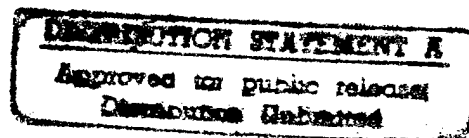


report

CR-190

NPS Gains Module of the ELIM-COMPLIP System of Manpower Planning Models

Henry S. Weigel
Betty W. Holz
Kenneth D. Midlam
Lawrence D. Koenig



May 1977

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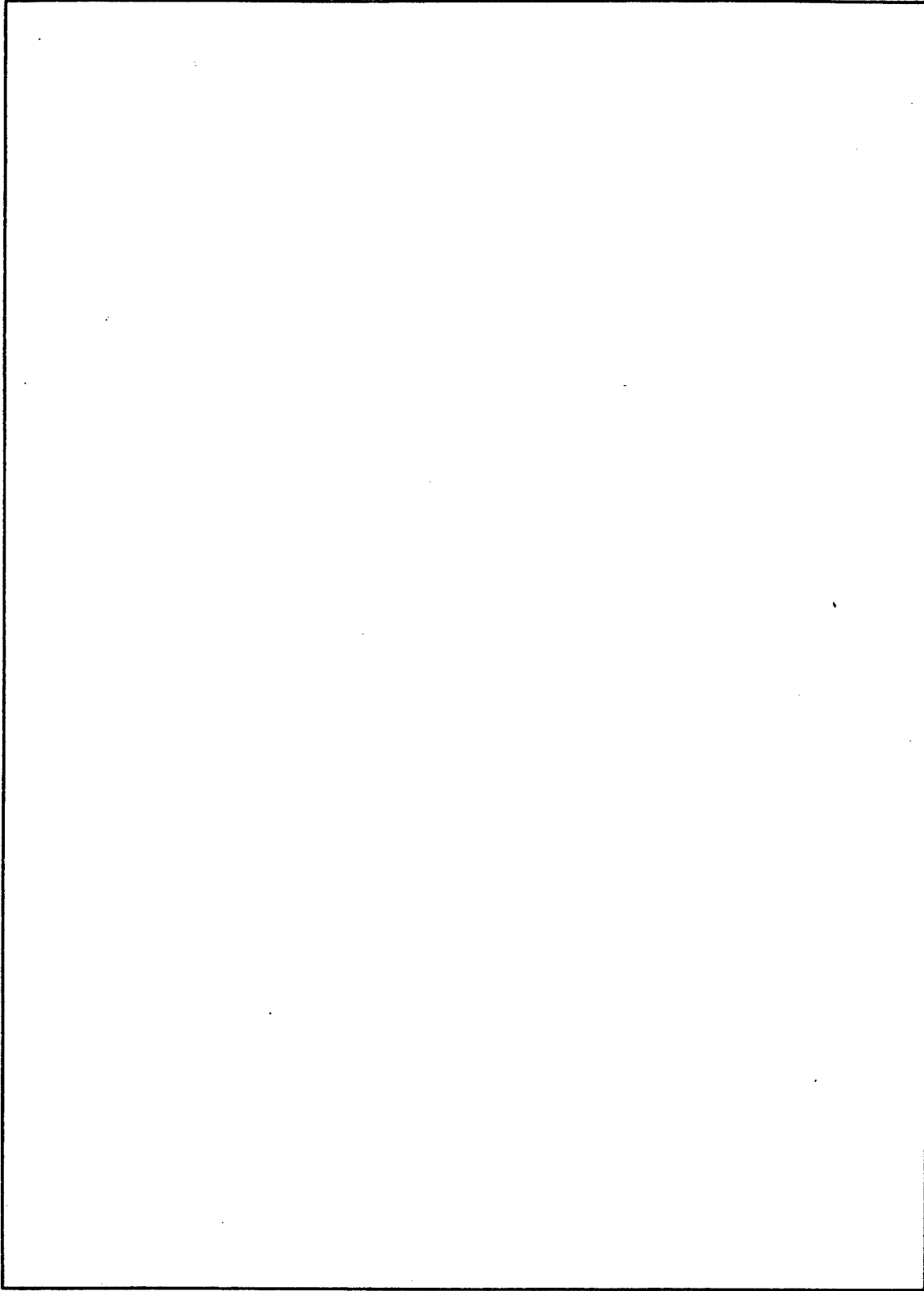
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ABBREVIATIONS AND ACRONYMS

ADT	active duty for training
BMD02R	Stepwise Multiple Linear Regression Program available from the UCLA package of Biomedical Computer Programs
C-group	Characteristic group
COMPLIP	Computation of Manpower Programs Using Linear Programming
DOD	Department of Defense
EAMAP	Evaluation of Army Manpower Accession Programs
ELIM	Enlisted Loss Inventory Model
EMF	Enlisted Master File
ETS	expiration of term of service
FT	first term
FTI	first timers
FY	fiscal year
GRC	General Research Corporation
IPM	Inventory Projection Module
LSN	lottery sequence number
MPA	Military Personnel, Army
MPD	Manpower Programs Division
NPS	no prior service
NPSGM	no prior service gains module
ODCSPER	Office of the Deputy Chief of Staff for Personnel
ODS	Office of the Secretary of Defense
POM	Program Objectives Memorandum
PS	prior service
RA	Regular Army

RAC	Research Analysis Corporation
REP	Reserve Enlisted Program
SAG	Study Advisory Group
STI	second timers
UCLA	University of California in Los Angeles

Chapter 1

INTRODUCTION

The ELIM-COMPLIP System, developed by the General Research Corporation (GRC) and the predecessor organization, Research Analysis Corporation (RAC), is one of the key tools used for Army manpower planning. The major components of the system are ELIM (Enlisted Loss Inventory Model), which is used to monitor, analyze, and make the official forecast of enlisted losses, and COMPLIP (Computation of Manpower Programs Using Linear Programming), which is used to generate the official Army manpower program, as well as programs used to evaluate policy alternatives. A recent addition to the system is a Gains Module, with the capability to forecast immediate reenlistments and the available quantities of various user-defined categories of supply-limited no-prior-service (NPS) gains. The capability to forecast immediate reenlistments was incorporated into existing modules of the system. However, a separate module was developed to forecast the supply-limited NPS gains. This is known as the NPS Gains Module (NPSCM) and is the subject of this document.

The ELIM-COMPLIP System has been documented in three volumes.¹ This documentation is currently in the process of being revised into four volumes to include the recent additions.²

¹Holz, B. W., et al, "The ELIM-COMPLIP System of Manpower Planning Models, Three Volumes, General Research Corporation, OAD-CR-18, December 1973.

²Holz, B. W., et al, Two New Versions of the ELIM-COMPLIP System, Four Volumes, General Research Corporation, OAD-CR- , in process of being published.

SUMMARY OF THE ELIM-COMPLIP SYSTEM

General

The ELIM-COMPLIP System is used by the Manpower Programs Division (MPD) of the Office of the Deputy Chief of Staff for Personnel (ODCSPER) to produce the official Army manpower program, as well as to generate programs for use by the Department of the Army (DA) and Department of Defense (DOD) in the examination of Army manpower policy alternatives.

The manpower program is a forecast of various categories of Active Army strength, gains, and losses and the Reserve Enlisted Program (REP) of entry on active duty for training (ADT). A manpower program—which covers each month of the current fiscal year (FY), sometimes the immediately preceding FY, and from two to six future FYs—reflects the current status of Army manpower, recent past experience, and plans and assumptions concerning the future.

Inputs to the system include a variety of historical data, a large part of which is input from other automated systems, and a number of user specifications. Included in the latter are the following: (a) objectives (targets) for the Army's operating strength; (b) any applicable limitations on total end strength and/or man years; (c) projections of officer gains and losses^{*} and prior-service (PS) enlisted gains; (d) specifications concerning policies governing such matters as enlistments, reenlistments, extensions of terms of service, and various types of early release for enlisted personnel; (e) training objectives for the REP; and (f) the programmed capacity of the training base.

A number of types of output reports and graphical displays of both input and output data are available to assist the user in analyzing the effect of postulated policies and other assumptions. Outputs from the system have been used for such purposes as the following: (a) decisions about draft calls during the period FY70 to FY73;^{**} (b) evaluation of the

^{*} There is an option that permits COMPLIP to compute these projections in the light of user specifications concerning the officer force.

^{**} During most of this period only the COMPLIP part of the system was in existence.

effect of the discontinuation of the draft and determination of the requirements for volunteer enlistments; (c) preparation of the budget for military personnel (MPA); (d) preparation of Program Objectives Memorandum (POM), submitted annually to the Office of the Secretary of Defense (OSD); (e) consideration of proposed discharge programs, such as that used currently to screen recruits during the first six months of service; and (f) planning for the training of recruits.

ELIM

The function of ELIM is to produce forecasts of enlisted losses. ELIM accomplishes this by applying loss rates to the strengths of corresponding elements of the enlisted population. The loss rates are derived from historical data, subject to user modification, when desired, to reflect assumptions concerning the effect of postulated changes in policy or practice from that reflected in the historical data. For certain types of loss—specifically losses associated with any special early release policies—ELIM relies entirely on user-specified factors.

The population used by ELIM is a profile of the enlisted inventory derived primarily from the Enlisted Master File (EMF). The objective is to use as a base for loss projections information concerning the enlisted population that is the most recent available and that describes the population in terms of characteristics that can be expected to have an important influence on the frequency with which losses of various kinds occur.

The model makes separate projections for a number of different causes of loss associated with a number of different population categories. Losses are grouped into categories that reflect major manpower policies and/or consist of components that are relatively homogeneous in the way they vary with time and with the population variables used in the projection process.

The three versions of ELIM—ELIM-I, ELIM-II, and ELIM-III—differ with respect to the breakouts used for the first term (FT) Regular Army (RA) population. In all three versions the RA population is broken out by FT and career, where the distinction is that of the DCSPER-46 report,³ i.e., careerists are those who have more than 36 months of service, with all others designated FT. In ELIM-I the FT population is broken out by term of service and months to expiration of term of service (ETS).

³Dept. of Army, "Strength of the Army," DCSPER-46, published monthly.

In ELIM-II a distinction is made between "first timers" (FTI)—those who are serving on their first enlistment contract—and "second timers" (STI)—those who have either reenlisted or extended the term of service, but according to the DCSPER-46 definition are still designated FT. The FTI are broken out by term of service and months to ETS, while the STI are broken out only by months to ETS. The breakout of FTI vs STI enhances projection accuracy and provides additional historical strength and loss data that are useful for other applications.

In ELIM-III there is a further breakout of FTI in the first 21 months of service into a maximum of four groups, designated characteristic groups or C-groups, where the user specifies the definition of these classes in terms of characteristics such as age, race, sex, civilian education, and scores on classification tests. For example, C-group 1 might consist of high school graduates; C-group 2 of those classified in mental group 1, 2 or 3 who have not graduated from high school; C-group 3 of mental group 4 non-graduates who are aged 18-20; and C-group 4 of all others. It is anticipated that the user will vary these definitions to correspond to specific policies that are in effect or under consideration—e.g., constraints on the input of high school graduates or those classified in mental group 4. Another consideration bearing on the user's specification of C-group definitions is the influence of certain characteristics—e.g., civilian education, race, and age—on loss projection errors.

COMPLIP

The function of COMPLIP is to generate an optimal manpower program—i.e., a program that both satisfies all of the user-specifications, if it is feasible to do so, and is optimal in some sense, where the user can exercise some choice with respect to the criterion^{*} for optimality and a wide range of choice concerning constraints on the manpower program. Typically the model operates as follows: given user specifications concerning such matters as operating strength targets, constraints on various kinds of strength—e.g., total average strength (man years) and/or total end strength—and plans for the REP and the training base, COMPLIP determines the monthly levels of untrained (i.e., NPS) accessions for the Active Army

^{*}Usual practice is to specify two or more criteria to be used in sequence.

that bring projected operating strength into the closest possible agreement with the monthly targets. Once this has been accomplished, annual REP entry on ADT is maximized in such a way that monthly inputs to basic training centers are smoothed as much as possible.

The new version of COMPLIP, COMPLIP-G2, provides a number of new options with respect to model formulation. The most important of these is the capability to deal explicitly with the breakout of FT enlistees by the C-group discussed previously in connection with ELIM-III. Thus, constraints can be imposed, as appropriate, on the projected availability and allowable input of recruits corresponding to each C-group. Furthermore, loss rates applicable to each C-group are applied over the first 21 months of service. An automated Matrix Generator for COMPLIP-G2 facilitates the tailoring of the model for each application.

System Linkages

Automated linkages exist between the various modules of the system. To facilitate use, each type of user-supplied data must be input to the system only once. When the same data element is required by more than one module or program it is passed automatically from one to the other. Further, when a new run is made, the only inputs that must generally be supplied are those that differ from data used in the preceding run.

THE NPS GAINS MODULE

The categories of enlisted gains listed in the manpower program are given in Table 1, with FY75 monthly averages for each category. On the average, there were approximately 25,000 gains per month. About 63 percent were NPS gains and 23 percent immediate reenlistments. Reenlistments within 2 to 90 days, reenlistments after 90 days, returns to military control, Reserve Components, and administrative gains accounted for the remaining 14 percent.

Design specifications were developed for methods of projecting each of these gains categories except Reserve Components.* However, in consideration of both the significance of the category and the estimated

* A discussion of these design specifications is contained in the Phase I Report of the study, "ELIM-COMPLIP System Improvement."

level of effort required to develop the forecasting capability, the Study Advisory Group (SAG) directed that development be limited to programs associated with the two most numerous types of gains, NPS and immediate reenlistments.

Table 1
CATEGORIES OF ENLISTED GAINS

Category	Monthly average in FY75	Percent of total
No-prior-service (NPS)	15,806	62.5
Immediate reenlistment	5,852	23.1
Reenlistment within 2-90 days	192	0.8
Reenlist after 90 days	1,493	5.9
Returns to military control	1,704	6.7
Reserve components	112	0.4
Administrative gains (all other)	145	0.6
Total	25,304	100

Figure 1 is a system schematic depicting conceptually the extension of the system to include a Gains Module. Inputs to the module come from the ELIM data base, augmented by some additional data from the Modern Volunteer Army (MVA) master file.* Outputs of the Gains Module are input to the ELIM Inventory Projection Module (IPM) and COMPLIP.

A previous GRC study, titled "Evaluation of Army Manpower Accession Programs (EAMAP)," developed a nonlinear regression system to forecast Army volunteers and to compute the corresponding seasonal coefficients—i.e., the factors reflecting the seasonal patterns of enlistments of various groups—e.g., high school graduates and non-graduate mental groups 1, 2, and 3. The system, which is operational and has been used successfully, has been adapted for incorporation into the Gains Module for use in forecasting categories of RA NPS gains that are supply-limited.

* This file was developed by another GRC study.

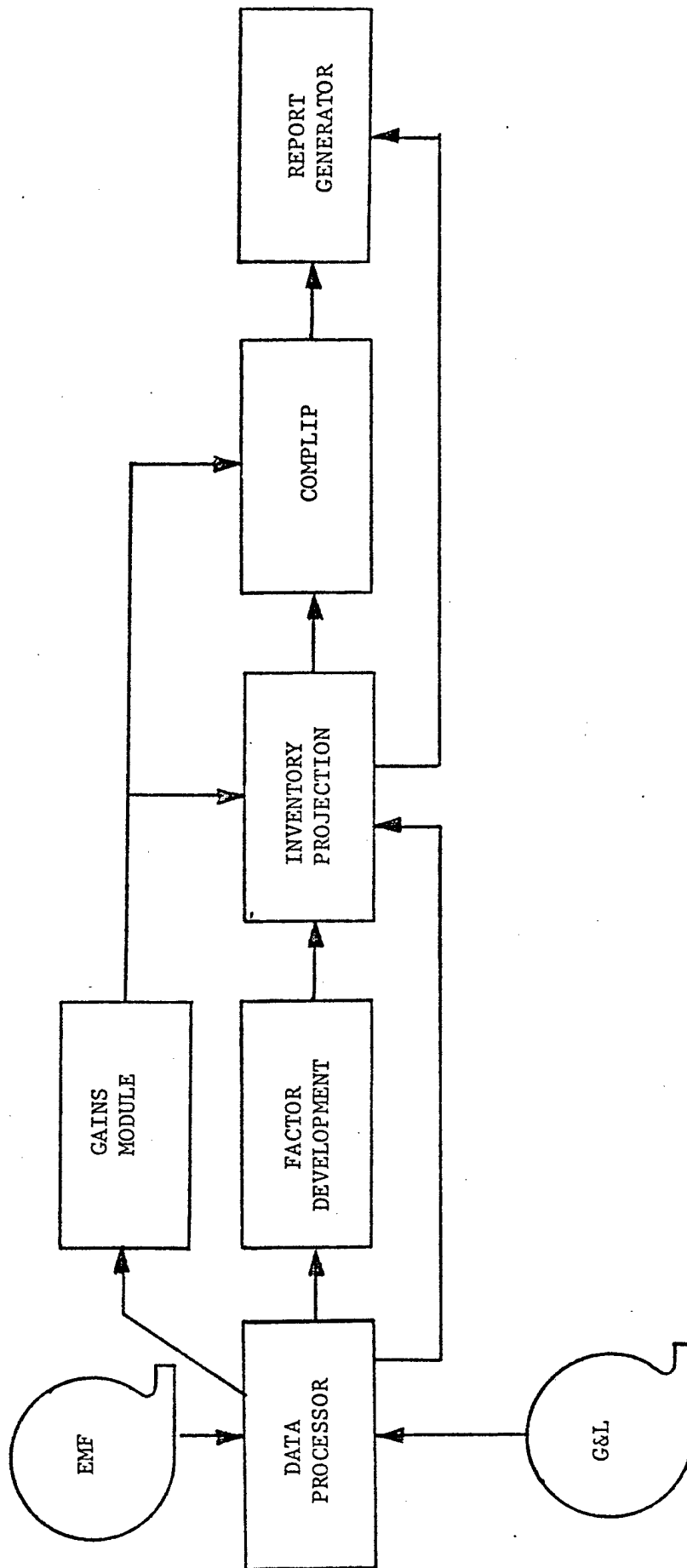


Fig. 1—ELIM-COMPLIP System Schematic Showing the Addition of a Gains Module

Projections of those NPS gains that are demand-limited—such as perhaps non-graduate mental group 4s—can be determined by means of the mechanisms provided in COMPLIP-G2.

The nonlinear regression is based on historical time series data on enlistments and related variables. Forecasting volunteers in a no-draft environment, based in part on historical data when the draft was in effect, requires that the historical data that are used be restricted to true volunteers. Several methods have been developed to separate the enlistments during the period of the draft into draft-induced and true volunteers. The so-called "GRC maximum" method (to be discussed later) is being used to estimate the true volunteers.

Chapter 2

SYSTEM DESCRIPTION

The function of the NPSGM is to provide a means by which forecasts of RA NPS gains can be made and the corresponding seasonal coefficients can be computed. The seasonal coefficients are factors reflecting the seasonal patterns of enlistments of various groups—e.g., high school graduates, and non-graduate mental groups I, II, and III. The method used is that of nonlinear multiple stepwise regression. This method was developed by GRC in a previous study.⁴ It consists of a nonlinear portion used to determine seasonal factors and a linear portion used to determine the regression coefficients for the independent or explanatory variables reflecting policies, programs, and economic and other environmental conditions. The linear portion uses the BMD02R linear multiple stepwise regression program taken from the statistical package compiled by W. J. Dixon of the University of California in Los Angeles (UCLA). The package is known as the UCLA Biomedical Computer Programs.⁵

The procedure for forecasting RA NPS gains consists of four major steps. These are shown schematically in Fig. 2. The first step is the development of historical time series of 250 categories of RA true volunteers defined on the basis of such characteristics as sex, civilian education, and race. The population breakouts are maintained for subsequent regression runs. The second step is to prepare the regression input

⁴Grissmer, D. W., et al, "An Evaluation of Army Manpower Accession Programs," General Research Corporation, April 1974.

