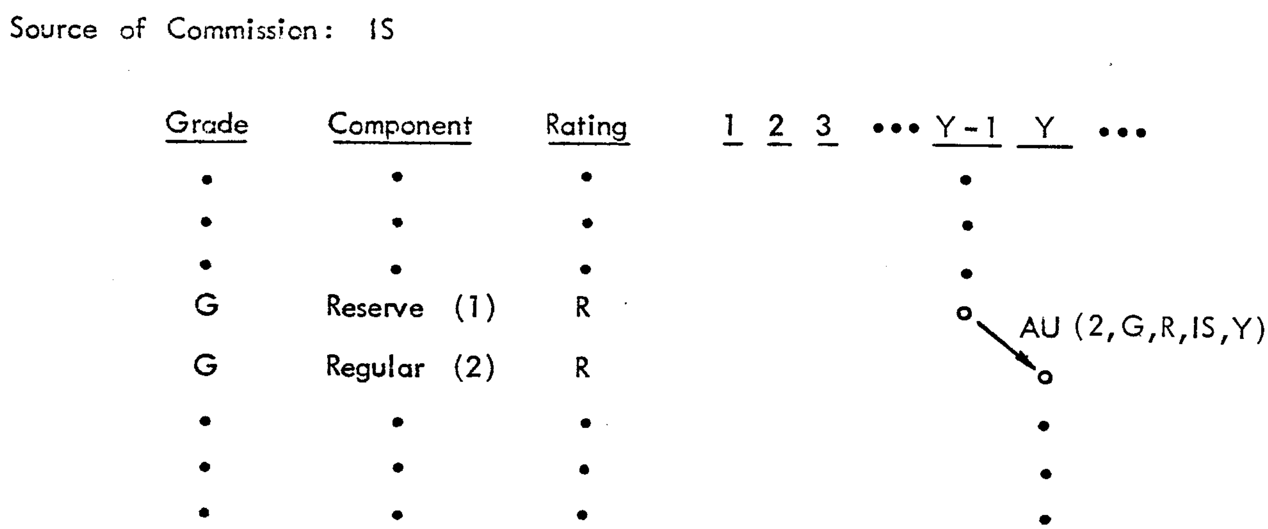

Fig. 3—Augmentation flows

*If the user, by his inputs, forces rating transfers and promotions to occur in the same year of service, the progression model will not halt computations, but will print warning messages after completion to indicate that the results should be considered as only approximately correct.

Rating Transfers and Augmentations: RA(2,1,R,IS,Y)

Figure 4 illustrates the flow of officers from state (1,1,3,IS,Y-1), i.e., reserve non-rated lieutenant, to states (2,1,1,IS,Y) and (2,1,2,IS,Y), i.e., regular lieutenant pilot and regular lieutenant navigator, respectively. In other words, a *reserve non-rated* lieutenant becomes a *regular rated* lieutenant, i.e., both rating transfer and augmentation occur. RA(2,1,R,IS,Y) represents the flow into rating R (R = 1 for pilot and 2 for navigator) in the above example.

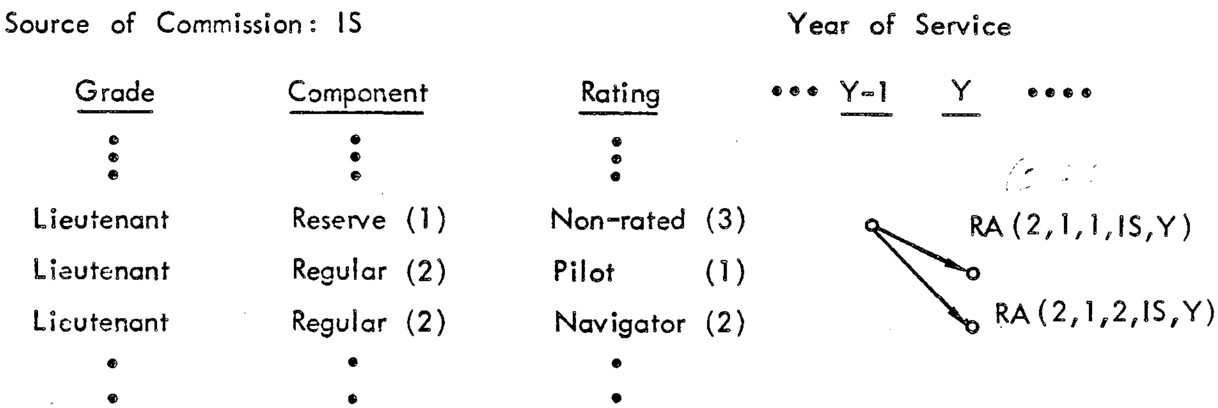

Fig. 4 — Rating transfer—augmentation flows

Promotion Flows: PR(C,G,R,IS,Y)

The flow of officers from state (C,G-1,R,IS,Y-1) to state (C,G,R,IS,Y), i.e., a promotion from grade G-1 to grade G, is illustrated in Fig. 5.

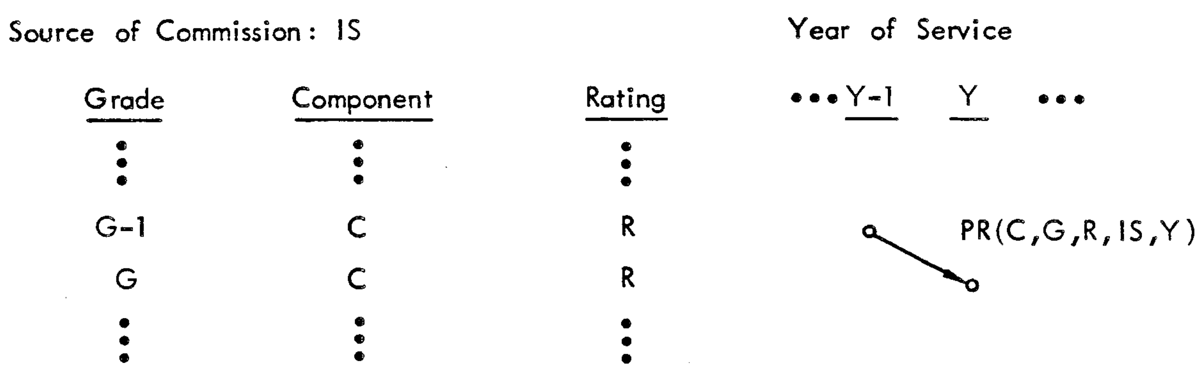

Fig. 5 — Promotion flows

Promotion and Augmentation Flows: PA(2,G,R,IS,Y)

Figure 6 illustrates the flow of officers who are reserve officers in grade G-1 during YOS Y-1 and who are augmented into the regular component *and* promoted into grade G during YOS Y, i.e., their movement is from state (1,G-1,R,IS,Y-1) into state (2,G,R,IS,Y).

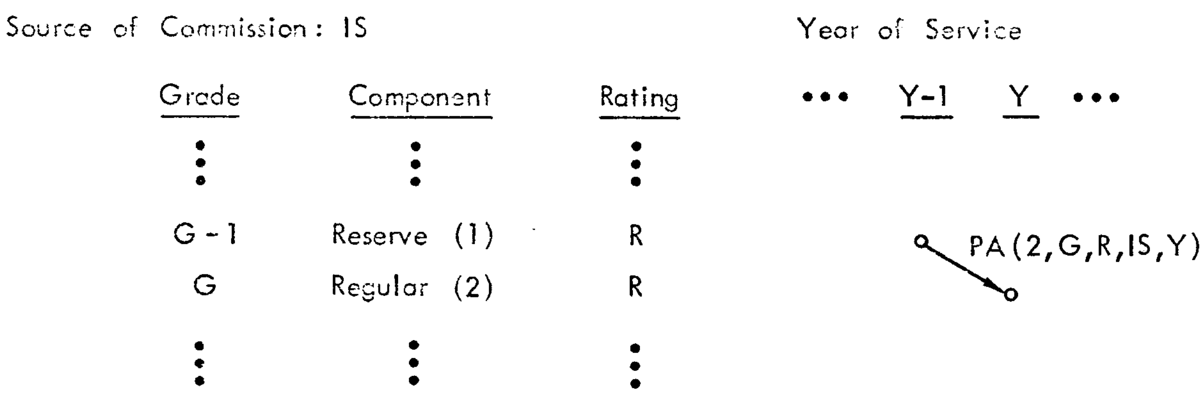

Fig. 6—Promotion and augmentation flows

Lateral Flows: LAT(C,G,R,IS,Y)

This consists of the flow of officers who do not change their status from YOS Y-1 to YOS Y except to age one year, i.e., they flow from state (C,G,R,IS,Y-1) into state (C,G,R,IS,Y) as illustrated in Fig. 7.

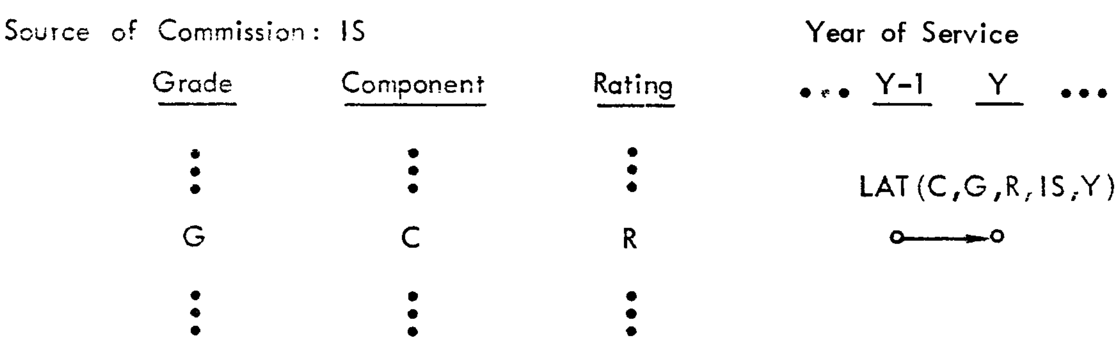

Fig. 7—Lateral flows

PROMOTION PHASE POINT AND PROMOTION OPPORTUNITY

The officer force personnel planning models are based on the concept of a promotion phase point and promotion opportunity, as defined below.

Promotion Phase Point

In the progression or the constraints model, promotions into a given grade can occur in any one of four consecutive years of service. The first two of these years of service are referred to as the *secondary promotion zone* (or secondary zone). Promotions into the secondary zone are called *below-the-zone promotions*. The last two of the four promotion years of service are referred to as the *primary zone*, and the first year of the primary zone--the third year of the four-year promotion interval--is called the promotion *phase point*. Most of the promotions into the grade take place into the phase point.

Figure 8, which illustrates the promotion flows from captain to major, shows that the total number of promotions of pilots from captain to major is 900, with 755 occurring in the eleventh year of service, the promotion phase point for promotion to major for pilots. The ninth and tenth years of service are in the secondary zone, the eleventh and twelfth are in the primary zone, with the eleventh year of service the first year in the primary zone.

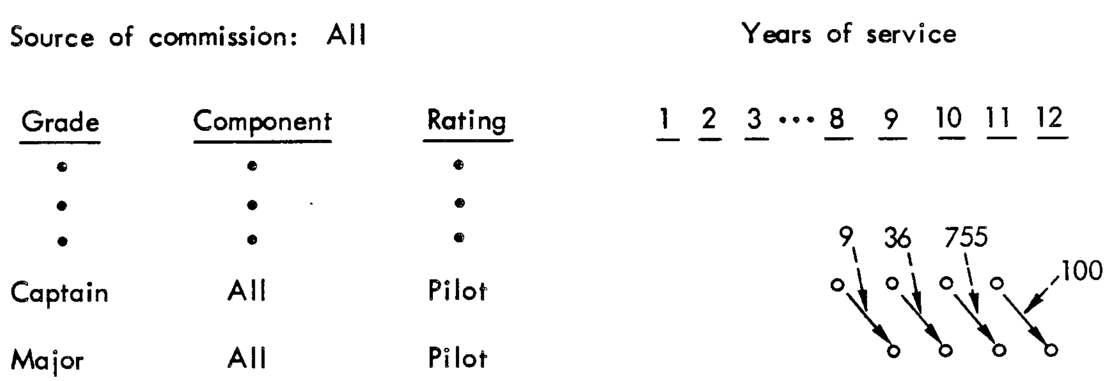

Fig. 8—Promotion phase point in YOS 11

The grade limitations model permits the user to specify as many promotion paths from one grade to the next higher grade as he desires; it is not limited to four years of service as is the progression or the constraints model.*

Promotion Opportunity

The promotion opportunity into grade G is defined as the proportion of officers in grade G-1 or higher in the first year of the primary zone who achieve promotion to grade G during their career. In other words, if we define E to be the number of officers in either grade G-1 or higher at the phase point, and if P is the total number of officers promoted to grade G, then the promotion opportunity is given by

$$P.O. = \frac{P}{E}$$

The quantity E is referred to as the "number of eligibles." Thus, if there is a cohort of 1000 captains or higher grade officers with 11 years of service, and 900 of the 1000 have received below-the-zone promotions to major or are subsequently promoted to major, then the promotion opportunity to major is 90 percent.

EQUILIBRIUM CONDITION

In this particular steady-state system, in which the number in the state does not change from year to year, the flows into a given state must equal the number in the state and also the flows out of the state. Figure 9 illustrates the equilibrium condition. It shows flows into and out of state (2,3,1,2,11) and the quantity in the state.

*In Air Force terminology, the phase point is the year of service into which most promotions take place. However, the output logic, which is the same for the progression, constraints, and grade limitations models, defines the phase point as the third year when the promotion zone is four years, i.e., when there are four consecutive years with promotion flows. In all other cases (fewer or more than four consecutive years of promotions) the output logic selects the phase point to be the year during which the largest number of promotions take place.

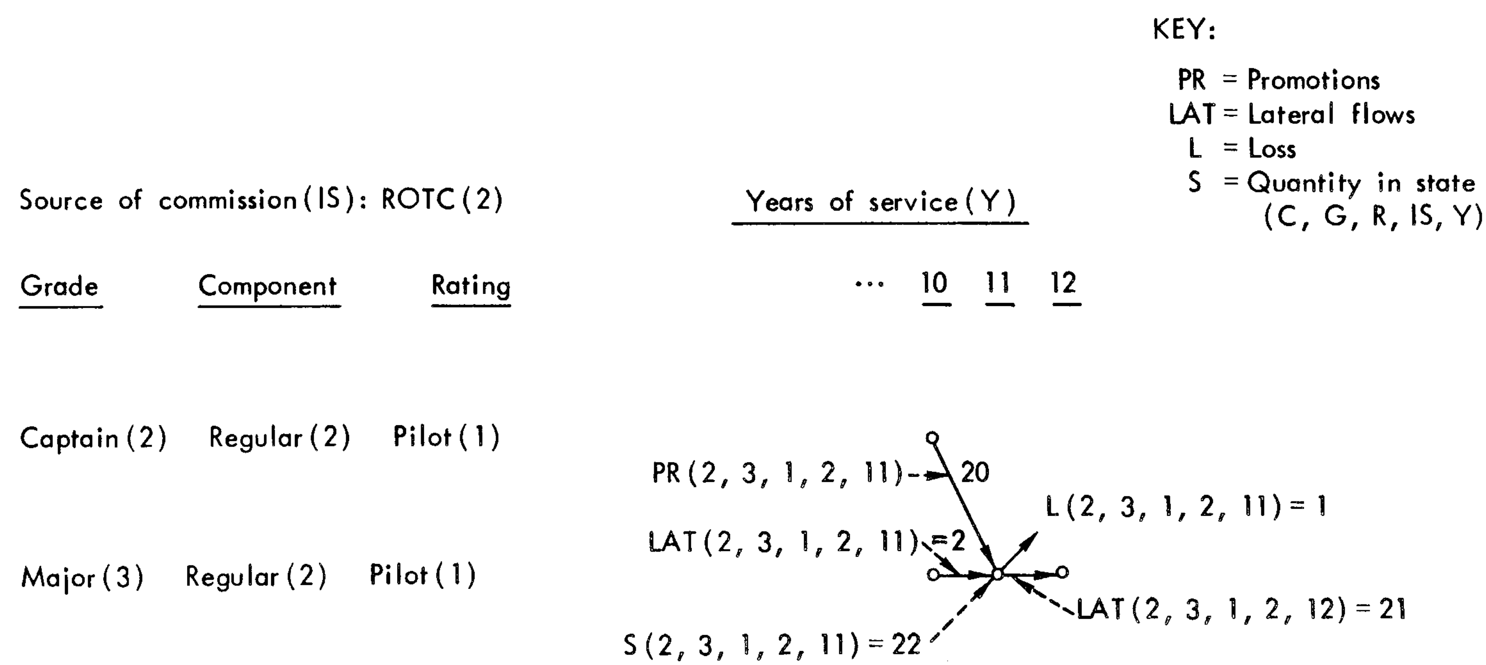

Fig. 9—Equilibrium condition: flows in = steady-state quantity = flows out for regular ROTC pilot majors with 11 years of service

Thus

Annual flows in: PR(2,3,1,2,11) + LAT(2,3,1,2,11) =
20 + 2 = 22

Annual flows out: L(2,3,1,2,11) + LAT(2,3,1,2,12) =
1 + 21 = 22

State: S(2,3,1,2,11) = 22

Thus the equilibrium condition is maintained.

Now that the reader has been introduced to the concepts and vocabulary of the officer force models, each model will be described in turn in the following subsections. The reader will find a more detailed discussion later in this report or in a companion report devoted to each model.*

PROGRESSION MODEL

Figure 10 is a schematic representation of the progression model in its computation of the initial states and flows of ROTC non-rated officers. Using as input annual accessions, loss, training, and augmentation rates, the progression model computes the number of annual losses, UPT and UNT production, and augmentations from reserve to regular component for the first year of service. Finally, the model computes the number of lateral flows of ROTC non-rated officers into the second year of service. The model continues by computing flows of reserve and regular ROTC non-rated officers out of the second year of service and into the third year of service as is illustrated in Fig. 10. By continuing this process, the progression model computes, explicitly, the flows out of each node or state, the number in the state, and the flows into each state for all years of service for non-rated ROTC officers, as depicted in Fig. 11.

Promotion flows from one grade to the next produce the cascading effect shown by the dashed lines with arrows in Fig. 11. Promotion years constitute a cycle of consecutive years during which an officer may be promoted from one grade to the next higher. The computation of state and flow quantities during promotion years of service is more

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*See pp. iii and iv for a list of companion studies.

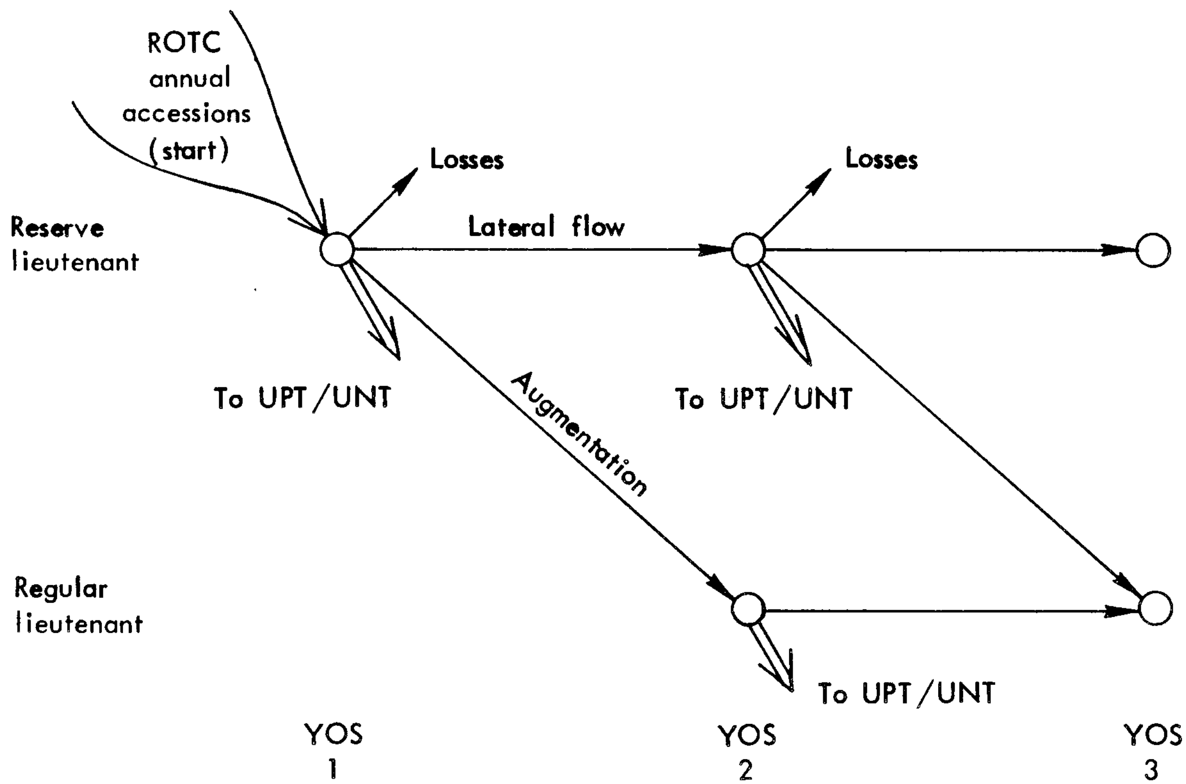

Fig. 10—Progression model initial states and flows of non-rated officers

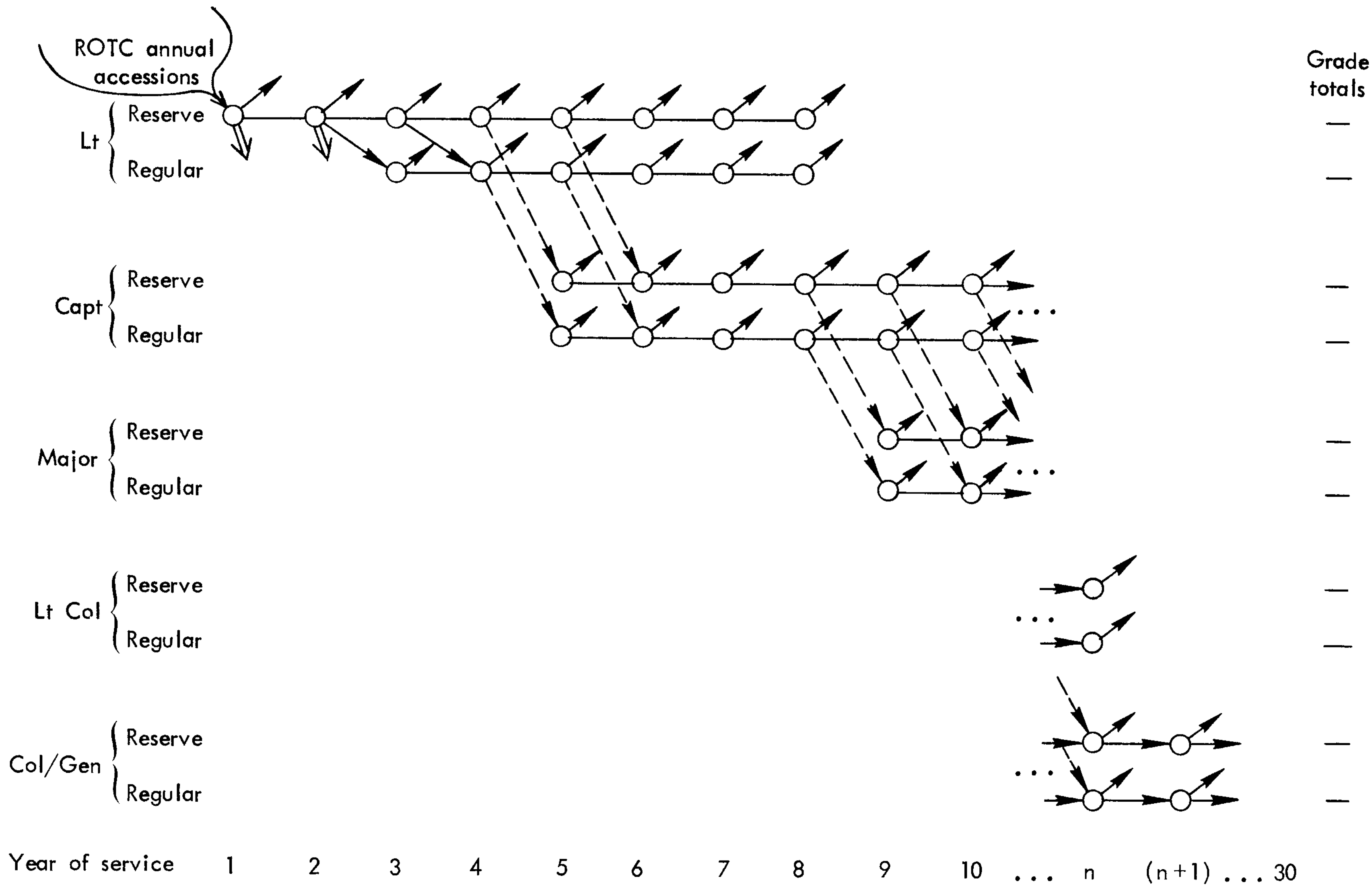

Fig. 11 — Non-rated officer structure states and flows

complicated than that for nonpromotion years of service, because promotions during years of service prior to the phase point are affected by the number of officers entering the phase point who are in the lower grade or who have already been promoted to the next higher grade. Therefore, the progression model must *simultaneously* consider the entire cycle of years of service during which promotions from one grade to the next higher grade may take place. In the progression model, the user may specify this cycle or promotion zone to be from one to four years duration, but not longer than four years.*

A similar set of computations is made for ROTC pilots and navigators except that the second year of service is the first state possible for ROTC rated officers, since it is assumed that it takes about one year to enter and complete UPT or UNT training. The initial flows into pilot and navigator states are the identical flows out of non-rated states into UPT or UNT; again, the equilibrium condition holds.

Identical computations may be made for Academy or OTS accessions, except that there are no reserve officer states for flows of Academy-graduated officers.

The progression model inputs are accessions and the rates and data necessary to compute annual losses, UPT and UNT pilot and navigator production, augmentations of reserve to regular component, and promotions. Outputs of the progression model indicate the computed inventory in each state and amount of flows into and out of each state in detail and in summary formats.

CONSTRAINTS MODEL

As indicated in Fig. 12, the progression model discussed above is a subroutine used by the constraints model, the inputs of which include annual accessions from the Academy and ROTC. The output will have the computed annual accessions from OTS and sources other than ROTC and the Academies. Other inputs for officers from each source of commission

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*The constraints model also limits promotions to a cycle not to exceed four years duration; however, the grade limitations model does not have this restriction and promotions may occur in a cycle with as many years duration as the user wishes.

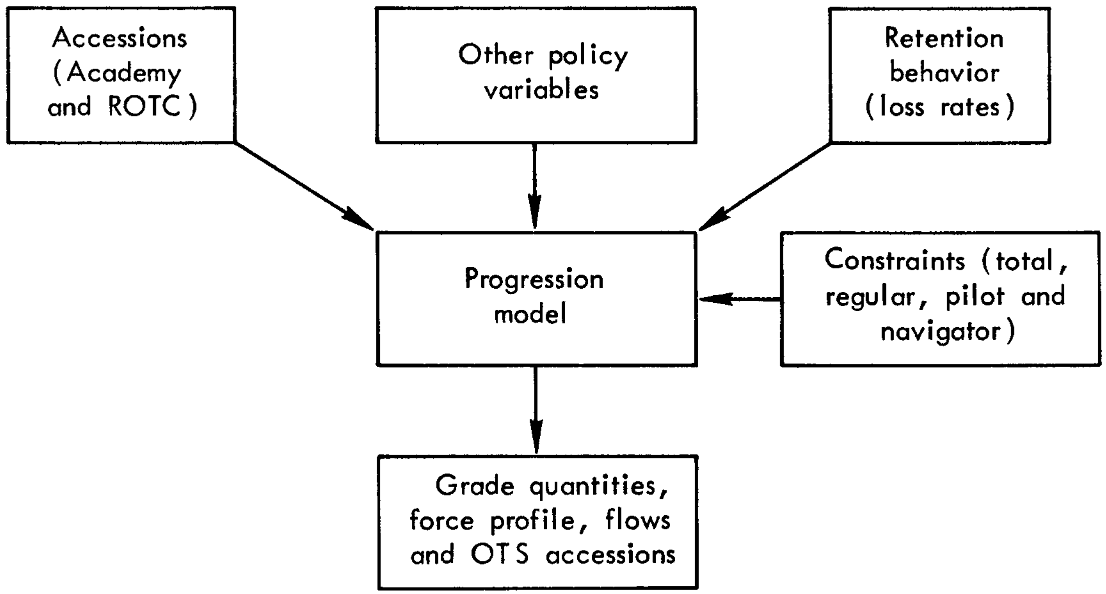

Fig. 12—Constraints model

include loss rates and other policy variables such as training and augmentation rates used in the progression model subroutine. In addition, the following manpower constraints must also be provided:

- o Total number of officers
- o Number of regular officers
- o Number of pilots
- o Number of navigators
- o Career reserve requirements

The career reserve requirement inputs provide, for the reserve sources of commission, a mechanism for selecting officers for career reserve status.

The constraints model, using the progression model as a guide, will try to superimpose the manpower requirements on the officer structure. The constraints model first distributes the Academy officers over the years of service. If any manpower requirement is exceeded after this, the constraints model warns the user that the officer structure is overconstrained and halts execution. If, on the other hand, no manpower requirements are exceeded, then the constraints model distributes the ROTC officers over the years of service, trying to satisfy the ROTC career reserve requirements as it does so. Once again, if any manpower requirements are exceeded, the constraints model warns the user that the system is overconstrained. Finally, if the manpower requirements are still not satisfied, the constraints model will attempt to satisfy these requirements with the OTS source of commission. With the OTS source of commission the model has the most flexibility. The model may alter augmentation and rating transfer rates in its attempts to satisfy the manpower requirements and will determine the number of OTS accessions needed to satisfy the manpower constraints.

The inputs and outputs for the constraints model are the same as for the progression model except that the constraints are specified, OTS accessions are computed, and some OTS rates may be adjusted by the algorithms of the constraints model. The outputs of the constraints model show the computed OTS accessions and adjusted rates as well as

the number of officers in each grade, force profile, and flows in detailed and summary formats.

GRADE LIMITATIONS MODEL

Figure 13 is a graphic presentation of the grade limitations model in its computation of the final states and flows of ROTC non-rated officers. The grade limitations model is sometimes called the "backward" model because of the order in which the computations are done relative to grade, highest grade computed first; this is done because all flows into a grade in the grade limitations model occur only to fill vacancies created by losses in that or higher grades. For the highest grade (colonel/general combined) the losses in that grade completely determine the number of promotions required from the grade of lieutenant colonel to colonel. Thus by knowing the total number of colonel/generals authorized, the loss rates, and the flow or frequency distribution of promotions into colonel/generals, the model is able to compute a unique mathematical solution for (1) the losses from the grade, (2) the number of officers in each cell, (3) the total number of promotions into the grade, and (4) the distribution of promotions into the grade by year of service. Similarly, because the model knows the promotion flows out of the grade of lieutenant colonel, the total number of lieutenant colonels authorized, the loss rates, and the flow or frequency distribution of promotions into the grade of lieutenant colonel, it can compute a unique mathematical solution for the flows into the grade of lieutenant colonel and the quantity of officers in each cell. Working backward, the model continues until this type of computation is made for all grades through and including the grade of lieutenant, as is shown in Fig. 14.

It is possible for more than one type of flow to occur into and within a grade. For example, flows into ROTC regular non-rated captains may include promotions of regular non-rated lieutenants who become regular non-rated captains as well as reserve non-rated captains augmented into the regular component to become regular non-rated captains. The grade limitations model needs as an input the flow ratio of the number of augmentations to the number of promotions into ROTC regular

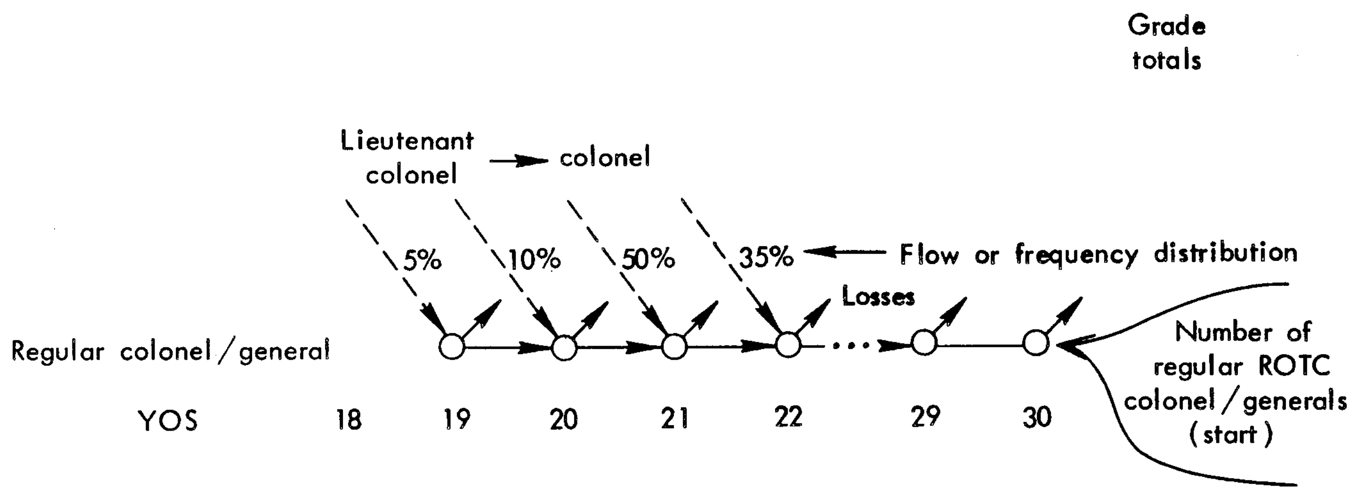

Fig. 13—Grade limitations (backward) model, final states and flows of nonrated officers

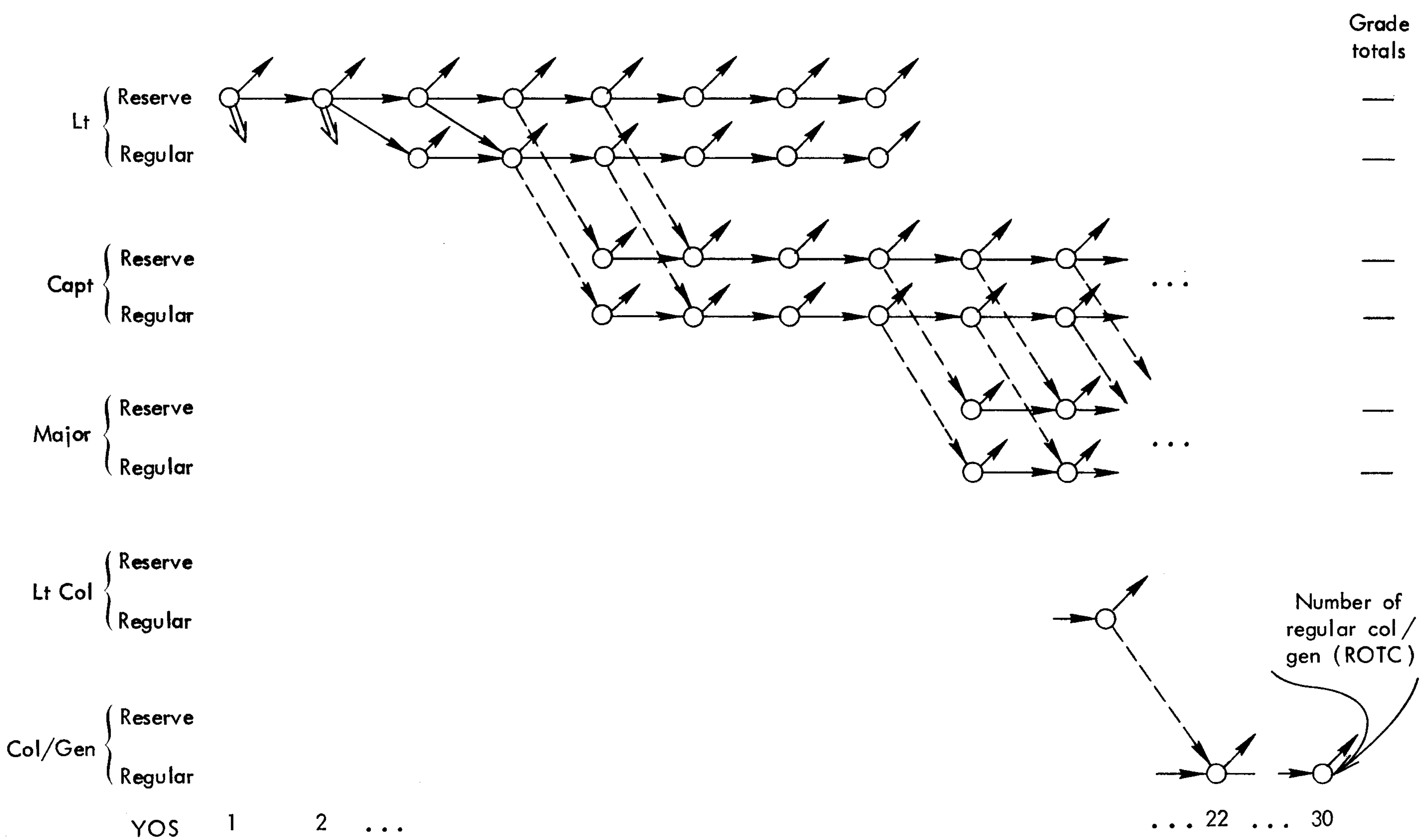

Fig. 14 — Nonrated officer structure states and flows

non-rated captains. For example, if 100 officers flow into ROTC regular non-rated captain status each year and the augmentation/promotion flow ratio is 1:3, then there must be 25 augmentations and 75 promotions into ROTC regular non-rated status each year under the equilibrium condition and steady-state assumption. It may seem that providing grade limitations and flow ratios in terms of ROTC regular non-rated captain and similar categories could be difficult. However, the progression or constraints model can be used to great advantage in estimating these and other inputs for the grade limitations model. Flow or frequency distributions (see Fig. 13) detailing the fraction of a flow that occurs each year of service are also inputs to the grade limitations model that may be obtained by means of the progression or constraints models, if they are not available from other sources.

Figure 15 is a schematic diagram of the primary inputs and outputs of the grade limitations model. A more detailed description of the model may be found in a companion report.*

The grade limitations model is useful when the Congress or other authority imposes a set of grade limitations, at which time the Air Force is faced with the problem of determining accessions and personnel policies consistent with these limitations and long-run Air Force objectives.

BEHAVIORAL MODEL

The behavioral model is designed to simulate the responsiveness of officer retention rates to changes in promotion probabilities, promotion phase points, and--for reserve component officers--changing probabilities of augmenting into the regular component. Additionally, the model controls for factors external to the Air Force, e.g., officer pay and alternative civilian pay.

The model is actually a system of three equations: a separate equation for pilots, navigators, and non-rated officers. For each equation, retention rates may be estimated for various combinations of source of commission (Academy, ROTC, OTS, and other), component (regular

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*See pp. iii and iv for a list of companion studies.

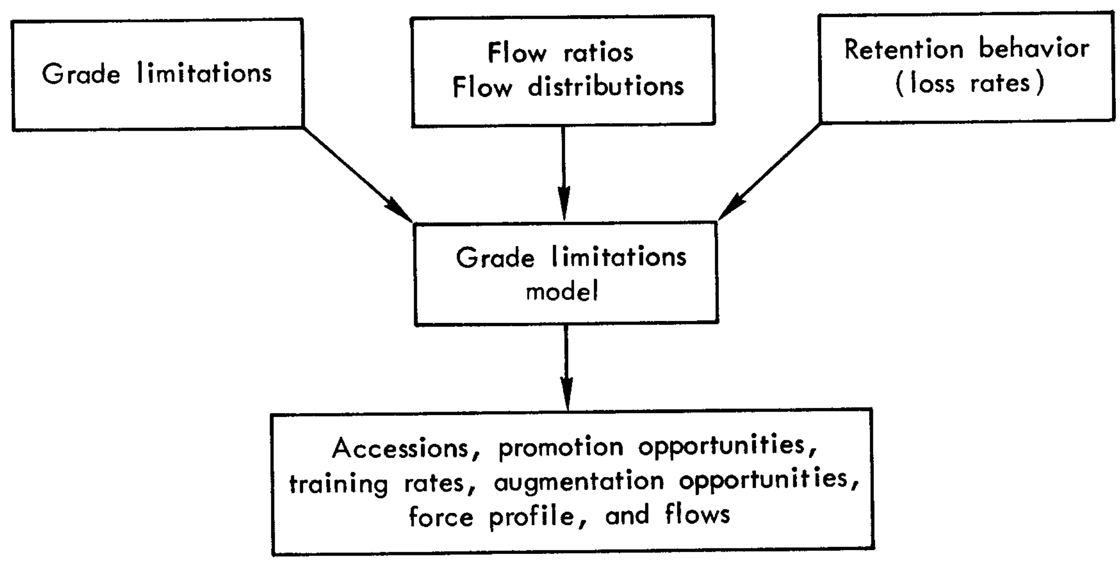

Fig. 15 — Grade limitations (backward) model

or reserve), grade, and years of service in conjunction with the values of variables listed above: promotion probabilities, promotion phase points, and augmentation probabilities.

The logistic curve was chosen as the appropriate functional form for each of the three equations because it has two desirable properties. First, the function constrains the predicted retention rates to lie (appropriately) between zero and one. Second, given certain statistical properties of the independent variables, it can be shown that the logistics function may be derived from the Bayes Theorem, a well-known statistical theorem on conditional probabilities.*

Currently, steady-state deterministic simulation models are used to examine the implications of policy changes on the officer force structure. However, there is no functional relationship established that may be used to relate the effect of personnel policy changes on retention rates and their interaction. The behavioral model, used together with the progression, constraints, or grade limitations models, is an effort to relate the interaction of policy changes to changes in retention rates and their mutual impact on the officer force structure.

A more detailed description of the behavioral model and its inputs and outputs may be found in a companion report.†

This section's brief description of the progression model has indicated how the computer program is organized and operates and has briefly treated its inputs and outputs. The progression model computer program is written in Fortran and requires approximately 30 CPU sec and 100K words of core storage on an IBM 370/158 computer. We do not plan to write a programmer's manual; however, the program is replete with explanatory remarks, and the input and output sections that follow may be used as a user's guide to the program. Further, for those granted permission from the U.S. Air Force to obtain the progression model (or other model) tape, the tape will be accompanied by sufficient instructions so that it can be run on the user's computer.

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*For the Bayes Theorem justification and for an exposition of the logistic function see Ref. 3.

†See pp. iii and iv for a list of companion studies.

Section III and Appendixes A and B describe in detail the mathematical basis of the progression model and its computations. Sections IV and V describe the inputs and outputs, respectively, of the progression model. While not complete, the outputs should be sufficient to illustrate how one set of several runs could be made, each exactly the same except that one input is varied in some differential amount to illustrate the impact of some policy change. Or, in a more complex analysis, we could make several sets of such runs to get interactions among these policy variables. For a further discussion of this point, the reader is advised to read the first in this series of reports.*

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*See pp. iii and iv for a list of companion studies.

III. MATHEMATICAL MODEL

The mathematical basis of the model is Markovian; in it, all Air Force officers are classified into states according to the following characteristics:

- Component
- Grade
- Aeronautical rating
- Source of commission
- Year of service

Under actual conditions, losses, completion of UPT and UNT (called rating transfers), augmentation from the reserve to the regular component, and promotions can occur throughout a given year in no particular order. However, to facilitate computation in the model we assume that these personnel flows (i.e., changes in state during a given year) occur in sequential order (or *computation phases*) as follows:

1. Losses
2. Rating transfers
3. Augmentations
4. Promotions

This makes computations far more tractable with little loss of accuracy, if any. Let PR(C,G,R,IS,Y) be the number of Air Force officers procured (accessions) or promoted into state (C,G,R,IS,Y). We set the number in the state for non-rated lieutenants in YOS 1 to be the number of procurements:

$$S(C,1,3,IS,1) = PR(C,1,3,IS,1) \qquad (1)$$

where C = 1 for the ROTC and OTS accessions (IS = 2 or 3), and C = 2 for Academy accessions (IS = 1). This implies that all officers begin

their officer careers as non-rated in YOS 1 and that only Academy graduates can be awarded a regular commission upon entry into the officer force, the ROTC and OTS accessions being awarded reserve commissions. Thus there can be no rated officers in the first year of service, nor can ROTC or OTS officers be in the regular component in their first year of service. The above is based on the fact that present Air Force policy precludes regular appointments to non-Academy graduates upon graduation from ROTC, OTS, or another non-Academy source, and that it takes approximately one year to complete UPT or UNT training. Let

B(C,G,R,IS,Y) = The loss rate that applies to officers in state (C,G,R,IS,Y).

RE(C,G,R,IS,Y) = The retention rate that applies to officers in state (C,G,R,IS,Y) (2)

= 1 - B(C,G,R,IS,Y).

Then

L(C,G,R,IS,Y) = Losses of officers from state (C,G,R,IS,Y) (3)

= S(C,G,R,IS,Y) · B(C,G,R,IS,Y).

Let

RAT(C,1,1,IS,Y)* = The proportion of officers in state (C,1,3,IS,Y) who are not lost to the Air Force in YOS Y and who complete UPT and become pilots in YOS Y+1.

RAT(C,1,2,IS,Y)* = The proportion of officers in state (C,1,3,IS,Y) who are not lost to the Air Force in YOS Y and complete UNT and become navigators in YOS Y+1.

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*See Appendix A for computation.

RAT(C,1,3,IS,Y) = The proportion of officers in state (C,1,3,IS,Y) who are not lost to the Air Force in YOS Y and who become pilots or navigators in YOS Y+1
= RAT(C,1,1,IS,Y) + RAT(C,1,2,IS,Y).

NRAT(C,1,3,IS,Y) = The proportion of officers in state (C,1,3,IS,Y) who are not lost to the Air Force in YOS Y and who do not become pilots or navigators in YOS Y+1 (4)
= 1 - RAT(C,1,3,IS,Y).

AUG(2,G,R,IS,Y) = The proportion of eligible officers who flow from state (1,G,R,IS,Y) to state (2,G,R,IS,Y+1) (i.e., who are augmented).

NAUG(2,G,R,IS,Y) = The proportion of eligible officers in state (1,G,R,IS,Y) who are not augmented. (5)
= 1 - AUG(2,G,R,IS,Y).

We will examine how the flows between the states are computed by examining the computations performed at several representative values for years of service.

FIRST YEAR OF SERVICE

Figures 16 and 17 illustrate the first year of service for Academy and non-Academy graduates, respectively. As can be seen from the figures, in moving from the first to the second year of service the model first determines losses (the "L" phase), then rating transfers (the "RT" phase), and finally augmentations (the "AU" phase in Fig. 17).

Academy Officers

From Fig. 16, for Academy officers:

1. The number in state (2,1,3,1,1) equals the number of accessions

Source of commission: Academy

State or flow: PR S L RT S

Year of service: 1 2

KEY:

PR = Procurement (accessions)
S = State
L = Loss
RT = Rating transfer

Grade	Component	Rating
Lieutenant	Regular	Nonrated
Lieutenant	Regular	Pilot
Lieutenant	Regular	Navigator

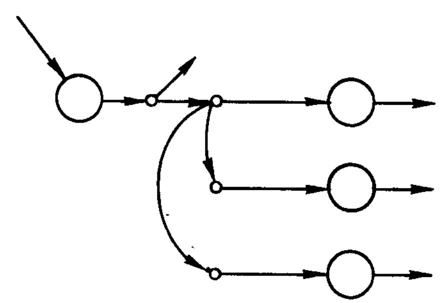


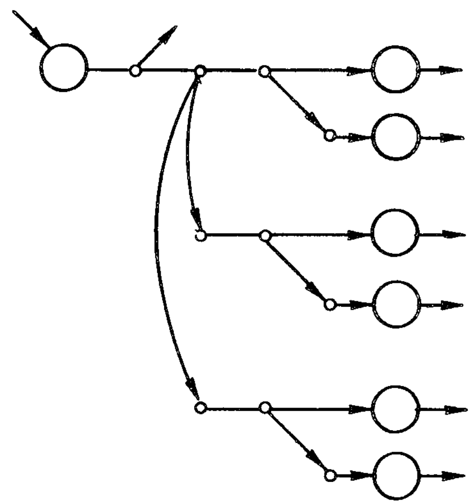
Fig. 16—First year of service, Academy graduates

Source of commission: OTS/other

State or flow: PR S L RT AU S

Year of service: 1 2

Grade	Component	Rating
Lieutenant	Reserve	Nonrated
Lieutenant	Regular	Nonrated
Lieutenant	Reserve	Pilot
Lieutenant	Regular	Pilot
Lieutenant	Reserve	Navigator
Lieutenant	Regular	Navigator



KEY:

PR = Procurement (accessions)
S = State
L = Loss
RT = Rating transfer
AU = Augmentation

Fig. 17—First year of service, non-Academy source of commission

from the Academy, or

$$S(2,1,3,1,1) = PR(2,1,3,1,1).$$

2. The losses from state (2,1,3,1,1) equal the number in state (2,1,3,1,1) times the loss rate for state (2,1,3,1,1), or

$$L(2,1,3,1,1) = S(2,1,3,1,1) \cdot B(2,1,3,1,1).$$

3. The number of Academy graduates who become pilots in YOS 1 equals the Academy graduates retained times the pilot rating transfer rate, or

$$RT(2,1,1,1,2) = [S(2,1,3,1,1) \cdot RE(2,1,3,1,1)] \cdot RAT(2,1,1,1,1).$$

4. Similarly, for navigators

$$RT(2,1,2,1,2) = [S(2,1,3,1,1) \cdot RE(2,1,3,1,1)] \cdot RAT(2,1,2,1,1).$$

5. The number of non-rated Academy graduates in state (2,1,3,1,2) is given by $S(2,1,3,1,2) = S(2,1,3,1,1) - L(2,1,3,1,1) - RT(2,1,1,1,2) - RT(2,1,2,1,2)$, which is equivalent to

$$S(2,1,3,1,2) = [S(2,1,3,1,1) \cdot RE(2,1,3,1,1)] \cdot NRAT(2,1,3,1,1).$$

For pilots and navigators who are Academy graduates,

$$S(2,1,1,1,2) = RT(2,1,1,1,2)$$

and

$$S(2,1,2,1,2) = RT(2,1,2,1,2).$$

Non-Academy Officers

From Fig. 17, for non-Academy officers (e.g., OTS or other officers)

S(1,1,3,3,1) = OTS accessions into state (1,1,3,3,1)
= PR(1,1,3,3,1).

L(1,1,3,3,1) = Losses of officers from state (1,1,3,3,1) in YOS 1
= S(1,1,3,3,1) · B(1,1,3,3,1).

RT(1,1,1,3,2) = Pilot rating transfers from state (1,1,3,3,1) into state (1,1,1,3,2)
= S(1,1,3,3,1) · RE(1,1,3,3,1) · RAT(1,1,1,3,1) · NAUG(2,1,1,3,1).

RA(2,1,1,3,2) = Pilot rating transfers and augmentations from state (1,1,3,3,1) into state (2,1,1,3,2)
= S(1,1,3,3,1) · RE(1,1,3,3,1) · RAT(1,1,1,3,1) · AUG(2,1,1,3,1).*

RT(1,1,2,3,2) = Navigator rating transfers from state (1,1,3,3,1) into state (1,1,2,3,2)
= S(1,1,3,3,1) · RE(1,1,3,3,1) · RAT(1,1,2,3,1) · NAUG(2,1,2,3,1).

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*One way of thinking about flows is to picture the paths officers might take as they proceed from the first to the second year of service. For example, the number of officers who receive augmentations and rating transfers to pilot is computed in the following steps: We are interested in the number of officers that move from state (1,1,3,3,1) to state (2,1,1,3,2).

- Eliminate losses.
  Officers remaining: S(1,1,3,3,1) · RE(1,1,3,3,1).

- Determine pilot rating transfers.
  Officers taking this path: S(1,1,3,3,1) · RE(1,1,3,3,1) · RAT(1,1,1,3,1).

- Determine the number of these officers that are to receive augmentations.
  Pilots taking this path: S(1,1,3,3,1) · RE(1,1,3,3,1) · RAT(1,1,1,3,1) · AUG(2,1,1,3,1).

In other words, each successive step--or each successive multiplier--indicates the path being considered.

RA(2,1,2,3,2) = Navigator rating transfers and augmentations from state (1,1,3,3,1) into state (2,1,2,3,2)

= S(1,1,3,3,1) · RE(1,1,3,3,1) · RAT(1,1,2,3,1) · AUG(2,1,2,3,1).

AU(2,1,3,3,2) = Non-rated augmentations from state (1,1,3,3,1) into state (2,1,3,3,2)

= S(1,1,3,3,1) · RE(1,1,3,3,1) · NRAT(1,1,3,3,1) · AUG(2,1,3,3,1).

LAT(1,1,3,3,2) = Lateral flows from state (1,1,3,3,1) into state (1,1,3,3,2)

= S(1,1,3,3,1) · RE(1,1,3,3,1) · NRAT(1,1,3,3,1) · NAUG(2,1,3,3,1)

= S(1,1,3,3,1) - L(1,1,3,3,1) - RT(1,1,1,3,2) - RA(2,1,1,3,2) - RT(1,1,2,3,2) - RA(2,1,2,3,2) - AU(2,1,3,3,2).

S(1,1,3,3,2) = LAT(1,1,3,3,2).

S(2,1,3,3,2) = AU(2,1,3,3,2).

S(1,1,1,3,2) = RT(1,1,1,3,2).

S(2,1,1,3,2) = RA(2,1,1,3,2).

S(1,1,2,3,2) = RT(1,1,2,3,2).

S(2,1,2,3,2) = RA(2,1,2,3,2).

NONPROMOTION YEAR OF SERVICE, LIEUTENANTS

Figures 18 and 19 illustrate the states and flows for non-rated and rated lieutenants and captains during their second through sixth year of service. In Figures 18 and 19 there are no below-the-zone, i.e., secondary-zone, promotions, and UPT and UNT graduates get their wings no later than their fourth year of service. Further, lieutenants must complete four years of total active federal commissioned service before being eligible for promotion to captain. Lieutenants not selected for promotion in their fifth year of service get one additional chance to be selected for promotion in the following year.

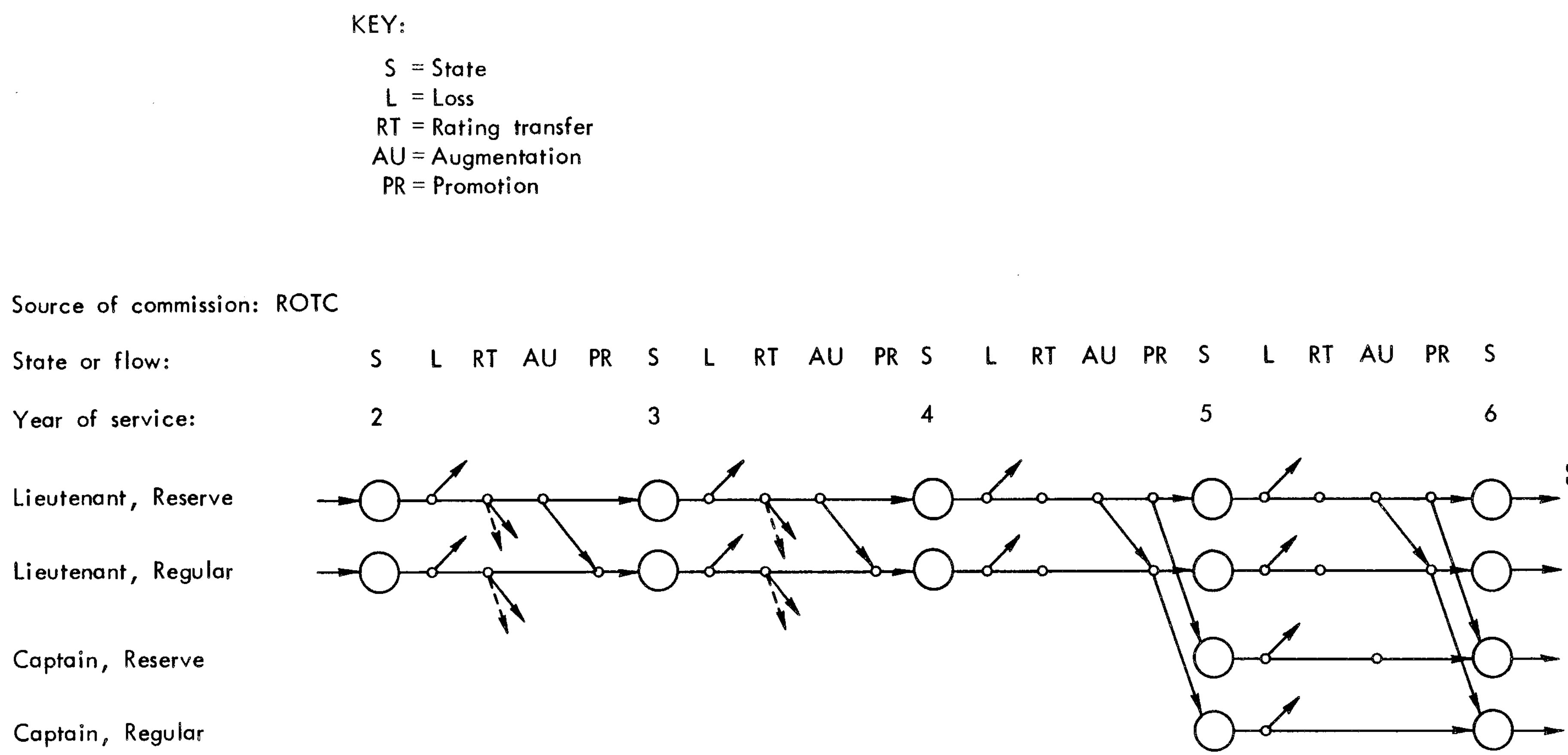

Fig. 18 — Promotion cycle, from lieutenant to captain, non-rated: phase point YOS 5
No below-the-zone promotions

KEY:

S = State
L = Loss
RT = Rating transfer
AU = Augmentation
PR = Promotion

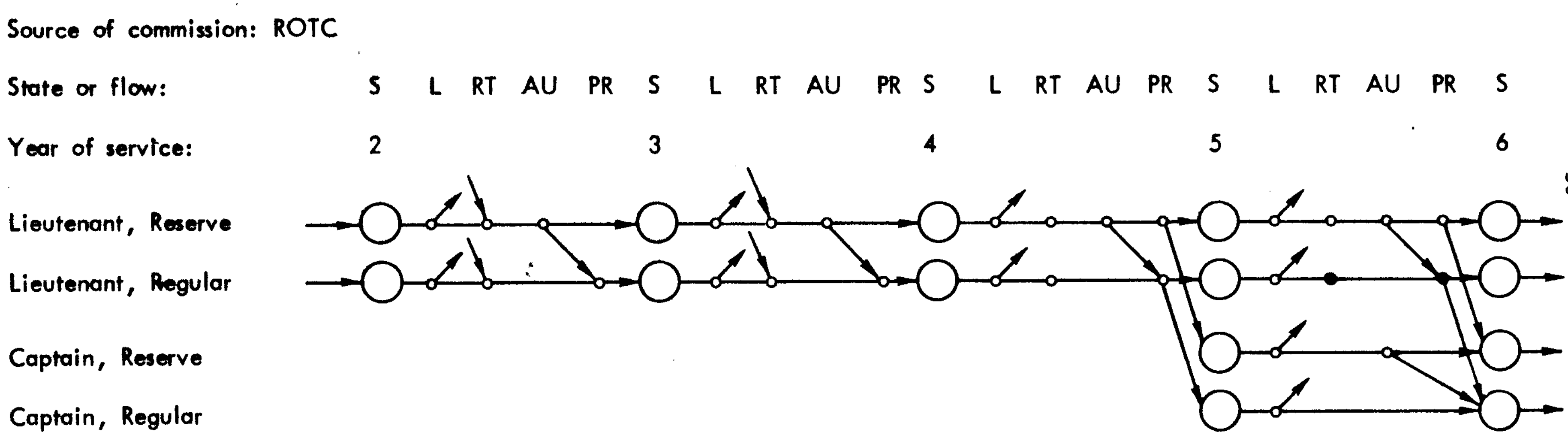

Fig. 19—Promotion cycle, from lieutenant to captain, pilot (or navigator): Phase point YOS 5
No below-the-zone promotions

Nonpromotion Year of Service, Non-Rated Lieutenants

We will consider a year of service, Y-1, during which a non-rated lieutenant is not eligible for promotion, such as the second year of service in Fig. 18. We wish to compute the flows out of the states with YOS Y-1 and into states with YOS Y, and the quantities in states with YOS Y.