⁵W. J. Dixon, "Biomedical Computer Programs," University of California Publications in Automatic Computation No. 2, University of California Press, 1970.

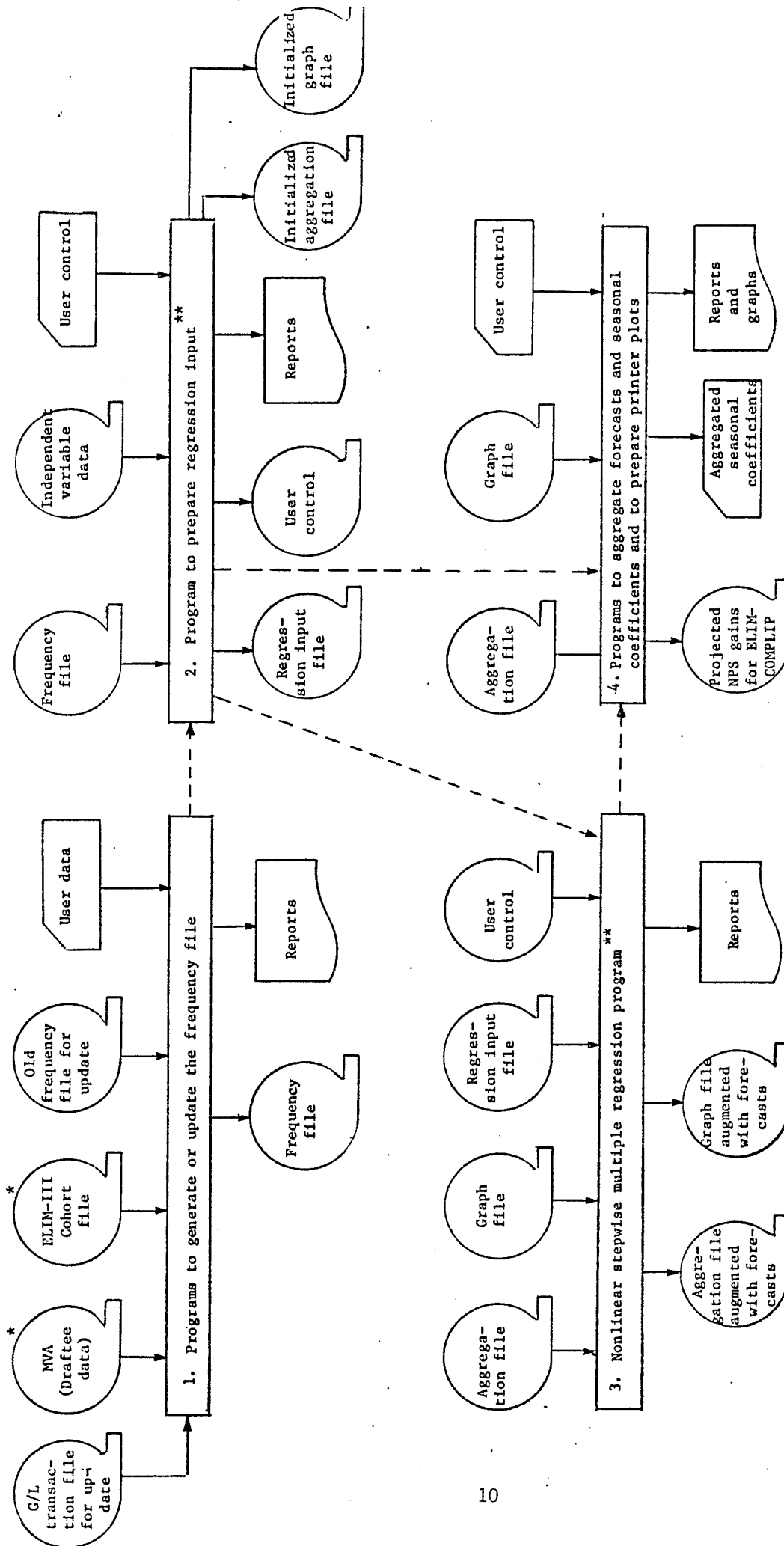


Fig. 2—Schematic of NPS Gains Projection Procedure

Note: - - - - - Indicates control flow

* Used only in the initial frequency file generation run.

** Steps 3 and 4 must be run under the same job control so that the aggregation file and the graph file are not
rewound prior to step 3.

by aggregating the detailed population breakouts into the desired set of subgroups, adding the time series of the selected explanatory (or independent) variables, and compiling control cards for the regression program. The third step is to exercise the regression model in order to produce the forecasts for each of the desired set of population subgroups. The fourth step is to aggregate the forecasts of the subgroups into at most four groups referred to as characteristic groups or C-groups used by COMPLIF, compute seasonal coefficients for each of the C-groups based on the aggregated forecasts, and produce printer graphs of the historical time series and of the time series computed by the regression equation for both the historical time frame, and 12 months of forecast. Graphs are produced for each of the population categories for which a regression run was made.

DEVELOPMENT OF HISTORICAL DATA

The true volunteers during the draft era are estimated using the "GRC maximum" method. This method stems from the relationship between the number of enlistees during the draft era and the lottery sequence numbers (LSNs), as shown in Fig. 3. The graph confirms the conviction that many of the enlistees volunteered because of draft pressure. Note the leveling off of the graph after LSN 240. This characteristic formed the basis for concluding that volunteers with LSN greater than 240 were true volunteers, since they were in little or no danger of being drafted.

A precise formulation of the estimating relationship is given by the following equation:

$$V_T = E_{WO} + D_{WO} + (366/126) (E + D) \quad (1)$$

where V_T equals the estimated number of true volunteers, E_{WO} equals the number of RA volunteers without LSNs, D_{WO} equals the number of volunteers for the draft without LSNs, E equals the number of RA volunteers with LSNs 241 to 366 and D equals the number of volunteers for the draft with LSNs 241 to 366. The rationale behind this estimating relation is as follows. Volunteers with LSNs in the range 241 to 366 are considered to be true volunteers. The number of LSNs in this range is 126, while the total number of LSNs is 366. The ratio 366/126 is used in Eq 1 for the

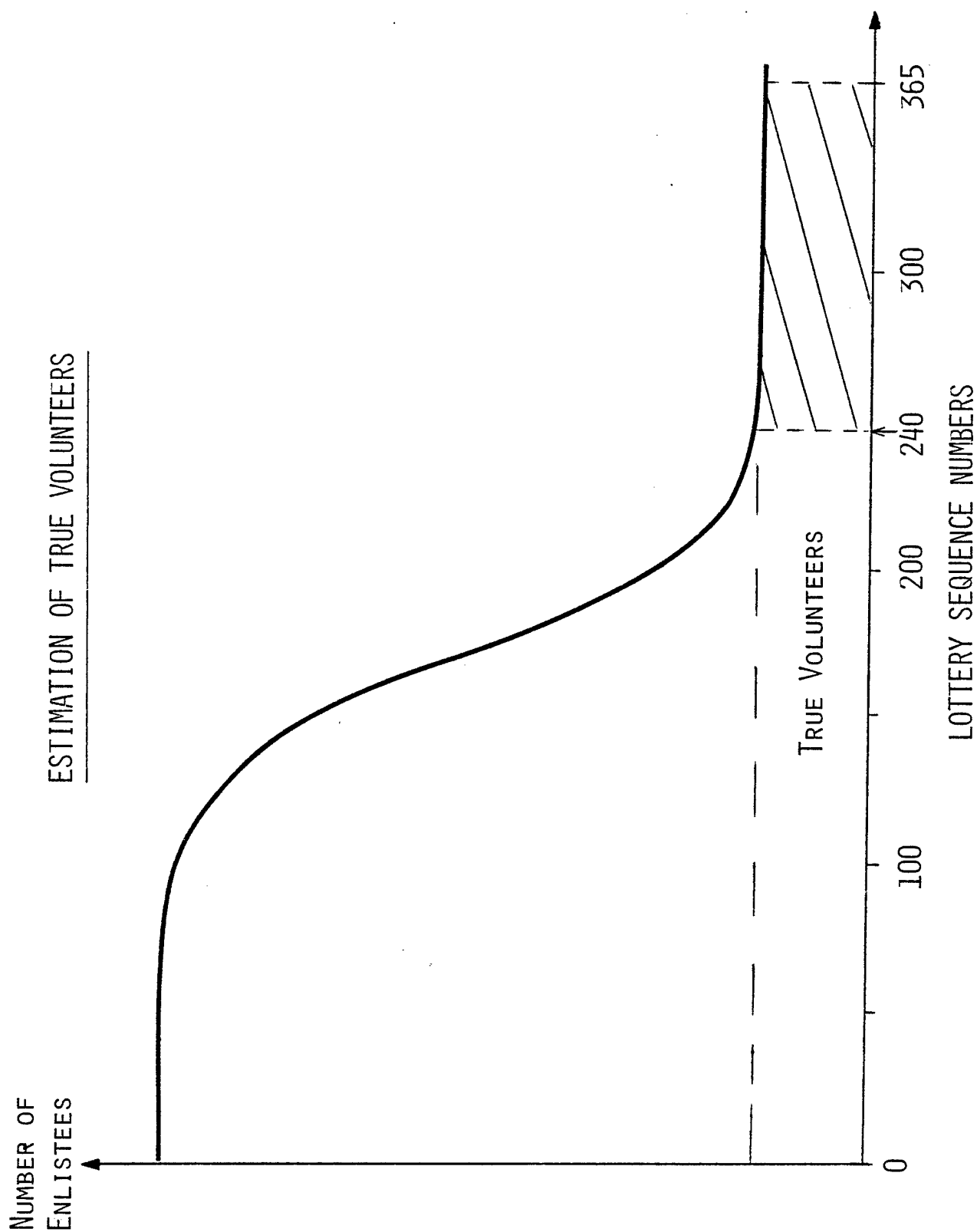


Fig. 3—Relationship Between the Number of Enlistees and Lottery Sequence Numbers

following reasons: (a) since LSNs are drawn randomly, individuals with LSNs 241 to 366 are a random sample of all individuals with LSNs; and (b) the total expected number of true volunteers of individuals with LSNs includes a proportionate number with LSNs in the range 1 to 240. All enlistees without LSNs are assumed to be true volunteers.

The estimating procedure is used to tabulate true volunteers for each month through June 1973. After June 1973 the accessions are tabulated directly. The frequency tabulations are made for each cell of two population partitions, given in Table 2, for each month for which historical data exists. Thus, a time series is formed for each population cell. Partition 1 includes categories 1 through 196, where the breakouts are based on sex, civilian education, race, mental group, age, and bonus. Partition 2 includes categories 197 to 250, where the breakouts are based on term of service, civilian education, race, and mental group. Both partitions are mutually exclusive and exhaustive partitions of the population. The sources for these data are the MVA master file^{*} for the draftee true volunteers^{**} and the ELIM-III cohort file for the RA true volunteers. Table 3 gives the MVA master file format and Table 4 gives the ELIM-III cohort file format. Monthly additions to the volunteer time series data base can be made by means of an update program that uses the Gains transaction file as input. The format of the Gains transaction file is given in Table 5.

REGRESSION INPUT

The second step in this forecasting procedure is to prepare the input for the regression program. This is done by means of a regression input generator that produces a file containing control cards for the regression program, and the time series for each dependent (i.e., volunteer category) and independent or explanatory variable to be used in the projection process. In order to form the time series for the desired volunteer categories, the user specifies the categories of Table 2 to be aggregated. The aggregations are based either on partition 1 or partition 2, not both.

^{*}This file was created under a previous GRC study.

^{**}Extracting these data from the MVA Master File is a one-time operation.

Table 2

CATEGORIES FOR NPS GAINS FREQUENCY DISTRIBUTIONS

Partition number	Category number	Sex	True volunteer	Civilian education	Race	Mental group	Age	Bonus	Term of enlistment
1	1	female ^a	yes	HS grad ^b	black	1,2	all	no	all
	2	"	"	"	white & other	"	"	"	"
	3	"	"	GED ^c	black	"	"	"	"
	4	"	"	"	white & other	"	"	"	"
	5	male ^d	"	HS grad	black	1,2,3A	<18	yes	"
	6	"	"	"	"	"	"	no	"
	7	"	"	"	"	"	≥18,<20	yes	"
	8	"	"	"	"	"	"	no	"
	9	"	"	"	"	"	≥20,<22	yes	"
	10	"	"	"	"	"	"	no	"
	11	"	"	"	"	"	"	yes	"
	12	"	"	"	"	"	≥22	yes	"
	13-20	"	"	"	"	"	"	no	"
	21-28	"	"	"	"	3B	Same as for groups 1,2,3A	"	"
	29-52	"	"	"	"	4,5	Same as for groups 1,2,3A	"	"
	53-100	"	"	"	white & other	"	"	"	"
	101-148	"	"	GED	Same as	HS grad	"	"	"
	149-196	"	"	Some HS	"	"	"	"	"
	197	both	"	No HS	"	"	"	"	"
	198	"	"	HS grad	black	1,2,3A	all	both	2
2	199	"	"	"	"	3B	"	"	"
	200-202	"	"	"	"	4,5	"	"	"
	203-208	"	"	"	white & other	"	Same as for black	"	"
	209-214	"	"	GED	Same as	HS grad	"	"	"
	215-232	"	"	not grad or GED	"	"	"	"	"
	233-250	"	"	Same as	2 year term	"	"	"	3
		"	"	"	"	"	"	"	4,5,6
		"	"	"	"	"	"	"	"
		"	"	"	"	"	"	"	"
		"	"	"	"	"	"	"	"

^aIt is assumed that all females are true volunteers, either HS graduate or GED, mental group 1 or 2, and no bonus.^bHigh school graduate.^cGeneral education development.^dVolunteers for draft and RA

Table 3

MVA MASTER FILE FORMAT

I. MVA MASTER FILE

- A. Density - 800 BP1
- B. Mode - BCD
- C. Record size - 120 characters
- D. Blocking factor - 40 records/block; 4800 characters/block
- E. Label records - none
- F. Parity - even

II. DATA ELEMENTS

<u>Variable name</u>	<u>Chars</u>	<u>Pos</u>	<u>Type</u>	<u>Comments</u>
1. 5-digit ZIP code	5	1-5	N	No blanks
2. Date of birth*	6	6-11	N	No blanks
3. Branch of service*	1	12	N	From ACC or DEP- Branch-Service
4. Lottery category*	1	13	N	
5. Lottery number*	3	14-16	N	Zero fill
6. Term of enlistment	1	17	A	
7. Enlistment option code	4	18-21	A	
8. Type entry	1	22	N	If ACC date=0, then 9
9. Accession date*	6	23-28	N	Zero fill
10. DEP date	6	29-34	N	Zero fill
11. AFQT category	1	35	N	Zero fill
12. AFQT score	3	36-38	N	Zero fill
13. Race	1	39	N	1-7
14. Education	1	40	A	
15. Number of dependents (not counting self)	1	41	N	0-9
16. Last service	1	42	A	
17. Sex	1	43	A	M or F
18. State	2	44-45	A	
19. Blank	3	46-48	A	
20. Blank	2	49-50	A	
21. Marital status	1	51	A	
22. Lottery location	1	52	N	1 = 000-60 2 = 61-120 3 = 121-180 4 = 181-240 5 = 241-300 6 = 301-366

Table 3 (cont'd)

<u>Variable name</u>	<u>Chars</u>	<u>Pos</u>	<u>Type</u>	<u>Comments</u>
23. RMS	3	53-55	A	
24. Training commitment	4	56-59	A	
25. Waiver	1	60	A	
26. SSN	9	61-69	N	Specifications on temporary SSN are currently a mystery.
27. Status code	1	70	A	Extracted from DEP or ACC status code.
28. AQB	30	71-100	N	999 = no test scores available, Jan 70 through Mar 73 use psn 71-91.
29. Recruiter code	7	101-107	A	
30. Transaction date *	6	108-113	N	Year/month/day either ACC date or DEP date.
31. Age *	2	114-115	N	Attained age in years (not rounded) at DEP or ACC date.
32. Religion	2	116-117	A	ACC date.
33. Blank	3	118-120	A	

* Validity checks have been performed on these fields.

Table 4

ELIM III COHORT FILE FORMAT*

Field description	Characters	Code description
SSAN or TIN	1 - 9	
Filler	10 - 10	
Date of birth	11 - 16	(YYMMDD)
AFQT score	17 - 18	99-invalid
Sex	19 - 19	M, F, 9-invalid
Race	20 - 20	1-white, 2-black, 3-other; 9-invalid
Term of enlistment	21 - 21	9-invalid
Training commitment	22 - 25	4 char MOS (not edited)
Civilian education	26 - 26	9-invalid; 0 to 8-no HS; A,B,C,D- some HS; Y or F-GED; other-HS graduate
Mental category	27 - 27	1,2,3,4,5; 9-invalid
Enlistment options	28 - 31	1st char: 1-combat arms, 2-service schools, 3-other, 4-RA (unassigned) option; 1st char: B-bonus
AQB score summary	32 - 41	each character represents a test score 0-invalid; 1,2-score < 90; 3,4 - (90,99); 5,6,7 - (100,109); 8,9 - score = 110
AQB category	42 - 42	
Lottery number	43 - 45	999-invalid
Number of dependents	46 - 46	9-invalid
Marital status	47 - 47	
Moral waiver	48 - 48	
Age in months	49 - 51	999-invalid
Number of transactions	52 - 53	01 - 12
Date of transaction**	54 - 57	(YYMM)
Type of transaction**	58 - 60	GHF - NPS gain
	:	
	:	
	131 - 134	
	135 - 137	

*The codes on this file have been checked for validity.

**Date and type of transaction codes may be repeated up to a total of 12 sets.

Table 5

GAIN AND EXTENSION RECORD FORMAT

File Identification: BE ME 0013

Record Identification: Gains Transactions/Extensions Transactions
DCSPER-46, Part II (Edit)

Relative positions	Name of data element	No. of characters	Type of characters ^a
1-15	Name personnel	15	M
16-17	Sending PPA code	2	M
18	Blank	1	M
19-20	Service number prefix	2	A
21-29	Social security account number	9	M
30-32	Grade in which serving (abbr)	3	M
33	Grade in which serving	1	M
34-36	Months service for pay	3	N
37-41	Primary Military occupational specialty	5	M
42	Race	1	A
43	Service component	1	A
44	Term of service or enlistment	1	N
45-46	Current assignment	2	M
47-49	Blank	3	M
50	Previous regular Army service	1	M
51-52	Year service code Generated	2	M
53-56	Expiration of term of service (yr mo)	4	N
57-60	Parent unit and morning report indicator	4	M
61-62	Sub unit code	2	M
63-64	Type transaction	2	M
65-70	Transaction date (yr mo da)	6	N
71	Assignment code Generated	1	M
72	ETS PETS code Generated	1	N
73	Reception station code	1	M
74-76	Separation program number (previous)	3	M
77-80	Process yr mo Generated	4	N
81-82	Category code Generated	2	N
83-86	Basic active service (yr mo)	4	A
87-88	Status	2	M
89	Civilian education code	1	M
90	Mental group	1	N
91-92	Armed forced qualification test score	2	N
93-98	Date of birth (yr mo da)	6	N
99	Sex	1	A
100-101	Receiving PPA code	2	M
102-105	Enlistment options	4	M
106-109	Basic pay entry (yr mo)	4	N
110	Dual service component status	1	A

Table 5 (cont'd)

Relative positions	Name of data element	No. of characters	Type of characters ^a
111	Special personnel category	1	A
112-115	ETS of previous service (yr mo)	4	N
116	Propay	1	N
117-130	Blank		
131-132	PMOS evaluation score	2	N
133	Overseas/CONUS code	1	M
134	Military personnel class	1	A
135	Record mark	1	M

^aAn A means alphabetic, N means numeric; M means that the field may contain any characters.

The NPSGM permits the user to make aggregations for a maximum of 20 volunteer categories that are used as dependent variables. It is not necessary that these aggregate categories be either mutually exclusive or exhaustive. The user will be provided with a message listing any duplicated or omitted categories. However, for the purpose of generating input for the ELIM-COMPLIP System, it is necessary that the set of dependent variables be mutually exclusive. On the other hand, they will not in general be exhaustive, since regression will be used to project only those NPS gains categories that are supply limited. An example of a mutually exclusive but not exhaustive set of dependent variables is given in Table 6.

Table 6

EXAMPLE OF CATEGORIES FOR WHICH REGRESSION RUNS
CAN BE MADE
(Aggregated from Population Partition I)

1. Females
2. Male, HSG, Black, Cat I, II, III
3. Male, HSG, Black, Cat IV, V
4. Male, HSG, Not Black, Cat I, II, III
5. Male, HSG, Not Black, Cat IV, V
6. Male, NHSG, Black, Cat I, II, III
7. Male, NHSG, Not Black, Cat I, II, III

The forecasts for each dependent variable are based on selected independent variables. Examples of independent variables are military pay, unemployment rate among the 16-21 year old male out-of-school labor force, and advertising expenditures for accessions. The file of independent variable data shown in the schematic of Fig. 2 contains historical values for a set of independent variables that have proved useful in the projection of volunteer enlistments in other GRC studies. A list of such variables is shown in Table 7. Historical values of each of the independent variables have been obtained from previous GRC studies. Values of these variables must be kept current by the user. For the 12 months for which forecasts will be made, the user has the option of specifying the values for the corresponding independent variables or of having the program extend the last available value to the end of the projection period.

Table 7

DEFINITIONS OF INDEPENDENT VARIABLES

APLCY	A dummy variable that is set during the time period when recruiter credit was not given for Cat III non-high school enlistees and is 0 otherwise. The phasedown of the values represent the gradual withdrawal of the policy.
AQOTDM	The variable is the number of males to be recruited by the Army. The quota is set by the Department of the Army.
BNSHSG	A dummy variable that is set to 1.0 each month in which the \$1500 enlistment bonus is in effect for high school graduates.
BNSINC	A dummy variable that is set to 1.0 each month in which the \$1000 incremental bonus is in effect for enlistees.
BNSKLI [*]	A dummy variable that is set to 1.0 for May and June 1973 and June 1974 and subsequent months in which a bonus was in effect for skills.
BNSKL2	A dummy variable that is set to 1.0 each month beginning in June 1974 in which a bonus is in effect for skills.
BNSNHS	A dummy variable that is set to 1.0 each month in which the \$1500 enlistment bonus is in effect for non-high school graduates.
CAOPTS	Number of combat arms options available.
CAT4LM	The percent of NPS enlistments permitted as mental Category IV.
DUNEMP	Deseasonalized unemployment rates for 16-21 out-of-school males.
HSPL74	A dummy variable that is set to one when maximum HS grad policy is in effect. The withdrawal of the policy is modeled by a ramp since a period of time is required for the recruiter to develop the non-HS market again (in test set equal to 1.0 in April 73 with a ramp before and after this month).

^{*}It is recommended that the bonus for skills for June 1974 and subsequent months be reflected by BNSKL2 only and the corresponding values for BNSKLI be set to zero.

Table 7 (cont'd)

MICIPA	The ratio of military RMC (regular military compensation) for grade E-1 to the civilian average weekly wages for two industries—Wholesale and Retail Trade Services.
OPTSTO	The number of combat arms and service schools options, it measures the number of new separate options available to an incoming recruit to the Army.
PAIDTV	This variable measures the number of paid TV advertisements sponsored by the Army during their paid TV and radio advertising campaign. Source for the data is "Effectiveness of the Modern Volunteer Army Advertising Program," prepared by Stanford Research Institute for OSAMVA, December 1971.
PASURG	Dummy variable designed to reflect the impact of a new pay raise.
PRTMED	The number of media insertions placed in national circulation magazines plus the number of national newspaper campaigns.
RECASS	Number of Army recruiter assistants assigned to Hometown Recruiter Assistant Plan each month.
RECR	Number of Army recruiters on production each month.
TIME	A variable measuring increasing time.
TYOPT	A dummy variable reflecting when options are available for two year enlistees who are high school graduates.
TYOPTN	A dummy variable reflecting when options are available for two year enlistees who are non-high school graduates.
UOCCAN	Number of Army unit of choice canvassers.

Sometimes it is desirable to use independent variables that have been lagged by a few months to reflect the possibility of a delayed effect on the volunteers. The program permits up to nine copies of each variable, incorporating the desired lag. Copies of a variable including the variable itself are designated a family. A limit can be imposed on the number of members of a family that can be in the regression solution at any one time. In practice, this limit has usually been one.

Provision is made for a sign (i.e., plus, minus, or blank for either) to be associated with each independent variable to control the sign of its coefficient upon entering the regression equation. For most variables except time use of this option is desirable because the objective is not only to obtain a good fit of the equation to the historical data but also to obtain an accurate forecast 12 months into the future. Without sign control a good fit may be obtained but a trend may be established between independent and dependent variables that has an adverse effect on the projected values. With sign control a logically sound model can be constructed that establishes the appropriate type of correlation—i.e., positive or negative—between dependent and independent variables. For example, the variable reflecting a bonus for high school graduates should have a plus sign when used with the dependent variable that represents high school graduates. An example with a negative sign restriction is the case of using the independent variable "high school policy 74" with dependent variables representing not-high school graduates. Since the policy was designed to maximize the intake of high school graduates, it tended to minimize the not-high school graduate accessions and hence the variable reflecting this policy is negatively correlated with the dependent variables reflecting not-high school graduates.

For each dependent variable a set of independent variables that are candidates to enter the regression equation must be specified. Examples of dependent and independent variable combinations are given in Table 8. The reason the user specifies the independent variables is to eliminate those that are not applicable for the given dependent variable. Some independent variables are obviously not applicable for a given dependent variable* and experience may teach that certain other independent variables

*For example, it is obvious that the independent variable representing the combat arms bonus is not applicable to the dependent variable representing females.

Table 8

EXAMPLES OF DEPENDENT AND CORRESPONDING INDEPENDENT VARIABLES

Independent variables*	Mnemonics	Sign restric- tion	Dependent variables			
			HSG black	HSG not black	Not HSG black	Not HSG not black
Military civilian pay ratio	MICIPA	+	x	x	x	x
Recruiters	RECR	+	x	x	x	x
Recruiters (-1)	RECR	+	x	x	x	x
Recruiters (-2)	RECR	+	x	x	x	x
Recruiter assistants	RECASS	+	x	x	x	x
Recruiter assistants (-1)	RECASS	+	x	x	x	x
Recruiter assistants (-2)	RECASS	+	x	x	x	x
Unit of choice canvassers	UOCCAN	+	x	x	x	x
Unit of choice canvassers (-1)	UOCCAN	+	x	x	x	x
Unit of choice canvassers (-2)	UOCCAN	+	x	x	x	x
Combat arms options	CAOPTS	+	x	x		
Combat arms options (-1)	CAOPTS	+	x	x		
Combat arms options (-2)	CAOPTS	+	x	x		
Bonus - HSG	BNSHSG	+	x	x		
Bonus - NHSG	BNSNHS	+			x	x
Bonus - Increment	BNSINC	+	x	x		
Bonus - Skills	BNSKL2	+	x	x		
Two year option (HSG)	TYOPT	+	x	x		
Two year option (NHSG)	TYOPTN	+			x	x
Total options	OPTSTO	+			x	x
Total options (-1)	OPTSTO	+			x	x
Total options (-2)	OPTSTO	+			x	x
Pay surge	PASURG	+	x	x	x	x
Cat IV limit	CAT4LM	+	x	x		
Print media	PRTMED	+	x	x		
Unemployment	DUNEMP	+	x	x	x	x
Unemployment (-1)	DUNEMP	+	x	x	x	x
Unemployment (-2)	DUNEMP	+	x	x	x	x
High school policy 74	HSPL74	-			x	x
Army policy	APLCY	-			x	x
Time	TIME		x	x	x	x

* Definitions of the independent variables are given in Table 7.

do not contribute to the regression equations of certain dependent variables. The obvious advantage of eliminating as many of the independent variables for each dependent variable as possible is that it reduces computer running time. Another advantage is that the regression equation will be based on meaningful variables. Forecasts for 12 months into the future can be expected to be more reliable when based on equations containing variables that have a logical relationship than when based merely on a statistical relationship.

REGRESSION ANALYSIS

Methodology

In an earlier GRC study^{*} a nonlinear regression model was developed that was incorporated into the BMD02R program of the UCLA BMD computer package. As indicated previously, the nonlinear portion of the combined model is used to determine the multiplicative seasonal factors, while the linear portion uses a stepwise procedure to determine the coefficients of the independent variables in the regression equation. The analysis assumes the dependent variable time series is initially in unadjusted or seasonalized form and the independent variables are in deseasonalized form (e.g., deseasonalized unemployment rates). This, however, is not essential for the methodology of the model to hold. It is only desirable in the sense that the model computes seasonal adjustment factors for the dependent variable. The less seasoned variation of the dependent variable is explained by the independent variables, the more is explained by the seasonal adjustment factors. These seasonal adjustment factors should not be confused with the seasonal coefficients that are computed from the forecast values and forwarded to COMPLIP-G2.

The model is solved iteratively for the seasonal adjustment factors and the coefficients of the linear model. First, the seasonal coefficients are set to 1.0 and BMD02R is used to solve for the linear regression coefficients. These are then fixed and seasonal coefficients are determined by means of a least squares fit. The seasonal coefficients are then fixed and a new set of linear regression coefficients is determined. The procedure is repeated until convergence is reached. A schematic of the procedure is shown in Fig. 4.

^{*}See Reference 4.

INPUTS

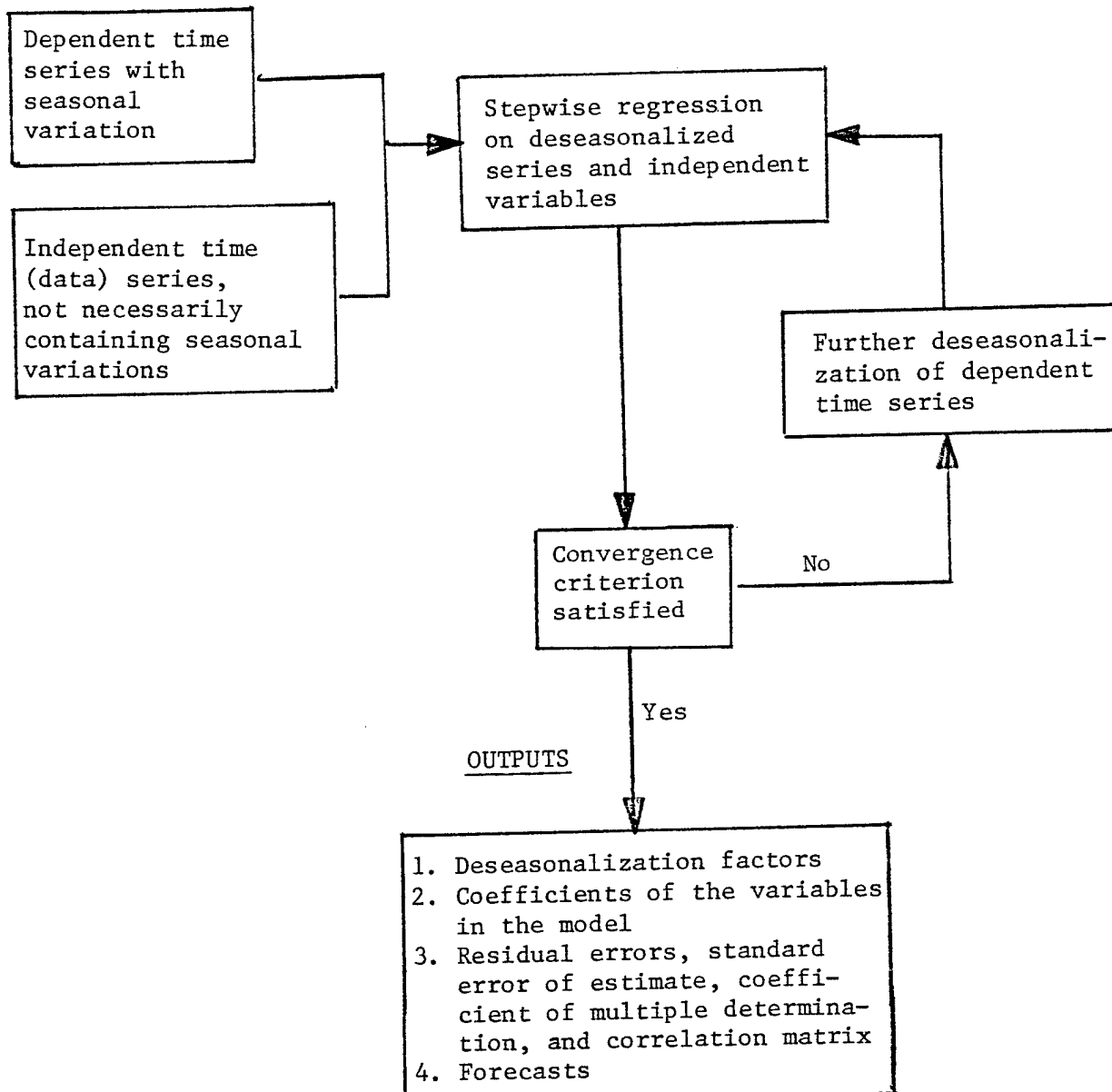


Fig. 4—Basic Cycle of the Deseasonalized Step Regression Model

The stepwise procedure requires two user specified F statistics as tolerances for bringing independent variables into the solution and for removing them. Suppose F_1 and F_2 are such tolerances, where, $F_1 \leq F_2$. Let F_v denote the F statistic of the variable with the largest F statistic that is not in the solution. Then, if $F_v > F_2$ and the variable satisfies the user imposed entering restrictions (i.e., sign restriction and limit on the number of members per family that can be in the solution at any one time), it is entered into the solution. Similarly, for removing variables from the solution, if $F_v < F_1$, the variable is excluded from the solution.

The model requires the following user input:

1. A dependent variable $Y = \text{col}(y_1, y_2, \dots, y_n)$ which is typically a time series with n representing the number of observed values.
2. An independent variable data matrix $X = [x_{ij}]$, an n by p matrix where p is the number of independent variables. Each column vector represents a time series of n observed values for an independent variable.
3. The number of observations, n , of the (seasonalized) dependent variable Y . The number of observations should be more than one cycle, r ($r = 12$) of the seasonal period (say, at least two cycles).

The model has the following mathematical form:

$$\begin{bmatrix} s_1^{-1} y_1 \\ s_2^{-1} y_2 \\ \vdots \\ s_n^{-1} y_n \end{bmatrix} = \begin{bmatrix} a_0 + x_{11} a_1 + x_{12} a_2 + \dots + x_{1p} a_p \\ a_0 + x_{21} a_1 + x_{22} a_2 + \dots + x_{2p} a_p \\ \vdots \\ a_0 + x_{n1} a_1 + x_{n2} a_2 + \dots + x_{np} a_p \end{bmatrix} \quad (2)$$

where $s_1^{-1}, s_2^{-1}, \dots, s_n^{-1}$ are the reciprocals of the seasonal coefficients and $a_1, a_2, \dots, a_p$ are the regression coefficients of the independent variables. Both sets of coefficients are determined by the model. Since s_i is a seasonal coefficient it is assumed that $s_i = s_{i+r}$ for $i = 1, 2, \dots, n-r$. The basic procedure used in solving for s_i , $i = 1, 2, \dots, n$ and the a_j , $j = 1, 2, \dots, p$ is the method of least squares applied to the following function:

$$\min_{s_i^{-1}, a_j} \mathfrak{J}(s_i^{-1}, a_j) = \sum_{i=1}^n \left[s_i^{-1} y_i - \sum_{j=0}^p x_{ij} \hat{a}_j \right]^2 \quad (3)$$

As stated earlier, the solution procedure is iterative. For iteration k

let $\hat{y}_i(k) = s_i^{-1}(k) y_i$ and let $\hat{x}_i(k) = \sum_{j=0}^p x_{ij} \hat{a}_j(k)$. For k = 1,

$\hat{y}_i(1) = y_i$ since initially s_i^{-1} is assumed to be 1.0 for all i, and

$\hat{a}_j(1)$ for j = 1, 2, ..., p are determined by BMD02R. At iteration k,

k > 1, the method of least squares is used to solve Eq (4) for $s_i^{-1}(k)$,

i = 1, 2, ..., r, where r is assumed to be 12 and $s_i^{-1}(k) = s_{i+r}^{-1}(k)$ for

i = 1, 2, ..., n-r.

$$\min_{s_i^{-1}(k)} \mathfrak{J}_1(s_i^{-1}(k)) = \sum_{i=1}^n \left[s_i^{-1}(k) y_i - \hat{x}_i(k-1) \right]^2 \quad (4)$$

where $\hat{x}_i(k-1)$ is a known quantity having been determined by ordinary least squares in iteration k-1. The equations to be solved for $s_i^{-1}(k)$ are obtained by taking the partial derivatives and setting them to zero. That is,

$$\frac{\partial \mathfrak{J}_1}{\partial s_i^{-1}(k)} = 0 \quad (5)$$

yields, for i = 1, 2, ..., r,

$$s_i^{-1}(k) = \frac{y_i \hat{x}_i(k-1) + y_{i+r} \hat{x}_{i+r}(k-1) + y_{i+2r} \hat{x}_{i+2r}(k-1) + \dots}{y_i^2 + y_{i+r}^2 + y_{i+2r}^2 + \dots} \quad (6)$$

The second half of iteration k makes use of the newly computed $s_i^{-1}(k)$ in computing $y_i(k)$ and BMD02R is used to solve for the $\hat{a}_j(k)$ in Eq (7).

$$\min_{a_j(k)} J_2(a_j(k)) = \sum_{i=1}^n \left[\hat{y}_i(k) - \sum_{j=0}^p x_{ij} \hat{a}_j(k) \right]^2 \quad (7)$$

The iterative process is assumed to converge when

$$| s_i^{-1}(k) - s_i^{-1}(k-1) | \leq .001 \quad (8)$$

for all i and

$$| \hat{a}_j(k) - \hat{a}_j(k-1) | \leq .001 \text{ for all } j.$$

If convergence is slow or if there is no convergence, the process is terminated at 25 iterations. Experience has shown that convergence is usually reached within 25 iterations.

Since the BMD02R is a stepwise regression, only the independent variables that pass the F tolerance and meet the sign criterion are introduced into the regression equation. Generally, this means that most of the independent variables are not in the equation if the number made available is in the neighborhood of 15 or 20. One case was experienced at GRC where different sets of independent variables entered the stepwise regression on successive iterations. After 25 iterations, for such a case, the regression equations will include only one set of the independent variables. It should be noted that this case is a rarity.