For ROTC officers, IS = 2 and

S(1,1,3,2,Y-1) = Number of reserve non-rated lieutenants from ROTC in YOS Y-1, i.e., the number in state (1,1,3,2,Y-1).

S(2,1,3,2,Y-1) = Number of regular non-rated lieutenants from ROTC in YOS Y-1, i.e., the number in state (2,1,3,2,Y-1).

L(C,1,3,2,Y-1) = Number of officers lost from state (C,1,3,2,Y-1) in YOS Y-1
= S(C,1,3,2,Y-1) · B(C,1,3,2,Y-1).

S(1,1,3,2,Y-1) · RE(1,1,3,2,Y-1) · RAT(1,1,1,2,Y-1)[†]
= The number of (1,1,3,2,Y-1) reserve non-rated officers from ROTC who become pilots in YOS Y.[*]

S(1,1,3,2,Y-1) · RE(1,1,3,2,Y-1) · RAT(1,1,2,2,Y-1)[†]
= The number of ROTC reserve non-rated officers from state (1,1,3,2,Y-1) who become navigators in YOS Y.[*]

S(2,1,3,2,Y-1) · RE(2,1,3,2,Y-1) · RAT(2,1,1,2,Y-1)
= The number of ROTC regular non-rated officers from state (2,1,3,2,Y-1) who become pilots in YOS Y.[†]

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[*] Note that in Fig. 18 these values are shown as flows out of the non-rated classification--the arrows that lead nowhere in the "RT" phases. In Fig. 19, which represents the rated classification, they are shown as flows into the "RT" phases. Some of these officers will also receive augmentations this year.

[†] See Appendix A for computation of RAT(2,1,R,2,Y-1).

S(2,1,3,2,Y-1) · RE(2,1,2,3,Y-1) · RAT(2,1,2,2,Y-1)
= The number of ROTC regular non-rated officers from state (2,1,3,2,Y-1) who become navigators in YOS Y.*

AU(2,1,3,2,Y) = The number of ROTC reserve non-rated officers from state (1,1,3,2,Y-1) who remain non-rated and who are augmented into the regular component and flow into state (2,1,3,2,Y) during YOS Y
= S(1,1,3,2,Y-1) · RE(1,1,3,2,Y-1) · NRAT(1,1,3,2,Y-1) · AUG(2,1,3,2,Y-1).

LAT(1,1,3,2,Y) = The number of ROTC officers from state (1,1,3,2,Y-1) who are not lost to the Air Force in YOS Y-1, who do not complete UPT or UNT in YOS Y, and who are not augmented into the regular component in YOS Y. They simply age one year, i.e., flow laterally from state (1,1,3,2,Y-1) into state (1,1,3,2,Y)
= S(1,1,3,2,Y-1) · RE(1,1,3,2,Y-1) · NRAT(1,1,3,2,Y-1) · NAUG(2,1,3,2,Y-1).

LAT(2,1,3,2,Y) = Lateral flows from state (2,1,3,2,Y-1) into state (2,1,3,2,Y)--regular non-rated in Y-1 to regular non-rated in Y
= S(2,1,3,2,Y-1) · RE(2,1,3,2,Y-1) · NRAT(2,1,3,2,Y-1).

where

RAT(C,1,1,IS,Y-1) = The proportion of officers not lost to the service who become pilots in YOS Y by completing UPT in YOS Y.

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*See Appendix A for computation of RAT(2,1,R,2,Y-1).

RAT(C,1,2,IS,Y-1) = The proportion of officers not lost to the service who become navigators in YOS Y by completing UNT in YOS Y.

RAT(C,1,3,IS,Y-1) = The proportion of officers not lost to the service who become either pilots or navigators in YOS Y by completing UPT or UNT in YOS Y.

= RAT(C,1,1,IS,Y-1) + RAT(C,1,2,IS,Y-1).

NRAT(C,1,3,IS,Y-1) = The proportion of officers not lost to the service who do not complete UPT or UNT in YOS Y, i.e., non-rated officers in both YOS Y-1 and YOS Y

= 1 - RAT(C,1,3,IS,Y-1).

AUG(2,1,3,IS,Y-1) = The proportion of remaining officers who are augmented into the regular component and flow into state (2,1,3,IS,Y) during YOS Y.

and

NAUG(2,1,3,IS,Y-1) = 1 - AUG(2,1,3,IS,Y-1).

Then

S(1,1,3,2,Y) = LAT(1,1,3,2,Y)

and

S(2,1,3,2,Y) = LAT(2,1,3,2,Y) + AU(2,1,3,2,Y).

Nonpromotion Year of Service, Pilot or Navigator Lieutenants

Figure 19 illustrates the flows for pilot (or navigator) lieutenants and captains from ROTC in their second through sixth years of service. This subsection deals with the "nonpromotion" years of service, i.e., the second through fourth, in which only lieutenants

exist. Note that IS = 2 for ROTC and that rated losses are computed in the same manner as non-rated.

RT(1,1,R,2,Y) = Number of rating transfers into state (1,1,R,2,Y) during YOS Y, i.e., the number of non-rated reserve officers from state (1,1,3,2,Y-1) who become pilots (or navigators) but who are not augmented into the regular component in YOS Y

= S(1,1,3,2,Y-1) · RE(1,1,3,2,Y-1) · RAT(1,1,R,2,Y-1) · NAUG(2,1,R,2,Y-1).*

RA(2,1,R,2,Y) = Number of non-rated reserve officers from state (1,1,3,2,Y-1) who are augmented into the regular component *and* also become pilots (or navigators), both in YOS Y

= S(1,1,3,2,Y-1) · RE(1,1,3,2,Y-1) · RAT(1,1,R,2,Y-1) · AUG(2,1,R,2,Y-1).*

RT(2,1,R,2,Y) = Number of rating transfers from state (2,1,3,2,Y-1) into state (2,1,R,2,Y) during YOS Y

= S(2,1,3,2,Y-1) · RE(2,1,3,2,Y-1) · RAT(2,1,R,2,Y-1).*

LAT(1,1,R,2,Y) = The number of officers from state (1,1,R,2,Y-1) who flow laterally into state (1,1,R,2,Y)

= S(1,1,R,2,Y-1) · RE(1,1,R,2,Y-1) · NAUG(2,1,R,2,Y-1).

LAT(2,1,R,2,Y) = The number of officers from state (2,1,R,2,Y-1) who flow laterally into state (2,1,R,2,Y)

= S(2,1,R,2,Y-1) · RE(2,1,R,2,Y-1).

---

*S(1,1,3,2,Y-1) · RE(1,1,3,2,Y-1) · RAT(1,1,1,2,Y-1) and S(2,1,3,2,Y-1) · RE(2,1,3,2,Y-1) · RAT(2,1,1,2,Y-1) are the rating transfer flows from the non-rated states (see pp. 37, 38).

AU(2,1,R,2,Y) = The number of reserve officers from state (1,1,R,2,Y-1) who are augmented into state (2,1,R,2,Y) in YOS Y
= S(1,1,R,2,Y-1) · RE(1,1,R,2,Y-1) · AUG(2,1,R,2,Y-1).

S(1,1,R,2,Y) = The number of officers in state (1,1,R,2,Y)
= LAT(1,1,R,2,Y) + RT(1,1,R,2,Y).

S(2,1,R,2,Y) = The number of officers in state (2,1,R,2,Y)
= LAT(2,1,R,2,Y) + RA(2,1,R,2,Y) + RT(2,1,R,2,Y) + AU(2,1,R,2,Y).

where R = 1 (pilot) or 2 (navigator).

PROMOTION YEAR OF SERVICE, NON-RATED LIEUTENANT

Figure 20 depicts the states and flows for non-rated lieutenants over a four-year promotion cycle with a two-year secondary zone and a two-year primary zone.* Promotions from lieutenant to captain normally do not occur over a four-year cycle but are usually limited to a cycle of one or two years duration, as was illustrated in Fig. 18 for non-rated officers. As we shall see in the discussion of the inputs required by the model, the user has complete flexibility in specifying the promotion zones for each of the grades, including whether or not to allow below-the-zone promotions. In Fig. 20 we illustrate the more general case.

Several points should be made before examining the flow computations that take place during the promotion cycle years. First, we have defined the promotion zone to be four years or less in length. This restriction is required to make the promotion computations tractable. Second, rather than requiring the user to specify promotion rates in each year of the promotion zone, we ask that promotion opportunities be provided. Two opportunities are required: The percentage of eligibles that receive promotion to the higher grade during or prior to the

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*Note that five integers are required to express the four cycle years, since the year *before* the beginning of the promotion cycle must be represented in order to denote entry into the cycle.

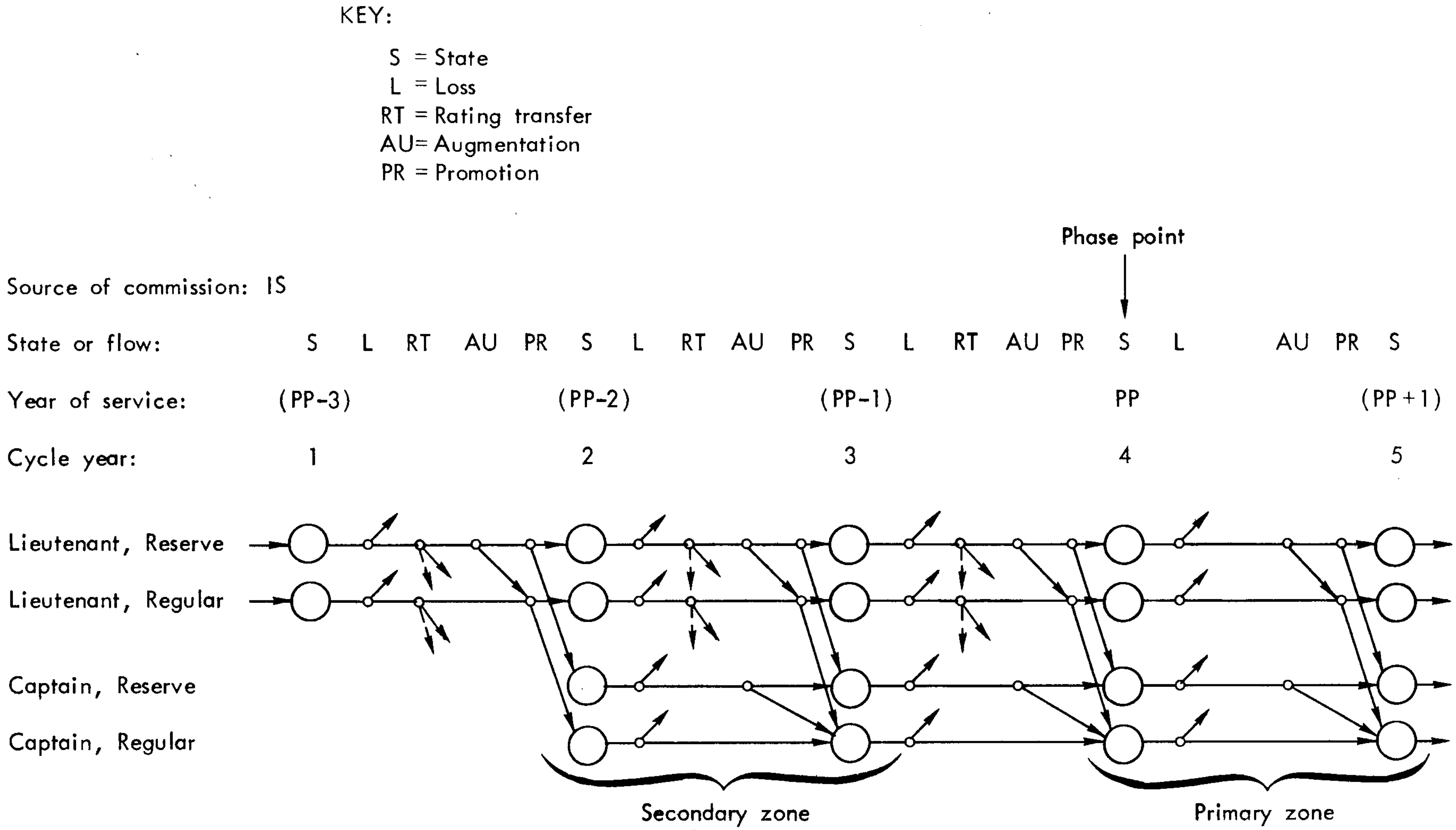

Fig. 20—Four-year promotion cycle, from lieutenant to captain, nonrated: variable phase point, YOS PP

first year of the primary zone, and the percentage of eligibles that receive promotion by the last year of the promotion cycle. Finally, we require two below-the-zone promotion parameters: The percentage of all promotions that must take place in the secondary zone and the percentage of secondary-zone promotions that are to take place in the first year of the secondary zone. With these promotion parameters provided by the user, the model proceeds to solve a set of eight simultaneous linear equations in eight unknowns, the unknowns being the number of promotions, both regular and reserve, to be made in each of the promotion years. Appendix B presents the equations and their solutions.

Finally, one additional point concerning rating transfers needs mention. The mathematical basis of the progression model assumes that rating transfers and promotions do not occur during the same year. Appendix A discusses the model's assumptions when initially transforming rating transfer inputs into the form required by the computation sequences and the mathematics of this initial transformation. For example, if the phase point year of service, PP, is six in a *hypothetical case,* then year of service PP-2 equals four, and rating transfers could occur during the second and third years of service, secondary-zone promotions in the fourth and fifth years of service, and primary-zone promotions in the sixth and seventh years of service. If the user requests that rating transfers and promotions occur during the same year, the computer will complete the computation but will print an error message indicating that the states and flows are not precise, since its mathematical assumptions were ignored. In general, the errors will be small when this occurs.

The computations for non-rated lieutenants are illustrated by Fig. 20. Let Y = PP-2, PP-1, PP, PP+1, where PP = phase point for promotions from lieutenant into captain. Then

S(C,1,3,IS,Y-1) = Number of non-rated lieutenants in state (C,1,3,IS,Y-1).

S(C,2,3,IS,Y-1) = Number of non-rated captains in state (C,2,3,IS,Y-1).*

L(C,G,3,IS,Y-1) = Number of losses of non-rated officers from state (C,G,3,IS,Y-1) in YOS Y-1
= S(C,G,3,IS,Y-1) · B(C,G,3,IS,Y-1).

S(C,1,3,IS,Y-1) · RE(C,1,3,IS,Y-1) · RAT(C,1,1,IS,Y-1)
= Number of non-rated officers in state (C,1,3,IS,Y-1) who complete UPT and are awarded aeronautical rating of pilot in YOS Y.

S(C,1,3,IS,Y-1) · RE(C,1,3,IS,Y-1) · RAT(C,1,2,IS,Y-1)
= Number of non-rated officers in state (C,1,3,IS,Y-1) who complete UNT and are awarded aeronautical rating of navigator in YOS Y.

S(C,1,3,IS,Y-1) · RE(C,1,3,IS,Y-1) · RAT(C,1,3,IS,Y-1)
= Number of non-rated officers in state (C,1,3,IS,Y-1) who complete UPT or UNT and are awarded aeronautical rating of pilot or navigator in YOS Y.

S(C,1,3,IS,Y-1) · RE(C,1,3,IS,Y-1) · NRAT(C,1,3,IS,Y-1)
= Number of non-rated officers in state (C,1,3,IS,Y-1) who do not change aeronautical rating in YOS Y.

PR(C,2,R,IS,Y)† = The number of officers in state (C,1,R,IS,Y-1) who are promoted into state (C,2,R,IS,Y) in YOS Y.

PA(2,2,R,IS,Y)† = The number of officers in state (1,1,R,IS,Y-1) who are promoted and augmented into the regular component, both in YOS Y, moving into state (2,2,R,IS,Y).

---

*Note that S(C,2,3,IS,PP-3) = 0 in Figs. 20 and 21.

†The formulas for computing this quantity and their derivation are given in Appendix B.

$RT(C,1,R,IS,Y)^*$ = The number of officers from state (C,1,3,IS,Y-1) who complete UPT (if R = 1) or UNT (if R = 2) and become pilots or navigators in YOS Y, "moving" into state (C,1,R,IS,Y).

and

$RA(2,1,R,IS,Y)^*$ = The number of officers from state (1,1,3,IS,Y-1) who complete UPT (if R = 1) or UNT (if R = 2) and who are also augmented into the regular component, both in YOS Y, "moving" into state (2,1,R,IS,Y).

Then

LAT(1,1,3,IS,Y) = Quantity of lateral flows from state (1,1,3,IS,Y-1) into state (1,1,3,IS,Y)

$$= S(1,1,3,IS,Y-1) \cdot RE(1,1,3,IS,Y-1) \cdot NRAT(1,1,3,IS,Y-1) \cdot NAUG(2,1,3,IS,Y-1) - PR(1,2,3,IS,Y).$$

LAT(2,1,3,IS,Y) = Lateral flows from state (2,1,3,IS,Y-1) into state (2,1,3,IS,Y)

$$= S(2,1,3,IS,Y-1) \cdot RE(2,1,3,IS,Y-1) \cdot NRAT(2,1,3,IS,Y-1) - PR(2,2,3,IS,Y).$$

LAT(1,2,3,IS,Y) = Lateral flows from state (1,2,3,IS,Y-1) into state (1,2,3,IS,Y)

$$= S(1,2,3,IS,Y-1) \cdot RE(1,2,3,IS,Y-1) \cdot NAUG(2,2,3,IS,Y-1).$$

LAT(2,2,3,IS,Y) = Lateral flows from state (2,2,3,IS,Y-1) into state (2,2,3,IS,Y)

$$= S(2,2,3,IS,Y-1) \cdot RE(2,2,3,IS,Y-1).$$

---

*The formulas for computing this quantity and their derivation are given in Appendix B.

S(1,1,3,IS,Y) = Number in state (1,1,3,IS,Y)
= LAT(1,1,3,IS,Y).

S(2,1,3,IS,Y) = Number in state (2,1,3,IS,Y)
= LAT(2,1,3,IS,Y) + AU(2,1,3,IS,Y).

S(1,2,3,IS,Y) = Number in state (1,2,3,IS,Y)
= LAT(1,2,3,IS,Y) + PR(1,2,3,IS,Y).

S(2,2,3,IS,Y) = Number in state (2,2,3,IS,Y)
= LAT(2,2,3,IS,Y) + AU(2,2,3,IS,Y) + PA(2,2,3,IS,Y) + PR(2,2,3,IS,Y).

PROMOTION YEAR OF SERVICE, RATED (PILOT OR NAVIGATOR) LIEUTENANT

As depicted in Fig. 21, which is a generalization of Fig. 19, the model makes the following computations for pilot or navigator lieutenants and captains for those years of service in the promotion cycle from lieutenant to captain:

For R = 1, 2:

LAT(1,1,R,IS,Y) = The number of lateral flows from state (1,1,R,IS,Y-1) into state (1,1,R,IS,Y)
= S(1,1,R,IS,Y-1) · RE(1,1,R,IS,Y-1) · NAUG(2,1,R,IS,Y-1) - PR(1,2,R,IS,Y).*

LAT(2,1,R,IS,Y) = The number of lateral flows from state (2,1,R,IS,Y-1) into state (2,1,R,IS,Y)
= S(2,1,R,IS,Y-1) · RE(2,1,R,IS,Y-1) - PR(2,2,R,IS,Y).*

LAT(1,2,R,IS,Y) = The number of lateral flows from state (1,2,R,IS,Y-1) into state (1,2,R,IS,Y)
= S(1,2,R,IS,Y-1) · RE(1,2,R,IS,Y-1) · NAUG(2,2,R,IS,Y-1).

LAT(2,2,R,IS,Y) = The number of lateral flows from state (2,2,R,IS,Y-1) into state (2,2,R,IS,Y)
= S(2,2,R,IS,Y-1) · RE(2,2,R,IS,Y-1).

Then

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*See Appendix B for PR(C,G,R,IS,Y) and its derivation.

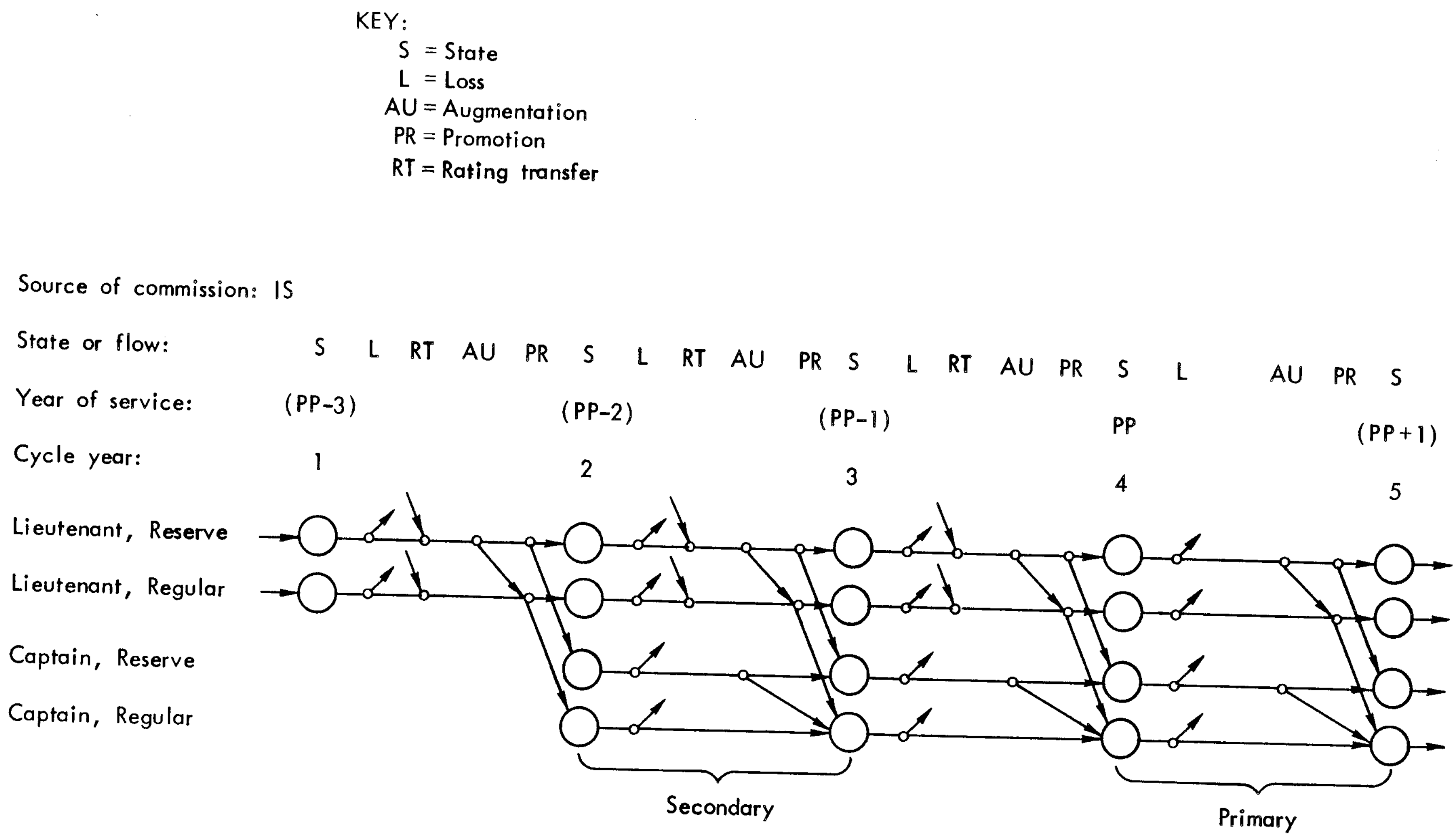

Fig. 21 — Four-year promotion cycle, from lieutenant to captain, pilot (or navigator): variable phase point, YOS PP

S(1,1,R,IS,Y) = The number of officers in state (1,1,R,IS,Y)
= LAT(1,1,R,IS,Y) + RT(1,1,R,IS,Y).

S(2,1,R,IS,Y) = The number of officers in state (2,1,R,IS,Y)
= LAT(2,1,R,IS,Y) + AU(2,1,R,IS,Y) + RT(2,1,R,IS,Y) + RA(2,1,R,IS,Y).

S(1,2,R,IS,Y) = The number of officers in state (1,2,R,IS,Y)
= LAT(1,2,R,IS,Y) + PR(1,2,R,IS,Y).

S(2,2,R,IS,Y) = The number of officers in state (2,2,R,IS,Y)
= LAT(2,2,R,IS,Y) + PR(2,2,R,IS,Y) + AU(2,2,R,IS,Y) + PA(2,2,R,IS,Y).

It can be shown that, in a four-year promotion cycle with zero rating transfers during the cycle, the formulas for non-rated are equivalent to those for rated lieutenants. If policy is such that promotions are permitted in only three or fewer years of the four-year promotion cycle, then the formulas permit nonzero rating transfers to be calculated during those years of service in the cycle with zero promotions.

VARIABLE PHASE POINT

The phase point, PP, is an input designated by the user. Thus, for promotion to captain, if (1) the PP is set to YOS 5, (2) no below-the-zone promotions from lieutenant to captain are designated by the user, and (3) rating transfers into YOS 5 are set to zero, Figs. 20 and 21 become Figs. 18 and 19, respectively.

NONPROMOTION YEAR OF SERVICE, CAPTAIN AND HIGHER GRADES

The flows for the higher grades are similar to those for lieutenants, the only distinction being that for the higher grades no rating transfers are permitted, thereby eliminating from the flow equations the rating transfer parameters required for lieutenant flows.

Figure 22 depicts the states and flows that occur in a year of service for a captain or higher grade during which the officer is ineligible for promotion.

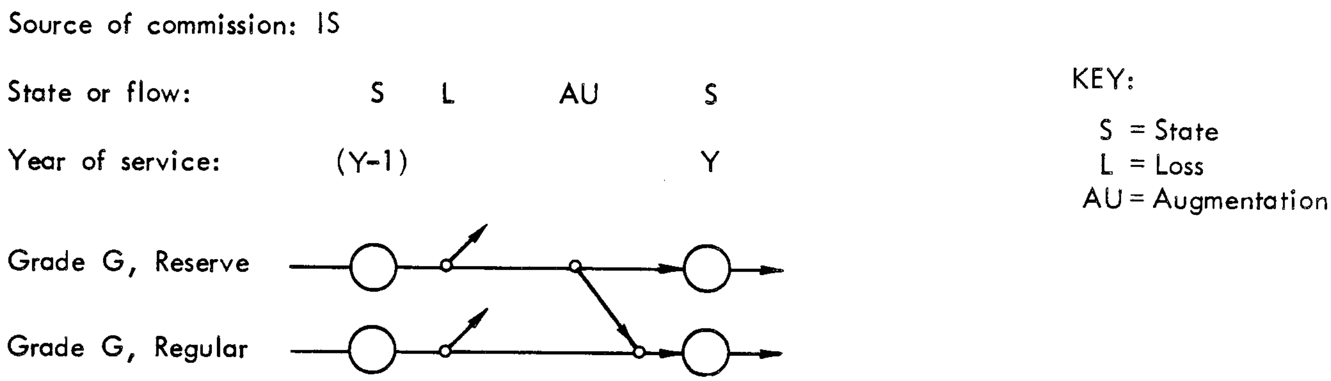

Fig. 22 — Nonpromotion YOS, captain and higher grades

Figure 22 is the same as shown for the second, third, and fourth year of service in Figs. 18 and 19, except that rating transfers are omitted. The formulas used by the model in a nonpromotion year of service for captains and higher grades become

S(C,G,R,IS,Y-1) = Number of officers in state (C,G,R,IS,Y-1).

LAT(1,G,R,IS,Y) = Number of lateral flows from state (1,G,R,IS,Y-1) into state (1,G,R,IS,Y)
= S(1,G,R,IS,Y-1) · RE(1,G,R,IS,Y-1) · NAUG(2,G,R,IS,Y-1).

LAT(2,G,R,IS,Y) = Number of lateral flows from state (2,G,R,IS,Y-1) into state (2,G,R,IS,Y)
= S(2,G,R,IS,Y-1) · RE(2,G,R,IS,Y-1).

AU(2,G,R,IS,Y) = Number of officers in state (1,G,R,IS,Y-1) augmented into state (2,G,R,IS,Y) in YOS Y
= S(1,G,R,IS,Y-1) · RE(1,G,R,IS,Y-1) · AUG(2,G,R,IS,Y-1).

S(1,G,R,IS,Y) = Number of officers in state (1,G,R,IS,Y)
= LAT(1,G,R,IS,Y).