Output

Output of the regression computer program includes the time series of the historical and computed (using the regression equation) values of the dependent variable, the deseasonalization factors, the coefficients of the variables in the model, the forecasts, the residual errors, the standard error of estimate, the coefficient of multiple determination and the correlation matrix. The deseasonalization factors are those used by the model. They have been determined in conjunction with the coefficients of those independent variables in the equation. They are not the seasonal coefficients to be used by COMPLIP. These are computed at a later step based on the forecast values.

The residual errors, standard error of estimate, and the coefficient of multiple determination measure the goodness of fit of the regression equation to the historical data. For example, the square of the coefficient of multiple determination, R^2 , $0 \leq R^2 \leq 1$, measures the variation in the dependent variable that is explained by the regression equation. The closer R^2 is to 1.0, the better the fit of the regression equation. Typical values for R^2 are in the neighborhood of .90. The definition is as follows:

$$R^2 = 1.0 - \frac{\text{residual sum of squares}}{\text{total sum of squares}}$$

The standard error of estimate, SE, is defined by

$$(SE)^2 = \frac{\text{residual sum of squares}}{\text{residual degrees of freedom}}$$

The standard error of estimate is a relative measure since its magnitude varies with the magnitude of the dependent variable. The residuals should be checked for sequences with the same sign, indicating some unexplained variation perhaps by the omission of some variable, such as a policy or program variable.

In the event an independent variable that is expected to be included in the regression equation is not included, the reason may be that it is highly correlated with another independent variable that is in the equation. This may be determined by examining the correlation matrix. Another reason for a variable's exclusion may be that it has a sign restriction that prevents it from entering the regression equation.

The output of the preprocessor program lists the independent variables (including copies of independent variables that have been lagged) that the user has made available for each dependent variable. The beginning of the regression output gives a similar list but with the dependent variable included as the first variable. Since the dependent variable is not included in the preprocessor list, the index of an independent variable in the regression output list is one more than the corresponding index in the preprocessor list. The user should take note of this when making cross reference checks.

The regression statistics are printed for the first iteration of the solution procedure and again for the last. The statistics of the last iteration are of greater interest since this is the final solution. Statistics are printed for each step of the linear regression. The last step is followed by a "Summary Table" that documents the change in the regression equation at each step. This is followed by a table entitled LIST OF RESIDUALS. The five columns listed in this table are entitled CASE, YDEP, YHAT, RESIDUAL, and PCTERR.

The column entitled CASE lists the index number of the time series. The index 1 corresponds to the first month represented in the regression. For example, if the first month of the data base is January 1971 and the maximum months of lag input to any of the independent variables is 2, then the index 1 corresponds to the month of March 1971 rather than January. The last 12 months of data listed corresponds to the projection period and is meaningless in this report except perhaps for the YHAT which are computed by the regression equation using only the linear coefficients.

The column entitled YDEP lists the historical time series of the dependent variable. Each of these quantities has been divided by the appropriate seasonal adjustment factor (i.e., the left hand side of Eq (2)). The last 12 values are the exception. These are obtained by extending the last historical value for 12 months without dividing by the seasonal adjustment factors. The column entitled YHAT represents the values computed by the linear portion of the regression equation (i.e., the right hand side of Eq (2)). The RESIDUALs are defined as $YDEP - YHAT$ and the PCTERR as $RESIDUAL/YDEP$.

The next table that is printed out is entitled MULTIPLICATIVE SEASONALS. This table has the following five-column heading: CASE, YDEP, YHAT, RESIDUAL, and SEASONAL. The CASE column is defined as before. The definitions of YDEP and YHAT are slightly different from those in the previous table. The column YDEP consists of the time series of the actual historical values of the dependent variable (without division by the corresponding seasonal adjustment factor as was the case in the previous table). The YHAT column consists of the product of the appropriate seasonal adjustment factor (for each month) and the monthly value computed by the linear portion of the regression equation. The SEASONAL column

consists of the seasonal adjustment, factor for each historical month that is computed by the nonlinear portion of the regression model. The RESIDUAL column is also defined as before.

Unlike the previous table, the range of this table does not include the 12 future months. The forecast values are given in the next table entitled FUTURE TIME STREAM with the three column headings CASE, FORECAST and SEASONALS. The CASE and SEASONAL columns are defined as before, the FORECAST column contains the 12 months of seasonally adjusted projected values. It is these forecast values that are used in the post processor programs and subsequently in COMPLIP-G2.

Sample Regression Results

The results discussed here are taken from the NPSGM system test run. The main purpose of the test run was to test the computer programs rather than to provide evidence of the quality of forecasts of NPS gains. Extensive analysis and experimentation with the model was not possible because of budget constraints. The test results should be considered illustrative of the model's capability rather than representative.

Although the volunteer data that were available extended through June 1974, only data through December 1973 were used and projections for CY 1974 were made. The reason for this is that the model should only be used to project supply limited enlistees. For several months, beginning with December 1974, the volunteers were enlisted on a demand limited basis,* making it a poor time interval in which to test the model. Therefore, the forecasts for December 1974 were greatly overprojected by the test run and have been excluded from the statistics shown in Table 9.

Two regression runs were made for each of the three population groups shown in Table 9, one for blacks and one for non-blacks. The R^2 coefficient measures the goodness of fit of the regression results to the historical data. Values in the neighborhood of .9 are generally considered satisfactory. Both, the mean errors and the mean absolute errors are computed on the basis

* For future applications of the model where the demand limited accessions are a part of the historical data, one or more special independent variables (perhaps based on quotas) should be introduced to help explain the enlistments during this period of departure from supply limitation.

Table 9

TEST RESULTS
(Excluding December)

Population group	R ² (Black)	R ² (Not black)	% Mean error	% Mean Absolute error
1. Male NHSG, Mental Category I, II, III	.97	.93	4.4	11.0
2. Male HSG, Mental Category I, II, III (Case 1)	.89	.83	-10.2	12.0
3. Male HSG, Mental Category I, II, III (Case 2)	.92	.84	- 7.6	10.0

of the first 11 months of the projections. The mean error reflects the cancellation of positive and negative error terms, whereas the mean absolute error is based on the magnitude of the errors without regard to sign.

Population Groups 2 and 3 are identical; however, the regression used different sets of independent (or explanatory variables). The time variable, defined in Table 7, was included for Group 3 and played an important role in entering the regression equation, whereas, it was omitted from Group 2. Notice that it made an improvement in the forecasts. Additional improvements could very likely be achieved by further analysis and experimentation with the model.

Table 10 compares the forecasts with the actual values for the population Group 1 defined in Table 9. Note the poor forecast for the month of December 1974. As was stated earlier, the reason for this is that December 1974 was the beginning of the period in which accessions were demand limited rather than supply limited. Whenever large deviations such as are shown for the months of January and July are projected, then further analysis should be undertaken to try to determine the causes. For example, an independent variable may need to be constructed to reflect the result of a program or policy decision that would explain these deviations.

It should be stated that proper use of the model, requires analytical expertise in (1) interpreting and analyzing the statistical results such

Table 10

COMPARISON OF FORECASTS WITH ACTUALS FOR CY74

NPS Males, NHSG, Mental Category I, II, III

Month	FORECAST			Actual	Difference Forecast -Actual	% Difference
	Case 6 Black	Case 7 Not Black	Total			
Jan	2198.6	6541.9	8741	7056	1685	23.9
Feb	1484.0	4670.8	6155	5910	245	4.1
Mar	1995.0	4026.0	6021	5777	244	4.2
Apr	1720.8	3713.0	5434	5765	-331	-5.7
May	2044.1	3116.4	5161	5477	-316	-5.8
Jun	3199.3	5454.5	8654	7470	1184	15.9
Jul	2016.6	5099.6	7116	5768	1348	23.4
Aug	2245.9	4476.6	6723	7076	-353	-5.0
Sep	2210.5	3859.5	6071	7405	-1334	-18.0
Oct	2047.5	5484.1	7532	6818	714	10.5
Nov	1689.4	4911.8	6601	6536	65	1.0
Dec	1484.5	4748.0	6233	2959	3274	110.6
Totals & Mean						
Error	24,338	56,104	80,442	74017	6425	8.7
Totals and Mean Error						
Excluding December			74,208	71058	3150	4.4
Mean Absolute Error					7819	11.0

as: elasticity, tests of statistical significance, collinearity, residuals, coefficient of multiple determination (R^2), and standard error of estimate; (2) formulation of explanatory variables based on economic conditions, policy decisions and programs, and (3) use of such variables.

POST PROCESSOR

One of the post processor programs aggregates the monthly forecasts into at most four population categories used in COMPLIP. Monthly forecasts for the supply limited groups can be combined to form data for COMPLIP constraints on annual availability. Since the forecasts are based on several years of historical data they are used as the basis for computing the seasonal coefficients used by COMPLIP by simply normalizing the first 12 months of the forecast values. Suppose for a given COMPLIP C-group the forecasts are denoted by $V_1, V_2, \dots, V_{12}$ and the corresponding seasonal coefficients by $s_1, s_2, \dots, s_{12}$. The computation is as follows:

$$s_i = \frac{V_i}{\sum_{j=1}^{12} V_j}, \quad i = 1, 2, \dots, 12.$$

Another function of the post processor is to produce printer plots of historical and forecast values of each of the dependent variables. This is accomplished by the graph program. The preprocessor and the regression routines generate the files of the data to be plotted.

Chapter 3

USAGE

This chapter is oriented towards the application of NPSGM and hence contains such information as input card and file descriptions and operating procedures. The NPSGM consists of six programs defined as follows:

- Program #1 - Data generator, used for initial creation of the frequency file.
- Program #1a - Frequency file update routine, used for updating an existing frequency file.
- Program #2 - Regression preprocessor, used for preparing regression inputs, and header data for the graph and aggregation files.
- Program #3 - Regression program.
- Program #4 - Graph program, used for developing printer graphs of historical and projected population time series.
- Program #5 - Aggregating program, used for aggregating projected population groups to form C-groups used in COMPLIP-G2 and compute seasonal coefficients.

The files in the schematics for each of the programs are denoted as tape files, although they may be disk files. For example, if logical unit 10 is a disk file, it is commonly referred to as TAPE10. Each file has an MT (magnetic tape) identifier for ease in cross referencing. Table 11 gives a summary of the files, identifying the creating program, the using program, the logical unit, and the MT identifier. Table 12 summarizes the file characteristics and approximate volume of data to be expected. The files are identified with the MT identifier used in Table 11 or the program schematics presented for each program description.

Table 11
FILE SUMMARY

File description	Action	Program #	Logical unit	MT identifier
MVA file	used by	1	1	MT1
ELIM III Cohort file	used by	1	2	MT2
Frequency file	created by	1	3	MT3
	alternatively created by	1a	2	MT5
	used by	1a	1	MT3 or MT5
	used by	2	1	MT3 or MT5
Gain/loss transaction file	used by	1a	4	MT4
Independent variable data	used by	2	10	MT6
Regression input file	created by	2	7	MT7
	used by	3	7	MT7
Regression control cards	created by	2	50	MT8
	used by	3	5	MT8
Scratch file 1	used by	3	1	MT9
Scratch file 2	used by	3	2	MT9a
Aggregation file	created by	2	15	MT10
	augmented by	3	15	MT10
	used by	5	2	MT10
Graph file	created by	2	20	MT11
	augmented by	3	30	MT12
	used by	4	1	MT12
Aggregated C-groups	created by	5	10	MT13
Graphs (to be copied to printer)	created by	4	10	MT14

Table 12

SUMMARY OF FILE CHARACTERISTICS

MT identifier of file	COBOL/ FORTRAN	Binary/ BCD	Maximum record* length	Fixed/ variable	Maximum* size
MT1**		BCD	60	F	
MT2	C	BCD	137	V	137,000,000
MT3	C	BCD	9	F	125,000
MT4	C	BCD	135	V	13,500,000
MT5	C	BCD	9	F	125,000
MT6	F	BCD	30	F	50,000
MT7	F	BCD	10	F	50,000
MT8	F	BCD	80	F	50,000
MT9	F	BIN	6	V	1,000
MT9a	F	BIN	255	V	30,000
MT10	F	BCD	10	F	5,000
MT11	F	BIN	10	F	5,000
MT12	F	BIN	132	V	5,000
MT13	F	BCD	60	V	3,000
MT14	F	BCD	132	V	200,000

* Measured in number of characters for coded files and number of words for binary files.

** This file need not be processed by USAMSSA.

DATA GENERATOR (PROGRAM #1)

The data generator is a COBOL based, batch mode program which creates a coded frequency file of non-prior-service volunteer data. A schematic of it is shown in Fig. 5. Input to this program is the GRC MVA data base, used to extract draftee data prior to June 1973, and the other input is the ELIM Cohort File, which provides volunteer data from January 1971 to the present.** This program was conceived to be run only one time, as another program serves to update the frequency file when new data become available. A flowchart of the program is given in Fig. 6.

An internal data array, 250 x 50 (where 50 is a dimension that represents the number of months of data that the program may store), provides temporary storage for volunteer accession counts until the end of the input data. The program tabulates series for each of 250 population categories defined in Table 2 of Chap. 2. The categories are partitioned into two sets. They are mutually exclusive and exhaustive within each set. The first set or partition consists of population categories 1 - 196, the second 197 - 250.

Data items, read from input, which make up the 250 different time-series are: sex, race, age, term of service, education, mental category and bonus received. Category numbers 1-4 are comprised only of females and ordered by civilian education, race and mental category. Category numbers 5-196 include only males ordered by civilian education, race, mental group, age and bonus received. Category numbers 197-250 include both males and females ordered by civilian education, race, mental group and term of enlistment. The separate mention of category numbers 1-4 is solely to inform the user that these four cells contain only female accessions data that are under slightly different sequence arrangement than are the remainder of Partition 1. For every valid record processed by programs #1 or #1a,* one entry is made in each of the two population partitions, so that both partitions reflect the same population. However, the populations may differ slightly for the two partitions because of the different data items defining each of them and the possible omission of some records due to invalid codes.

*Program 1a is the update program to be discussed in the next section.

**When this processing occurred the cohort file contained data through June 1974.

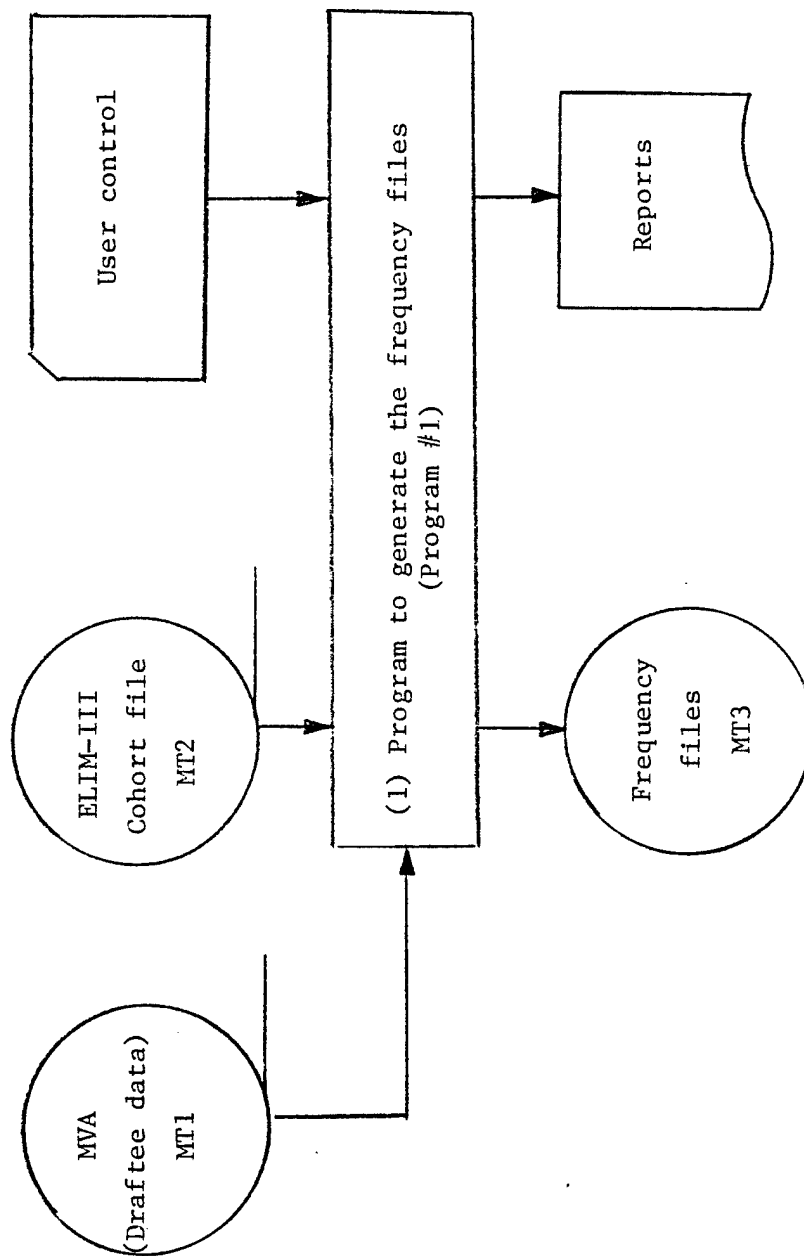


Fig. 5—Step 1 in the Projection of NPS Gains

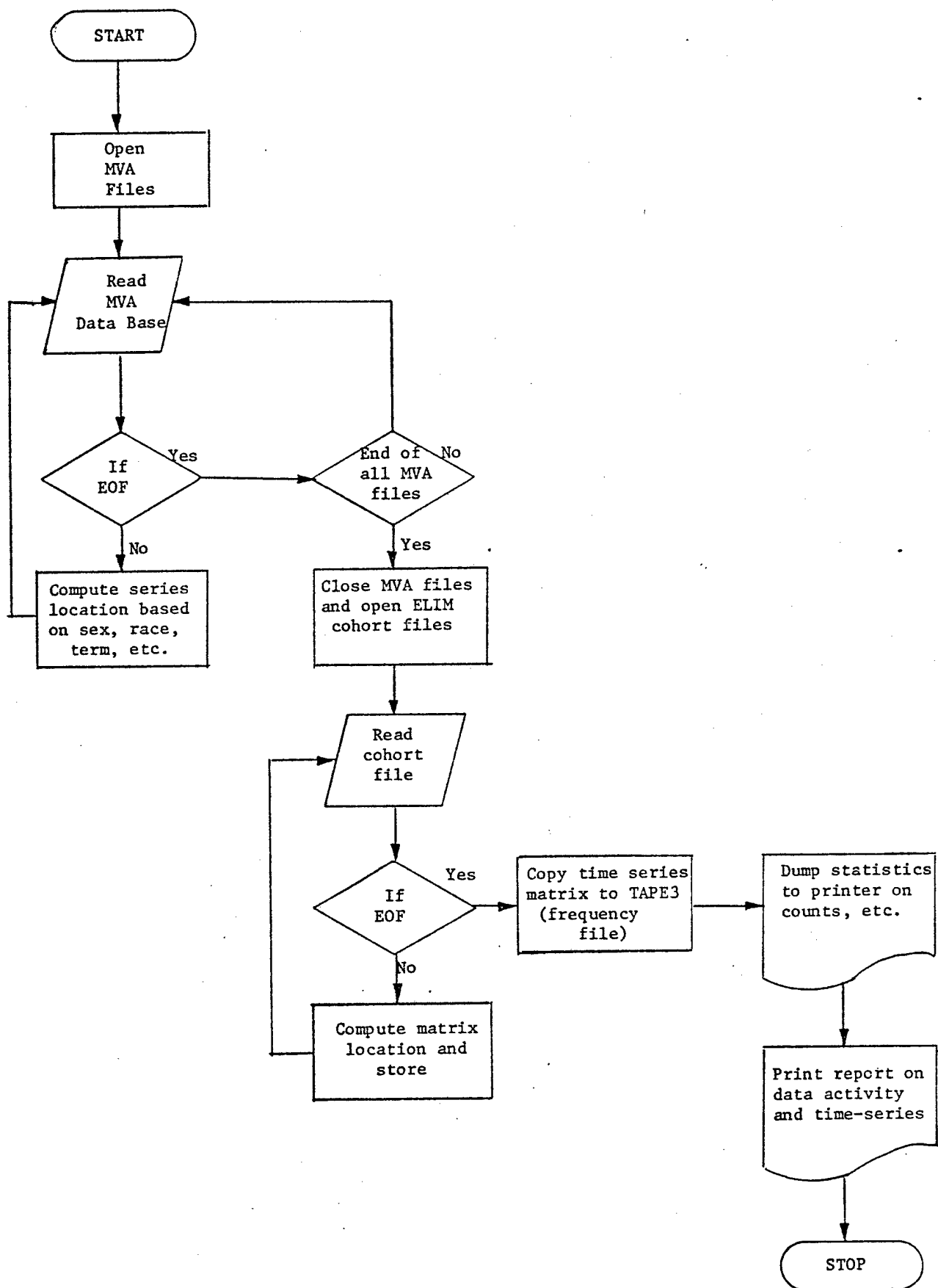


Fig. 6—Flowchart for the Data Generator—Program #1

Upon reaching end-of-file on the input data, a report summarizing the data processed is printed, along with a monthly count of the 250 series. These same data, written to tape in time-series form, become the frequency file.

Files

Input:

TAPE1 GRC MVA accession file
TAPE2 ELIM III Cohort file

Output:

TAPE3 Frequency file
PRINTER Report output, statistics on IO counts and
 input data validation summary

TAPE1. This is a coded file that contains accession data used to extract draftee information. It is of fixed record length with 40 records per block and 60 characters per record (MVA file, MT1).

TAPE2. This is a coded file containing RA enlisted data. It contains variable length records from 60 to 137 characters (ELIM-III cohort file, MT2).

TAPE3. Also a coded file, TAPE3 is the output frequency file having a fixed record length of nine characters per record, and 250 records per block (MT3).

Printer. This file displays total of records read and written and data validity counts. It also gives a report on the number of accessions per month which are in each of the 250 series.

The Job Control for CDC Cyber 70 for the Frequency File Generator is as follows:

```
T2000, MT3  Program #1
COBOL (LR,D)
REQUEST, TAPE1, R, S.
REQUEST, TAPE2, R.
* VSN, TAPE1 = 2434/2712/0538/3771/2043/1268.
* VSN, TAPE2 = 2546/2571/2757.
REQUEST, TAPE3, W, S, VSN = SAVE.  FREQ FILE
FILE (TAPE1, BT=K, RT=F, MBL=2400, FL=60, RB=40, CM=YES)
```

* These are internal GRC type numbers.

```
FILE (TAPE2, BT=C, RT=Z, FL=137, CM=YES)
FILE (TAPE3, BT=K, RT=F, MBL=2250, FL=09, RB=250, CM=YES)
LDSET (FILES=TAPE1/TAPE2/TAPE3)
LGO
```

FREQUENCY FILE UPDATE ROUTINE (PROGRAM #1a)

This COBOL program, like the Data Generator, creates a monthly time-series of 250 elements, based on specific data fields from the gain/loss transaction file. A schematic of this program is given in Fig. 7 and a flowchart is given in Fig. 8.

Inputs to this program are: (1) the gain/loss file, (2) the frequency file and (3) one parameter card. Outputs of the program are: (1) a new frequency file with new data applied and header records adjusted, and (2) a printer output file which displays statistics of the run and gives summaries of the data processed. The program has an internally dimensional array of 250 x 6, which allows input data to cover a six-month range. Data outside this range will be ignored.

A parameter card specifies the last calendar month for which the frequency file is to be updated. For the normal update mode, this last update month is later than the last month of the frequency file prior to the update. However, it is possible to add data for prior months, with such late transaction data being combined with the corresponding data already on the file. If the date on the parameter card is more than six months beyond the last month of the frequency file, an error condition is assumed and the program terminates. Other possible combinations of data base and parameter cards are described in Fig. 9.

Upon finding the parameter card date within the update capability of the program, as much of the original frequency file that will not be altered during the run is copied to the output frequency file. After processing of the data, the internal arrays are summed with the corresponding months of data on the original frequency file and copied to the output frequency file.

The frequency file contains four header records which contain starting date of the time-series and the length, in months, of the data base. During an update, corrections are made to the header to reflect the addition of new data.

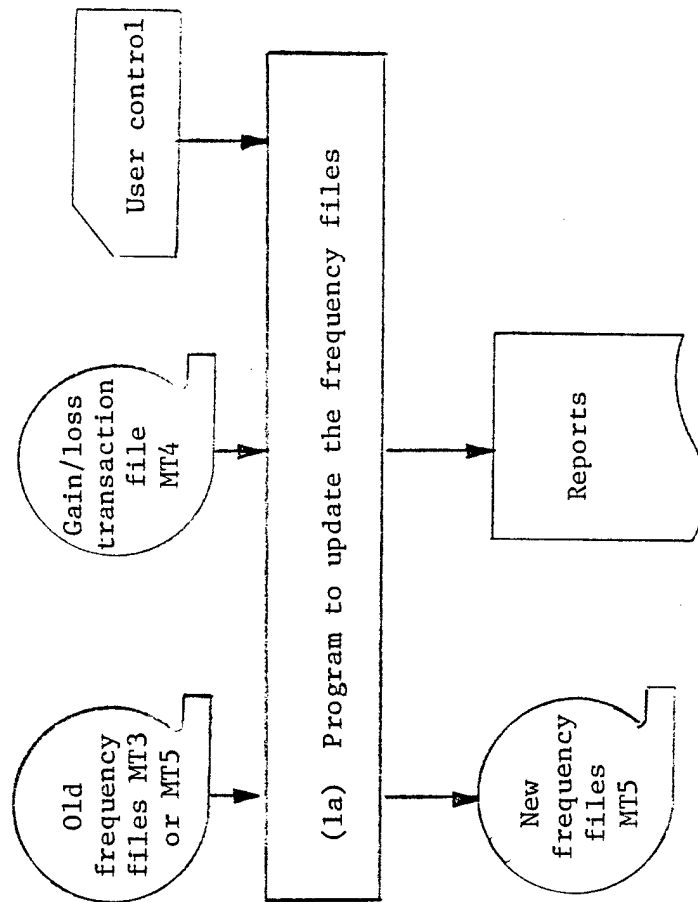


Fig. 7--Alternate Step 1 in the Projection NPS Gains

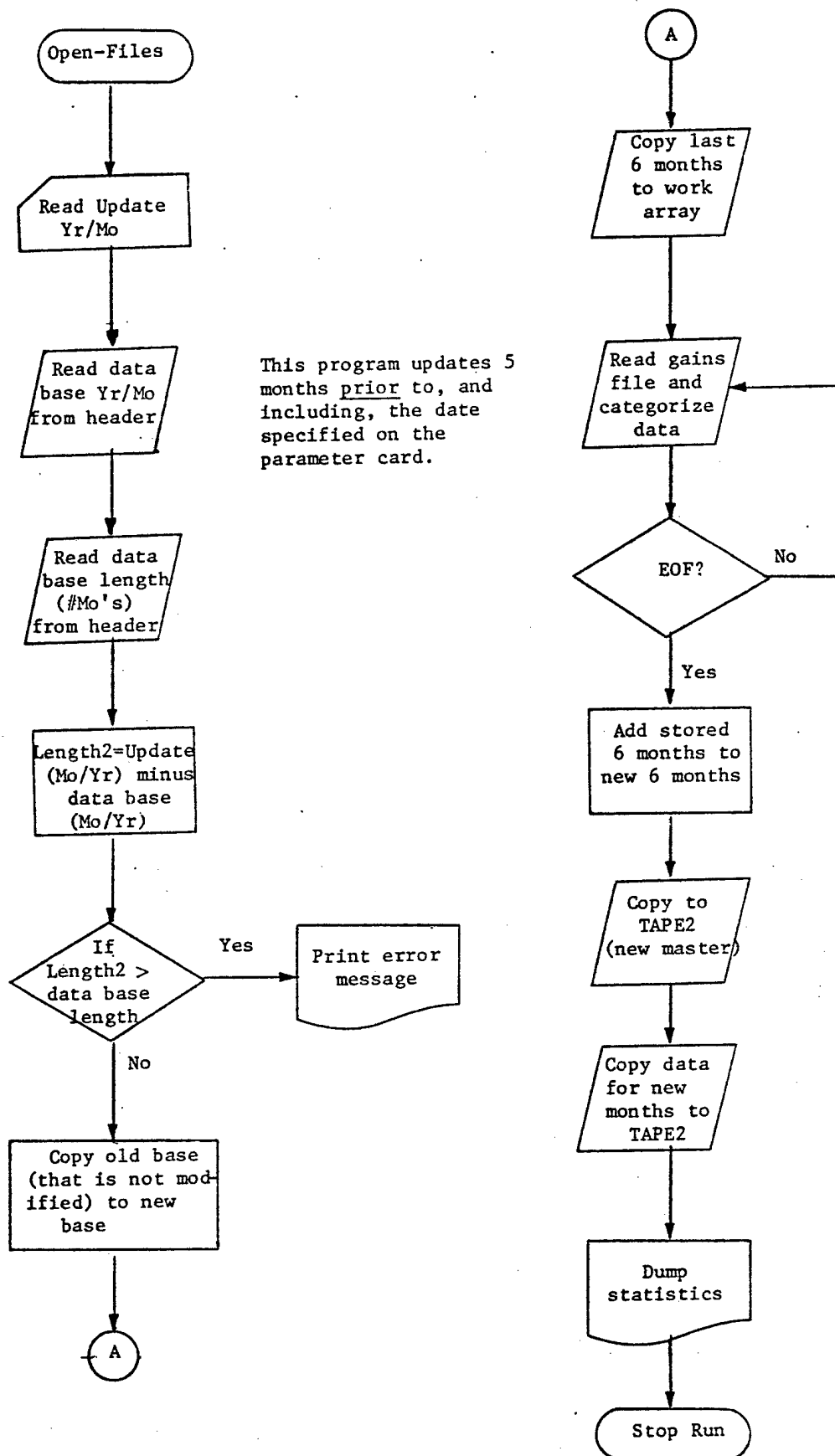


Fig. 8—Flowchart of Update Program (Program #1a)

Original frequency file

Original frequency file										
Σ		33	34	35	36	37	38	39	40	
Adds to end of old file										
		1	2	3	4	5	6			

Original frequency file
length = 40

After update, frequency file
length = 44

Summing of new data to old

[illegible]

46

After update, frequency file
length = 40

Summing of new data to old

	33	34	35	36	37	38	39	40

1	2	3	4	5	6		

After update, frequency file
length = 39

One month of original
data deleted

Fig. 9—Hypothetical Examples of Updates

A knowledge of the ending point of the existing frequency file is critical to a successful update.

Files

Input:

TAPE1 Frequency file (original)
TAPE4 Gain/loss file
CARD Parameter card (1)

Output:

TAPE2 Frequency file (newly generated)
PRINTER Lists IO operation counts, input parameter
 card list and new header information

TAPE1. This is the coded frequency file generated by Program #1 (Data Generator), (MT3); or by #1a as MT5 in a previous run.

TAPE2. This file is identical to TAPE1, in format, but reflects changes in the header and total file length, due to updating. In addition to the adding of new months of data, earlier months may be different if late transactions are posted, (MT5).

TAPE4. Gain/loss file that is used to update the frequency file (MT4).

Printer. Contains information pertaining to the update, such as starting and ending times of the update period, and how many months of new data will be added. It also displays new values assigned to replace the header records of the frequency file.

Input Card. A single parameter card identifies the last calendar month that the update will cover. The format is simply: Month/Year (I2, IX, I2).

All comparison against the input frequency file starting date is based on this date, and internal storage registers also are based on the accuracy of the date on this card.

A typical example of a parameter card for a particular update is as follows:

Data base length = 32, with last month of data
base being 06/75.

Parameter card being of the form 10/75 would produce 4 months of new data and update 2 months of previously existing data, if any data exists for these two months.

REGRESSION PREPROCESSOR AND REGRESSION PROGRAMS (Programs #2 and #3)

Both are FORTRAN programs. All the input files and control cards are supplied to the preprocessor program, which in turn prepares all the input for the regression program. In fact, in order to run the regression program, the preprocessor must first be exercised in order to prepare the input for the regression program. The two programs must be run under the same job control because one file (MT10) that is initially written in the preprocessor is continued to be written by the regression program and therefore must not be rewound at the start of the regression run. A schematic of the two programs is shown in Fig. 10.

By use of input parameter cards, the user is able to select many combinations of dependent variables from the frequency file, along with independent variables that help to explain variations in the dependent variable and attempt to find patterns so as to forecast these variables for the future.

For each dependent variable selected, the user is able to select independent variables to be regressed against the dependent variable. This constitutes a single problem. A subproblem would include the use of the same dependent variables. A listing of the independent variable time series is given in App. A.

The regression routine used in conjunction with the preprocessor is the nonlinear stepwise package described in Chap. 2. The BMD02R users manual^{*} can be referenced to help explain the listing of most of the input data, which is generated for the user with the preprocessor.

Frequency File Arrangement and Aggregation

The frequency file is comprised of 250 cells per month for as many months as the data base covers. These 250 cells are broken into two sets (or partitions) consisting of 196 and 54 categories, respectively.

For any particular run, a maximum of 20 aggregations can be made from either of the partitions, thereby creating 20 dependent variables. Care must be taken to ensure that for a selected run, all choices of dependent variables come from the same partition. If any cells within

^{*} See Reference 5 of Chap. 2.

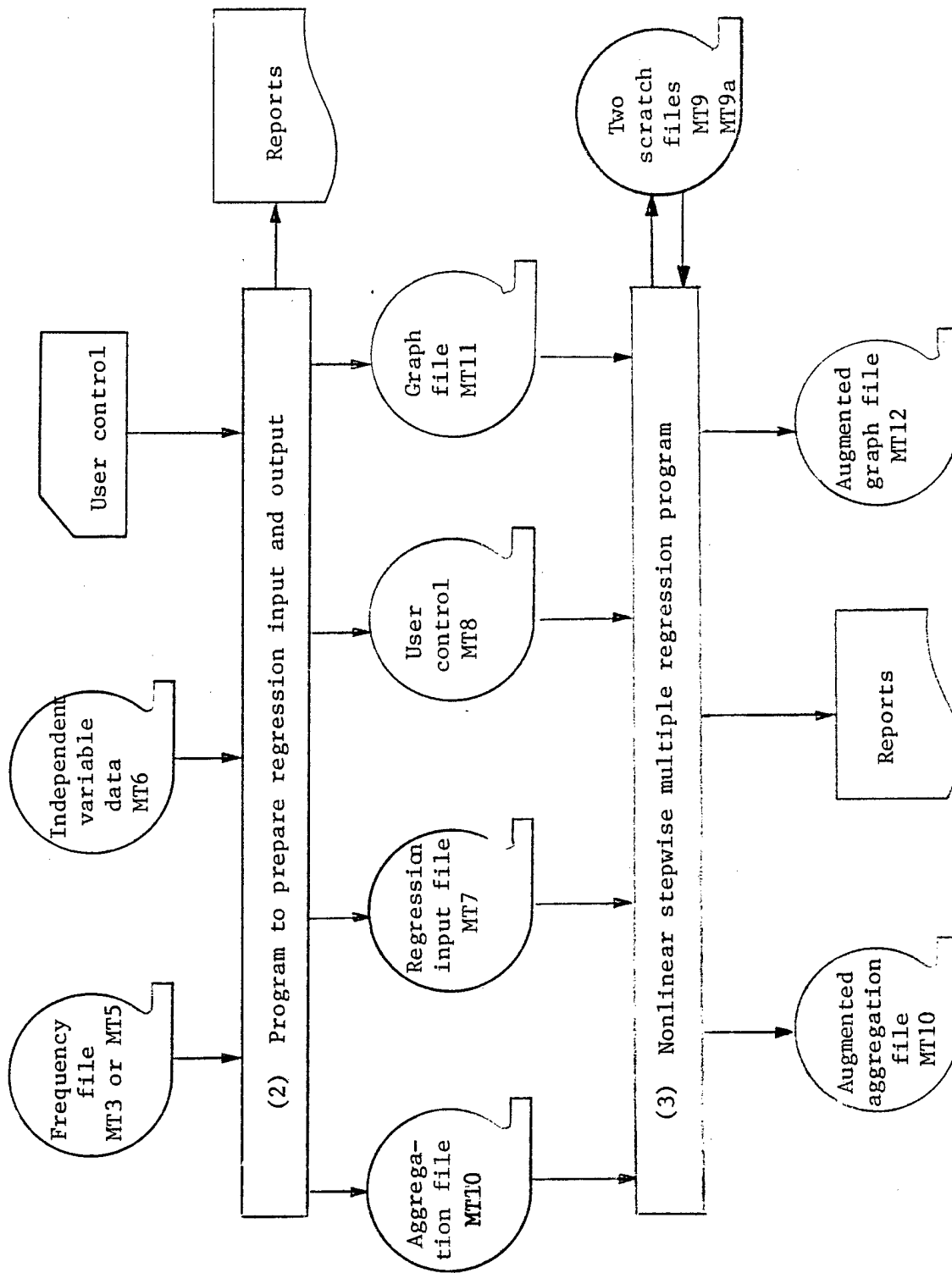


Fig. 10—Steps 2 and 3 in the Projection of NPS Gains

the selected partition are omitted, an error message will be given, as will the case where a cell from the wrong partition is selected to form one of the dependent variables. Neither of these two error conditions will terminate the run, but messages will be given, listing the cells which were duplicated, omitted or included from the wrong partition. The preprocessor will only abort if the input card sequence is in error or if one of the cards specifying the selected cells is not in ascending order. (Refer to series card, type 3, for a further description of the error.)

Refer to the detailed tables, Tables 13 and 14 of the frequency file layout, in order to select cells that are to be combined to form each dependent variable.

File Description

Preprocessor input consists of:

- 1) TAPE1 (MT3 or MT5) ELIM-COMPLIP frequency (dependent variable data)
- 2) TAPE10 (MT6) Independent variable time-series data base to be maintained by means of the system update or edit features.
- 3) TAPE5 User control cards.

Preprocessor output consists of:

- 1) TAPE50 (MT8) Regression control card file.
- 2) TAPE7 (MT7) Dependent and independent variable time-series .
- 3) TAPE6 and System printer Printer file with all user control card activity, regression card image input data and statistics on data selected for each regression.
- 4) TAPE20 (MT11) Date and data structure information for dependent variable graphs.
- 5) TAPE15 (MT10) Data structure information for aggregations.

Regression routine input:

- 1) Items (1), (2), (4) and (5) under preprocessor output using the same logical units except for TAPE 50, which is read as TAPE5.