S(2,G,R,IS,Y) = The number of officers in state (2,G,R,IS,Y)
= LAT(2,G,R,IS,Y) + AU(2,G,R,IS,Y).

PROMOTION YEAR OF SERVICE, INTO GRADE OF MAJOR OR HIGHER

Figure 23 depicts the states and flows associated in a four-year promotion cycle for promotion to major or higher grade with a variable phase point, two years of secondary-zone promotions, and two years of primary-zone promotions. If rating transfers are omitted, Figs. 20 and 21 will each reduce to Fig. 23 for captain and higher grades. Thus, with the omission of rating transfers and changes in grade notation, the formulas shown earlier for use in the computation of states and flows for lieutenants and captains in the promotion cycle years of service are revised to read as follows:

AU(2,G,R,IS,Y) = Number of officers augmented into regular component in YOS Y who flow from state (1,G,R,IS,Y-1) into state (2,G,R,IS,Y).

S(C,G,R,IS,Y-1) = Number of officers in state (C,G,R,IS,Y-1).

PR(C,G+1,R,IS,Y)* = Number of officers promoted from state (C,G,R,IS,Y-1) into state (C,G+1,R,IS,Y) during YOS Y.

PA(2,G+1,R,IS,Y)* = Number of officers who are promoted and augmented into regular component, both in YOS Y, from state (1,G,R,IS,Y-1) into state (2,G+1,R,IS,Y).

LAT(C,G,R,IS,Y) = Lateral flows from state (C,G,R,IS,Y-1) into state (C,G,R,IS,Y).

LAT(1,G,R,IS,Y) = S(1,G,R,IS,Y-1) · RE(1,G,R,IS,Y-1) · NAUG(2,G,R,IS,Y-1) - PR(1,G+1,R,IS,Y).

LAT(2,G,R,IS,Y) = S(2,G,R,IS,Y-1) · RE(2,G,R,IS,Y-1) - PR(2,G+1,R,IS,Y).

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*See Appendix B for formulas and their derivation.

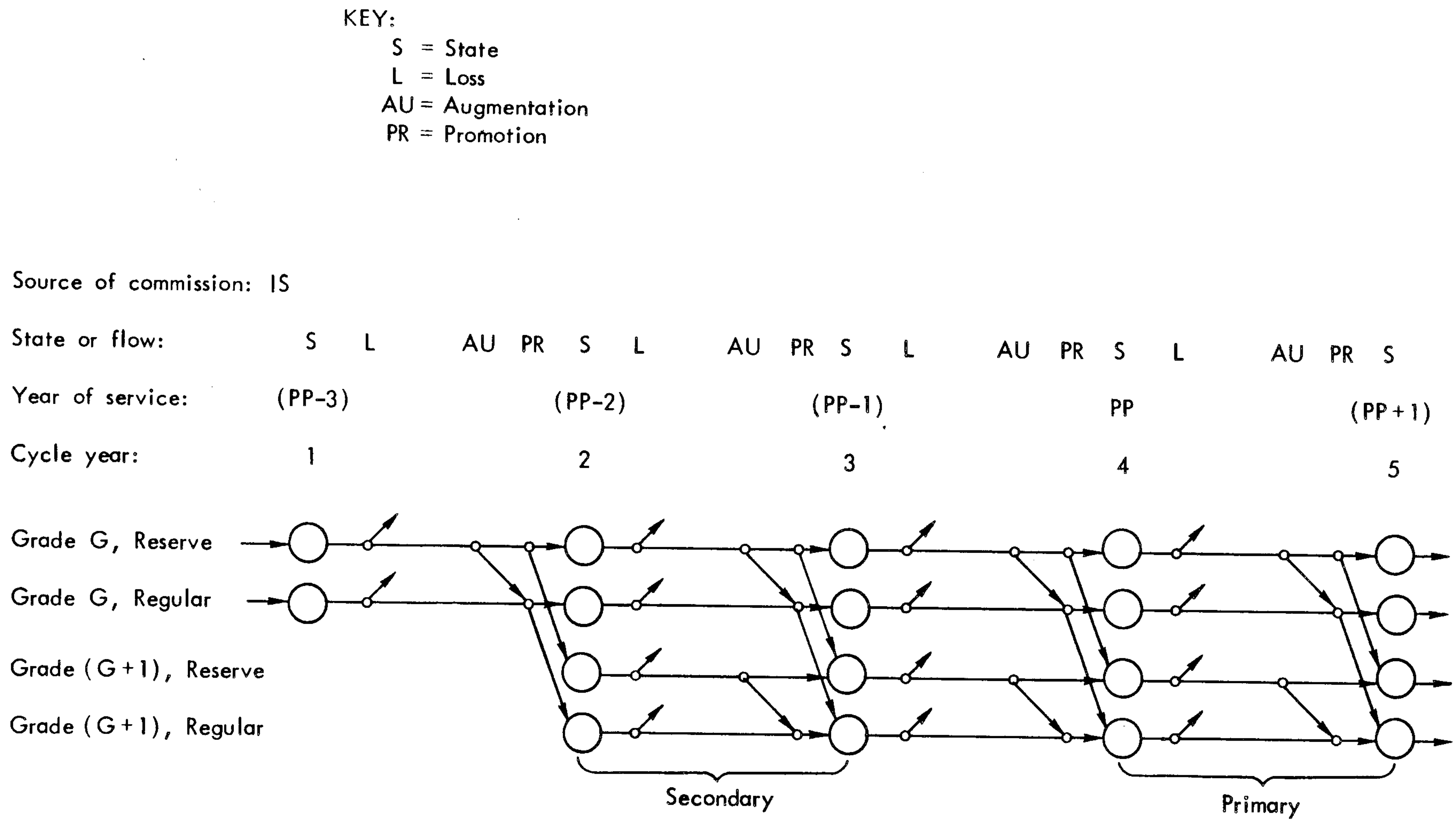

Fig. 23—Four-year promotion cycle into major (or higher grade): variable phase point, YOS PP

$$LAT(1,G+1,R,IS,Y) = S(1,G+1,R,IS,Y-1) \cdot RE(1,G+1,R,IS,Y-1) \cdot NAUG(2,G+1,R,IS,Y-1).$$

$$LAT(2,G+1,R,IS,Y) = S(2,G+1,R,IS,Y-1) \cdot RE(2,G+1,R,IS,Y-1).$$

$$S(1,G,R,IS,Y) = LAT(1,G,R,IS,Y).$$

$$S(2,G,R,IS,Y) = LAT(2,G,R,IS,Y) + AU(2,G,R,IS,Y).$$

$$S(1,G+1,R,IS,Y) = LAT(1,G+1,R,IS,Y) + PR(1,G+1,R,IS,Y).$$

$$S(2,G+1,R,IS,Y) = LAT(2,G+1,R,IS,Y) + AU(2,G+1,R,IS,Y) + PA(2,G+1,R,IS,Y) + PR(2,G+1,R,IS,Y).$$

IV. INPUT DATA

The user of the OFPM may specify greatly detailed inputs to the model so that it may compute the effects of the inputs on the officer force structure inventory and flows under steady-state conditions. The flexibility of inputs available to the user permits him to modify accessions, rating transfers, augmentations, and promotions in terms of component, grade, aeronautical rating, source of commission, or years of service. If the user does not wish to incorporate this amount of detail, then the input forms and the model permit aggregation when this serves the user's purpose.

In general, the input data consist of the following:

ACCESSIONS

The annual number of Air Force officers graduating from the following sources of commission:

- o Academies
- o ROTC
- o OTS/other

TRAINING RATES (RATING TRANSFER RATES)

The fraction of annual accessions from each source of commission who become pilots (or navigators) in their second, third, etc. year of service.

PROMOTION DATA BY GRADE, RATING, AND SOURCE OF COMMISSION

- o The phase point, i.e., the first year of primary-zone promotions.
- o Cumulative promotion opportunities for the first and second years of the primary zone.
- o The fraction of all promotions that occur in the secondary zone, i.e., "below-the-zone."

- The fraction of below-the-zone promotions that occur in the first year below the zone.

ATTRITION OR LOSS RATES

The fraction of officers in a state who will be lost to the Air Force due to death, disability, separation, retirement, or other reason.

AUGMENTATION RATES INTO THE REGULAR COMPONENT

The fraction of eligible officers in YOS Y who will be augmented into the regular component in YOS Y+1.

Each type of data and its input format will be discussed in detail. There are, however, several common characteristics shared by all five types.

COMMON CHARACTERISTICS

Unless otherwise indicated, columns 1-20 of each input card should contain the following information:

Columns 1-4	Type of data (discussed below)
	ACSS - accessions data
	PROM - promotion data
	LOSS - attrition data
	AUG - augmentation data
	RCAT - rating transfer or training rate
Columns 5-8	Component
	REG - regular
	RES - reserve
	ALL - RES and REG
Columns 9-12	Grade
	LT - Lieutenant
	CAP - Captain
	MAJ - Major
	LTC - Lieutenant colonel
	COL - Colonel

Columns 13-16 Rating

PIL - pilot

NAV - navigator

NR, SUP - non-rated or support

RAT - PIL and NAV

ALL - PIL, NAV, and NR

Columns 17-20 Source of Comission

AFA - Air Force Academy

ROTC - Reserve Officers Training Corps

SMSO[*], OTS - Officer Training School

RES - ROTC and OTS

ALL - Academy, ROTC, and OTS

In addition, each type of input data should be preceded by a card containing the type of input data in columns 1-4, and the last card in the input deck should be blank.

Columns 73-80 of each input card may be used for sequencing of the input deck. Finally, the input should begin with two cards whose contents are described at the end of this section.

ACCESSIONS DATA (ACSS)

These data indicate the number of annual graduates from each source of commission. Figure 24 illustrates the input deck's format.[†] All three accessions may be entered on one card. Each may, however, be placed on a separate card. Columns 5-20 should remain blank. Columns 45-72 may be used for descriptive information.

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[*] School of Military Science-Officer (SMS-O) is the past designation for OTS.

[†] The input illustrations in this section are excerpts from the input deck used to generate the sample run discussed in the next section.

Fig. 24 — Accession Data

Type of Data: ACSS,		Annual Accessions				
		Air Force Academy	ROTC	OTS/other		
01–04	05–20	21–28	29–36	37–44	45–72	73–80
ACSS						
ACSS		960	4500	3880		

PROMOTION DATA (PROM)

These data describe by grade, rating, and source of commission the cumulative promotion opportunities, below-the-zone promotion constraints, and promotion phase points for promotion *into* the indicated grade. Figure 25 illustrates the format of the input deck.

Promotions to the indicated grade may take place in any one of four promotion years. In the first two years, only below-the-zone promotions can take place. In the last two years, primary-zone promotions can take place.

The *phase point* is the first year of the primary zone, i.e., the first year into which primary-zone promotions can be made. For example, in Fig. 25, for promotion to major the phase point is the tenth year.

The *cumulative promotion opportunities* for the first and second years of the primary zone indicate the percentage of those officers eligible for promotion to the grade that are promoted by the indicated year. Thus, as illustrated, if the cumulative promotion opportunities to the grade of major were 75 percent in the first primary zone year and 80 percent in the second primary-zone year, then 75 percent of those eligible for promotion would be promoted not later than the end of the first primary-zone year, and 80 percent of those eligible would be promoted not later than the end of the second primary-zone year.

The *below-the-zone promotion percentage*[*] indicates the fraction of promotions that can take place below the zone. The *first year below-the-zone* percentage indicates the fraction of below-the-zone promotions that can take place in the first below-the-zone promotion year. Thus, as illustrated for promotion to major, if the below-the-zone percentage were 50 percent[†] and if the first year below-the-zone percentage were 10 percent, then 50 percent of all promotions to the indicated grade

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[*] For lieutenants, normally the below-the-zone percentage is zero, since promotion to captain requires completion of four years total active federal commissioned service.

[†] The personnel planner will readily identify this as a hypothetical example, since the below-the-zone promotions to major are usually much less than 50 percent.

Fig. 25— Promotion Data

Type of Data: PROM	(01–08: 05–08 crossed out)	Grade: CAP, MAJ, LTC, COL (promote to grade)	Rating: PIL, NAV, NR SUP=NR RAT=PIL & NAV	Soc: AFA ROTC SMSO OTS=SMSO RES=ROTC & SMSO	Cumulative promotion opportunities (percent): First year of primary promotion zone	Cumulative promotion opportunities (percent): Second year of primary promotion zone	Below-the-zone Promotions: Percent of total promotions that occur BTZ	Below-the-zone Promotions: % of BTZ promotions that occur first BTZ yr	Phase Point: First year of promotions to grade in the primary zone		
01–04	05–08	09–12	13–16	17–20	21–28	29–36	37–44	45–52	53–60	61–72	73–80
PROM											
PROM		CAP	ALL	ALL	95	95	1.39		5		
PROM		MAJ	ALL	ALL	75	80	5	50	10		
PROM		LTC	ALL	ALL	60	70	10	60	16		
PROM		COL	ALL	ALL	45	50	14	45	22		

would occur in the two below-the-zone promotion years, and 10 percent of those below-the-zone promotions (or 5 percent of all promotions) would take place in the first below-the-zone promotion year.

Note that, although not illustrated in the example, separate promotion parameters may be provided for each source of commission and rating within a grade. Thus, for example, ROTC pilots may have different promotion parameters than Academy pilots. Note also that, since we are describing promotions *into* a grade, the lieutenant grade (LT) should not be used when preparing this input form.

Focusing for the moment on the promotion parameters for captains, the promotion opportunity in both the first and second years of the primary zone is 95 percent. This in effect causes all primary-zone promotions to take place in the first primary-zone year. Note too that no promotions are scheduled to take place in the first year of the secondary zone. Thus in this example lieutenants can be promoted to captain *out of* YOS 3 and 4, and into YOS 4 and 5. Columns 5-8, the component field, should be left blank. Columns 61-72 may be used for descriptive information.

ATTRITION DATA (LOSS)

These data indicate the rates of attrition (due to death, disability, retirement, separation, etc.) by component, grade, rating, source of commission, and year of service. Figure 26 illustrates the input deck's format.

Each input data entry indicates the fraction of officers with the indicated component, grade, rating, source of commission, and year of service that leave the officer force during or at the conclusion of the year of service. For example, referring back to Fig. 26, the example entry indicates that of all pilot lieutenants with Air Force Academy commissions who hold regular commissions in the third year of service, 1.3 percent will leave the force during or at the conclusion of the third year of service--the OFPM computation algorithms will remove these officers from the force during their third year of service. Columns 69-72 of the input cards may be used for descriptive information.

Fig. 26— Attrition Data (Loss)

Type of Data: LOSS	Component REG, RES	Grade: LT, CAP MAJ, LTC, COL	Rating: PIL, NAV, NR SUP=NR RAT= PIL&NAV	Soc: AFA ROTC SMSO OTS= SMSO RES= ROTC & SMSO	Attrition: Year of service	Attrition: Attrition i.e. Loss rate	Attrition: Year of service	Attrition: Attrition i.e. Loss rate	Attrition: Year of service	Attrition: Attrition i.e. Loss rate	Attrition: Year of service	Attrition: Attrition i.e. Loss rate	Attrition: Year of service	Attrition: Attrition i.e. Loss rate	Attrition: Year of service	Attrition: Attrition i.e. Loss rate		
01 02 03 04	05 06 07 08	09 10 11 12	13 14 15 16	17 18 19 20	21 22 23	24 25 26 27 28	29 30 31	32 33 34 35 36	37 38 39	40 41 42 43 44	45 46 47	48 49 50 51 52	53 54 55	56 57 58 59 60	61 62 63	64 65 66 67 68	69 70 71 72	73 74 75 76 77 78 79 80
LOSS																		
LOSS	REG	LT	PIL	AFA	2	0.0	3	.013	4	.014	5	.035	6	1.0				
LOSS	REG	LT	PIL	ROTC	4	.01	5	.01	6	1.0								
LOSS	REG	LT	PIL	SMSO	4	.015	5	.015	6	1.0								

AUGMENTATION DATA (AUG)

These data indicate, by grade, rating, source of commission, and year of service, the fraction of officers augmented into the regular force from the reserve force. Figure 27 illustrates the format of the input deck.

In the example, of all lieutenant pilots with three years of service holding reserve commissions from ROTC or from OTS/other, 25 percent will be augmented into the regular force, i.e., will be awarded regular commissions. Note that these officers are considered by the computation algorithm to be reserve in the third year of service and regular in the fourth. Note also that the *rate of flow out* is applied only to those officers remaining after attrition and rating transfer changes are taken into consideration (see below for a discussion of rating transfer changes). Finally, note that all reserve majors are augmented.

Since augmentation takes place from reserve into regular, columns 5-8 (the component field) should be left blank. Also, since only ROTC and OTS award reserve commissions to graduates--Academy graduates are awarded regular commissions--the Academy source of commission is not permitted in columns 17-20 (the source of commission field). Columns 69-72 of the input cards may be used for descriptive information.

RATING TRANSFER DATA (RCAT)

These data indicate by source of commission and years of service the number of non-rated lieutenants who become pilots and navigators. The data are presented as a fraction of annual accessions from the indicated source of commission. Figure 28 illustrates the format of the input deck.

The example entry in Fig. 28 illustrates the use of the input form. It indicates how non-rated officers become pilots. In YOS 1, 63.3 percent of the Academy graduates enter UPT and become pilots in YOS 2; 9.79 percent of the Academy graduates enter UNT in YOS 1 and become navigators in YOS 2. The remaining Academy graduates become non-rated officers or are lost to the Air Force.

Fig. 27 — Augmentation Data (Reserve to Regular)

Type of Data: AUG	(Reserve only)	Grade: LT, CAP, MAJ, LTC, COL	Rating: PIL, NAV, NR, SUP, NR, RAT= PIL&NAV	Soc: AFA, ROTC, SMSO, OTS= SMSO, RES= ROTC & SMSO	Augmentation: Year of service	Augmentation: Rate of Flow out	Augmentation: Year of service	Augmentation: Rate of Flow out	Augmentation: Year of service	Augmentation: Rate of Flow out	Augmentation: Year of service	Augmentation: Rate of Flow out	Augmentation: Year of service	Augmentation: Rate of Flow out	Augmentation: Year of service	Augmentation: Rate of Flow out
AUG																
AUG		LT	PIL	RES	3	.25	4	.267	5	.126						
AUG		CAP	PIL	RES	3	.25	4	.267	5	.126						
AUG		LT	NAV	RES	3	.23	4	.218	5	.139						
AUG		CAP	NAV	RES	3	.23	4	.218	5	.135	6	.039				
AUG		LT	NR	RES	2	.072	3	.149			5	.147				
AUG		CAP	NR	RES			3	.149			5	.147				
AUG		MAJ	ALL	RES	8	1.0	9	1.0	10	1.0						

Fig. 28 — Rating Category Data (UPT and UNT Graduation Rates)

Type of Data: RCAT (01–04)	(05–08)	(Lieut. only) (09–12)	Rating: PIL, NAV, NR SUP=NR RAT= PIL&NAV (13–16)	Soc: AFA ROTC SMSO OTS= SMSO RES= ROTC & SMSO (17–20)	Rating Category: Year of service (21–23)	Rating Category: Fraction of annual accessions (24–28)	Rating Category: Year of service (29–31)	Rating Category: Fraction of annual accessions (32–36)	Rating Category: Year of service (37–39)	Rating Category: Fraction of annual accessions (40–44)	Rating Category: Year of service (45–47)	Rating Category: Fraction of annual accessions (48–52)	Rating Category: Year of service (53–55)	Rating Category: Fraction of annual accessions (56–60)	Rating Category: Year of service (61–63)	Rating Category: Fraction of annual accessions (64–68)	(69–72)	(73–80)
RCAT																		
RCAT			PIL	AFA	1	.633												
RCAT			NAV	AFA	1	.0979												
RCAT			PIL	ROTC	1	.322												
RCAT			NAV	ROTC	1	.146												
RCAT			PIL	SMSØ	1	.138												
RCAT			NAV	SMSØ	1	.132												

Columns 5-8, the component field, should be left blank. The computer program will use the attrition and augmentation data to determine how the new rated officers should be distributed over the components.* Further, since the algorithm permits only lieutenants to become rated, columns 9-12 should also remain blank. Columns 69-72 may be used for descriptive information.

THE TITLE AND OPTIONS CARDS

In addition to the five types of input data, two cards are required at the *beginning* of each input deck. On the first card, the user may enter a run title which will appear on each page of output produced by the model. If we refer to Figs. 30 through 49 in Section V, the title used for that run is shown at the top of each page, namely, "Officer Force Progression Model Example."

The second of the two cards may be used to request more detail in the output reports. Since the entire outputs, aggregated and unaggregated, may run to hundreds of pages, the user may specify that he wishes only aggregated outputs or only some of the unaggregated outputs. The format of this card is shown in Fig. 29. Blanks indicate that the option is *not* desired, e.g., if columns 1 and 2 are left blank, officer flow reports for each component will not be produced. If anything other than a blank is shown in an option field, then the indicated detailed output will be generated. The fields and detailed reports they select are:

Columns 1-2:	If not blank, officer flow reports for each component.
Columns 3-4:	If not blank, officer flow reports for each rating.
Columns 5-6:	If not blank, officer flow reports for each source of commission.
Columns 7-10:	Leave blank if implied forward computation input reports not wanted.

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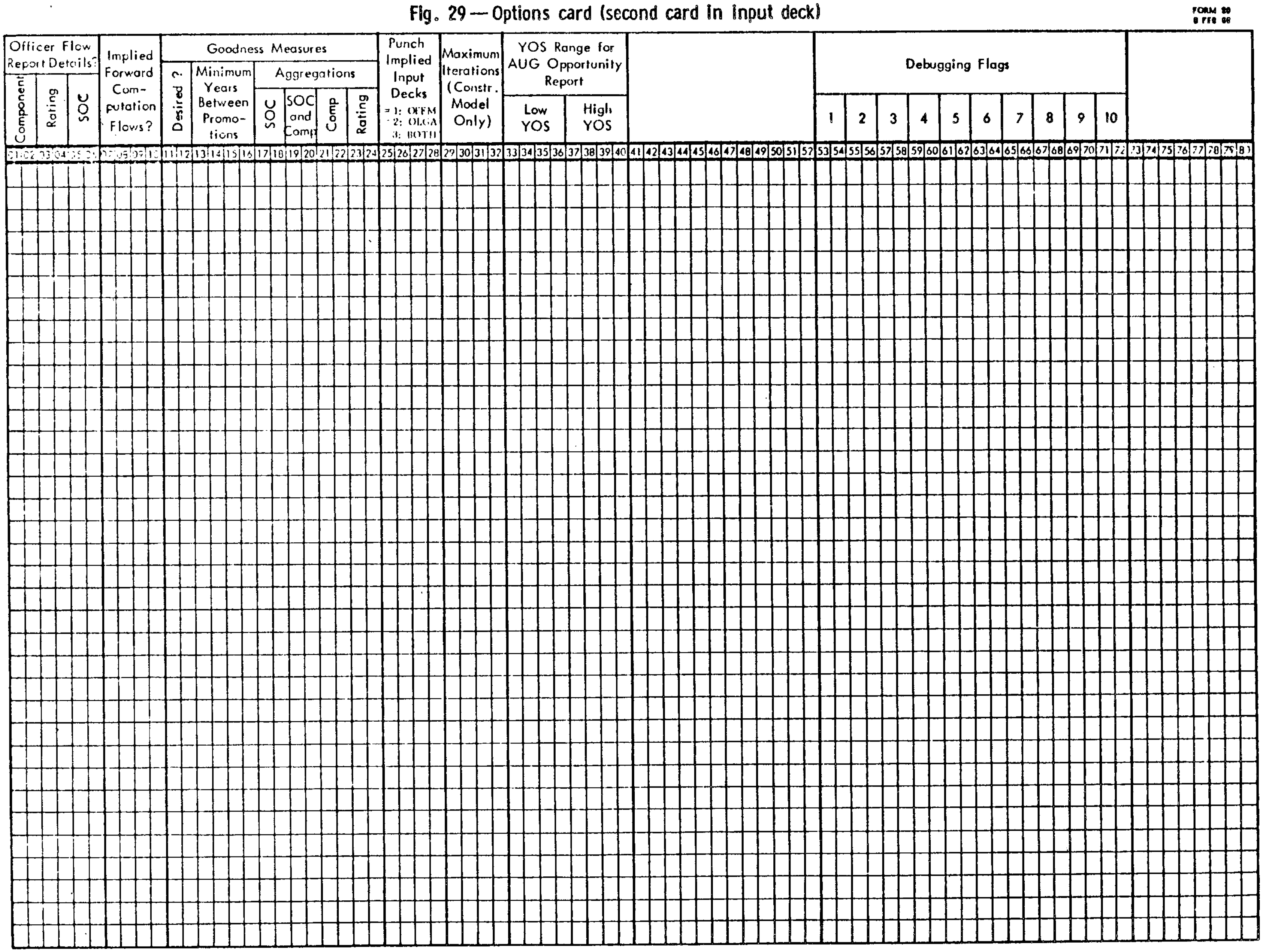
*See Appendix A.

Fig. 29 — Options card (second card in input deck)



Columns 11-12: Blank if goodness measures outputs are not wanted.*

Columns 13-16: The minimum waiting period (in years) between promotions. This must be a 1 or more and defaults to 2. (goodness measure package* only).

Columns 17-18: Blank if goodness measures* not to be aggregated by source of commission.

Columns 19-20: Blank if goodess measures* not to be aggregated by source *and* component.

Columns 21-22: Blank if goodness measures* not to be aggregated by component only.

Columns 23-24: Blank if goodness measures* not to be aggregated by rating.

Columns 25-28: This contains: 1 if the user wants to have an input deck for the progression model punched out; 2 if he wants an input deck for the grade limitations model; 3 if he wants both.†

Columns 29-32: Ignored (used by constraints model).

---

*The goodness measures package is not currently available in the progression model, but we include a description of how to select it for completeness. This package will be added at a later date; a description of it will be included in the report to be published on the grade limitations model (see pp. iii and iv).

†After the progression model computes the officer structure and the associated officer flows within the officer structure, it then determines what the progression model inputs *must have been* in order to generate the officer structure and associated flows. The model does this *without referring back* to the original inputs used to generate the officer structure. In addition, the model also determines what the grade limitations model inputs would have to be in order to generate an identical officer structure and associated officer flows. The ability of the model to generate grade limitations model inputs is extremely useful when the progression model and grade limitations model are used in concert. The recomputation of the progression model's own inputs is useful for model verification and debugging purposes when compared with the actual inputs.

Columns 33-40: Year of service range for Augmentation Opportunity report. If blank, YOS 3 and 7 are used (see p. 84).

Columns 53-72: Leave blank. Used for debugging purposes.

V. OUTPUT DATA

The OFPM is able to present the officer structure in terms of officer inventories and flows in great detail or in summary form. Thus the user of the model may obtain a macro view of the effects on the officer structure of changes in policies concerning accessions, training rates, augmentations, attrition, or promotions; or he may examine detailed impacts in terms of inventory and flows into a state consisting of officers with the same component, grade, aeronautical rating, source of commission, and year of service; or he may look at intermediate levels of outputs, such as what happens to pilots under a given set of policies, or to Academy graduates, etc. Since the output can run to several hundred pages, we will present excerpts from a model run.

In general, the outputs include the following:

- Inputs by the user for each computer run.
- Officer force grade distributions.
  Number of officers by year of service and grade for aeronautical rating, source of commission, and component.
- Distribution of lieutenant colonels and below.
  Number of lieutenant colonels and below by year of service, component, and aeronautical rating for each source of commission.
- Distribution of colonels and higher.
  Number of colonels and higher by year of service, component, and aeronautical rating for each source of commission.
- Officer flows in and out of each state.
  Year of service by type of flow for component, grade, aeronautical rating, and source of commission combinations.
- Computation of loss, rating transfer, augmentation and promotion quantities, and rates.
  Year of service by flows computed successively within each year of service for component, grade, aeronautical rating, and source of commission combinations.

- o Distribution of augmentations, promotions, and promotion-augmentations for the grade limitations model.

The OFPM computes the distribution of augmentations, promotions, and promotion-augmentations by year of service, grade, aeronautical rating, and source of commission as required inputs for the grade limitations model. It also computes the quantitative relationships between augmentations and promotions and between promotion-augmentations and promotions as required inputs for the grade limitations model. Thus these inputs may be used as a starting point by that model.

OFFICER FORCE GRADE DISTRIBUTIONS

Figures 30 through 34 contain Officer Force Grade Distribution reports for the ROTC source of commission. For example, in Fig. 30 we see how ROTC pilots are distributed by component over the grades and years of service. In YOS 11, 27 of the ROTC pilots hold reserve commissions and 464 hold regular commissions, resulting in a total of 491 ROTC pilots with eleven years of service. In Figs. 31 and 32 distributions for navigators and non-rated officers are shown, in Fig. 33 we display the distribution of all rated ROTC officers, and in Fig. 34 we display the distribution of all ROTC officers. Focusing on Fig. 34 we see that in YOS 1 there are 4500 ROTC officers, which is precisely the number of ROTC annual accessions as provided in the inputs (see the discussion of accessions data inputs on page 55).

At the bottom of each page of the Officer Force Grade Distribution report, two summary lines are printed. Focusing again on Fig. 34 we see that the 4500 annual ROTC accessions generate a total of 48,763 ROTC officers, 23,967 of which are reserve and 24,796 of which are regular. The average year of service for an ROTC officer is shown to be 8.76 years, with reserve officers averaging 3.77 years and regular officers averaging 13.59 years.

OFFICER FORCE RATING DISTRIBUTIONS

Figures 35 and 36 illustrate the Officer Force Rating Distribution report, showing how officers are distributed over the three

OFFICER FORCE PROGRESSION MODEL EXAMPLE

OFFICER FORCE GRADE DISTRIBUTION
RATING PIL SOURCE OF COMMISSION ROTC

	RESERVE COMPONENT						REGULAR COMPONENT						BOTH RESERVE AND REGULAR COMPONENTS					
YEAR	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL
2	1449					1449							1449					1449
3	1433					1433							1433					1433
4	1050	14				1064	350	5				355	1400	19				1419
5	39	735				774	32	601				633	70	1336				1407
6	34	637				671	36	687				723	70	1324				1394
7		317				317		544				544		862				862
8		202	3			205		462	7			469		664	10			674
9		139	3			141		402	18			420		541	21			561
10		31	88			119		97	297			394		128	385			513
11		21	6			27		73	391			464		94	397			491
12									388			388			388			388
13									384			384			384			384
14									365	16		380			365	16		380
15									349	26		375			349	26		375
16									148	222		370			148	222		370
17									109	255		364			109	255		364
18									108	250		358			108	250		358
19									101	247		348			101	247		348
20									89	230	6	325			89	230	6	325
21										198	13	211				198	13	211
22										105	86	191				105	86	191
23										78	85	163				78	85	163
24										63	80	144				63	80	144
25										50	76	127				50	76	127
26										45	70	115				45	70	115
27											58	58					58	58
28											44	44					44	44
29											28	28					28	28
30											9	9					9	9
TOTAL	4004.	2096.	100.	0.	0.	6200.	418.	2871.	2754.	1785.	557.	8386.	4422.	4967.	2854.	1785.	557.	14586.
AVERAGE YEAR OF SERVICE	2.94	6.29	9.97	0.0	0.0	4.19	4.25	6.98	13.56	19.33	24.80	12.82	3.07	6.69	13.44	19.33	24.80	9.15

Fig. 30—Officer force grade distribution, ROTC pilots

OFFICER FORCE PROGRESSION MODEL EXAMPLE

OFFICER FORCE GRADE DISTRIBUTION
RATING NAV SOURCE OF COMMISSION ROTC

YEAR	RESERVE COMPONENT						REGULAR COMPONENT						BOTH RESERVE AND REGULAR COMPONENTS					
	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL
2	657					657							657					657
3	650					650							650					650
4	488	6				495	146	2				148	634	8				643
5	19	362				381	13	241				254	32	603				635
6	16	308				324	15	289				305	31	597				629
7		185				185		246				246		432				432
8		140	3			142		223	4			227		363	7			370
9		125	2			127		203	11			213		327	13			340
10		31	87			118		51	158			209		82	246			327
11		23	6			29		40	249			288		63	255			317
12									247			247			247			247
13									245			245			245			245
14									234	10		244			234	10		244
15									225	17		241			225	17		241
16									96	143		239			96	143		239
17									71	166		237			71	166		237
18									70	166		236			70	166		236
19									68	164		232			68	164		232
20									61	149	4	214			61	149	4	214
21										127	8	135				127	8	135
22										66	54	120				66	54	120
23										57	60	117				57	60	117
24										57	60	117				57	60	117
25										51	58	109				51	58	109
26										42	52	94				42	52	94
27											40	40					40	40
28											37	37					37	37
29											23	23					23	23
30											4	4					4	4
TOTAL	1831.	1180.	98.	0.	0.	3109.	174.	1295.	1738.	1215.	400.	4822.	2005.	2475.	1836.	1215.	400.	7931.
AVERAGE YEAR OF SERVICE																		
	2.96	6.60	9.98	0.0	0.0	4.56	4.25	7.13	13.67	19.55	24.90	13.99	3.07	6.87	13.47	19.55	24.90	10.29

Fig. 31 — Officer force grade distribution, ROTC navigators

OFFICER FORCE GRADE DISTRIBUTION

RATING NR SOURCE OF COMMISSION ROTC

	RESERVE COMPONENT						REGULAR COMPONENT						BOTH RESERVE AND REGULAR COMPONENTS					
YEAR	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL
1	4500					4500							4500					4500
2	2372					2372							2372					2372
3	2190					2190	170					170	2360					2360
4	1842	14				1856	491	4				494	2333	18				2350
5	45	864				909	21	408				429	67	1272				1339
6	33	634				667	25	482				507	59	1116				1174
7		563				563		452				452		1015				1015
8		518	10			528		426	8			434		944	18			962
9		482	10			492		404	26			430		886	36			921
10		121	344			466		102	326			429		224	671			894
11		92	24			116		79	685			764		171	709			880
12									682			682			682			682
13									676			676			676			676
14									645	28		673			645	28		673
15									623	47		670			623	47		670
16									266	399		665			266	399		665
17									199	457		655			199	457		655
18									196	455		650			196	455		650
19									175	442		617			175	442		617
20									136	400	10	546			136	400	10	546
21										340	21	361				340	21	361
22										170	139	309				170	139	309
23										121	145	266				121	145	266
24										93	134	227				93	134	227
25										69	112	180				69	112	180
26										52	96	147				52	96	147
27											72	72					72	72
28											45	45					45	45
29											27	27					27	27
30											10	10					10	10
TOTAL	10982.	3288.	388.	0.	0.	14658.	707.	2357.	4643.	3071.	811.	11588.	11689.	5644.	5031.	3071.	811.	26246.
AVERAGE YEAR OF SERVICE	2.15	6.94	9.99	0.0	0.0	3.43	3.86	7.23	13.71	19.14	24.46	13.98	2.25	7.06	13.42	19.14	24.46	8.09

Fig. 32—Officer force grade distribution, non-rated ROTC

OFFICER FORCE PROGRESSION MODEL EXAMPLE

OFFICER FORCE GRADE DISTRIBUTION
RATING RAT SOURCE CF CCMMISSION ROTC

	RESERVE COMPONENT						REGULAR COMPONENT						BOTH RESERVE AND REGULAR COMPONENTS					
YEAR	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL
2	2106					2106							2106					2106
3	2083					2083							2083					2083
4	1538	20				1559	496	7				502	2034	27				2061
5	58	1097				1154	44	843				887	102	1939				2041
6	50	945				995	51	976				1028	101	1922				2023
7		503				503		791				791		1293				1293
8		341	6			347		685	11			696		1027	17			1044
9		263	5			268		605	29			633		868	34			902
10		62	176			237		148	455			603		210	630			840
11		44	12			56		112	640			752		156	652			808
12									636			636			636			636
13									629			629			629			629
14									598	26		624			598	26		624
15									574	43		616			574	43		616
16									243	365		608			243	365		608
17									181	420		601			181	420		601
18									178	415		594			178	415		594
19									169	411		580			169	411		580
20									150	379	10	539			150	379	10	539
21										325	22	347				325	22	347
22										171	140	310				171	140	310
23										136	145	281				136	145	281
24										121	140	261				121	140	261
25										101	135	236				101	135	236
26										87	122	209				87	122	209
27											98	98					98	98
28											81	81					81	81
29											52	52					52	52
30											13	13					13	13
TOTAL	5835.	3276.	198.	0.	0.	9309.	592.	4167.	4492.	3000.	957.	13208.	6427.	7443.	4690.	3000.	957.	22517.
AVERAGE YEAR OF SERVICE																		
	2.95	5.49	9.98	0.0	0.0	4.31	4.25	7.03	13.60	19.42	24.84	13.24	3.07	6.75	13.45	19.42	24.84	9.55

Fig. 33 — Officer force grade distribution, ROTC rated officers (pilots and navigators)

OFFICER FORCE PROGRESSION MODEL EXAMPLE

OFFICER FORCE GRADE DISTRIBUTION
RATING ALL SOURCE OF COMMISSION ROTC

	RESERVE COMPONENT						REGULAR COMPONENT						BOTH RESERVE AND REGULAR COMPONENTS					
YEAR	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL	LIEUT	CAPT	MAJOR	LTCOL	CL/GN	TOTAL
1	4500					4500							4500					4500
2	4478					4478							4478					4478
3	4273					4273	170					170	4443					4443
4	3380	34				3415	987	10				997	4367	45				4412
5	103	1961				2064	66	1250				1316	169	3211				3380
6	83	1579				1662	77	1458				1535	160	3037				3197
7		1065				1065		1243				1243		2309				2309
8		860	15			875		1111	19			1130		1971	35			2005
9		745	15			760		1008	55			1063		1754	69			1823
10		183	520			703		251	781			1032		434	1301			1735
11		136	36			172		191	1325			1516		327	1360			1688
12									1318			1318			1318			1318
13									1305			1305			1305			1305
14									1243	54		1297			1243	54		1297
15									1197	89		1286			1197	89		1286
16									509	764		1273			509	764		1273
17									379	877		1256			379	877		1256
18									374	870		1244			374	870		1244
19									344	853		1197			344	853		1197
20									286	780	20	1085			286	780	20	1085
21										665	43	708				665	43	708
22										341	279	619				341	279	619
23										256	291	547				256	291	547
24										214	274	488				214	274	488
25										170	246	416				170	246	416
26										139	218	356				139	218	356
27											170	170					170	170
28											126	126					126	126
29											79	79					79	79
30											23	23					23	23
TOTAL	16817.	6563.	586.	0.	0.	23967.	1299.	6523.	9135.	6071.	1768.	24796.	18116.	13087.	9721.	6071.	1768.	43763.
AVERAGE YEAR OF SERVICE																		
	2.43	6.67	9.98	0.0	0.0	3.77	4.04	7.10	13.66	19.28	24.66	13.59	2.54	6.88	13.43	19.28	24.66	8.76

Fig. 34 — Officer force grade distribution, All ROTC officers

OFFICER FORCE PROGRESSION MODEL EXAMPLE

OFFICER FORCE RATING DISTRIBUTION
LIEUTENANT COLONEL AND BELOW
SOURCE OF COMMISSION ALL

YEAR OF SERVICE	PILOT			NAVIGATOR			NONRATED			TOTAL OVER ALL RATINGS		
	RESERVE	REGULAR	TOTAL	RESERVE	REGULAR	TOTAL	RESERVE	REGULAR	TOTAL	RESERVE	REGULAR	TOTAL
1							8380	960	9340	8380	960	9340
2	1984	608	2592	1169	94	1263	5169	255	5424	8323	957	9280
3	1963	608	2571	1157	93	1250	4760	622	5382	7880	1323	9203
4	1458	1086	2544	883	355	1238	4021	1323	5344	6361	2764	9125
5	1058	1457	2515	678	542	1219	2061	1159	3220	3797	3158	6955
6	915	1559	2474	576	621	1197	1429	1290	2719	2920	3470	6390
7	453	1225	1678	340	515	855	1193	1154	2347	1985	2894	4879
8	308	1066	1374	278	476	754	1110	1096	2206	1696	2638	4334
9	229	977	1206	252	452	704	1041	1078	2119	1522	2507	4029
10	198	927	1125	235	446	681	986	1075	2061	1420	2447	3867
11	46	1045	1091	59	611	670	244	1776	2020	349	3433	3781
12		866	866		522	522		1564	1564		2953	2953
13		856	856		516	516		1543	1543		2914	2914
14		845	845		511	511		1537	1537		2893	2893
15		834	834		505	505		1493	1493		2832	2832
16		822	822		498	498		1453	1453		2773	2773
17		810	810		480	480		1420	1420		2710	2710
18		799	799		475	475		1395	1395		2670	2670
19		777	777		461	461		1320	1320		2559	2559
20		709	709		411	411		1123	1123		2243	2243
21		453	453		253	253		704	704		1411	1411
22		243	243		132	132		347	347		722	722
23		191	191		109	109		253	253		554	554
24		166	166		102	102		201	201		470	470
25		140	140		90	90		155	155		386	386
26		117	117		76	76		118	118		311	311
TOTAL	8613.	19189.	27802.	5626.	9348.	14973.	30394.	26416.	56810.	44633.	54953.	99535.
AVERAGE YEAR OF SERVICE	4.26	11.29	9.11	4.63	12.60	9.60	3.52	12.18	7.55	3.80	11.94	8.29

Fig. 35—Officer force rating distribution, lieutenant colonel and below

OFFICER FORCE PROGRESSION MODEL EXAMPLE

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OFFICER FORCE RATING DISTRIBUTION
COLONEL/GENERALS
SOURCE OF COMMISSION ALL

YEAR OF SERVICE	PILOT			NAVIGATOR			NONRATED			TOTAL OVER ALL RATINGS		
	RESERVE	REGULAR	TOTAL	RESERVE	REGULAR	TOTAL	RESERVE	REGULAR	TOTAL	RESERVE	REGULAR	TOTAL
21		31	31		17	17		43	43		91	91
22		199	199		108	108		284	284		591	591
23		208	208		118	118		299	299		625	625
24		199	199		115	115		271	271		585	585
25		188	188		111	111		231	231		530	530
26		176	176		101	101		198	198		475	475
27		156	156		84	84		154	154		394	394
28		126	126		73	73		105	105		304	304
29		94	94		50	50		66	66		209	209
30		29	29		11	11		20	20		60	60
TOTAL	0.	1407.	1407.	0.	787.	787.	0.	1670.	1670.	0.	3865.	3865.
AVERAGE YEAR OF SERVICE												
	0.0	25.04	25.04	0.0	25.00	25.00	0.0	24.57	24.57	0.0	24.83	24.83

Fig. 36—Officer force rating distribution, colonels and generals

ratings. Both excerpts span all sources of commission, the first dealing with officers holding grades of lieutenant colonel and below, and the second dealing with colonels and above. We see, for example, that in YOS 7 there are 1678 pilots, 453 of which are reserve and 1225 of which are regular. None of them hold grades higher than lieutenant colonel. We see also that in YOS 30 there are 20 nonrated officers, all holding regular commissions and all with the grade of colonel or higher. As with the Officer Force Grade Distribution reports, two summary lines are included at the bottom of each page of the Officer Force Rating Distribution report.

OFFICER FLOWS

Figures 37 through 39 illustrate the Officer Flow report. This report shows officer flows into and out of each state by component, grade, rating, source of commission, and year of service. Focusing on the top half of Fig. 37, we are looking at all lieutenant ROTC officers, that is, we are spanning all components and ratings. We see that there are 4500 ROTC officers in the current state in YOS 1, which is precisely the number of annual ROTC accessions. Turning our attention to the items to the right of the current state, we see that 22 of these 4500 officers are lost; 2106 receive rating transfers and 2372 flow laterally, i.e., advance one year of service only.

Moving to YOS 2, we see that there are 4478 officers in the current state, 2372 of them having flowed laterally from YOS 1 and 2106 of them having received rating transfers in YOS 1.

If we now turn our attention to the bottom half of Fig. 37, which deals with all ROTC captains, we see that there are 3211 officers in the current state in YOS 5, 363 of them flowing into the current state via the augmentation *and* promotion path, and 2811 flowing into the current state via the promotion *only* path. And comparing the captain flows into YOS 5 with the lieutenant flows out of YOS 4, we see the 363 lieutenants receiving both augmentation and promotion and the 2811 lieutenants receiving only promotions. As with the two preceding reports, several summary lines are printed at the foot of each Officer Flow report section.

OFFICER FORCE PROGRESSION MODEL EXAMPLE PAGE 162

OFFICER FLOWS

COMPONENT ALL GRADE LT RATING ALL SOURCE OF COMMISSION ROTC

YOS	FLOWS INTO THE CURRENT OFFICER STATE: LATERAL FLOW	RATING TRANSFERS ONLY	RATING TRANSFERS WITH AUG	AUGMENTATIONS ONLY	AUGMENTATIONS WITH PRO	PROMOS ONLY	CURRENT OFFICER STATE	FLOWS OUT OF THE CURRENT OFFICER STATE: ATTRITION	RATING TRANSFERS ONLY	RATING TRANSFERS WITH AUG	AUGMENTATIONS ONLY	AUGMENTATIONS WITH PRO	PROMOS ONLY	LATERAL FLOW
1	4500						4500	22	2106					2372
2	2372	2106					4478	34			170			4273
3	4273			170			4443	31			818	9	36	3549
4	3549			818			4367	1024			19	363	2811	150
5	150			19			169	9			13	0	0	147
6	147			13			160	160						
TOT	14990.	2106.	0.	1021.	0.	0.	18116.	1281.	2106.	0.	1021.	373.	2846.	10490.

TOTAL RATING TRANSFERS 2106 IN 2106 OUT TOTAL AUGMENTATIONS 1021 IN 1393 OUT TOTAL PROMOTIONS 0 IN 3219 OUT

COMPONENT ALL GRADE CAP RATING ALL SOURCE OF COMMISSION ROTC

YOS	FLOWS INTO THE CURRENT OFFICER STATE: LATERAL FLOW	RATING TRANSFERS ONLY	RATING TRANSFERS WITH AUG	AUGMENTATIONS ONLY	AUGMENTATIONS WITH PRO	PROMOS ONLY	CURRENT OFFICER STATE	FLOWS OUT OF THE CURRENT OFFICER STATE: ATTRITION	RATING TRANSFERS ONLY	RATING TRANSFERS WITH AUG	AUGMENTATIONS ONLY	AUGMENTATIONS WITH PRO	PROMOS ONLY	LATERAL FLOW
4					9	36	45	8			5			32
5	32			5	363	2811	3211	174			249			2788
6	2788			249	0	0	3037	729			8			2301
7	2301			8			2309	303					35	1971
8	1971						1971	182					35	1754
9	1754						1754	87					1233	434
10	434						434	20					87	327
11	327						327	327						
TOT	9606.	0.	0.	262.	373.	2846.	13087.	1830.	0.	0.	262.	0.	1389.	9606.

TOTAL RATING TRANSFERS 0 IN 0 OUT TOTAL AUGMENTATIONS 634 IN 262 OUT TOTAL PROMOTIONS 3219 IN 1389 OUT

Fig. 37 — Officer flows, ROTC lieutenants and captains

OFFICER FORCE PROGRESSION MODEL EXAMPLE

OFFICER FLOWS

COMPONENT ALL GRADE MAJ RATING ALL SOURCE OF COMMISSION ROTC

YOS	FLOWS INTO THE CURRENT OFFICER STATE: LATERAL FLOW	RATING TRANSFERS: ONLY	RATING TRANSFERS: WITH AUG	AUGMENTATIONS: ONLY	AUGMENTATIONS: WITH PRO	PROMOS ONLY	CURRENT OFFICER STATE	FLOWS OUT OF THE CURRENT OFFICER STATE: ATTRITION	RATING TRANSFERS: ONLY	RATING TRANSFERS: WITH AUG	AUGMENTATIONS: ONLY	AUGMENTATIONS: WITH PRO	PROMOS ONLY	LATERAL FLOW
8						35	35							
9	19			15		35	69	1			15			19
10	53			15		1233	1301	27			15			53
11	763			511		87	1360	43			511			763
12	1318						1318	12						1318
13	1305						1305	8						1305
14	1243						1243	11					54	1243
15	1197						1197	12					36	1197
16	509						509	3					676	509
17	379						379	5					127	379
18	374						374	30						374
19	344						344	58						344
20	286						286	286						286
TOT	7791.	0.	0.	541.	0.	1389.	9721.	497.	0.	0.	541.	0.	892.	7791.

TOTAL RATING TRANSFERS 0 IN 0 OUT TOTAL AUGMENTATIONS 541 IN 541 OUT TOTAL PROMOTIONS 1389 IN 892 OUT

COMPONENT ALL GRADE LTC RATING ALL SOURCE OF COMMISSION ROTC

YOS	FLOWS INTO THE CURRENT OFFICER STATE: LATERAL FLOW	RATING TRANSFERS: ONLY	RATING TRANSFERS: WITH AUG	AUGMENTATIONS: ONLY	AUGMENTATIONS: WITH PRO	PROMOS ONLY	CURRENT OFFICER STATE	FLOWS OUT OF THE CURRENT OFFICER STATE: ATTRITION	RATING TRANSFERS: ONLY	RATING TRANSFERS: WITH AUG	AUGMENTATIONS: ONLY	AUGMENTATIONS: WITH PRO	PROMOS ONLY	LATERAL FLOW
14						54	54							
15	54					36	89	1						54
16	88					676	764	14						88
17	750					127	877	7						750
18	870						870	17						870
19	853						853	54						853
20	780						780	90					20	780
21	665						665	86					24	665
22	341						341	53					238	341
23	256						256	42					31	256
24	214						214	44						214
25	170						170	31						170
26	139						139	139						139
TOT	5179.	0.	0.	0.	0.	892.	6071.	579.	0.	0.	0.	0.	313.	5179.

TOTAL RATING TRANSFERS 0 IN 0 OUT TOTAL AUGMENTATIONS 0 IN 0 OUT TOTAL PROMOTIONS 892 IN 313 OUT

Fig. 38 — Officer flows, ROTC majors and lieutenant colonels

OFFICER FLOWS

COMPONENT ALL GRADE COL RATING ALL SOURCE OF COMMISSION ROTC

YOS	FLOWS INTO THE CURRENT OFFICER STATE: LATERAL FLOW	RATING TRANSFERS: ONLY	RATING TRANSFERS: WITH AUG	AUGMENTATIONS: ONLY	AUGMENTATIONS: WITH PRO	PROMOS ONLY	CURRENT OFFICER STATE	FLOWS OUT OF THE CURRENT OFFICER STATE: ATTRITION	RATING TRANSFERS: ONLY	RATING TRANSFERS: WITH AUG	AUGMENTATIONS: ONLY	AUGMENTATIONS: WITH PRO	PROMOS ONLY	LATERAL FLOW
20						20	20	1						19
21	19					24	43	3						40
22	40					238	279	19						260
23	260					31	291	17						274
24	274						274	27						246
25	246						246	29						218
26	218						218	47						170
27	170						170	44						126
28	126						126	47						79
29	79						79	56						23
30	23						23	23						
TOT	1455.	0.	0.	0.	0.	313.	1768.	313.	0.	0.	0.	0.	0.	1455.

TOTAL RATING TRANSFERS 0 IN 0 OUT TOTAL AUGMENTATIONS 0 IN 0 OUT TOTAL PROMOTIONS 313 IN 0 OUT

COMPONENT ALL GRADE LT RATING PIL SOURCE OF COMMISSION SMSO

YOS	FLOWS INTO THE CURRENT OFFICER STATE: LATERAL FLOW	RATING TRANSFERS: ONLY	RATING TRANSFERS: WITH AUG	AUGMENTATIONS: ONLY	AUGMENTATIONS: WITH PRO	PROMOS ONLY	CURRENT OFFICER STATE	FLOWS OUT OF THE CURRENT OFFICER STATE: ATTRITION	RATING TRANSFERS: ONLY	RATING TRANSFERS: WITH AUG	AUGMENTATIONS: ONLY	AUGMENTATIONS: WITH PRO	PROMOS ONLY	LATERAL FLOW
2		535					535	5						530
3	530						530	5			129	2	5	388
4	388			129			518	8			5	97	387	21
5	21			5			26	0			2	0	0	24
6	24			2			25	25						
TOT	963.	535.	0.	136.	0.	0.	1635.	44.	0.	0.	136.	99.	392.	963.

TOTAL RATING TRANSFERS 535 IN 0 OUT TOTAL AUGMENTATIONS 136 IN 235 OUT TOTAL PROMOTIONS 0 IN 491 OUT

Fig. 39—Officer flows, ROTC colonels

OFFICER FLOWS AND IMPLIED FORWARD COMPUTATION RATES

The next report, illustrated with Figs. 40 and 41, shows how the officers move through the various phases of the computation process as they flow from one year of service to the next. Recall that the model moves officers from one year of service to the next in the following steps:

- Attrition
- Rating transfers (if lieutenant)
- Augmentation
- Promotion

The report illustrates the actions taken at each step of the cycle.

The reports illustrated by Figs. 40 and 41 refer to ROTC pilots holding regular commissions, and each report deals with a different grade. At the top of Fig. 40 lieutenants are reported. We see that in YOS 3 there are no officers in the current state--the initial officer state. Thus there are no losses. There are, however, 355 augmentations from reserve pilot to regular pilot, and the report shows this as a flow into the cycle. Continuing, five promotions to captain take place, thus yielding 350 officers in YOS 4--which is precisely the number reported in the Officer Force Grade Distribution report of regular lieutenants as shown in Fig. 30, p. 70.

If we focus now on YOS 4, with 350 in the initial state, 4 are lost, leaving 347 remaining. No rating transfers take place and 278 augmentations into the regular force take place, resulting in a total or residue of 625, from which 593 promotions to captain take place. The loss rates are also computed and printed to provide a comparison with the user-provided input quantities.

Turning now to the middle report in Fig. 40, which deals with captains, we see in YOS 3 and 4 promotion flows of 5 and 593 officers, respectively, into the cycle. These are the 5 and 593 officers promoted out of lieutenant.

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OFFICER FLOWS AND IMPLIED FORWARD COMPUTATION RATES

COMPONENT REG GRADE LT RATING PIL SOURCE OF COMMISSION ROTC

YEAR	INITIAL OFFICER STATE	ATTRITION PHASE			RATING TRANSFER PHASE		AUGMENTATION PHASE		PROMOTION PHASE		
		LOSSES	LOSS RATE	RESIDUE	TRNSFRS IN	RESIDUE	AUGMNTS IN	RESIDUE	PROMOS	PROMO RATE	RESIDUE
3											
4	350	4	0.0100	347		347	355	355	5 OUT	0.0131	350
5	32	0	0.0100	31		31	278	625	593 OUT	0.9493	32
6	36	36	1.0000				5	36	0 OUT	0.0000	36

COMPONENT REG GRADE CAP RATING PIL SOURCE OF COMMISSION ROTC

YEAR	INITIAL OFFICER STATE	ATTRITION PHASE			AUGMENTATION PHASE		PROMOTION PHASE		
		LOSSES	LOSS RATE	RESIDUE	AUGMNTS IN	RESIDUE	PROMOS	PROMO RATE	RESIDUE
3									
4	5	0	0.0100	5			5 IN		5
5	601	6	0.0100	595	4	8	593 IN		601
6	687	143	0.2080	544	92	687	0 IN		687
7	544	75	0.1380	469		544			544
8	462	52	0.1130	410		469	7 OUT	0.0153	462
9	402	28	0.0690	374		410	8 OUT	0.0187	402
10	97	5	0.0490	93		374	277 OUT	0.7401	97
11	73	73	1.0000			93	20 OUT	0.2146	73

COMPONENT REG GRADE MAJ RATING PIL SOURCE OF COMMISSION ROTC

YEAR	INITIAL OFFICER STATE	ATTRITION PHASE			AUGMENTATION PHASE		PROMOTION PHASE		
		LOSSES	LOSS RATE	RESIDUE	AUGMNTS IN	RESIDUE	PROMOS	PROMO RATE	RESIDUE
8	7			7					
9	18	1	0.0540	17	3	10	8 IN		18
10	297	10	0.0350	286	2	19	277 IN		297
11	391	3	0.0070	388	85	371	20 IN		391
12	388	5	0.0120	384		388			388
13	384	3	0.0090	380		384			384
14	365	5	0.0150	359		380	16 OUT	0.0410	365
15	349	4	0.0120	345		359	10 OUT	0.0289	349
16	148	1	0.0100	146		345	197 OUT	0.5710	148
17	109	1	0.0110	108		146	37 OUT	0.2525	109
18	108	7	0.0660	101		108			108
19	101	12	0.1190	89		101			101
20	89	89	1.0000			89			89

Fig. 40—Officer flows and implied forward computation rates

OFFICER FORCE PROGRESSION MODEL EXAMPLE

OFFICER FLOWS AND IMPLIED FORWARD COMPUTATION RATES

COMPONENT REG GRADE LTC RATING PIL SOURCE OF COMMISSION ROTC

YEAR	INITIAL OFFICER STATE	ATTRITION PHASE			AUGMENTATION PHASE		PROMOTION PHASE		
		LOSSES	LOSS RATE	RESIDUE	AUGMNTS IN	RESIDUE	PROMOS	PROMO RATE	RESIDUE
14	16			16		16	10 IN		26
15	26	1	0.0390	25		25	197 IN		222
16	222	4	0.0180	218		218	37 IN		255
17	255	5	0.0190	250		250			250
18	250	3	0.0120	247		247			247
19	247	11	0.0450	236		236	6 OUT	0.0256	230
20	230	24	0.1060	205		205	7 OUT	0.0359	198
21	196	20	0.1030	178		178	73 OUT	0.4101	105
22	105	17	0.1610	88		88	10 OUT	0.1084	78
23	78	15	0.1910	63		63			63
24	63	13	0.2050	50		50			50
25	50	5	0.1070	45		45			45
26	45	45	1.0000						

COMPONENT REG GRADE COL RATING PIL SOURCE OF COMMISSION ROTC

YEAR	INITIAL OFFICER STATE	ATTRITION PHASE			AUGMENTATION PHASE		PROMOTION PHASE		
		LOSSES	LOSS RATE	RESIDUE	AUGMNTS IN	RESIDUE	PROMOS	PROMO RATE	RESIDUE
20	6			6		6	7 IN		13
21	13	1	0.0390	13		13	73 IN		86
22	86	10	0.1190	76		76	10 IN		85
23	85	5	0.0570	80		80			80
24	80	4	0.0500	76		76			76
25	76	6	0.0810	70		70			70
26	70	12	0.1670	58		58			58
27	58	14	0.2420	44		44			44
28	44	16	0.3600	28		28			28
29	28	19	0.6700	9		9			9
30	9	9	1.0000						

Fig. 41 — Officer flows and implied forward computation rates

IMPLIED FORWARD COMPUTATION PROMOTION PARAMETERS

Figures 42 and 43 illustrate a report produced by the OFPM to provide a means to check the accuracy of the model's promotion computation algorithms. The model, *utilizing computation results only and making no use of input parameters*, computes what the promotion inputs must have been as indicated by the actual promotions made. A brief glance at the promotion inputs as shown in Fig. 25, p. 58, will confirm that the promotion algorithms are operating properly in this model run.

In addition to producing a grade's promotion parameters by rating and sources of commission, aggregate parameters over ratings and sources are also produced. Also printed is the computed number of eligibles and promotions. For example, focusing on ROTC pilots eligible for promotion to captain, the Promotion Parameters report indicates that there are 1407 eligibles, which is the total number of ROTC pilots with five years of service as reported on the Officer Force Grade Distribution report, Fig. 30, p. 70.