Table 13

CATEGORIES FOR TRUE VOLUNTEER NPS GAINS FREQUENCY DISTRIBUTION
(Population Partition 1)

Female^a

Category number	Civilian education	Race	Mental group	Age	Bonus
1	HSG ^b	black	1,2	all	no
2	"	non-black	"	"	"
3	GED ^c	black	"	"	"
4	"	non-black	"	"	"

Male^d

Category number	Civilian education	Race	Mental group	Age	Bonus
5	HSG	black	1,2,3A	<18	yes
6	"	"	"	"	no
7	"	"	"	≥18, <20	yes
8	"	"	"	"	no
9	"	"	"	≥20, <22	yes
10	"	"	"	"	no
11	"	"	"	≥22	yes
12	"	"	"	"	no
13	HSG	black	3B	<18	yes
14	"	"	"	"	no
15	"	"	"	≥18, <20	yes
16	"	"	"	"	no
17	"	"	"	≥20, <22	yes
18	"	"	"	"	no
19	"	"	"	≥22	yes
20	"	"	"	"	no

Table 13(cont'd)

Male^d

Category number	Civilian education	Race	Mental group	Age	Bonus
21	HSG	black	4,5	<18	yes
22	"	"	"	"	no
23	"	"	"	≥18,<20	yes
24	"	"	"	"	no
25	"	"	"	≥20,<22	yes
26	"	"	"	"	no
27	"	"	"	≥22	yes
28	"	"	"	"	no
29	HSG	not black	1,2,3A	<18	yes
30	"	"	"	"	no
31	"	"	"	≥18,<20	yes
32	"	"	"	"	no
33	"	"	"	≥20,<22	yes
34	"	"	"	"	no
35	"	"	"	≥22	yes
36	"	"	"	"	no
37	HSG	not black	3B	<18	yes
38	"	"	"	"	no
39	"	"	"	≥18, <20	yes
40	"	"	"	"	no
41	"	"	"	≥20, <22	yes
42	"	"	"	"	no
43	"	"	"	≥22	yes
44	"	"	"	"	no

Table 13(cont'd)

Male^d

Category number	Civilian education	Race	Mental group	Age	Bonus
45	HSG	not black	4,5	<18	yes
46	"	"	"	"	no
47	"	"	"	≥18, <20	yes
48	"	"	"	"	no
49	"	"	"	≥20, <22	yes
50	"	"	"	"	no
51	"	"	"	≥22	yes
52	"	"	"	"	no
53	GED	black	1,2,3A	<18	yes
54	"	"	"	"	no
55	"	"	"	≥18, <20	yes
56	"	"	"	"	no
57	"	"	"	≥20, <22	yes
58	"	"	"	"	no
59	"	"	"	≥22	yes
60	"	"	"	"	no
61	GED	black	3B	<18	yes
62	"	"	"	"	no
63	"	"	"	≥18, <20	yes
64	"	"	"	"	no
65	"	"	"	≥20, <22	yes
66	"	"	"	"	no
67	"	"	"	≥22	yes
68	"	"	"	"	no

Table 13 (Cont'd)

Male^d

Category number	Civilian education	Race	Mental group	Age	Bonus
69	GED	black	4,5	<18	yes
70	"	"	"	"	no
71	"	"	"	≥ 18, <20	yes
72	"	"	"	"	no
73	"	"	"	≥ 20, <22	yes
74	"	"	"	"	no
75	"	"	"	≥ 22	yes
76	"	"	"	"	no
77	GED	not black	1,2,3A	<18	yes
78	"	"	"	"	no
79	"	"	"	≥ 18, <20	yes
80	"	"	"	"	no
81	"	"	"	≥ 20, <22	yes
82	"	"	"	"	no
83	"	"	"	≥ 22	yes
84	"	"	"	"	no
85	GED	not black	3B	<18	yes
86	"	"	"	"	no
87	"	"	"	≥ 18, <20	yes
88	"	"	"	"	no
89	"	"	"	≥ 20, <22	yes
90	"	"	"	"	no
91	"	"	"	≥ 22	yes
92	"	"	"	"	no

Table 13(cont'd)

Male^d

Category number	Civilian education	Race	Mental group	Age	Bonus
93	GED	not black	4,5	<18	yes
94	"	"	"	"	no
95	"	"	"	≥18, <20	yes
96	"	"	"	"	no
97	"	"	"	≥20, <22	yes
98	"	"	"	"	no
99	"	"	"	≥22	yes
100	"	"	"	"	no
101	some HS	black	1,2,3A	<18	yes
102	"	"	"	"	no
103	"	"	"	≥18, <20	yes
104	"	"	"	"	no
105	"	"	"	≥20, <22	yes
106	"	"	"	"	no
107	"	"	"	≥22	yes
108	"	"	"	"	no
109	some HS	black	3B	<18	yes
110	"	"	"	"	no
111	"	"	"	≥18, <20	yes
112	"	"	"	"	no
113	"	"	"	≥20, <22	yes
114	"	"	"	"	no
115	"	"	"	≥22	yes
116	"	"	"	"	no

Table 13 (cont'd)

Male^d

Category number	Civilian education	Race	Mental group	Age	Bonus
117	some HS	black	4,5	<18	yes
118	"	"	"	"	no
119	"	"	"	≥18, <20	yes
120	"	"	"	"	no
121	"	"	"	≥20, <22	yes
122	"	"	"	"	no
123	"	"	"	≥22	yes
124	"	"	"	"	no
125	some HS	not black	1,2,3A	<18	yes
126	"	"	"	"	no
127	"	"	"	≥18, <20	yes
128	"	"	"	"	no
129	"	"	"	≥20, <22	yes
130	"	"	"	"	no
131	"	"	"	≥22	yes
132	"	"	"	"	no
133	some HS	not black	3B	<18	yes
134	"	"	"	"	no
135	"	"	"	≥18, <20	yes
136	"	"	"	"	no
137	"	"	"	≥20, <22	yes
138	"	"	"	"	no
139	"	"	"	≥22	yes
140	"	"	"	"	no

Table 13(cont'd)

Male^d

Category number	Civilian education	Race	Mental group	Age	Bonus
141	some HS	not black	4,5	<18	yes
142	"	"	"	"	no
143	"	"	"	≥18, <20	yes
144	"	"	"	"	no
145	"	"	"	≥20, <22	yes
146	"	"	"	"	no
147	"	"	"	≥22	yes
148	"	"	"	"	no
149	no HS	black	1,2,3A	<18	yes
150	"	"	"	"	no
151	"	"	"	≥18, <20	yes
152	"	"	"	"	no
153	"	"	"	≥20, <22	yes
154	"	"	"	"	no
155	"	"	"	≥22	yes
156	"	"	"	"	no
157	no HS	black	3B	<18	yes
158	"	"	"	"	no
159	"	"	"	≥18, <20	yes
160	"	"	"	"	no
161	"	"	"	≥20, <22	yes
162	"	"	"	"	no
163	"	"	"	≥22	yes
164	"	"	"	"	no

Table 13 (cont'd)

Male ^d					
Category number	Civilian education	Race	Mental group	Age	Bonus
165	no HS	black	4,5	<18	yes
166	"	"	"	"	no
167	"	"	"	≥18, <20	yes
168	"	"	"	"	no
169	"	"	"	≥20, <22	yes
170	"	"	"	"	no
171	"	"	"	≥22	yes
172	"	"	"	"	no
173	no HS	not black	1,2,3A	<18	yes
174	"	"	"	"	no
175	"	"	"	≥18, <20	yes
176	"	"	"	"	no
177	"	"	"	≥20, <22	yes
178	"	"	"	"	no
179	"	"	"	≥22	yes
180	"	"	"	"	no
181	no HS	not black	3B	<18	yes
182	"	"	"	"	no
183	"	"	"	≥18, <20	yes
184	"	"	"	"	no
185	"	"	"	≥20, <22	yes
186	"	"	"	"	no
187	"	"	"	≥22	yes
188	"	"	"	"	no

Table 13 (cont'd)

Male ^d

Category number	Civilian education	Race	Mental group	Age	Bonus
189	no HS	not black	4,5	<18	yes
190	"	"	"	"	no
191	"	"	"	≥18, <20	yes
192	"	"	"	"	no
193	"	"	"	≥20, <22	Yes
194	"	"	"	"	no
195	"	"	"	≥22	yes
196	"	"	"	"	no

^aIt is assumed that all females are true volunteers, either HS graduate or GED, mental group 1 or 2, and no bonus.

^bHigh school graduate.

^cGeneral education development.

^dVolunteers for draft and RA.

Table 14

CATEGORIES FOR TRUE VOLUNTEER NPS GAINS FREQUENCY DISTRIBUTION
(Population Partition 2)

Category number	Civilian education	Race	Mental group	Term of enlistment
197	HSG	black	1,2,3A	2
198	"	"	3B	"
199	"	"	4,5	"
200	"	not black	1,2,3A	"
201	"	"	3B	"
202	"	"	4,5	"
203	GED	black	1,2,3A	2
204	"	"	3B	"
205	"	"	4,5	"
206	"	not black	1,2,3A	"
207	"	"	3B	"
208	"	"	4,5	"
209	not HSG or GED	black	1,2,3A	2
210	"	"	3B	"
211	"	"	4,5	"
212	"	not black	1,2,3A	"
213	"	"	3B	"
214	"	"	4,5	"
215	HSG	black	1,2,3A	3
216	"	"	3B	"
217	"	"	4,5	"
218	"	not black	1,2,3A	"
219	"	"	3B	"
220	"	"	4,5	"

Table 14 (cont'd)

Category number	Civilian education	Race	Mental group	Term of enlistment
221	GED	black	1,2,3A	3
222	"	"	3B	"
223	"	"	4,5	"
224	"	not black	1,2,3A	"
225	"	"	3B	"
126	"	"	4,5	"
227	not HSG or GED	black	1,2,3A	3
228	"	"	3B	"
229	"	"	4,5	"
230	"	not black	1,2,3A	"
231	"	"	3B	"
232	"	"	4,5	"
233	HSG	black	1,2,3A	4,5,6
234	"	"	3B	"
235	"	"	4,5	"
236	"	not black	1,2,3A	"
237	"	"	3B	"
238	"	"	4,5	"
239	GED	black	1,2,3A	4,5,6
240	"	"	3B	"
241	"	"	4,5	"
242	"	not black	1,2,3A	"
243	"	"	3B	"
244	"	"	4,5	"

Table 14 (cont'd)

Category number	Civilian education	Race	Mental group	Term of enlistment
245	not HSG or GED	black	1,2,3A	4,5,6
246	"	"	3B	"
247	"	"	4,5	"
248	"	not black	1,2,3A	"
249	"	"	3B	"
250	"	"	4,5	"

Regression output:

- 1) TAPE15 (MT10) Data structure information and forecasts for each regression run, to be used by the aggregation program.
- 2) TAPE6 Printer file with complete regression results.
- 3) TAPE30 (MT12) Date, data structure information, historical and forecast data for the graph program.

Input Parameter Card Description

Six card types are used for proper initiation of the preprocessor routine. Five are required and one is optional.

- Card type #1 Must precede all other input cards and contains base yr/mo data, title for the run, optional 'F' levels, and output controls.
- Card type #2 Contains information as to which table will be in use for run, and the name of one of the dependent variables. It also contains fields for the number of subproblems, the number of variables added by transgeneration and the number of transgeneration cards, if any.
- Card type #3 This card contains the series numbers that will be combined to form the dependent variable defined by card type #2.
- Card type #4 This card simply says 'END' and designates the end of a section. It shows the end of the dependent variable section, or the end of each group of independent variables selected for use in conjunction with each dependent variable.
- Card type #5 Contains the name of an independent variable, along with information about its effect on the regression equation, i.e., where the variable can enter the equation with positive or negative coefficients, and what lags the variable may have.
- Card type #6 This card is optional and is only used for transgeneration of variables. It is used in conjunction with card type #2.

Table 15 gives the layout for the required cards and Table 16 for the optional cards. Figure 11 shows the order of the input cards.

Table 15

PREPROCESSOR INPUT PARAMETER CARD LAYOUT

Card type	CC#	Field#	Format	Description
1 (base card)	1-4	1	A4	'BASE' is required here.
	11-12	2	I2	Year in which data will begin entering regression (does not have to agree with frequency file starting point).
	16-17	3	I2	Month in which data will begin entering regression (also does not have to agree with frequency file starting point).
	20-31	4	3A4	Title used to identify run. Also used in naming plot. (Alphanumeric)
	32-36	5	F5.2	Optional 'F' to enter (default is .15).
	37-41	6	F5.2	Optional 'F' to remove (default is .05).
	46	7	I1	"1" if a summary table of coefficient values and elasticities, and a twelve month projection of each C-group is desired; "b" otherwise.
2 (dependent variable card)	50	8	I1	"1" if the step-by-step results for the first and last iterations are desired; "3" if these step-by-step results are not needed.
	1-4	1	A4	Must be either 'TAB1' or 'TAB2' designating which population partition will be used.
	11-18	2	2A4	Name assigned to this dependent variable. (Alphanumeric)
	30-31	3	I2	Number of subproblems to be generated from this dependent variable.
	40-41	4	I2	Number of transgeneration cards, if any.
2a (dependent variable card)	50-51	5	I2	Number of variables added, due to trans-generation.
	1-68		17A4	Passed to graph program, only one is required for multiple subproblems.

Table 15 (cont'd)

Card type	CC#	Field#	Format	Description
3 (series card)	1-80	1-8	8(2I5)	Elements of the respective partition that will make up a particular dependent variable (from Figs. 13 and 14).
4 (end card)	1-3	1	A3	'END' denotes the end of the section; either the end of all dependent variables or the end of a group of independent variables.
5 (independent variable card)	1-8 15	1 2	2A4 A1	Name of independent variable. Either 'p', 'N' or blank, representing the sign which the coefficient of the variable must take in order for the variable to enter the regression. A blank indicates that there is no restrictions on the sign of the coefficient
	20	3	I1	The number of members of a family (original and lagged copies) of independent variables that can enter the equation (will usually = 1).
	21-80	4-16	12(I5)	Number of months the variable will lag.

Table 16

OPTIONAL CARD USED IN CONJUNCTION WITH CARD TYPE 2

Card type	CC#	Field#	Format	Description
6 (transgen card)	1-6	1	A6	Word 'TRNGEN' required [*]
	7-9	2	I3	Variable index k
	10-11	3	I2	Code for transgeneration list (see App B).
	12-14	4	I3	Variable index i
	15-20	5	I6	Variable index j or constant c

^{*} See App B for a description of BMD02R optional transgeneration control card input.

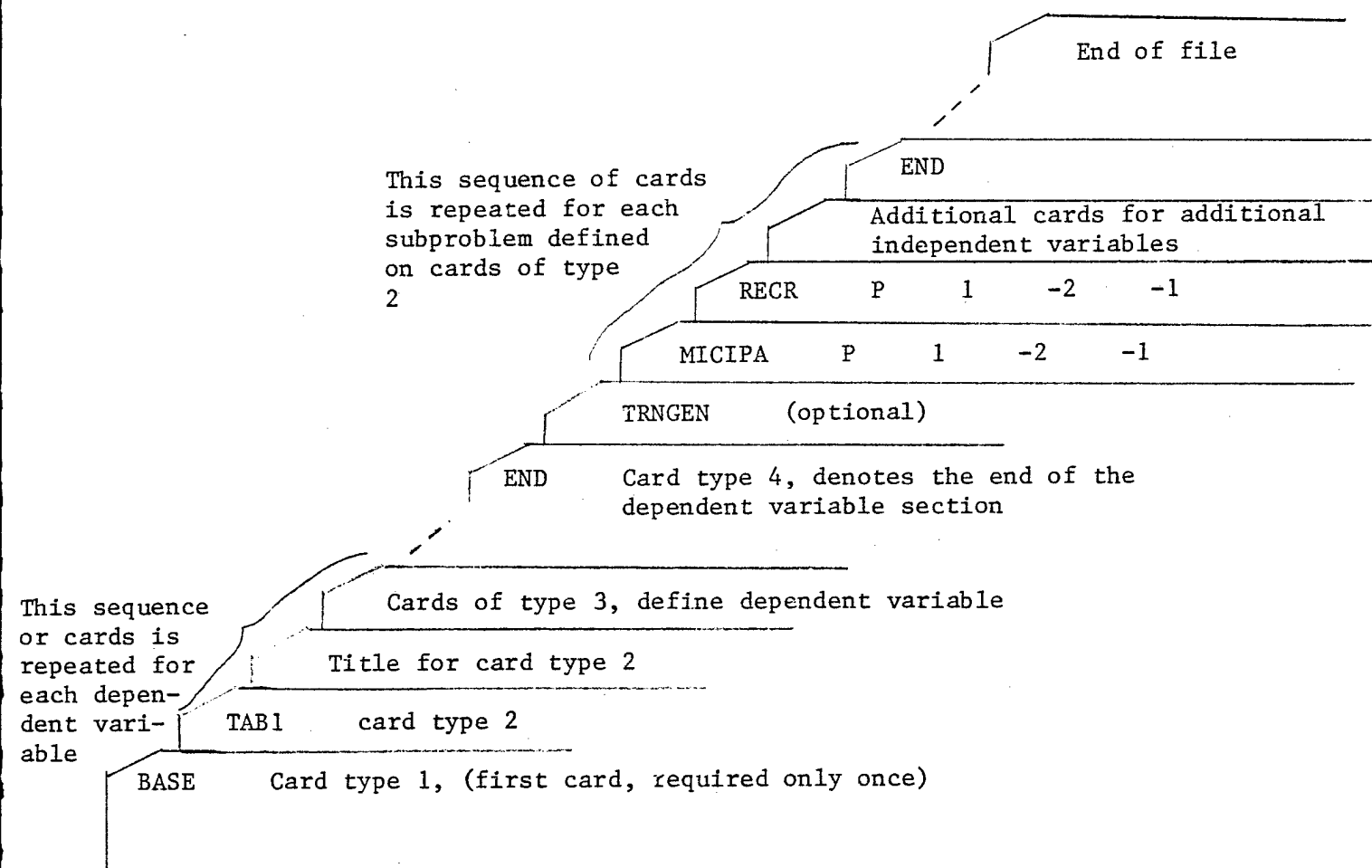


Fig. 11—Preprocessor Input Parameter Sequencing

Detailed Description of Dependent Variable Card Type 2

1. Field position 2 (dependent variable name)

This eight character field contains the name which the user assigns to the dependent variable which he creates. This name is carried throughout the regression routine and all subsequent reference to any dependent variable is via this name

2. Field position 3 (subproblem number)

This number denotes the number of times the stepwise regression subroutine is initiated for that particular dependent variable. Referring to Fig. 11, it is necessary to insert complete sets of independent variable cards, back-to-back, equal to the number specified in this field. If this fact is overlooked, the correspondence between the dependent variables and the sets of independent variables will be out of sequence.

3. Field position 4 (number of transgeneration cards)

This field should be zero filled except where transgeneration cards are to appear in the regression.

4. Field position 5 (number of variables added due to transgeneration)

Some transgeneration codes do not create new variables, but simply alter existing independent variables, in which case this field should be zero. (Refer to Appendix B for details on transgeneration codes).

Detailed Description of Series Card Type 3

1. This card is broken into eight 10 character numeric fields. Each of the eight fields is again broken into two 5 character fields.

2. To use one of these 10 character fields as an example, assume that for a particular dependent variable, the following series numbers are to be selected: 1 to 6, 12, 37, 55 to 60, 65, and 70 to 73.

Rather than require to user to punch 1, 2, 3, 4, 5 and 6 into specific fields, the range may be specified, as shown here.