AUGMENTATION OPPORTUNITIES

Figure 44 contains the Augmentation Opportunities report. Recall that the progression model requires that *augmentation rates* be provided, i.e., the fraction of those eligible reserve officers in a given year of service that actually are augmented into the regular force. However, a more meaningful policy variable is augmentation opportunity, i.e., the percentage of officers from a reserve source of commission that hold regular commissions. The Augmentation Opportunities report produces the opportunities implied by the augmentation rates.

Unless the user makes a contrary request on the Options card (see p. 67), augmentation opportunities will be printed for YOS 3-7. Focusing on ROTC pilots again, we see that in YOS 4, the augmentation opportunity is 25 percent, with 1064 reserve ROTC pilots and 355 regular ROTC pilots, yielding a total of 1419. Note that 355 is 25 percent of 1419, and are consistent with Fig. 30, p. 70.

IMPLIED GRADE LIMITATIONS COMPUTATION INPUTS

The final set of outputs to be discussed deals with the grade limitations model. Using computation results only, the progression

OFFICER FORCE PROGRESSION MODEL EXAMPLE

IMPLIED FORWARD COMPUTATION PROMOTION PARAMETERS

GRADE	RATING	SOURCE OF COMMISSION	CUMULATIVE PROMOTION OPPORTUNITY: FIRST YEAR OF PRIMARY ZONE	CUMULATIVE PROMOTION OPPORTUNITY: SECOND YEAR OF PRIMARY ZONE	BELOW-THE-ZONE PROMOTIONS: BELOW-THE-ZONE PROMOTION PCT.	BELOW-THE-ZONE PROMOTIONS: FIRST YEAR BELOW THE-ZONE PERCENT	PROMOTION PHASE POINT	ELIGIBLES	PROMOTIONS
CAP	PIL	AFA	95.00	95.00	1.39	0.0	5	592	562
CAP	PIL	ROTC	95.00	95.00	1.39	0.0	5	1407	1336
CAP	PIL	SMSO	95.00	95.00	1.39	0.0	5	517	491
CAP	PIL	ALL	95.00	95.00	1.39	0.0	5	2515	2390
CAP	NAV	AFA	95.00	95.00	1.39	0.0	5	90	85
CAP	NAV	ROTC	95.00	95.00	1.39	0.0	5	635	603
CAP	NAV	SMSO	95.00	95.00	1.39	0.0	5	495	470
CAP	NAV	ALL	95.00	95.00	1.39	0.0	5	1219	1159
CAP	NR	AFA	95.00	95.00	1.39	0.0	5	211	201
CAP	NR	ROTC	95.00	95.00	1.39	0.0	5	1339	1279
CAP	NR	SMSO	95.00	95.00	1.39	0.0	5	1671	1596
CAP	NR	ALL	95.00	95.00	1.39	0.0	5	3220	3076
CAP	ALL	AFA	95.00	95.00	1.39	0.0	5	892	848
CAP	ALL	ROTC	95.00	95.00	1.39	0.0	5	3380	3219
CAP	ALL	SMSO	95.00	95.00	1.39	0.0	5	2683	2558
CAP	ALL	ALL	95.00	95.00	1.39	0.0	5	6955	6624
MAJ	PIL	AFA	75.00	80.00	5.00	50.00	10	350	280
MAJ	PIL	ROTC	75.00	80.00	5.00	50.00	10	513	412
MAJ	PIL	SMSO	75.00	80.00	5.00	50.00	10	262	210
MAJ	PIL	ALL	75.00	80.00	5.00	50.00	10	1125	901
MAJ	NAV	AFA	75.00	80.00	5.00	50.00	10	57	46
MAJ	NAV	ROTC	75.00	80.00	5.00	50.00	10	327	262
MAJ	NAV	SMSO	75.00	80.00	5.00	50.00	10	297	238
MAJ	NAV	ALL	75.00	80.00	5.00	50.00	10	681	545
MAJ	NR	AFA	75.00	80.00	5.00	50.00	10	117	94
MAJ	NR	ROTC	75.00	80.00	5.00	50.00	10	894	716
MAJ	NR	SMSO	75.00	80.00	5.00	50.00	10	1050	841
MAJ	NR	ALL	75.00	80.00	5.00	50.00	10	2061	1650
MAJ	ALL	AFA	75.00	80.00	5.00	50.00	10	524	419
MAJ	ALL	ROTC	75.00	80.00	5.00	50.00	10	1735	1389
MAJ	ALL	SMSO	75.00	80.00	5.00	50.00	10	1609	1288
MAJ	ALL	ALL	75.00	80.00	5.00	50.00	10	3867	3096

Fig. 42 — Implied forward computation promotion parameters, captain and major

OFFICER FORCE PROGRESSION MODEL EXAMPLE

IMPLIED FORWARD COMPUTATION PROMOTION PARAMETERS

GRADE	RATING	SOURCE OF COMMISSION	CUMULATIVE PROMOTION OPPORTUNITY: FIRST YEAR OF PRIMARY ZONE	CUMULATIVE PROMOTION OPPORTUNITY: SECOND YEAR OF PRIMARY ZONE	BELOW-THE-ZONE PROMOTIONS: BELOW-THE-ZONE PROMOTION PCT.	BELOW-THE-ZONE PROMOTIONS: FIRST YEAR BELOW THE-ZONE PERCENT	PROMOTION PHASE POINT	ELIGIBLES	PROMOTIONS
LTC	PIL	AFA	60.00	70.00	10.00	60.00	16	260	182
LTC	PIL	ROTC	60.00	70.00	10.00	60.00	16	370	260
LTC	PIL	SMSO	60.00	70.00	10.00	60.00	16	192	135
LTC	PIL	ALL	60.00	70.00	10.00	60.00	16	822	577
LTC	NAV	AFA	60.00	70.00	10.00	60.00	16	44	31
LTC	NAV	ROTC	60.00	70.00	10.00	60.00	16	239	167
LTC	NAV	SMSO	60.00	70.00	10.00	60.00	16	216	151
LTC	NAV	ALL	60.00	70.00	10.00	60.00	16	498	349
LTC	NR	AFA	60.00	70.00	10.00	60.00	16	87	62
LTC	NR	ROTC	60.00	70.00	10.00	60.00	16	665	465
LTC	NR	SMSO	60.00	70.00	10.00	60.00	16	701	493
LTC	NR	ALL	60.00	70.00	10.00	60.00	16	1453	1020
LTC	ALL	AFA	60.00	70.00	10.00	60.00	16	391	275
LTC	ALL	ROTC	60.00	70.00	10.00	60.00	16	1273	392
LTC	ALL	SMSO	60.00	70.00	10.00	60.00	16	1109	779
LTC	ALL	ALL	60.00	70.00	10.00	60.00	16	2773	1946
COL	PIL	AFA	45.00	50.00	14.00	45.00	22	152	76
COL	PIL	ROTC	45.00	50.00	14.00	45.00	22	191	96
COL	PIL	SMSO	45.00	50.00	14.00	45.00	22	100	50
COL	PIL	ALL	45.00	50.00	14.00	45.00	22	442	222
COL	NAV	AFA	45.00	50.00	14.00	45.00	22	14	7
COL	NAV	ROTC	45.00	50.00	14.00	45.00	22	120	60
COL	NAV	SMSO	45.00	50.00	14.00	45.00	22	105	53
COL	NAV	ALL	45.00	50.00	14.00	45.00	22	239	120
COL	NR	AFA	45.00	50.00	14.00	45.00	22	42	21
COL	NR	ROTC	45.00	50.00	14.00	45.00	22	309	157
COL	NR	SMSO	45.00	50.00	14.00	45.00	22	281	143
COL	NR	ALL	45.00	50.00	14.00	45.00	22	632	322
COL	ALL	AFA	45.00	50.00	14.00	45.00	22	208	105
COL	ALL	ROTC	45.00	50.00	14.00	45.00	22	619	313
COL	ALL	SMSO	45.00	50.00	14.00	45.00	22	487	247
COL	ALL	ALL	45.00	50.00	14.00	45.00	22	1314	664

Fig. 43—Implied forward computation promotion parameters, lieutenant colonel and colonel

OFFICER FORCE PROGRESSION MODEL EXAMPLE

AUGMENTATION OPPORTUNITIES

SOURCE OF COMMISSION ROTC

YEAR OF SERVICE	PILOT				NAVIGATOR				NONRATED			
	RESERVE	REGULAR	TOTAL	OPPORTUNITY	RESERVE	REGULAR	TOTAL	OPPORTUNITY	RESERVE	REGULAR	TOTAL	OPPORTUNITY
3	1433	0	1433	0	650	0	650	0	2190	170	2360	7
4	1064	355	1419	25	495	148	643	23	1856	494	2350	21
5	774	633	1407	45	381	254	635	40	909	429	1339	32
6	671	723	1394	52	324	305	629	48	667	507	1174	43
7	317	544	862	63	185	246	432	57	563	452	1015	45

SOURCE OF COMMISSION SMSO

YEAR OF SERVICE	PILOT				NAVIGATOR				NONRATED			
	RESERVE	REGULAR	TOTAL	OPPORTUNITY	RESERVE	REGULAR	TOTAL	OPPORTUNITY	RESERVE	REGULAR	TOTAL	OPPORTUNITY
3	530	0	530	0	507	0	507	0	2570	199	2770	7
4	394	131	525	25	388	116	503	23	2165	577	2743	21
5	284	233	517	45	297	198	495	40	1152	519	1671	31
6	245	265	509	52	252	236	488	48	762	601	1363	44
7	135	224	359	62	154	202	356	57	630	543	1174	46

SOURCE OF COMMISSION [illegible]ES

YEAR OF SERVICE	PILOT				NAVIGATOR				NONRATED			
	RESERVE	REGULAR	TOTAL	OPPORTUNITY	RESERVE	REGULAR	TOTAL	OPPORTUNITY	RESERVE	REGULAR	TOTAL	OPPORTUNITY
3	1963	0	1963	0	1157	0	1157	0	4760	369	5129	7
4	1458	486	1944	25	883	264	1146	23	4021	1072	5093	21
5	1058	865	1924	45	678	452	1130	40	2061	948	3009	32
6	915	988	1903	52	576	541	1117	43	1429	1109	2537	44
7	453	768	1221	63	340	449	788	57	1193	996	2189	45

Fig. 44 — Augmentation opportunities

model determines what the grade limitations inputs would have been had this been a run of the grade limitations as opposed to the progression model. Figures 45 and 46 contain some of the grade limitation outputs, which indicate how promotions were distributed over the years of service by component, grade, rating, and source of commission. For instance, at the top of Fig. 45 we see how regular Academy promotions were distributed: 2.5 percent of the promotions to major took place in YOS 8, 2.5 percent in YOS 9, 88.8 percent in YOS 10, and 6.2 percent in YOS 11. Focusing on the secondary-zone promotions (YOS 8 and 9), we see that 5 percent of the promotions were awarded below the zone, and that 50 percent of those promotions took place in the first of the two secondary-zone years. Both of these percentages are consistent with the secondary-zone promotion inputs of Fig. 25, p. 58.

ERROR AND WARNING MESSAGES

The OFPM thoroughly checks the input deck for errors and inconsistencies, producing extensive diagnostic messages whenever such a situation is encountered. In addition, the output package thoroughly reviews each output line printed for negative entries and for violations of the state equations that support the steady-state modeling process. This extensive output checking was originally included as a debugging tool, but has also proved extremely useful during general use of the model.

To aid in locating these error and warning messages, an error and warning message summary is produced at the end of each run (unless, of course, no errors or warnings were printed). The sample run used for illustrative purposes contained no such messages. To provide an illustration of the message summary format, we modified the sample run slightly by adding a pilot rating transfer rate of 10 percent for non-rated ROTC officers with four years of service. Thus in the fourth year of service we asked the model to train 450 non-rated ROTC lieutenants to be pilots. We chose YOS 4 because it lies in the promotion zone for promotion out of lieutenant and into captain. As discussed on p. 8, the user is cautioned not to do this because results are only approximate, thereby forcing the model to generate warning messages.

OFFICER FORCE PROGRESSION MODEL EXAMPLE

IMPLIED BACKWARD COMPUTATION INPUTS

PROMOTION DISTRIBUTIONS

COMPONENT REG SOURCE OF COMMISSION AFA

PILOT

CAPTAIN		MAJOR		LT. COL		COL/GEN	
YOS	FRACT	YOS	FRACT	YOS	FRACT	YOS	FRACT
4	0.014	8	0.025	14	0.060	20	0.063
5	0.986	9	0.025	15	0.040	21	0.077
		10	0.888	16	0.757	22	0.760
		11	0.062	17	0.143	23	0.100

NAVIGATOR

CAPTAIN		MAJOR		LT. COL		COL/GEN	
YOS	FRACT	YOS	FRACT	YOS	FRACT	YOS	FRACT
4	0.014	8	0.025	14	0.060	20	0.063
5	0.986	9	0.025	15	0.040	21	0.077
		10	0.887	16	0.757	22	0.760
		11	0.062	17	0.143	23	0.100

NONRATED

CAPTAIN		MAJOR		LT. COL		COL/GEN	
YOS	FRACT	YOS	FRACT	YOS	FRACT	YOS	FRACT
4	0.014	8	0.025	14	0.060	20	0.063
5	0.986	9	0.025	15	0.040	21	0.077
		10	0.888	16	0.759	22	0.762
		11	0.062	17	0.141	23	0.098

PROMOTION DISTRIBUTIONS

COMPONENT RES SOURCE OF COMMISSION ROTC

PILOT

CAPTAIN		MAJOR		LT. COL		COL/GEN	
YOS	FRACT	YOS	FRACT	YOS	FRACT	YOS	FRACT
4	0.019	8	0.031				
5	0.981	9	0.026				
6	0.000	10	0.884				
		11	0.058				

NAVIGATOR

CAPTAIN		MAJOR		LT. COL		COL/GEN	
YOS	FRACT	YOS	FRACT	YOS	FRACT	YOS	FRACT
4	0.018	8	0.026				
5	0.982	9	0.025				
6	0.000	10	0.888				
		11	0.061				

NONRATED

CAPTAIN		MAJOR		LT. COL		COL/GEN	
YOS	FRACT	YOS	FRACT	YOS	FRACT	YOS	FRACT
4	0.016	8	0.025				
5	0.984	9	0.025				
6	0.000	10	0.888				
		11	0.062				

PROMOTION DISTRIBUTIONS

COMPONENT REG SOURCE OF COMMISSION ROTC

PILOT

CAPTAIN		MAJOR		LT. COL		COL/GEN	
YOS	FRACT	YOS	FRACT	YOS	FRACT	YOS	FRACT
5	1.000	8	0.023	14	0.060	20	0.063
6	0.000	9	0.025	15	0.040	21	0.077
		10	0.889	16	0.758	22	0.761
		11	0.064	17	0.142	23	0.099

NAVIGATOR

CAPTAIN		MAJOR		LT. COL		COL/GEN	
YOS	FRACT	YOS	FRACT	YOS	FRACT	YOS	FRACT
5	1.000	8	0.025	14	0.060	20	0.063
6	0.000	9	0.025	15	0.040	21	0.077
		10	0.887	16	0.757	22	0.760
		11	0.063	17	0.143	23	0.100

NONRATED

CAPTAIN		MAJOR		LT. COL		COL/GEN	
YOS	FRACT	YOS	FRACT	YOS	FRACT	YOS	FRACT
4	0.003	8	0.025	14	0.060	20	0.063
5	0.997	9	0.025	15	0.040	21	0.077
6	0.000	10	0.887	16	0.757	22	0.762
		11	0.063	17	0.143	23	0.098

Fig. 45— Implied backward computation of promotion distributions

OFFICER FORCE PROGRESSION MODEL EXAMPLE

IMPLIED BACKWARD COMPUTATION INPUTS

PROMOTION DISTRIBUTIONS

COMPONENT RES SOURCE OF COMMISSION SMSD

PILOT

CAPTAIN YOS	CAPTAIN FRACT	MAJOR YOS	MAJOR FRACT	LT. COL YOS	LT. COL FRACT	COL/GEN YOS	COL/GEN FRACT
4	0.019	8	0.027				
5	0.981	9	0.026				
6	0.000	10	0.886				
		11	0.061				

NAVIGATOR

CAPTAIN YOS	CAPTAIN FRACT	MAJOR YOS	MAJOR FRACT	LT. COL YOS	LT. COL FRACT	COL/GEN YOS	COL/GEN FRACT
4	0.018	8	0.026				
5	0.982	9	0.025				
6	0.000	10	0.888				
		11	0.062				

NONRATED

CAPTAIN YOS	CAPTAIN FRACT	MAJOR YOS	MAJOR FRACT	LT. COL YOS	LT. COL FRACT	COL/GEN YOS	COL/GEN FRACT
4	0.016	8	0.025				
5	0.984	9	0.025				
6	0.000	10	0.888				
		11	0.061				

PROMOTION DISTRIBUTIONS

COMPONENT REG SOURCE OF COMMISSION SMSD

PILOT

CAPTAIN YOS	CAPTAIN FRACT	MAJOR YOS	MAJOR FRACT	LT. COL YOS	LT. COL FRACT	COL/GEN YOS	COL/GEN FRACT
5	1.000	8	0.024	14	0.060	20	0.063
6	0.000	9	0.025	15	0.040	21	0.077
		10	0.888	16	0.757	22	0.761
		11	0.063	17	0.143	23	0.099

NAVIGATOR

CAPTAIN YOS	CAPTAIN FRACT	MAJOR YOS	MAJOR FRACT	LT. COL YOS	LT. COL FRACT	COL/GEN YOS	COL/GEN FRACT
5	1.000	8	0.025	14	0.060	20	0.063
6	0.000	9	0.025	15	0.040	21	0.077
		10	0.887	16	0.758	22	0.761
		11	0.063	17	0.142	23	0.099

NONRATED

CAPTAIN YOS	CAPTAIN FRACT	MAJOR YOS	MAJOR FRACT	LT. COL YOS	LT. COL FRACT	COL/GEN YOS	COL/GEN FRACT
4	0.003	8	0.025	14	0.060	20	0.063
5	0.997	9	0.025	15	0.040	21	0.077
6	0.000	10	0.887	16	0.758	22	0.762
		11	0.064	17	0.142	23	0.098

Fig. 46 — Implied backward computation of promotion distributions

Figures 47 and 48 contain the Officer Flow reports that caused the generation of the warning messages shown in Fig. 49. Turning to the top of Fig. 47 we note first the presence of asterisks in YOS 4 and YOS 5, which indicate that the steady-state equations are not satisfied--the flows *out* do not equal the number in the current state in YOS 4, and the flows *in* do not equal the number in the current state in YOS 5. We also note that in YOS 4, -38 officers were augmented out, while in YOS 5 -38 were augmented in.

Comparing Fig. 47, which coincidentally is a computer page 47, with the warning messages for computer page 47 in the warning message summary, we note that all four conditions were detected and reported, along with a word of caution concerning the concurrent use of rating transfers and promotions. The warning messages for computer page 49 are similar to those for computer page 47.

OFFICER FORCE PROGRESSION MODEL FLOW IMBALANCE EXAMPLE PAGE 47

OFFICER FLOWS

COMPONENT ALL GRADE LT RATING ALL SOURCE OF COMMISSION RES

YOS	FLOWS INTO THE CURRENT OFFICER STATE: LATERAL FLOW	RATING TRANSFERS		AUGMENTATIONS		PROMOS ONLY	CURRENT OFFICER STATE	FLOWS OUT OF THE CURRENT OFFICER STATE: ATTRITION	RATING TRANSFERS		AUGMENTATIONS		PROMOS ONLY	LATERAL FLOW
		ONLY	WITH AUG	ONLY	WITH PRO				ONLY	WITH AUG	ONLY	WITH PRO		
1	8380						8380	57	3154					5169
2	5169	3154					8323	73			369			7880
3	7880			369			8249	67			438	16	64	6665
4	6665			1438			8102 *	2105	367	81	-38	605	5089	244
5	244	367	81	-38			* 303	23			20	0	0	260
6	260			20			280	280						
TOT	28598.	3520.	81.	1788.	0.	0.	33638.	2606.	3520.	81.	1788.	621.	5153.	20218.

TOTAL RATING TRANSFERS 3601 IN 3601 OUT TOTAL AUGMENTATIONS 1788 IN 2409 OUT TOTAL PROMOTIONS 0 IN 5774 OUT

COMPONENT ALL GRADE CAP RATING ALL SOURCE OF COMMISSION RES

YOS	FLOWS INTO THE CURRENT OFFICER STATE: LATERAL FLOW	RATING TRANSFERS		AUGMENTATIONS		PROMOS ONLY	CURRENT OFFICER STATE	FLOWS OUT OF THE CURRENT OFFICER STATE: ATTRITION	RATING TRANSFERS		AUGMENTATIONS		PROMOS ONLY	LATERAL FLOW
		ONLY	WITH AUG	ONLY	WITH PRO				ONLY	WITH AUG	ONLY	WITH PRO		
4					16	64	80	14			9			57
5	57			9	605	5089	5760	432			437			4890
6	4890			437	0	0	5323	1195			14			4119
7	4119			14			4132	499					64	3569
8	3569						3569	283					64	3221
9	3221						3221	140					2280	802
10	802						802	32					160	609
11	609						609	609						
TOT	17267.	0.	0.	460.	621.	5153.	23501.	3205.	0.	0.	460.	0.	2569.	17267.

TOTAL RATING TRANSFERS 0 IN 0 OUT TOTAL AUGMENTATIONS 1081 IN 460 OUT TOTAL PROMOTIONS 5774 IN 2569 OUT

Fig. 47—OFPM flow imbalance example, officer flows, lieutenant

OFFICER FORCE PROGRESSION MODEL FLOW IMBALANCE EXAMPLE

OFFICER FLOWS

COMPONENT ALL GRADE COL RATING ALL SOURCE OF COMMISSION RES

YOS	FLOWS INTO THE CURRENT OFFICER STATE: LATERAL FLOW	RATING TRANSFERS: ONLY	RATING TRANSFERS: WITH AUG	AUGMENTATIONS: ONLY	AUGMENTATIONS: WITH PRO	PROMOS ONLY	CURRENT OFFICER STATE	FLOWS OUT OF THE CURRENT OFFICER STATE: ATTRITION	RATING TRANSFERS: ONLY	RATING TRANSFERS: WITH AUG	AUGMENTATIONS: ONLY	AUGMENTATIONS: WITH PRO	PROMOS ONLY	LATERAL FLOW
20						34	34	2						32
21	32					41	74	4						69
22	69					409	478	29						449
23	449					53	502	35						467
24	467						467	42						425
25	425						425	47						378
26	378						378	72						306
27	306						306	71						235
28	235						235	85						150
29	150						150	110						41
30	41						41	41						
TOT	2552.	0.	0.	0.	0.	538.	3090.	538.	0.	0.	0.	0.	0.	2552.

TOTAL RATING TRANSFERS 0 IN 0 OUT TOTAL AUGMENTATIONS 0 IN 0 OUT TOTAL PROMOTIONS 538 IN 0 OUT

COMPONENT ALL GRADE LT RATING ALL SOURCE OF COMMISSION ALL

YOS	FLOWS INTO THE CURRENT OFFICER STATE: LATERAL FLOW	RATING TRANSFERS: ONLY	RATING TRANSFERS: WITH AUG	AUGMENTATIONS: ONLY	AUGMENTATIONS: WITH PRO	PROMOS ONLY	CURRENT OFFICER STATE	FLOWS OUT OF THE CURRENT OFFICER STATE: ATTRITION	RATING TRANSFERS: ONLY	RATING TRANSFERS: WITH AUG	AUGMENTATIONS: ONLY	AUGMENTATIONS: WITH PRO	PROMOS ONLY	LATERAL FLOW
1	9340						9340	60	3856					5424
2	5424	3856					9280	77			369			8834
3	8834			369			9203	78			1438	16	76	7596
4	7596			1438			9033 *	2156	367	81	-38	605	5925	288
5	288	367	81	-38		*	348	26			20	0	0	302
6	302			20			322	322						
TOT	31784.	4222.	81.	1788.	0.	0.	37526.	2718.	4222.	81.	1788.	621.	6001.	22444.

TOTAL RATING TRANSFERS 4303 IN 4303 OUT TOTAL AUGMENTATIONS 1788 IN 2409 OUT TOTAL PROMOTIONS 0 IN 6622 OUT

Fig. 48 — OFPM flow imbalance example, officer flows, colonel

OFFICER FORCE PROGRESSION MODEL FLOW IMBALANCE EXAMPLE PAGE 63

ERROR AND WARNING MESSAGE SUMMARY

PAGE NO.	TYPE OF MESSAGE
47	NEGATIVE STATE OR FLOW
47	OFFICER FLOW IMBALANCE FOR FLOWS OUT OF CURRENT STATE, PROBABLY DUE TO CONCURRENT RATING TRANSFERS AND PROMOTIONS IN THIS YOS ALL RATING TRANSFER AND PROMOTION FLOWS OUT OF THE CURRENT STATE ARE APPROXIMATE
47	NEGATIVE STATE OR FLOW
47	OFFICER FLOW IMBALANCE FOR FLOWS INTO CURRENT STATE
49	NEGATIVE STATE OR FLOW
49	OFFICER FLOW IMBALANCE FOR FLOWS OUT OF CURRENT STATE, PROBABLY DUE TO CONCURRENT RATING TRANSFERS AND PROMOTIONS IN THIS YOS ALL RATING TRANSFER AND PROMOTION FLOWS OUT OF THE CURRENT STATE ARE APPROXIMATE
49	NEGATIVE STATE OR FLOW
49	OFFICER FLOW IMBALANCE FOR FLOWS INTO CURRENT STATE

Fig. 49—OFPM flow imbalance example, error and warning message summary

Appendix A

DERIVATION OF RATING TRANSFER RATES, RAT(C,G,R,IS,Y)

The user of the OFPM provides, as inputs, the fraction of annual accessions from each source of commission that are to become pilots or navigators in their second, third, fourth, etc., year of service. However, the model's computation scheme requires rating transfer *rates*, i.e., the fraction of those officers in a *state* that are to receive rating transfers. For example, where the model's inputs may ask that 30 percent of annual ROTC accessions be granted rating transfers to pilot in their second year of service, the model's computations need to know the fraction of those non-rated ROTC officers with two years of service that are to be granted their pilot wings. In this appendix we describe how the fractions of annual accessions are converted to the required rating transfer rates. Let

g(R,IS,Y) = Fraction of annual accessions from source of commission IS who become pilots (R = 1) or navigators (R = 2) in YOS Y+1. These are the rating transfer inputs provided by the user.

S(C,G,3,IS,Y) = Number of non-rated officers in state (C,G,3,IS,Y).

RAT(C,G,R,IS,Y) = The proportion of non-rated officers in state (C,G,3,IS,Y) who are not lost to the Air Force in YOS Y and who complete UPT (if R = 1) or UNT (if R = 2) and are awarded an aeronautical rating of pilot (R = 1) or navigator (R = 2) in YOS Y+1. These are the rates we wish to compute.

RAT(C,G,3,IS,Y) = RAT(C,G,1,IS,Y) + RAT(C,G,2,IS,Y).

NRAT(C,G,3,IS,Y) = 1 - RAT(C,G,3,IS,Y).

AUG(2,G,R,IS,Y) = The augmentation rate for reserve officers in state (1,G,R,IS,Y) to be

augmented into the regular component in YOS Y+1.

NAUG(2,G,R,IS,Y) = 1 - AUG(2,G,R,IS,Y).

S"(C,G,3,IS,Y) = Number of non-rated officers in state (C,G,3,IS,Y) *assuming no promotions* out of state.

Then,

S(1,1,3,IS,1) = 0 if IS is 1 (Academy); no Academy graduates hold reserve commissions.

And

S(2,1,3,IS,1) = 0 if IS is 2 (ROTC) or IS is 3 (OTS/other); non-Academy graduates do not hold regular commissions in their first year of service under present policies.

S(C,1,3,IS,1) = Annual accessions from source of commission IS where C = 1 for non-Academy, and C = 2 for Academy.

Also

RE(C,G,R,IS,Y) = Proportion of officers in state (C,G,R,IS,Y) not lost to the Air Force in YOS Y; i.e., the fraction retained.

Then

$$S''(1,1,R,IS,2) = S(1,1,3,IS,1) \cdot RE(1,1,3,IS,1) \cdot RAT(1,1,R,IS,1) \cdot NAUG(2,1,R,IS,1) \quad \text{(A-1)}$$

= Number of reserve pilots (R = 1) or navigators (R = 2) in YOS 2.

$$S''(2,1,R,IS,2) = S(1,1,3,IS,1) \cdot RE(1,1,3,IS,1) \cdot RAT(1,1,R,IS,1) \cdot AUG(2,1,R,IS,1) + S(2,1,3,IS,1) \cdot RE(2,1,3,IS,1) \cdot RAT(2,1,R,IS,1). \tag{A-2}$$

= Number of regular pilots (R = 1) or navigators (R = 2) in YOS 2.

Note that in the above two equations the values for RAT are not known. Thus, in terms of the unknown rating transfer rates, the *total* number of officers with rating R in YOS 2 is given by

$$S''(1,1,R,IS,2) + S''(2,1,R,IS,2) = S(1,1,3,IS,1) \cdot RE(1,1,3,IS,1) \cdot RAT(1,1,R,IS,1) + S(2,1,3,IS,1) \cdot RE(2,1,3,IS,1) \cdot RAT(2,1,R,IS,1) \tag{A-3}$$

where R = 1 for pilot,
R = 2 for navigator.