1	6	or	5	5	6	0	,	etc.
1 2 3 4 5 6 7 8 9 10			11	14 15	19 20			

To specify a single element of a table the user would simply place that series number in the second five digit field (right justified), i.e.,

12	
	1 2 3 4 5 6 7 8 9 10

A blank in the fifth position of each 10 character field indicates that it is not a series of elements, but a single element.

This example could be placed on a single series card. When a second, third or fourth card is required, it is imperative that the tenth position of each 10 character field be filled, otherwise the scanning terminates and the program assumes the end of the series.

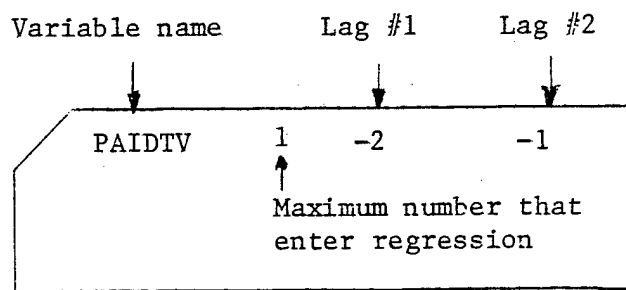
Detailed Description of Independent Variable Card, Type 5

1. The first data field contains the name of an independent variable data file. This name must agree with a name in the table of names, listed on every run of the preprocessor. Refer to App 6 for the correct abbreviated spellings of these names.

2. Field position 2 requires a 'P', 'N', or a blank. A 'P' or 'N' forces the sign of the coefficient of the entering variable such that it can only have a positive or negative effect on the regression result. If a variable is forced to have a positive coefficient and it would otherwise have a significant negative effect in the regression, the algorithm will exclude it from the regression.

3. Field position 3 must contain the number of variables from the same family of variables that can be in the regression equation at any one time. Two variables belong to the same family if they were created from the same original independent variable by means of lagging. The original variable also belongs to the family.

4. The fourth field position through the 16th is used in cases where an independent variable, such as a program variable, has a lagging effect. The first of the sixteen fields represents the maximum lag (or shift) that a variable may possess. For each position of these fields which is filled, a new variable will, essentially, be created. An illustration will help to clarify these data fields.



In this example, three variables would be generated. The first would have a lag of 2 months, the second a lag of 1 month and the third would be the original variable, which is included automatically. During the course of the regression, only one of these variables could enter with either a positive or negative coefficient.

Note: In order to properly align the data bases, the preprocessor searches all independent variable data cards and stores the maximum shift of all variables, and adjusts the starting point of the data bases. A maximum shift of two months would shorten the time span of a data base by two months.

								generated variables			
								$V_8^{L_1}$	$V_8^{L_2^*}$		
Month	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8			
1								10	no data	no data	1
2								20	no data	no data	2
3								30	20	10	3 new starting point

Therefore, labels generated would appear: $1V_1$, $2V_2$, $3V_3 \dots 8V_8 L_2$, $9V_8 L_1$, $10V_8 L_0$.

Sample input parameter listing 1:

This example shows the relationship of each dependent to its independent variable string.

```

BASE      71   01  **TEST RUN**
TAB1      FEMALES          1      00      00
                                FEMALES
      1      4
TAB1      B-HS-1-3          1      00      00
                                MALE, BLACK, HSG, CAT 1, 2, 3
      5      20
TAB1      B-HS-4-5          1      00      00
                                MALE, BLACK, HSG, CAT 4, 5
      21      28

```

*Where $V_8 L_0$, $V_8 L_1$ and $V_8 L_2$ stand for variable V_8 lagged by zero, one and two months, respectively.

TAB1	W-HS-1-3	1	00	00
		MALE, WHITE, HSG, CAT 1, 2, 3		
29	44			
TAB1	W-HS-4-5	1	00	00
		MALE, WHITE, HSG, CAT 4, 5		
45	52			
TAB1	R-NHS-1-3	1	00	00
		MALE, NHSG, PLACK, CAT 1, 2, 3		
53	68 101 116 149 164			
TAB1	W-NHS-1-3	1	00	00
		MALE, NHSG, WHITE, CAT 1, 2, 3		
77	92 125 140 173 188			

END

MICIPA	P	1	-2	-1
PASURG	P	1		
RECASS	P	1	-2	-1
RECR	P	1	-2	-1
TIME		1		
PRTMED	P	1	-2	-1
BNSHSG	P	1		
BNSKL1	P	1		
BNSKL2	P	1		
TYOPT	P	1		

END

MICIPA	P	1	-2	-1
PASURG	P	1		
RECASS	P	1	-2	-1
DUNEMP	P	1	-2	-1
PRTMED	P	1	-2	-1
BNSHSG	P	1		
BNSKL1	P	1		
BNSINC	P	1		
PAIDTV	P	1	-2	-1
UOCCAN	P	1	-2	-1
CAOPTS	P	1	-2	-1
TYOPT	P	1		

END

MICIPA	P	1	-2	-1
PASURG	P	1		
RECASS	P	1	-2	-1
RECR	P	1	-2	-1
DUNEMP	P	1	-2	-1
PRTMED	P	1	-2	-1
PAIDTV	P	1	-2	-1
UOCCAN	P	1	-2	-1
CAOPTS	P	1	-2	-1
TYOPT	P	1		
BNSNHS	P	1		
CAT4LM	P	1		

END

MICIPA	P	1	-2	-1
PASURG	P	1		
RECASS	P	1	-2	-1
DUNEMP	P	1	-2	-1
PRTMED	P	1	-2	-1
BNSHSG	P	1		
BNSKL1	P	1		
BNSINC	P	1		
PAIDTV	P	1	-2	-1
UOCCAN	P	1	-2	-1
CAOPTS	P	1	-2	-1
TYOPT	P	1		
END				
MICIPA	P	1	-2	-1
PASURG	P	1		
RECASS	P	1	-2	-1
RECR	P	1	-2	-1
DUNEMP	P	1	-2	-1
PRTMED	P	1	-2	-1
PAIDTV	P	1	-2	-1
UOCCAN	P	1	-2	-1
CAOPTS	P	1	-2	-1
TYOPT	P	1		
BNSNHS	P	1		
CAT4LM	P	1		
END				
MICIPA	P	1	-2	-1
PASURG	P	1		
RECASS	P	1	-2	-1
RECR	P	1	-2	-1
DUNEMP	P	1	-2	-1
PRTMED	P	1	-2	-1
BNSNHS	P	1		
HSPL74	N	1		
UOCCAN	P	1	-2	-1
OPTSTO	P	1	-2	-1
APLCY	N	1		
TYOPTN	P	1		
END				
MICIPA	P	1	-2	-1
PASURG	P	1		
RECASS	P	1	-2	-1
RECR	P	1	-2	-1
DUNEMP	P	1	-2	-1
PRTMED	P	1	-2	-1
BNSNHS	P	1		
HSPL74	N	1		
UOCCAN	P	1	-2	-1
OPTSTO	P	1	-2	-1
APLCY	N	1		
TYOPTN	P	1		
END				

Sample input parameter listing 2:

This example demonstrates the placement of transgeneration cards in a deck set-up. They always precede independent variables for the corresponding dependent variable.

```

BASE      71    01  **TEST RUN**
TAB2      BLK-17-AS      1      02      01
TITLE
197  206  214  235      238      24  242  250
END
TRNGEN007 080063.0000
TRNGEN013 090062.0000
RECR      P      1
RECCASS   D      1  -2  -1
UOCCAN    P      1  -2  -1
TYOPTN    P      1
CAOPTS    P      1  -2  -1
END

```

In this simple example, there is only one dependent variable. There are five basic independent variables with six more generated through lags.

The transgeneration cards will also create an extra variable. The dependent variable card specifies that there are two transgeneration cards, and that one new variable will be added, due to transgeneration.

The formats of the TRNGEN cards are defined in App B. The indices referred to correspond to those assigned by BMD02R as follows with the lags indicated in parentheses:

Index	Variable
1	dependent variable
2	RECR
3	RECCASS(-2)
4	RECCASS(-1)
5	RECCASS(0)
6	UOCCAN(-2)
7	UOCCAN(-1)
8	UOCCAN(0)
9	TYOPTN(0)
10	CAOPTS(-2)
11	CAOPTS(-1)
12	CAOPTS(0)

In the first TRNGEN card, 08 denotes the additive operation, 07 the variable to be replaced, 06 the variable operated on, and 3.0 a constant. Symbolically, this is expressed by:

$$X_6 + 3.0 \longrightarrow X_7$$

where X_6 and X_7 refer to UOCCAN(-2) and UOCCAN(-1), respectively. In the second TRNGEN card, 09 denotes the multiplicative operation. Symbolically, this is expressed by

$$2.0 X_6 \longrightarrow X_{13}$$

where X_6 is as before and X_{13} is a new variable.

POST PROCESSOR—GRAPH PROGRAM (PROGRAM #4)

This routine is dependent upon the successful completion of the preprocessor program, to ensure creation of a file containing input data to this routine. In addition to this file, a minimum of 3 input parameter cards are required.

The output of the program is a plot for each dependent variable selected for use in the preprocessor, as well as a deviations table listing the dependent variable values, regression equations estimates ($\hat{Y}$), the residual error based on the two preceding quantities, and the percent error.

All plots are assigned to an output file, as are the deviations tables, but the tables are only generated if requested in the parameter cards. A schematic of the post processor including both the graph (program #4) and the aggregating (program #5) programs is given in Fig. 12.

Input Files

TAPE1 (MT12). This file contains binary data written from the regression routine. It consists of data length, starting and ending dates, time-series data for the dependent variable, and projections.

TAPE5. This is the parameter card file and contains control information, such as today's data, whether graphs are to be printed, tape number of input data, name given to the run, and end of data identifier.

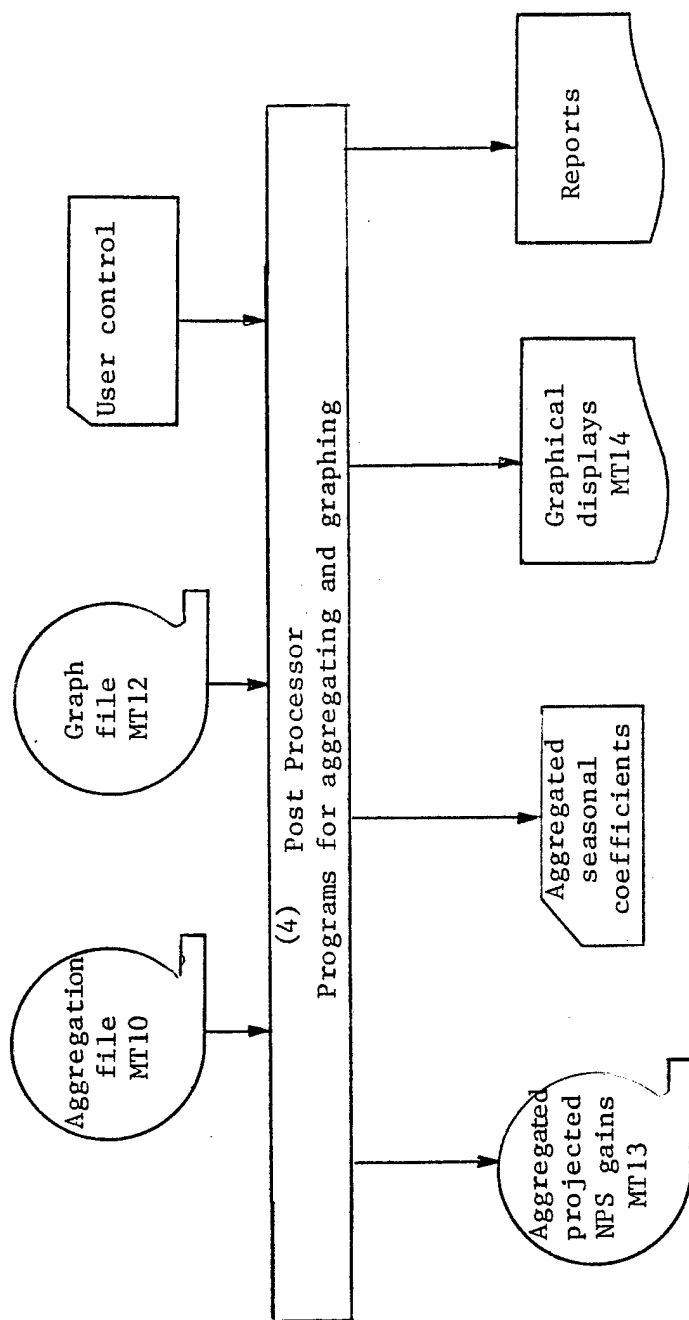


Fig. 12—Step 4 in the Projection of NPS Gains

Output Files

TAPE10 (MT14). Contains the graphs. This allows the graphs to be retained for later printing, or if graphs are not desired, to be ignored.

TAPE6. This is the standard printer file and will contain titles, input parameter specifications, and deviations tables.

Input Card Formats and Specifications

Card #	CC#	Format	Program name	Description
1	1-12	3A4	DATE	Today's data (in any form).
2	1-2	I2	IG	Place '99' if only graphs are desired, otherwise leave blank.
	6-10	I5	ITAPE	Tape # of input data, if other than TAPE1.
3	1-80	20A4	IASSUM	Any alphanumeric description of this run. User can use as many cards here as he wishes.
n	1-4	I4	IH9	Must contain 9999 to indicate end of input data, where n is the number of data cards.

The following is a listing of sample input data.

```
MAP  2 1976
      1
TEST OF PLOT ROUTINE
9999
```

POST PROCESSOR—AGGREGATION PROGRAM (PROGRAM #5)

This routine, which is the last in the series of the NPSGM, aggregates the dependent variables selected for use in the preprocerror program into a maximum of four C-groups. Generated within this program are aggregated seasonal coefficients and consolidated historical and projection data for each of the C-groups defined by the user.

The outputs of the program consists of (a) one file containing 12-month forecasts (expressed in thousands) beginning on the first month after the end of the data base and (b) a punch file, used as input to the COMPLIP-G2 model. The punch file contains the seasonal coefficients associated with each month of the forecast period for each C-group.

Inputs to the program consists of a file containing projected time-series data and input parameter cards. The input file contains projections, organized in a similar manner as the dependent variable file in that there are as many 12-month groups of projections as there are dependent variable series on the first file. The card input consists of four types of cards. They are: (1) the title card, (2) user supplied estimates of accessions for the 12 future months of population groups that are not included in the regression results, but are desired to be included in the aggregations for the C-groups to be used in COMPLIP-G2, (3) control cards indicating the aggregations to be made, and (4) the END terminator card.

Of a maximum of 20 possible dependent variables coming from the pre-processor, a total of four new C-groups may be created through aggregation. The program assumes that all variables coming in will be used in one of the C-groups, although it is not a fatal error if one is omitted. The use of any dependent variable in more than one C-group will result in a fatal diagnostic and a terminated run.

This aggregation is done by listing the series, coming from input, that are to be aggregated into each of the new C-groups, therefore, a knowledge of the preprocessor output is essential for meaningful aggregation.

If the population groups defined by the dependent variables from the regression run do not span the entire population, then the user may input additional groups (similar to those from the regression program) by means of card input. The index numbers assigned to the user-supplied groups will follow those used for the dependent variables, and the total must not exceed 20. For example, if seven dependent variables were used in the regression run (each defining a unique population group), then the first user-supplied group would have the index eight assigned to it. The indices are used in defining the aggregations.

The card formats are as follows:

Title Card, Card Type 1 - FORMAT (15A4)

This input consists of one card with the title to be printed on the reports.

User-Supplied Population Groups, Card Type 2 - FORMAT (A3, F8.2)

This input consists of 12 cards for each user supplied population group, one card for each of the projection months defined by the regression program. Within each group the cards must follow the same sequence projected by the regression program. That is, if the first projection month is July, then the cards are ordered as follows: July, August, September,...,May, June, for each group, one group following another group in succession. The last card of the last user-supplied group is followed by an END card (card type 4). The END card is read with the A3 format.

C-Group Definition, Card Type 3 - FORMAT (A3, 7X, 7 (I3, 7X)

The use of as many cards as are necessary to list all of the dependent variables as user-supplied population groups that comprise each C-group is permitted until a maximum of 20 is reached or an END card is encountered. Each set of cards defining a C-group is followed by an END card. The END card is read with the A3 format.

END, Card Type 4

This is a delimiter card. The word END is punched in the first three card columns. The card is read with the format statements for card types 2 and 3.

The following is a listing of a sample input data.

```
TEST OF AGGREGATION ROUTINE USING 7 DEPENDENT VARIABLES
1000.00
2000.00
3000.00
4000.00
5000.00
6000.00
7000.00
8000.00
9000.00
10000.00
11000.00
12000.00
END
1
END
2      4
END
3      5      6      7
END
8
END
```

Input for user defined group,
group 8

Figure 13 gives a schematic of the data card setup.

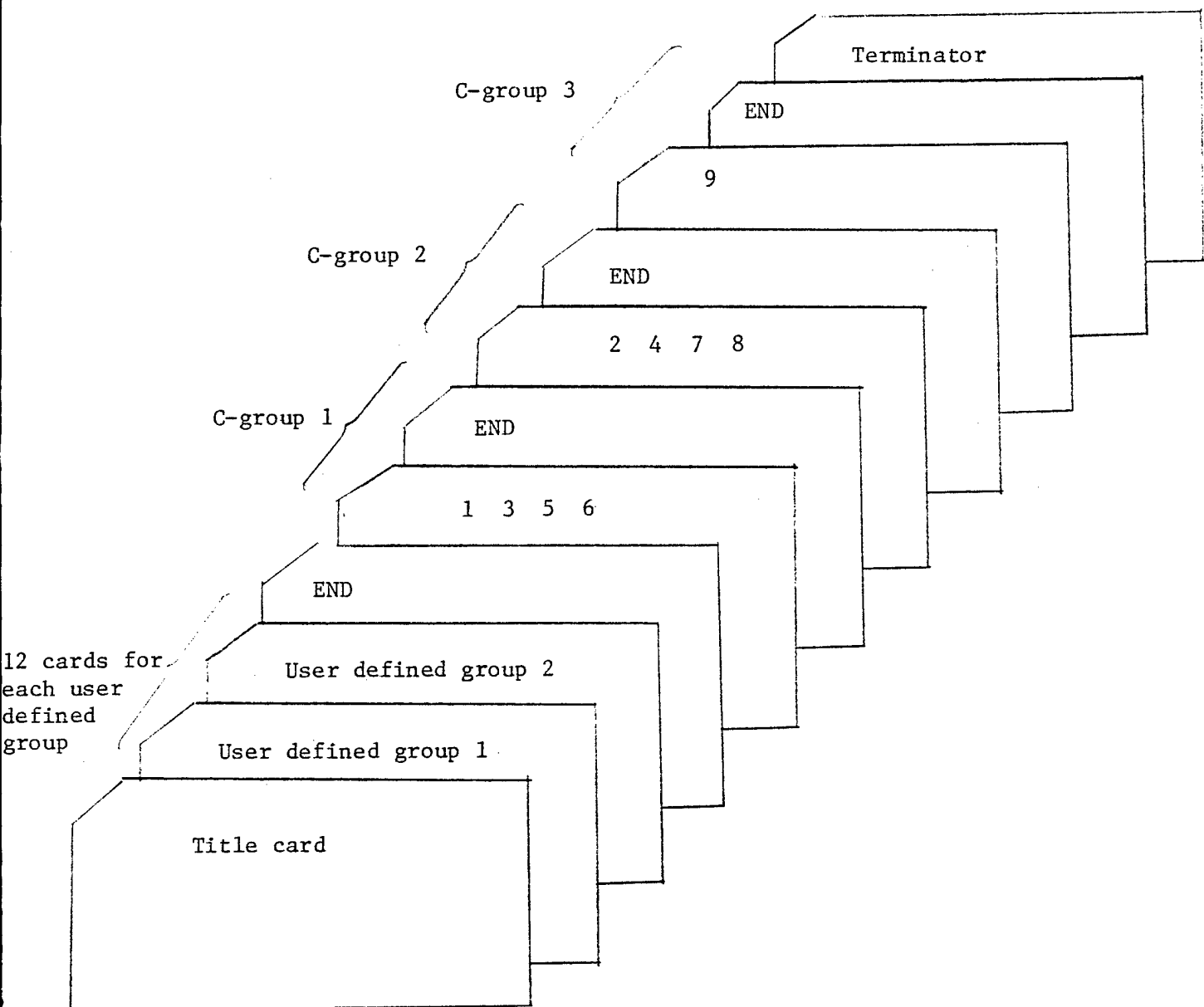


Fig. 13—Example of Input Cards for Aggregation Program

In this case, 7 dependent variables came from the input file and two population groups were input by cards.