Now, working from the inputs provided by the user, we know that

$$S''(1,1,R,IS,2) + S''(2,1,R,IS,2) = g(R,IS,1) \cdot [S(1,1,3,IS,1) + S(2,1,3,IS,1)]. \tag{A-4}$$

Substituting A-4 into A-3, we obtain

$$g(R,IS,1) \cdot [S(1,1,3,IS,1) + S(2,1,3,IS,1)] = S(1,1,3,IS,1) \cdot RE(1,1,3,IS,1) \cdot RAT(1,1,R,IS,1) + S(2,1,3,IS,1) \cdot RE(2,1,3,IS,1) \cdot RAT(2,1,R,IS,1). \tag{A-5}$$

In Eq. A-5 all the quantities are known except RAT(1,1,R,IS,1) and RAT(2,1,R,IS,1).

One additional assumption is needed to determine these unknown rating transfers. We assume that

$$RAT(1,1,R,IS,1) = RAT(2,1,R,IS,1). \tag{A-6}$$

In other words, reserve non-rated lieutenants from source of commission IS are equally as likely to receive rating transfers as their regular counterparts.

We can now solve for the unknown rating transfers, yielding

$$\mathrm{RAT}(C,1,R,IS,1) = \frac{g(R,IS,1) \cdot [S(1,1,3,IS,1) + S(2,1,3,IS,1)]}{S(1,1,3,IS,1) \cdot \mathrm{RE}(1,1,3,IS,1) + S(2,1,3,IS,1) \cdot \mathrm{RE}(2,1,3,IS,1)} \qquad \text{(A-7)}$$

where R = 1 for pilot,

R = 2 for navigator.

In general, the rating transfer rates for YOS Y are determined by

$$\mathrm{RAT}(C,1,R,IS,Y) = \frac{g(R,IS,Y) \cdot [S(1,1,3,IS,1) + S(2,1,3,IS,1)]}{S''(1,1,3,IS,Y) \cdot \mathrm{RE}(1,1,3,IS,Y) + S''(2,1,3,IS,Y) \cdot \mathrm{RE}(2,1,3,IS,Y)} \qquad \text{(A-8)}$$

where $S''(1,1,3,IS,Y) = S''(1,1,3,IS,Y-1) \cdot \mathrm{RE}(1,1,3,IS,Y-1) \cdot \mathrm{NRAT}(1,1,3,IS,Y-1) \cdot \mathrm{NAUG}(2,1,3,IS,Y-1)$

and $S''(2,1,3,IS,Y) = S''(1,1,3,IS,Y-1) \cdot \mathrm{RE}(1,1,3,IS,Y-1) \cdot \mathrm{NRAT}(1,1,3,IS,Y-1) \cdot \mathrm{AUG}(2,1,3,IS,Y-1) + S''(2,1,3,IS,Y-1) \cdot \mathrm{RE}(2,1,3,IS,Y-1) \cdot \mathrm{NRAT}(2,1,3,IS,Y-1)$.

In summary, the above computations have assumed the following:

- o For a given source of commission and a given year of service, reserve non-rated lieutenants are equally as likely to receive rating transfers as their regular counterparts.
- o Promotions occur only in those years of service subsequent to the years of service during which rating transfers have been made.

Since it will be required by the discussion in Appendix B, we would like to show how to compute the number of officers that receive rating transfers in a given year of service. If YOS Y_i corresponds to promotion cycle year i, then

$$r_i = S(1,1,3,IS,Y_{i-1}) \cdot RE(1,1,3,IS,Y_{i-1}) \cdot RAT(1,1,R,IS,Y_{i-1}) \tag{A-9}$$

$$R_i = S(2,1,3,IS,Y_{i-1}) \cdot RE(2,1,3,IS,Y_{i-1}) \cdot RAT(2,1,R,IS,Y_{i-1}) \tag{A-10}$$

where r_i = The number of reserve non-rated lieutenants who complete UPT if R = 1 (or UNT if R = 2) and become pilots (or navigators) in YOS Y_i,*

R_i = The number of regular non-rated lieutenants who complete UPT if R = 1 (or UNT if R = 2) and become pilots (or navigators) in YOS Y_i.

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*If R = 3, then it is the sum of non-rated lieutenants who become pilots and non-rated lieutenants who become navigators in YOS Y_i. As an illustration, if i = 4, then Y_i = 5, R = 1 and r_4 is defined as the number of reserve non-rated officers who become pilots in their fifth YOS, which is the fourth promotion cycle year.

Appendix B

DERIVATION OF PROMOTION FORMULAS AND RELATED OFFICER FORCE PROGRESSION MODEL STATES AND FLOWS

In this appendix we shall derive the formulas required to compute the quantity of officers to promote each year in a manner consistent with promotion, augmentation, and other established personnel policies. Appendix B is in three parts: (1) non-rated lieutenants, (2) rated lieutenants, and (3) captain and higher grades, rated and non-rated officers.

PART 1: NON-RATED LIEUTENANTS

Figure B-1 depicts a five-year promotion cycle for non-rated lieutenants. The reader will note that Fig. B-1 is the same as Fig. 20 in Section II of the text except that the paths have been labeled for reserve and regular promotions with P_i and π_i, respectively, to designate the quantity of non-rated promotions to captain during promotion cycle year i.*

SYMBOLS AND NOTATION

In the formulas used below, we will make some changes of symbols and notation used in the text in the interest of simplicity. First, since the derivation of formulas applies to non-rated officers with the same source of commission, we will omit the rating and source of commission from our symbols. Second, it is more convenient to use the cycle year rather than the year of service in our notation. Third, we

---

*During years when rating transfers occur and $r_i \neq 0$ or $R_i \neq 0$, then normally the number of promotions equals zero, i.e., $\pi_i = 0$ and $P_i = 0$. In the years of service subsequent to those in which rating transfers occur but during which promotions occur, then normally $r_i = 0$ and $R_i = 0$ but $\pi_i > 0$ or $P_i > 0$. If the user has inputs such that rating transfers and promotions both occur in the same year of service, the model will solve the equations but print an error message since RAT(C,1,R,IS,Y) has been computed in Appendix A under the assumption of zero promotions. Usually the error will be quite small. In all years of service subsequent to those during which rating transfers are permitted, RAT(C,1,R,IS,Y) = 0 and NRAT(C,1,R,IS,Y) = 1.

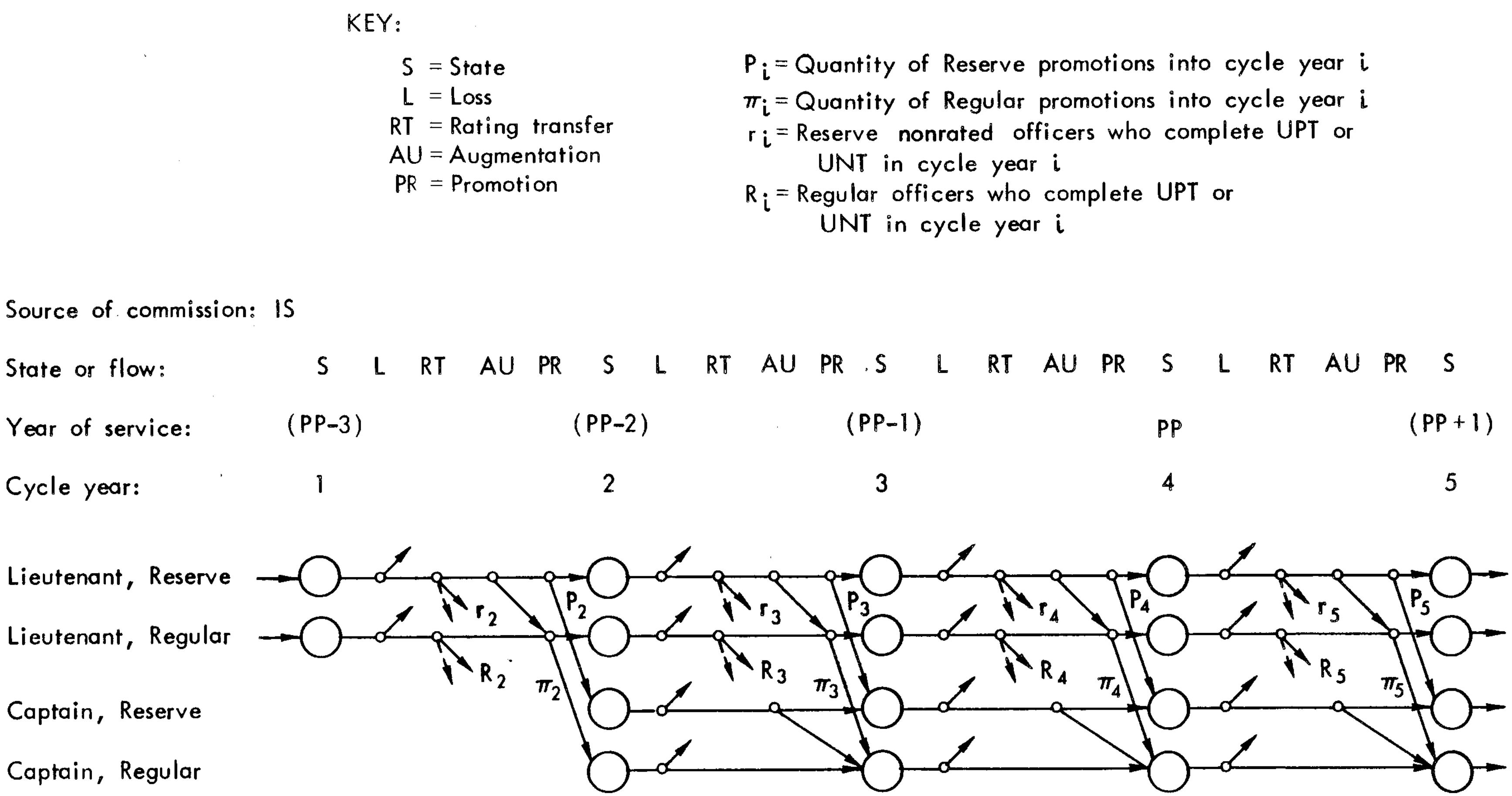

Fig. B-1—Promotion cycle, from lieutenant to captain, nonrated: variable phase point, YOS PP

will specify the component in the symbol. Further, subscript G will be understood as the grade of lieutenant, and G+1 as grade of captain, in the first part. It is convenient to use these conventions since we will use many of the formulas in the second and third parts without change. Therefore,

S(RES,G,i) = Number of non-rated (in Part 1) reserve officers with grade G in cycle year i with source of commission IS, i.e., number of non-rated officers with source of commission IS in state (RES,G,i).

Thus, S(RES,G,4) in three-subscript form in the first part of this appendix is equivalent to S(1,G,3,IS,PP) in five-subscript form as used in Section II of the text.
Similarly,

S(REG,G,i) = Number of non-rated regular officers with grade G in cycle year i with source of commission IS (i.e., the number of non-rated officers with source of commission IS in state (REG,G,i)).

B(RES,G,i) = Loss rate for officers in state (RES,G,i).

B(REG,G,i) = Loss rate for officers in state (REG,G,i).

RE(RES,G,i) = Retention rate for officers in state (RES,G,i)
= 1-B(RES,G,i).

RE(REG,G,i) = Retention rate for officers in state (REG,G,i)
= 1-B(REG,G,i).

It is also clear that augmentations always flow from the reserve to the regular component and, in this report, rating transfers always flow from non-rated to rated. Further, in this report, only lieutenants are awarded aeronautical ratings. Therefore, in this appendix's simplified notation only two subscripts are required for augmentation and for rating transfer flows.

Thus,

AUG(G,i) = The augmentation opportunity for reserve officers in grade G and cycle year i for augmentation into the regular component during cycle year i+1

= AUG(2,G,R,IS,Y) in five-subscript form where there is a unique year of service Y, for each cycle year i = 1,2,3,4,5, depending on the designation of the phase point, PP.

NAUG(G,i) = 1-AUG(G,i).

RAT(RES,i) = The proportion of eligible non-rated reserve lieutenants who will complete UPT or UNT and be awarded aeronautical ratings in cycle year i+1.

= RAT(1,1,3,IS,Y) in five-subscript form.

RAT(REG,i) = The proportion of eligible non-rated regular lieutenants who will complete UPT or UNT and be awarded aeronautical ratings in cycle year i+1

= RAT(2,1,3,IS,Y) in five-subscript form.

NRAT(RES,i) = 1-RAT(RES,i).

NRAT(REG,i) = 1-RAT(REG,i).

RECURSIVE FORMULAS

Figure B-1 shows that S(RES,G+1,1) = S(REG,G+1,1) = 0, i.e., there are no captains in the first year of the promotion cycle. The model has computed and has values for S(RES,G,1) and S(REG,G,1); therefore, these values may be considered as known or given at this stage of the computation. Then for non-rated lieutenants we have the following recursive formulas, for i = 1,2,3,4.

$$S(RES,G,i+1) = S(RES,G,i) \cdot RE(RES,G,i) \cdot NRAT(RES,i) \cdot NAUG(G,i) - P_{i+1}. \qquad (B-1)$$

$$S(REG,G,i+1) = S(REG,G,i) \cdot RE(REG,G,i) \cdot NRAT(REG,i) + S(RES,G,i) \cdot RE(RES,G,i) \cdot NRAT(RES,i) \cdot AUG(G,i) - \pi_{i+1}. \qquad (B-2)$$

$$S(RES,G+1,i+1) = S(RES,G+1,i) \cdot RE(RES,G+1,i) \cdot NAUG(G+1,i) + P_{i+1}. \qquad (B-3)$$

$$S(REG,G{+}1,i{+}1) = S(REG,G{+}1,i) \cdot RE(REG,G{+}1,i) + S(RES,G{+}1,i) \cdot RE(RES,G{+}1,i) \cdot AUG(G{+}1,i) + \pi_{i+1}. \qquad \text{(B-4)}$$

STATE QUANTITY FORMULAS IN TERMS OF STATE QUANTITIES FOR CYCLE YEAR 1

By applying B-1 through B-4 recursively, we can express the number of officers in each non-rated state in the promotion cycle in terms of known parameters and the eight unknown promotion quantities. For example, in the second year of the promotion cycle, the non-rated state quantities are

$$S(RES,G,2) = S(RES,G,1) \cdot RE(RES,G,1) \cdot NRAT(RES,1) \cdot NAUG(G,1) - P_2.$$

$$S(REG,G,2) = S(REG,G,1) \cdot RE(REG,G,1) \cdot NRAT(REG,1) + S(RES,G,1) \cdot RE(RES,G,1) \cdot NRAT(RES,1) \cdot AUG(G,1) - \pi_2.$$

$$S(RES,G{+}1,2) = P_2.$$

$$S(REG,G{+}1,2) = \pi_2.$$

In a similar manner, cycle year three can be expressed in terms of cycle year two and therefore in terms of cycle year one. Proceeding in this manner, all the years in the promotion cycle can be expressed in terms of known parameters and the eight unknown promotion quantities, thus yielding the following sixteen state quantities:

$$S(RES,G,i{+}1),\ S(REG,G,i{+}1),$$
$$S(RES,G{+}1,i{+}1),\ S(REG,G{+}1,i{+}1),\ \text{for } i = 1,2,3,4.$$

These state quantities, along with other inputs, will be used to derive eight constraint equations in the eight unknown promotion quantities P_2 thru P_5 and π_2 thru π_5.

EIGHT CONSTRAINT EQUATIONS

We now must specify the eight constraint equations. Two of them deal with below-the-zone promotions, two with cumulative promotion opportunity, and four relate reserve and regular promotions.

Secondary-Zone Promotions

The user of the model specifies the fraction (F) of secondary or below-the-zone promotions that take place in the first year of the promotion cycle.
Then

$$k_B = F/(1-F)$$

and

$$P_2 + \pi_2 = k_B \cdot (P_3+\pi_3) \qquad \text{(B-5)}$$

is the first constraint equation as required to insure that the proper distribution of below-the-zone promotions will occur in the two below-the-zone promotion years. The user also specifies the proportion (BZF) of total promotions that must occur the secondary zone. Thus the second condition that must be satisfied is given by

$$P_2 + P_3 + \pi_2 + \pi_3 = (BZF) \cdot (P_2+P_3+P_4+P_5+\pi_2+\pi_3+\pi_4+\pi_5) \qquad \text{(B-6)}$$

Promotion Opportunity

The third and fourth equations are constraint equations that provide for cumulative promotion opportunities in the first and second years in the primary zone. Let

C_4 = The proportion of officers who survive to the fourth promotion cycle year in grade G or higher who have been promoted to grade G+1 or higher during or prior to cycle year 4, i.e., the first year promotion opportunity.

Then the third constraint equation is given by

$$\begin{aligned} &S(RES,G+1,4) + S(REG,G+1,4) \\ &= C_4 \cdot [S(RES,G,4) + S(REG,G,4) + S(RES,G+1,4) \\ &\quad + S(REG,G+1,4)]. \end{aligned} \qquad \text{(B-7)}$$

Let

C_5 = The proportion of officers who survive to the *fourth* promotion cycle year in grade G or higher and who are promoted to grade G+1 during their career, i.e., the second year promotion opportunity.

Then the fourth constraint equation is given by

$$\begin{aligned} & S(RES,G{+}1,5) + S(REG,G{+}1,5) + S(RES,G{+}1,4) \\ & \cdot B(RES,G{+}1,4) + S(REG,G{+}1,4) \cdot B(REG,G{+}1,4) \\ = {} & C_5 \cdot [S(RES,G,4) + S(REG,G,4) \\ & + S(RES,G{+}1,4) + S(REG,G{+}1,4)]. \end{aligned} \qquad \text{(B-8)}$$

<u>Relating Reserve to Regular Promotions</u>

The last four constraint equations define relationships between P_i and π_i for i = 2,3,4,5 as follows:

$$P_i = k_i \cdot \pi_i \text{ for } i = 2,3,4,5. \qquad \text{(B-9)}$$

To estimate k_i, we assume the ratio of reserve to regular state quantities for cycle year i is approximately equal to what their ratios would have been had *no rating transfers or promotions occurred* and that k_i equals this ratio. Thus for zero rating transfers and promotions, we have from Fig. B-1

$$S^1(RES,G,2) = S(RES,G,1) \cdot RE(RES,G,1) \cdot NAUG(G,1). \qquad \text{(B-10)}$$

$$\begin{aligned} S^1(REG,G,2) = {} & S(REG,G,1) \cdot RE(REG,G,1) \\ & + S(RES,G,1) \cdot RE(RES,G,1) \cdot AUG(G,1). \end{aligned} \qquad \text{(B-11)}$$

$$S^1(RES,G,3) = S^1(RES,G,2) \cdot RE(RES,G,2) \cdot NAUG(G,2). \qquad \text{(B-12)}$$

$$\begin{aligned} S^1(REG,G,3) = {} & S^1(REG,G,2) \cdot RE(REG,G,2) \\ & + S^1(RES,G,2) \cdot RE(RES,G,2) \cdot AUG(G,2). \end{aligned} \qquad \text{(B-13)}$$

$$S^1(RES,G,4) = S^1(RES,G,3) \cdot RE(RES,G,3) \cdot NAUG(G,3). \qquad \text{(B-14)}$$

$$\begin{aligned} S^1(REG,G,4) = {} & S^1(REG,G,3) \cdot RE(REG,G,3) \\ & + S^1(RES,G,3) \cdot RE(RES,G,3) \cdot AUG(G,3) \end{aligned} \qquad \text{(B-15)}$$

$$S^1(RES,G,5) = S^1(RES,G,4) \cdot RE(RES,G,4) \cdot NAUG(G,4). \qquad (B\text{-}16)$$

$$S^1(REG,G,5) = S^1(REG,G,4) \cdot RE(REG,G,4) + S^1(RES,G,4) \cdot RE(RES,G,4) \cdot AUG(G,4). \qquad (B\text{-}17)$$

$$k_i = S^1(RES,G,i)/S^1(REG,G,i) \text{ for } i = 2,3,4,5. \qquad (B\text{-}18)$$

where

$S^1(RES,G,i)$ = Number of reserve officers in state (RES,G,i) under conditions of zero rating transfers and promotions $i = 2,3,4,5$.

$S^1(REG,G,i)$ = Number of regular officers in state (REG,G,i) under conditions of zero rating transfers and promotions $i = 2,3,4,5$.

Eight Constraint Equations in Terms of P_i and π_i, $i = 2,3,4,5$

We now have all the information required to solve for the number of reserve, P_i, and regular promotions, π_i, in promotion cycle years i, $i = 2,3,4,5$. We substitute the sixteen state quantities in terms of state quantities for cycle year 1 into the eight constraint equations (B-5) through (B-9). We also substitute k_i for $i = 2,3,4,5$ from equation (B-18) into (B-5) through (B-9) to produce the following eight constraint equations containing only eight unknown variables, P_i and π_i, $i = 2,3,4,5$.

$$P_2+\pi_2 = k_B(P_3+\pi_3). \qquad (B\text{-}19)$$

$$P_2+P_3+\pi_2+\pi_3 = (BZF) \cdot (P_2+P_3+P_4+P_5+\pi_2+\pi_3+\pi_4+\pi_5). \qquad (B\text{-}20)$$

$$J_2P_2+J_3P_3+P_4+L_2\pi_2+L_3\pi_3+\pi_4 = C. \qquad (B\text{-}21)$$

$$M_2P_2+M_3P_3+P_4+P_5+N_2\pi_2+N_3\pi_3+\pi_4+\pi_5 = D. \qquad (B\text{-}22)$$

$$P_2 = k_2 \cdot \pi_2. \qquad (B\text{-}23)$$

$$P_3 = k_3 \cdot \pi_3. \qquad (B\text{-}24)$$

$$P_4 = k_4 \cdot \pi_4. \qquad (B\text{-}25)$$

$$P_5 = k_5 \cdot \pi_5. \qquad (B\text{-}26)$$

where

$$J_2 = \alpha_2 \cdot C_4 + \beta_2 \cdot (1-C_4). \quad \text{(B-27)}$$
$$J_3 = \alpha_3 \cdot C_4 + \beta_3 \cdot (1-C_4). \quad \text{(B-28)}$$
$$L_2 = \gamma_2 \cdot C_4 + \Delta_2 \cdot (1-C_4). \quad \text{(B-29)}$$
$$L_3 = \gamma_3 \cdot C_4 + \Delta_3 \cdot (1-C_4). \quad \text{(B-30)}$$
$$C = C_4 \cdot (z_1+z_2+z_3). \quad \text{(B-31)}$$
$$M_2 = \alpha_2 \cdot C_5 + \beta_2 \cdot (1-C_5). \quad \text{(B-32)}$$
$$M_3 = \alpha_3 \cdot C_5 + \beta_3 \cdot (1-C_5). \quad \text{(B-33)}$$
$$N_2 = \gamma_2 \cdot C_5 + \Delta_2 \cdot (1-C_5). \quad \text{(B-34)}$$
$$N_3 = \gamma_3 \cdot C_5 + \Delta_3 \cdot (1-C_5). \quad \text{(B-35)}$$
$$D = C_5 \cdot (z_1+z_2+z_3). \quad \text{(B-36)}$$

and for non-rated lieutenants

$$\alpha_2 = RE(RES,G,2) \cdot NRAT(RES,2) \cdot [NAUG(G,2) \cdot RE(RES,G,3) \cdot NRAT(RES,3) + AUG(G,2) \cdot RE(REG,G,3) \cdot NRAT(REG,3)].$$
$$\beta_2 = RE(RES,G{+}1,2) \cdot [NAUG(G{+}1,2) \cdot RE(RES,G{+}1,3) + AUG(G{+}1,2) \cdot RE(REG,G{+}1,3)].$$
$$\alpha_3 = RE(RES,G,3) \cdot NRAT(RES,3).$$
$$\beta_3 = RE(RES,G{+}1,3).$$
$$\gamma_2 = RE(REG,G,2) \cdot NRAT(REG,2) \cdot RE(REG,G,3) \cdot NRAT(REG,3).$$
$$\Delta_2 = RE(REG,G{+}1,2) \cdot RE(REG,G{+}1,3).$$
$$\gamma_3 = RE(REG,G,3) \cdot NRAT(REG,3).$$
$$\Delta_3 = RE(REG,G{+}1,3).$$
$$z_1 = S(RES,G,1) \cdot RE(RES,G,1) \cdot NRAT(RES,1) \cdot [NAUG(G,1) \cdot \alpha_2 + AUG(G,1) \cdot \gamma_2].$$
$$z_2 = S(REG,G,1) \cdot RE(REG,G,1) \cdot NRAT(REG,1) \cdot \gamma_2.$$
$$z_3 = 0.$$

By substituting values of (P_i/k_i) from expressions (B-23) through (B-26) in equations (B-19) through (B-22) we get four equations and four unknown variables, π_i, $i = 2,3,4,5$. Further successive substitutions lead to the following explicit solutions of π_i, $i = 2,3,4,5$.

$$\pi_2 = \frac{k_B(BZF)D\left[\frac{1+k_3}{1+k_2}\right]}{(1+k_B)(1+k_3)(1-BZF)+(BZF)\left[\frac{k_B(1+k_3)}{(1+k_2)}(k_2M_2+N_2) + k_3M_3+N_3\right]} \quad (B-37)$$

$$\pi_3 = \frac{(BZF)D}{(1+k_B)(1+k_3)(1-BZF)+(BZF)\left[\frac{k_B(1+k_3)}{(1+k_2)}(k_2M_2+N_2) + k_3M_3+N_3\right]} \quad (B-38)$$

$$\pi_4 = \frac{C}{(1+k_4)} - \frac{\left[\frac{(BZF)D}{(1+k_4)}\right]\left[\frac{k_B(1+k_3)(J_2k_2+L_2)}{(1+k_2)} + J_3k_3+L_3\right]}{(1+k_B)(1+k_3)(1-BZF)+(BZF)\left[\frac{k_B(1+k_3)}{(1+k_2)}(k_2M_2+N_2) + k_3M_3+N_3\right]} \quad (B-39)$$

$$\pi_5 = \frac{1}{(1+k_5)}\left\{\frac{(1+k_B)(1+k_3)(1-BZF)D+(BZF)D\left[\frac{k_B(1+k_3)}{(1+k_2)}(J_2k_2+L_2) + J_3k_3+L_3\right]}{(1+k_B)(1+k_3)(1-BZF)+(BZF)\left[\frac{k_B(1+k_3)}{(1+k_2)}(k_2M_2+N_2) + k_3M_3+N_3\right]}\right\} - \frac{C}{(1+k_5)} \quad (B-40)$$

Then P_i, $i = 2,3,4,5$ can be computed using expressions (B-37) through (B-40) in expressions (B-23) through (B-26).

COMPUTATION OF FLOWS

Now that the model has computed the total number of regular promotions in cycle year i, it is necessary to prorate these promotions among officers:

- o Who were regular non-rated lieutenants* and were promoted to regular non-rated captain, $PR(2,2,3,IS,Y_i)$.†
- o Who were reserve non-rated lieutenants and who were augmented into the regular component and then promoted to regular non-rated captains, $PA(2,2,3,IS,Y_i)$.

where Y_i = Year of service that corresponds to cycle year i. Figure B-2 will be useful in following the explanation of the following computations. Let

a_i = The number of reserve non-rated lieutenants who are not lost to the Air Force in YOS Y_{i-1} and who do not complete UPT or UNT in YOS Y_i and who are augmented into the regular component in YOS Y_i, i = 2,3,4,5

$$= S(1,1,3,IS,Y_{i-1}) \cdot RE(1,1,3,IS,Y_{i-1}) \cdot NRAT(1,1,3,IS,Y_{i-1}) \cdot AUG(1,1,3,IS,Y_{i-1}).$$

and

b_i = Number of regular non-rated lieutenants who are not lost to the Air Force in YOS Y_{i-1} and who do not complete UPT or UNT in YOS Y_i, i = 2,3,4,5

$$= S(2,1,3,IS,Y_{i-1}) \cdot RE(2,1,3,IS,Y_{i-1}) \cdot NRAT(2,1,3,IS,Y_{i-1}).$$

$PR(1,2,3,IS,Y_i)$ = Number of non-rated reserve lieutenants with YOS Y_{i-1} who are promoted but who do not receive a rating transfer nor are augmented into the regular component in YOS Y_i

$$= P_i. \qquad \text{(B-41)}$$

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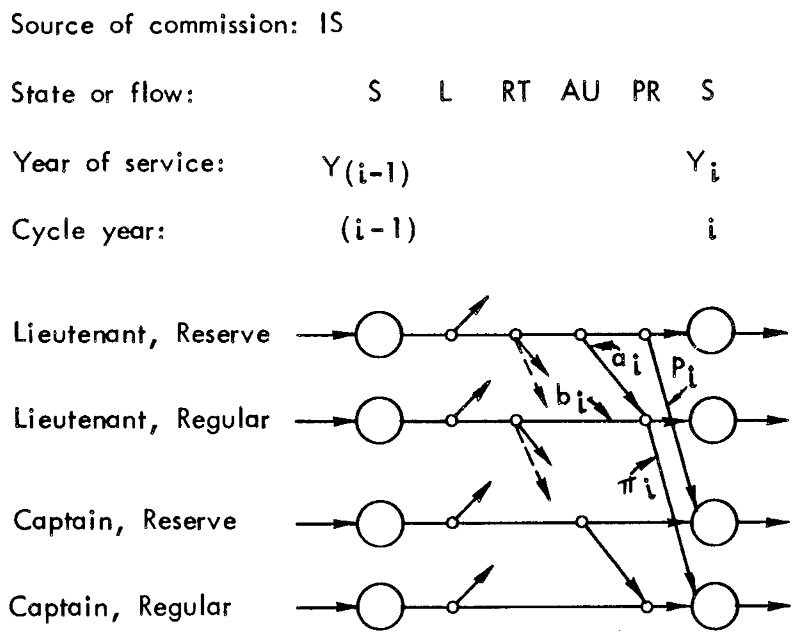
*In the discussion of grades in this appendix, all grades are current, not permanent.

†The five-subscript notation will be used for the remainder of Part 1.



KEY:

S = State
L = Loss
RT = Rating transfer
AU = Augmentation
PR = Promotion

Fig. B-2—Computation of flows: nonrated lieutenant

$PR(2,2,3,IS,Y_i)$ = Number of regular non-rated lieutenants with YOS Y_{i-1} who are promoted but who do not receive a rating transfer in YOS Y_i

$$= [b_i/(a_i+b_i)] \cdot \pi_i. \qquad \text{(B-42)}$$

$PA(2,2,3,IS,Y_i)$ = Number of reserve non-rated lieutenants with YOS Y_{i-1} who do not receive a rating transfer in YOS Y_i but who are promoted *and* augmented into the regular component in YOS Y_i

$$= [a_i/(a_i+b_i)] \cdot \pi_i.$$

$AU(1,1,3,IS,Y_i)$ = Number of reserve non-rated lieutenants with YOS Y_{i-1} who do not receive a rating transfer and who are not promoted in YOS Y_i but who are augmented into the regular component in YOS Y_i

$$= a_i - PA(2,2,3,IS,Y_i). \qquad \text{(B-44)}$$

$LAT(1,1,3,IS,Y_i)$ = Number of lateral flows from state $(1,1,3,IS,Y_{i-1})$ into state $(1,1,3,IS,Y_i)$

$$= S(1,1,3,IS,Y_{i-1}) \cdot RE(1,1,3,IS,Y_{i-1}) \cdot NRAT(1,1,3,IS,Y_{i-1}) \cdot NAUG(1,1,3,IS,Y_{i-1}) - P_i. \qquad \text{(B-45)}$$

$LAT(2,1,3,IS,Y_i)$ = Number of lateral flows from state $(2,1,3,IS,Y_{i-1})$ into state $(2,1,3,IS,Y_i)$

$$= S(2,1,3,IS,Y_{i-1}) \cdot RE(2,1,3,IS,Y_{i-1}) \cdot NRAT(2,1,3,IS,Y_{i-1}) - \pi_i. \qquad \text{(B-46)}$$

PART 2: PILOT OR NAVIGATOR LIEUTENANTS

Figure B-3 depicts a five-year promotion cycle for pilot or navigator lieutenants. Figure B-3 is similar to Fig. 21 in Section II with the paths P_i and π_i, respectively, labeled to designate the quantity of promotions of pilots (or navigators) to captain during promotion cycle year i.

KEY:

S = State
L = Loss
RT = Rating transfer
AU = Augmentation
PR = Promotion

P_i = Quantity of Reserve promotions into cycle year i
π_i = Quantity of Regular promotions into cycle year i
r_i = Reserve nonrated officers who complete UPT or UNT in cycle year i
R_i = Regular officers who complete UPT or UNT in cycle year i

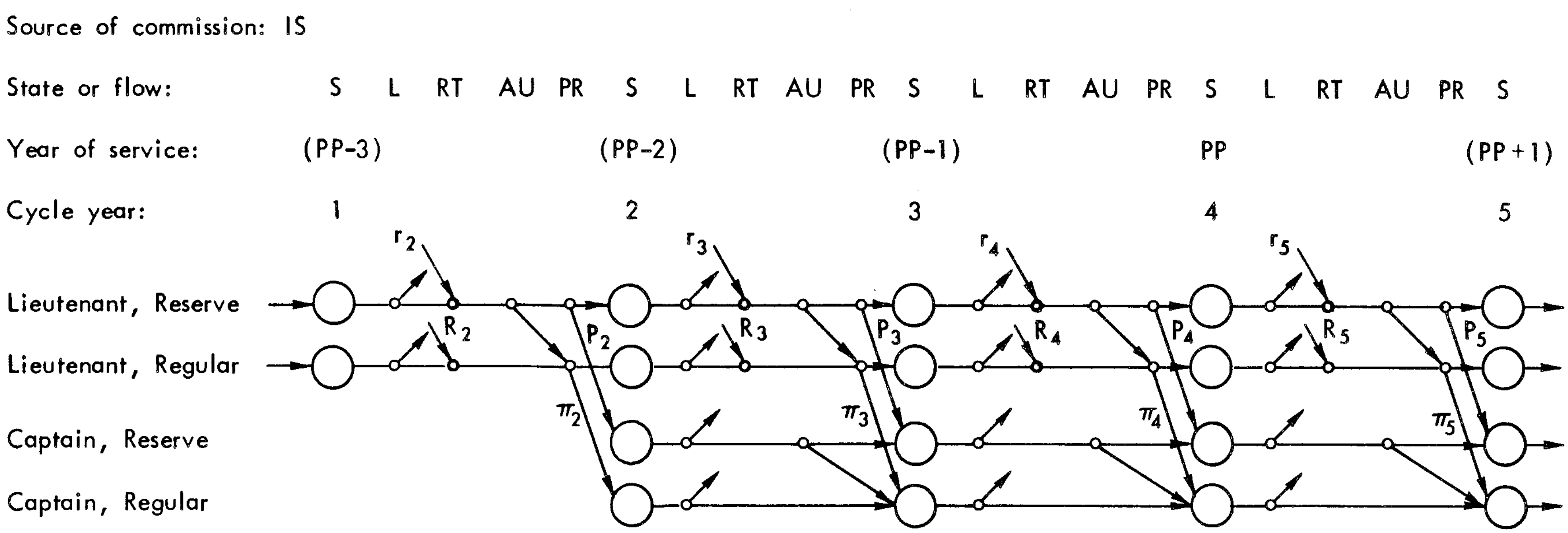


Fig. B-3 — Promotion cycle, lieutenant to captain, pilot (or navigator): variable phase point, YOS PP

SYMBOLS AND NOTATION

In Part 2,

r_i = The number of non-rated reserve lieutenants who complete UPT (or UNT) and are awarded an aeronautical rating of pilot (or navigator) in cycle year i as explained in Appendix A.

R_i = The number of non-rated regular lieutenants who complete UPT (or UNT) and are awarded an aeronautical rating of pilot (or navigator) in cycle year i as explained in Appendix A.

Other symbols and notation are as defined in Part 1 of this appendix, except that they apply to pilots (or navigators). For example,

S(RES,G,1) = The number of reserve pilots (or navigators) in grade G, in cycle year 1 with source of commission IS; since the aeronautical rating and source of commission are known during this part of the computation, they need not be subscripted.

RECURSIVE FORMULAS

From Fig. B-3, with lieutenant = G and captain = G+1,

$$S(RES,G+1,1) = S(REG,G+1,1) = 0.$$

The model has computed and has values for S(RES,G,1) and S(REG,G,1) so that these values are available when required during further computation described below.

Then for pilot (or navigator) lieutenants we have the following recursive formulas for i = 1,2,3,4:

$$S(RES,G,i+1) = [S(RES,G,i) \cdot RE(RES,G,i) + r_i] \cdot NAUG(G,i) - P_{i+1}. \qquad (B-47)$$

$$S(REG,G,i+1) = S(REG,G,i) \cdot RE(REG,G,i) + R_i + [S(RES,G,i) \cdot RE(RES,G,i) + r_i] \cdot AUG(G,i) - \pi_{i+1}. \quad \text{(B-48)}$$

$$S(RES,G+1,i+1) = S(RES,G+1,i) \cdot RE(RES,G+1,i) \cdot NAUG(G+1,i) + P_{i+1}. \quad \text{(B-49)}$$

$$S(REG,G+1,i+1) = S(REG,G+1,i) \cdot RE(REG,G+1,i) + S(RES,G+1,i) \cdot RE(RES,G+1,i) \cdot AUG(G+1,i) + \pi_{i+1}. \quad \text{(B-50)}$$

STATE QUANTITY FORMULAS IN TERMS OF STATE QUANTITIES FOR CYCLE YEAR 1

As in Part 1, by successive evaluation for i = 1,2,3,4 of expressions (B-47) through (B-50) we can get sixteen state quantity expressions in terms of eight unknown variables P_2 through P_5 and π_2 through π_5, and known parameters and state quantities for cycle year 1.

EIGHT CONSTRAINT EQUATIONS

The fraction, F, of the secondary or below-the-zone promotions is specified by the user of the model; as in Part 1,

$$k_B = F/(1-F)$$

and

$$P_2 + \pi_2 = k_B \cdot (P_3+\pi_3) \quad \text{(B-5)}$$

is the first constraint equation that the model must satisfy. As in Part 1, the user also specifies the proportion (BZF) of total promotions that must occur in the secondary zone, and

$$P_2 + P_3 + \pi_2 + \pi_3 = (BZF) \cdot (P_2+P_3+P_4+P_5+\pi_2+\pi_3+\pi_4+\pi_5) \quad \text{(B-6)}$$

is the second constraint equation. Similarly, the remaining six constraint equations for pilot (or navigator) lieutenants are exactly as required for non-rated lieutenants and are given by expressions (B-7) through (B-9) in Part 1.

Similarly, expressions (B-10) through (B-18) of Part 1 also apply to pilot (or navigator) lieutenants.

EIGHT CONSTRAINT EQUATIONS IN TERMS OF P_i and π_i, i = 2,3,4,5

For pilots (or navigators) expressions (B-19) through (B-36) are unchanged, with the following modifications:

$$\alpha_2 = RE(RES,G,2) \cdot [NAUG(G,2) \cdot RE(RES,G,3) + AUG(G,2,) \cdot RE(REG,G,3)].$$

$$\beta_2 = RE(RES,G+1,2) \cdot [NAUG(G+1,2) \cdot RE(RES,G+1,3) + AUG(G+1,2) \cdot RE(REG,G+1,3)].$$

$$\alpha_3 = RE(RES,G,3).$$

$$\beta_3 = RE(RES,G+1,3).$$

$$\gamma_2 = RE(REG,G,2) \cdot RE(REG,G,3).$$

$$\Delta_2 = RE(REG,G+1,2) \cdot RE(REG,G+1,3).$$

$$\gamma_3 = RE(REG,G,3).$$

$$\Delta_3 = RE(REG,G+1,3).$$

$$z_1 = S(RES,G,1) \cdot RE(RES,G,1) \cdot [NAUG(G,1) \cdot \alpha_2 + AUG(G,1) \cdot \gamma_2].$$

$$z_2 = S(REG,G,1) \cdot RE(REG,G,1) \cdot \gamma_2.$$

$$z_3 = r_2 \cdot [NAUG(G,1) \cdot \alpha_2 + AUG(G,1) \cdot \gamma_2] + r_3 \cdot [NAUG(G,2) \cdot \alpha_3 + AUG(G,2) \cdot \gamma_3] + r_4 + R_2 \cdot \gamma_2 + R_3 \cdot \gamma_3 + R_4.$$

As in Part 1, we are able to reduce the eight constraint equations to four equations, (B-37) through (B-40), that provide explicit solutions for π_2 through π_5 from which P_2 through P_5 may be solved using solutions of π_2 through π_5 in expressions (B-23) through (B-26).

COMPUTATION OF FLOWS

Figure B-4 is useful in explaining how flows of pilot (or navigator) lieutenants are computed. The following discussion is in terms of pilots but applies equally to navigators. Let

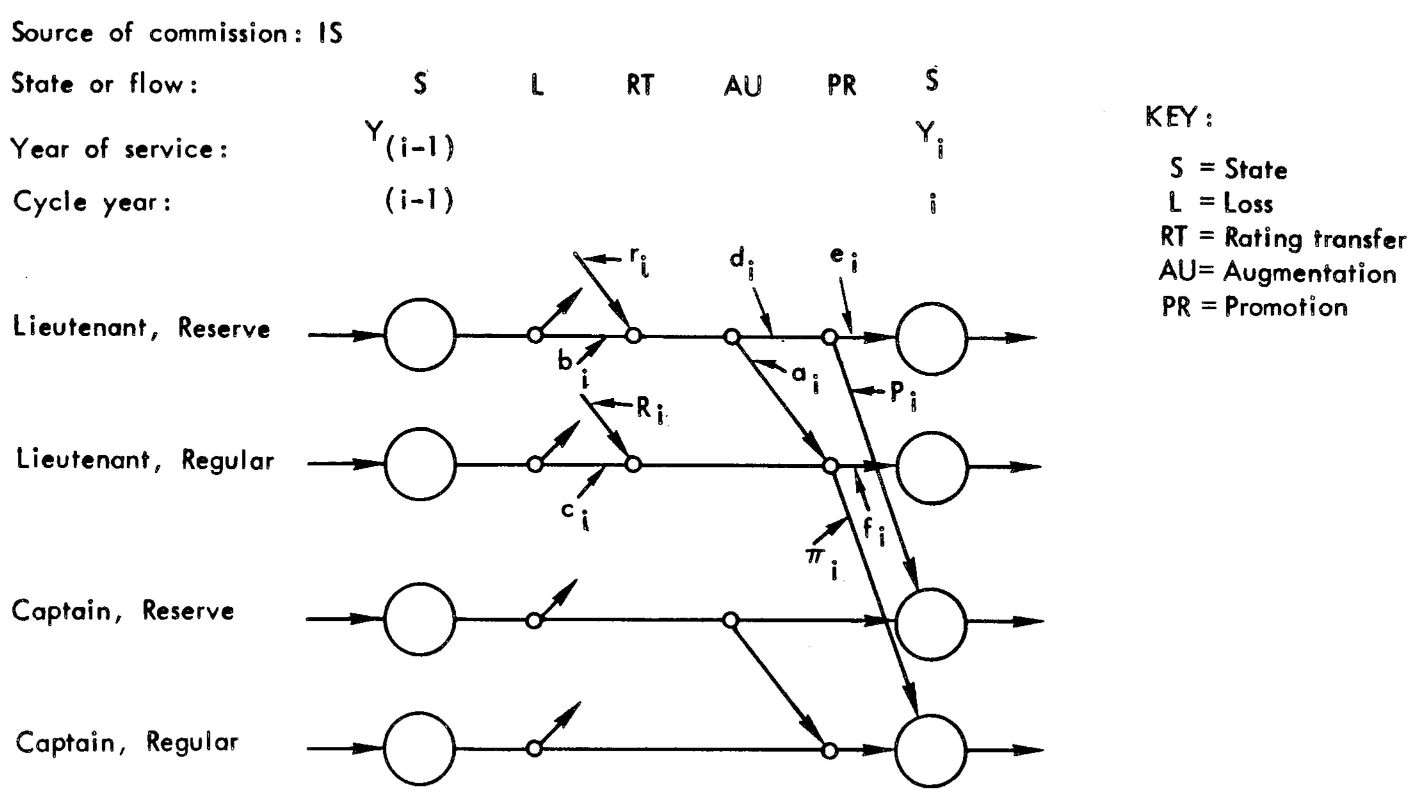


Fig. B-4—Computation of flows: pilot (or navigator) lieutenant

b_i = Number of reserve lieutenant pilots with source of commission IS who are in the officer force with YOS Y_{i-1} and who are not lost during YOS Y_{i-1}

$= S(1,1,1,IS,Y_{i-1}) \cdot RE(1,1,1,IS,Y_{i-1}).$*

c_i = Number of regular lieutenant pilots with source of commission IS who are in the officer force with YOS Y_{i-1} and who are not lost during YOS Y_{i-1}

$= S(2,1,1,IS,Y_{i-1}) \cdot RE(2,1,1,IS,Y_{i-1}).$

r_i = Number of non-rated reserve lieutenants with source of commission IS who complete UPT and receive an aeronautical rating of pilot in YOS Y_i.

R_i = Number of non-rated regular lieutenants with source of commission IS who complete UPT and receive an aeronautical rating of pilot in YOS Y_i.

P_i = Number of reserve pilot lieutenants with source of commission IS who are promoted to captain in YOS Y_i.

π_i = Number of regular pilot lieutenants with source of commission IS who are promoted to captain in YOS Y_i.

a_i = Number of reserve pilot lieutenants with source of commission IS who are augmented into the regular component in YOS Y_i

$= (b_i+r_i) \cdot AUG(2,1,1,IS,Y_{i-1}).$

d_i = Number of reserve pilot lieutenants with source of commission IS who are not lost or augmented into the regular component in YOS Y_i

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*We revert to the five-subscript notation for the remainder of this part.

$= (b+r_i) \cdot NAUG(2,1,1,IS,Y_{i-1})$.

e_i = Number of reserve pilots with source of commission IS who are not augmented into the regular component or lost to the Air Force or promoted in YOS Y_i.

$= (b_i+r_i) \cdot NAUG(2,1,1,IS,Y_{i-1}) - P_i$.

$RT(1,1,1,IS,Y_i)$ = Number of non-rated reserve lieutenants with source of commission IS who complete UPT in YOS Y_i but who are not augmented into the regular component or promoted in YOS Y_i.

$= r_i \cdot NAUG(2,1,1,IS,Y_{i-1}) \cdot [e_i/(P_i+e_i)]$.

$RT(2,1,1,IS,Y_i)$ = Number of non-rated regular lieutenants with source of commission IS who complete UPT and are awarded an aeronautical rating of pilot in YOS Y_i but who are not promoted in YOS Y_i

$= R_i \cdot [f_i/(f_i+\pi_i)]$

where

$$f_i = (b_i+r_i) \cdot AUG(2,1,1,IS,Y_{i-1}) + c_i + r_i - \pi_i.$$

also

$RA(2,1,1,IS,Y_i)$ = Number of non-rated reserve lieutenants with source of commission IS who complete UPT and are awarded an aeronautical rating of pilot and are also augmented into the regular component in YOS Y_i but who are not promoted in YOS Y_i

$= r_i \cdot AUG(2,1,1,IS,Y_{i-1}) \cdot [f_i/(f_i+\pi_i)]$.

$LAT(2,1,1,IS,Y_i)$ = Number of regular pilot lieutenants with YOS Y_{i-1} and source of commission IS who are not lost to the Air Force in YOS Y_{i-1} nor promoted in YOS Y_i

$= c_i \cdot [f_i/(f_i+\pi_i)]$.

$PR(2,2,1,IS,Y_i)$ = Number of regular pilot lieutenants with source of commission IS who are promoted in YOS Y_i and who were regular officers prior to YOS Y_i

$$= [S(2,1,1,IS,Y_{i-1}) \cdot RE(2,1,1,IS,Y_{i-1}) + R_i] \cdot [\pi_i/(f_i+\pi_i)].$$

$LAT(1,1,1,IS,Y_i)$ = Number of reserve pilot lieutenants with YOS Y_{i-1} and source of commission IS who are not lost to the Air Force in YOS Y_{i-1} nor promoted nor augmented into the regular component in YOS Y_i

$$= S(1,1,1,IS,Y_{i-1}) \cdot RE(1,1,1,IS,Y_{i-1}) \cdot NAUG(2,1,1,IS,Y_{i-1}) \cdot [e_i/(e_i+P_i)].$$

$PR(1,2,1,IS,Y_i)$ = Number of reserve pilot lieutenants with source of commission IS who are promoted in YOS Y_i but who are not augmented in YOS Y_i

$$= [S(1,1,1,IS,Y_{i-1}) \cdot RE(1,1,1,IS,Y_{i-1}) + r_i] \cdot NAUG(2,1,1,IS,Y_{i-1}) \cdot [P_i/(P_i+e_i)].$$

$PA(2,2,1,IS,Y_i)$ = Number of reserve pilot lieutenants with source of commission IS who are promoted and augmented in YOS Y_i

$$= [S(1,1,1,IS,Y_{i-1}) \cdot RE(1,1,1,IS,Y_{i-1}) + r_i] \cdot AUG(2,1,1,IS,Y_{i-1}) \cdot [\pi_i/(\pi_i+a_i)].$$

PART 3: CAPTAINS AND HIGHER GRADES; RATED AND NON-RATED OFFICERS

Figure B-5, which is the same as Fig. 23 in the text and is shown again in this appendix for the convenience of the reader, depicts the promotion cycle for any Grade G, captain or higher, being promoted into Grade G+1, major or higher. It will be noted that Fig. B-5 is exactly like Figs. B-1 and B-3 if there were no rating transfers* for lieutenants. Thus we set

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*Rating transfers occur only in the grade of lieutenant in the OFPM.

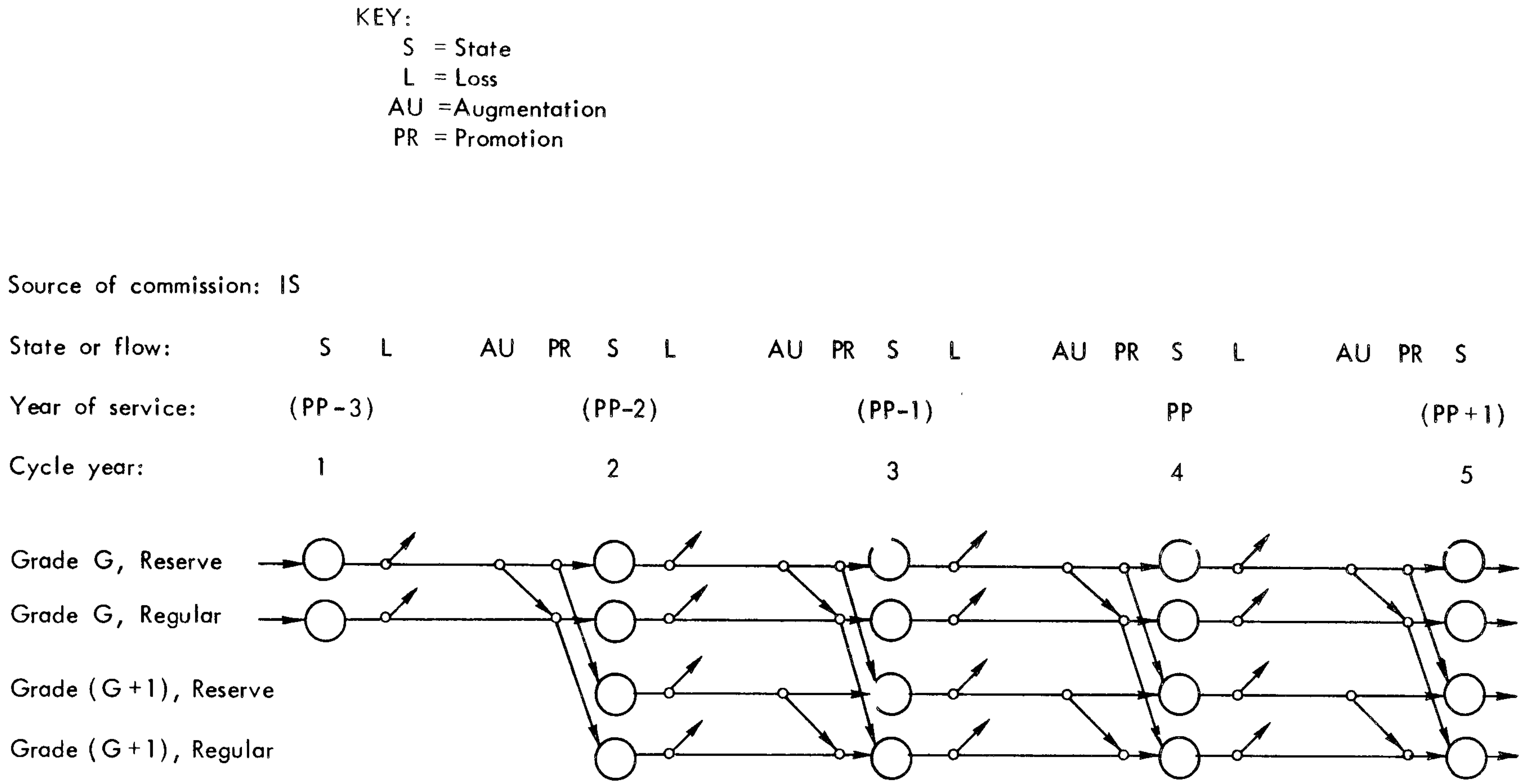

Fig. B-5—Four-year promotion cycle into major (or higher grade): variable phase point, YOS PP

$$r_i = R_i = 0,$$

$$\text{RAT(RES,i)} = \text{RAT(REG,i)} = 0$$
$$\text{NRAT(RES,i)} = \text{NRAT(REG,i)} = 1$$

and G in place of lieutenant (G=1) and G+1 in place of captain (G=2) in expressions (B-1) through (B-50). Then the expressions in Part 1 will agree with those in Part 2, and either may be used to compute the number of reserve and regular officers promoted in cycle year i respectively, P_i and π_i, i = 2,3,4,5, from Grade G to Grade G+1.

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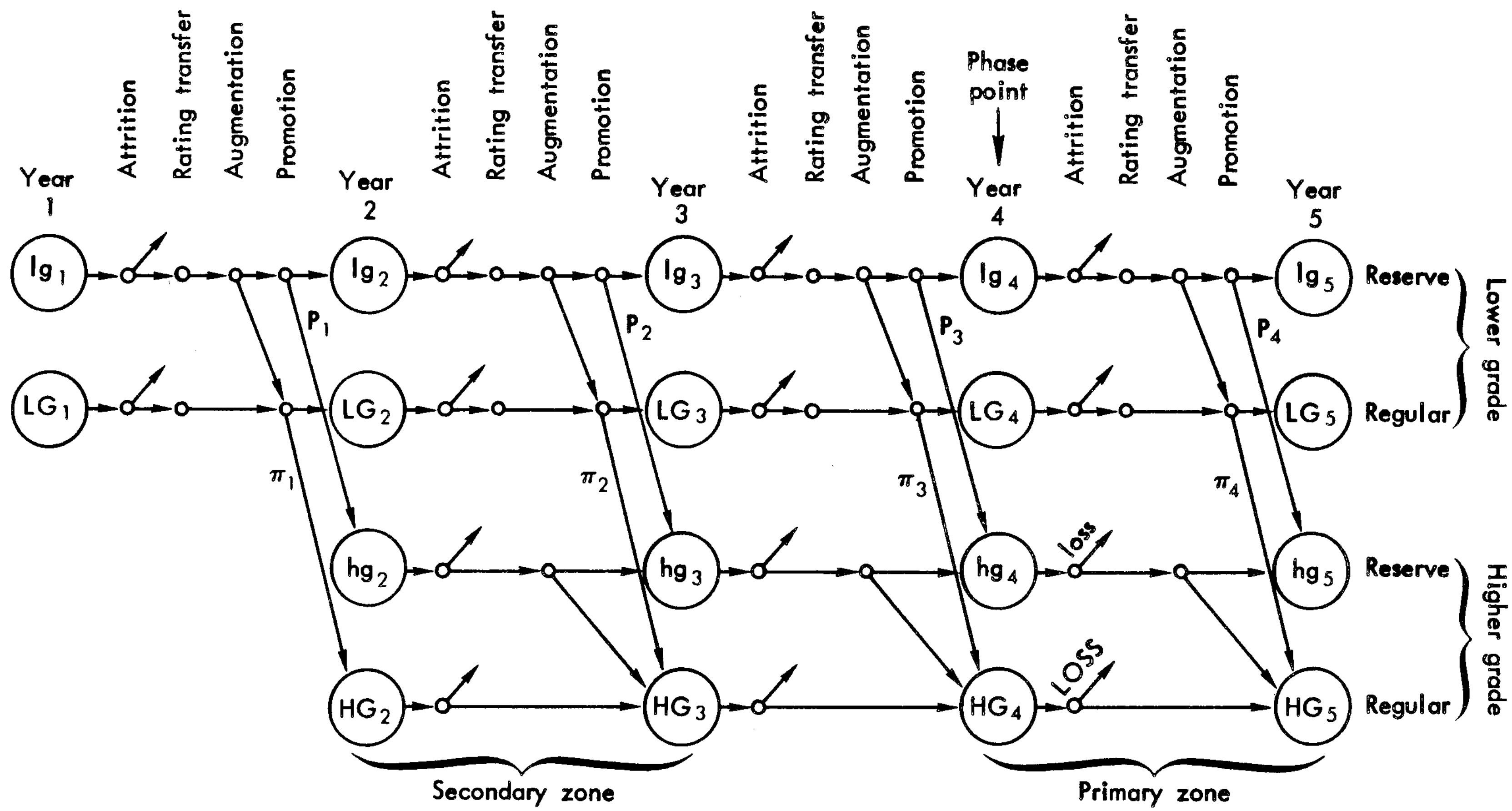
3. Nerlove, M., and S. J. Press, *Univariate and Multivariate Log-Linear and Logistic Models*, The Rand Corporation, R-1306-EDA/NIH, December 1973.



Lower case state labels identify reserve states, and upper case state labels refer to regular states

"lg" and "LG" identify the lower grade's states, while "hg" and "HG" refer to higher grade states

Fig. 3.1 — Promotion zone

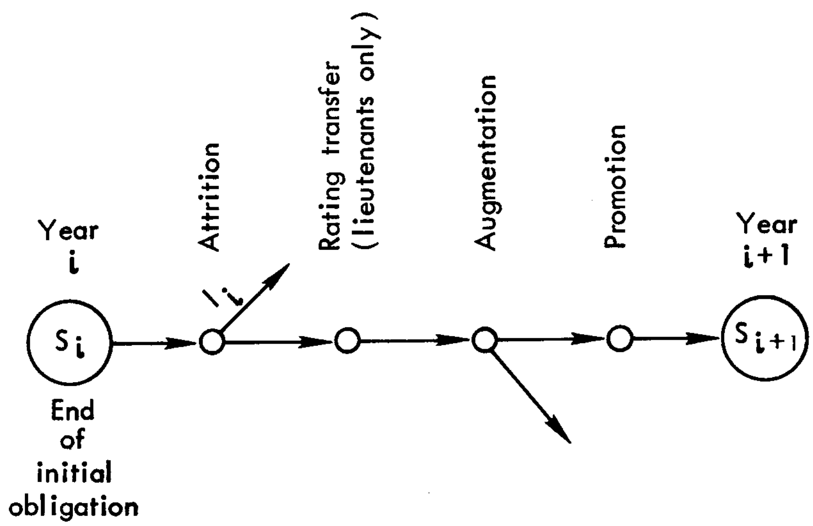


Fig. 3.2 — End of initial obligation — career reserve requirements

Miller, Sammis,
and Shukiar

THE OFFICER FORCE PROGRESSION MODEL: A STEADY-STATE MATHEMATICAL MODEL OF THE U. S. AIR FORCE OFFICER STRUCTURE

R-1607-PR