Input Files

TAPE2 (MT10). This is a BCD file containing the forecasts of the dependent variables that are to be aggregated.

TAPE5, This is the parameter card file containing control information supplied by the user.

Output Files

TAPE10 (MT13). This file contains the aggregated C-groups in the format required by the COMPLIP-G2 matrix generator as input file TAPE17.

TAPE7. This file should be assigned to the system punch. It contains the seasonal coefficients for use by the COMPLIP-G2 matrix generator.

REFERENCES

1. Holz, B. W., et al, The ELIM-COMPLIP System of Manpower Planning Models, Three Volumes, General Research Corporation, OAD-CR-18, December 1973.
2. Holz, B. W., et al, Two New Versions of the ELIM-COMPLIP System, Four Volumes, General Research Corporation, OAD-CR- , in process of being published.
3. Dept. of Army, "Strength of the Army," DCSPER-46, published monthly.
4. Grissmer, D.W., et al, "An Evaluation of Army Manpower Accession Programs," General Research Corporation, OAD-CR-37, April 1974.
5. W. J. Dixon, Editor, "Biomedical Computer Programs," University of California Publications in Automatic Computation No. 2, University of California Press, 1970.

Appendix A

LISTING OF INDEPENDENT VARIABLE TIME SERIES (For definitions see Table 7 of Chap. 2)

Note: Each time series is given in the following
four columns:

1. variable identifier
2. month
3. calendar year
4. monthly value

SOURCES OF INDEPENDENT VARIABLES

The sources are cited for those independent variables where it is not obvious (e.g., most policy variables reflect Department of the Army policies; no source is cited for them).

1. USAREC Req 680-1 is the source for the timing of the different options and the total options available to a recruit in any given month. This is the source for the following variables:

CAOPTS, OPTST0, TYOPT, TYOPTN

2. N.W. Ayer Co., the Army advertising agency is the source for the print media variable: PRTMED.

3. "Effectiveness of the Modern Volunteer Army Advertising Program," prepared by Stanford Research Institute for OSAMVA, December 1971, is the source for the paid TV variable: PAIDTV.

4. "Employment and Earnings," Bureau of Labor Statistics, February 1973 is the source of the seasonal adjustment factors and the unemployment rates. The seasonal adjustment factors for 16-19 year old males were applied to the unemployment data on 16-21 year old males from Tables A-5 and A-7 of the same monthly publication to derive the monthly estimates of seasonally adjusted unemployment rates: DUNEMP.

APLCY	1	71	0.00
APLCY	2	71	0.00
APLCY	3	71	0.00
APLCY	4	71	0.00
APLCY	5	71	0.00
APLCY	6	71	0.00
APLCY	7	71	0.00
APLCY	8	71	0.00
APLCY	9	71	0.00
APLCY	10	71	1.00
APLCY	11	71	.90
APLCY	12	71	.80
APLCY	1	72	.70
APLCY	2	72	.60
APLCY	3	72	.30
APLCY	4	72	.30
APLCY	5	72	.30
APLCY	6	72	.30
APLCY	7	72	0.00
APLCY	8	72	0.00
APLCY	9	72	0.00
APLCY	10	72	0.00
APLCY	11	72	0.00
APLCY	12	72	0.00
APLCY	1	73	0.00
APLCY	2	73	0.00
APLCY	3	73	0.00
APLCY	4	73	0.00
APLCY	5	73	0.00
APLCY	6	73	0.00
APLCY	7	73	0.00
APLCY	8	73	0.00
APLCY	9	73	0.00
APLCY	10	73	0.00
APLCY	11	73	0.00
APLCY	12	73	0.00
APLCY	1	74	0.00
APLCY	2	74	0.00
APLCY	3	74	0.00
APLCY	4	74	0.00
APLCY	5	74	0.00
APLCY	6	74	0.00
END			

AQOTDM	1	71	9910.00
AQOTDM	2	71	9427.00
AQOTDM	3	71	7978.00
AQOTDM	4	71	7546.00
AQOTDM	5	71	6466.00
AQOTDM	6	71	10982.00
AQOTDM	7	71	11281.00
AQOTDM	8	71	11609.00
AQOTDM	9	71	13098.00
AQOTDM	10	71	9889.00
AQOTDM	11	71	10562.00
AQOTDM	12	71	10297.00
AQOTDM	1	72	11928.00
AQOTDM	2	72	13230.00
AQOTDM	3	72	13977.00
AQOTDM	4	72	10790.00
AQOTDM	5	72	8902.00
AQOTDM	6	72	16686.00
AQOTDM	7	72	15354.00
AQOTDM	8	72	14094.00
AQOTDM	9	72	14706.00
AQOTDM	10	72	12601.00
AQOTDM	11	72	12550.00
AQOTDM	12	72	12229.00
AQOTDM	1	73	16200.00
AQOTDM	2	73	11089.00
AQOTDM	3	73	9754.00
AQOTDM	4	73	8958.00
AQOTDM	5	73	8000.00
AQOTDM	6	73	16500.00
AQOTDM	7	73	17300.00
AQOTDM	8	73	17000.00
AQOTDM	9	73	17800.00
AQOTDM	10	73	16100.00
AQOTDM	11	73	12900.00
AQOTDM	12	73	11600.00
AQOTDM	1	74	18000.00
AQOTDM	2	74	14800.00
AQOTDM	3	74	14000.00
AQOTDM	4	74	14300.00
AQOTDM	5	74	13300.00
AQOTDM	6	74	17500.00
AQOTDM	7	74	17400.00
AQOTDM	8	74	18600.00
AQOTDM	9	74	19500.00
AQOTDM	10	74	15600.00
AQOTDM	11	74	14000.00
AQOTDM	12	74	5700.00
AQOTDM	1	75	16800.00
AQOTDM	2	75	11900.00
AQOTDM	3	75	7000.00
AQOTDM	4	75	6400.00
AQOTDM	5	75	11600.00
AQOTDM	6	75	20700.00

AQOTDM (cont'd)

AQOTDM	7	75	16423.00
AQOTDM	8	75	17557.00
AQOTDM	9	75	18399.00
AQOTDM	10	75	14723.00
AQOTDM	11	75	13221.00
AQOTDM	12	75	5377.00
AQOTDM	1	76	15856.00
AQOTDM	2	76	11230.00
AQOTDM	3	76	6603.00
AQOTDM	4	76	6036.00
AQOTDM	5	76	10954.00
AQOTDM	6	76	19533.00
END			

BNSHSG	1	71	0.00
BNSHSG	2	71	0.00
BNSHSG	3	71	0.00
BNSHSG	4	71	0.00
BNSHSG	5	71	0.00
BNSHSG	6	71	0.00
BNSHSG	7	71	0.00
BNSHSG	8	71	0.00
BNSHSG	9	71	0.00
BNSHSG	10	71	0.00
BNSHSG	11	71	0.00
BNSHSG	12	71	0.00
BNSHSG	1	72	0.00
BNSHSG	2	72	0.00
BNSHSG	3	72	0.00
BNSHSG	4	72	0.00
BNSHSG	5	72	0.00
BNSHSG	6	72	1.00
BNSHSG	7	72	1.00
BNSHSG	8	72	1.00
BNSHSG	9	72	1.00
BNSHSG	10	72	1.00
BNSHSG	11	72	1.00
BNSHSG	12	72	1.00
BNSHSG	1	73	1.00
BNSHSG	2	73	1.00
BNSHSG	3	73	1.00
BNSHSG	4	73	1.00
BNSHSG	5	73	1.00
BNSHSG	6	73	1.00
BNSHSG	7	73	1.00
BNSHSG	8	73	1.00
BNSHSG	9	73	1.00
BNSHSG	10	73	1.00
BNSHSG	11	73	1.00
BNSHSG	12	73	1.00
BNSHSG	1	74	1.00
BNSHSG	2	74	1.00
BNSHSG	3	74	1.00
BNSHSG	4	74	1.00
BNSHSG	5	74	1.00
BNSHSG	6	74	1.00
END			

BNSINC	1	71	0.00
BNSINC	2	71	0.10
BNSINC	3	71	0.30
BNSINC	4	71	0.00
BNSINC	5	71	0.00
BNSINC	6	71	0.00
BNSINC	7	71	0.00
BNSINC	8	71	0.00
BNSINC	9	71	0.00
BNSINC	10	71	0.00
BNSINC	11	71	0.30
BNSINC	12	71	0.00
BNSINC	1	72	0.00
BNSINC	2	72	0.00
BNSINC	3	72	0.00
BNSINC	4	72	0.30
BNSINC	5	72	0.30
BNSINC	6	72	0.30
BNSINC	7	72	0.30
BNSINC	8	72	0.30
BNSINC	9	72	0.30
BNSINC	10	72	0.00
BNSINC	11	72	0.30
BNSINC	12	72	0.00
BNSINC	1	73	0.00
BNSINC	2	73	0.00
BNSINC	3	73	0.00
BNSINC	4	73	0.00
BNSINC	5	73	1.30
BNSINC	6	73	1.00
BNSINC	7	73	1.00
BNSINC	8	73	1.00
BNSINC	9	73	1.00
BNSINC	10	73	1.00
BNSINC	11	73	1.30
BNSINC	12	73	1.00
BNSINC	1	74	1.00
BNSINC	2	74	1.00
BNSINC	3	74	1.00
BNSINC	4	74	1.00
BNSINC	5	74	1.00
BNSINC	6	74	1.00
END			

BNSKL1	1	71	0.00
BNSKL1	2	71	0.00
BNSKL1	3	71	0.00
BNSKL1	4	71	0.00
BNSKL1	5	71	0.00
BNSKL1	6	71	0.00
BNSKL1	7	71	0.00
BNSKL1	8	71	0.00
BNSKL1	9	71	0.00
BNSKL1	10	71	0.00
BNSKL1	11	71	0.00
BNSKL1	12	71	0.00
BNSKL1	1	72	0.00
BNSKL1	2	72	0.00
BNSKL1	3	72	0.00
BNSKL1	4	72	0.00
BNSKL1	5	72	0.00
BNSKL1	6	72	0.00
BNSKL1	7	72	0.00
BNSKL1	8	72	0.00
BNSKL1	9	72	0.00
BNSKL1	10	72	0.00
BNSKL1	11	72	0.00
BNSKL1	12	72	0.00
BNSKL1	1	73	0.00
BNSKL1	2	73	0.00
BNSKL1	3	73	0.00
BNSKL1	4	73	0.00
BNSKL1	5	73	1.00
BNSKL1	6	73	1.00
BNSKL1	7	73	0.00
BNSKL1	8	73	0.00
BNSKL1	9	73	0.00
BNSKL1	10	73	0.00
BNSKL1	11	73	0.00
BNSKL1	12	73	0.00
BNSKL1	1	74	0.00
BNSKL1	2	74	0.00
BNSKL1	3	74	0.00
BNSKL1	4	74	0.00
BNSKL1	5	74	0.00
BNSKL1	6	74	1.00
BNSKL1	7	74	1.00
BNSKL1	8	74	1.00
BNSKL1	9	74	1.00
END			

BNSKL2	1	71	0.00
BNSKL2	2	71	0.00
BNSKL2	3	71	0.00
BNSKL2	4	71	0.00
BNSKL2	5	71	0.00
BNSKL2	6	71	0.00
BNSKL2	7	71	0.00
BNSKL2	8	71	0.00
BNSKL2	9	71	0.00
BNSKL2	10	71	0.00
BNSKL2	11	71	0.00
BNSKL2	12	71	0.00
BNSKL2	1	72	0.00
BNSKL2	2	72	0.00
BNSKL2	3	72	0.00
BNSKL2	4	72	0.00
BNSKL2	5	72	0.00
BNSKL2	6	72	0.00
BNSKL2	7	72	0.00
BNSKL2	8	72	0.00
BNSKL2	9	72	0.00
BNSKL2	10	72	0.00
BNSKL2	11	72	0.00
BNSKL2	12	72	0.00
BNSKL2	1	73	0.00
BNSKL2	2	73	0.00
BNSKL2	3	73	0.00
BNSKL2	4	73	0.00
BNSKL2	5	73	0.00
BNSKL2	6	73	0.00
BNSKL2	7	73	0.00
BNSKL2	8	73	0.00
BNSKL2	9	73	0.00
BNSKL2	10	73	0.00
BNSKL2	11	73	0.00
BNSKL2	12	73	0.00
BNSKL2	1	74	0.00
BNSKL2	2	74	0.00
BNSKL2	3	74	0.00
BNSKL2	4	74	0.00
BNSKL2	5	74	0.00
BNSKL2	6	74	1.00
BNSKL2	7	74	1.00
BNSKL2	8	74	1.00
BNSKL2	9	74	1.00
BNSKL2	10	74	1.00
BNSKL2	11	74	1.00
BNSKL2	12	74	1.00
BNSKL2	1	75	1.00
BNSKL2	2	75	1.00
BNSKL2	3	75	.67
BNSKL2	4	75	.50
END			

BNSNHS	1	71	0.00
BNSNHS	2	71	0.00
BNSNHS	3	71	0.00
BNSNHS	4	71	0.00
BNSNHS	5	71	0.00
BNSNHS	6	71	0.00
BNSNHS	7	71	0.00
BNSNHS	8	71	0.00
BNSNHS	9	71	0.00
BNSNHS	10	71	0.00
BNSNHS	11	71	0.00
BNSNHS	12	71	0.00
BNSNHS	1	72	0.00
BNSNHS	2	72	0.00
BNSNHS	3	72	0.00
BNSNHS	4	72	0.00
BNSNHS	5	72	0.00
BNSNHS	6	72	1.00
BNSNHS	7	72	1.00
BNSNHS	8	72	1.00
BNSNHS	9	72	1.00
BNSNHS	10	72	1.00
BNSNHS	11	72	1.00
BNSNHS	12	72	1.00
BNSNHS	1	73	1.00
BNSNHS	2	73	1.00
BNSNHS	3	73	1.00
BNSNHS	4	73	1.00
BNSNHS	5	73	0.00
BNSNHS	6	73	0.00
BNSNHS	7	73	0.00
BNSNHS	8	73	0.00
BNSNHS	9	73	0.00
BNSNHS	10	73	0.00
BNSNHS	11	73	0.00
BNSNHS	12	73	0.00
BNSNHS	1	74	0.00
BNSNHS	2	74	0.00
BNSNHS	3	74	0.00
BNSNHS	4	74	0.00
BNSNHS	5	74	0.00
BNSNHS	6	74	0.00
END			

CAT4LM	1	71	30.00
CAT4LM	2	71	30.00
CAT4LM	3	71	30.00
CAT4LM	4	71	30.00
CAT4LM	5	71	30.00
CAT4LM	6	71	30.00
CAT4LM	7	71	30.00
CAT4LM	8	71	30.00
CAT4LM	9	71	30.00
CAT4LM	10	71	5.00
CAT4LM	11	71	5.00
CAT4LM	12	71	20.00
CAT4LM	1	72	20.00
CAT4LM	2	72	20.00
CAT4LM	3	72	20.00
CAT4LM	4	72	20.00
CAT4LM	5	72	20.00
CAT4LM	6	72	20.00
CAT4LM	7	72	19.00
CAT4LM	8	72	19.00
CAT4LM	9	72	19.00
CAT4LM	10	72	19.00
CAT4LM	11	72	19.00
CAT4LM	12	72	19.00
CAT4LM	1	73	19.00
CAT4LM	2	73	15.00
CAT4LM	3	73	15.00
CAT4LM	4	73	15.00
CAT4LM	5	73	15.00
CAT4LM	6	73	15.00
CAT4LM	7	73	32.00
CAT4LM	8	73	19.00
CAT4LM	9	73	19.00
CAT4LM	10	73	19.00
CAT4LM	11	73	19.00
CAT4LM	12	73	19.00
CAT4LM	1	74	19.00
CAT4LM	2	74	19.00
CAT4LM	3	74	19.00
CAT4LM	4	74	19.00
CAT4LM	5	74	19.00
CAT4LM	6	74	19.00
CAT4LM	7	74	19.00
CAT4LM	8	74	19.00
CAT4LM	9	74	19.00
CAT4LM	10	74	14.00
CAT4LM	11	74	12.00
END			

CAOPTS	1	71	0.00
CAOPTS	2	71	15.00
CAOPTS	3	71	17.00
CAOPTS	4	71	24.00
CAOPTS	5	71	25.00
CAOPTS	6	71	28.00
CAOPTS	7	71	29.00
CAOPTS	8	71	30.00
CAOPTS	9	71	30.00
CAOPTS	10	71	30.00
CAOPTS	11	71	30.00
CAOPTS	12	71	30.00
CAOPTS	1	72	30.00
CAOPTS	2	72	30.00
CAOPTS	3	72	30.00
CAOPTS	4	72	30.00
CAOPTS	5	72	30.00
CAOPTS	6	72	30.00
CAOPTS	7	72	30.00
CAOPTS	8	72	30.00
CAOPTS	9	72	30.00
CAOPTS	10	72	30.00
CAOPTS	11	72	30.00
CAOPTS	12	72	30.00
CAOPTS	1	73	30.00
CAOPTS	2	73	30.00
CAOPTS	3	73	30.00
CAOPTS	4	73	30.00
CAOPTS	5	73	30.00
CAOPTS	6	73	30.00
CAOPTS	7	73	30.00
CAOPTS	8	73	30.00
CAOPTS	9	73	30.00
CAOPTS	10	73	30.00
CAOPTS	11	73	30.00
CAOPTS	12	73	30.00
CAOPTS	1	74	30.00
CAOPTS	2	74	30.00
CAOPTS	3	74	30.00
CAOPTS	4	74	30.00

- END

DUNEMP	1	71	14.29
DUNEMP	2	71	13.46
DUNEMP	3	71	13.64
DUNEMP	4	71	12.24
DUNEMP	5	71	13.41
DUNEMP	6	71	13.80
DUNEMP	7	71	13.78
DUNEMP	8	71	13.57
DUNEMP	9	71	12.35
DUNEMP	10	71	12.84
DUNEMP	11	71	13.50
DUNEMP	12	71	13.18
DUNEMP	1	72	14.29
DUNEMP	2	72	14.74
DUNEMP	3	72	14.14
DUNEMP	4	72	14.70
DUNEMP	5	72	13.19
DUNEMP	6	72	11.36
DUNEMP	7	72	11.77
DUNEMP	8	72	12.45
DUNEMP	9	72	11.09
DUNEMP	10	72	10.34
DUNEMP	11	72	10.70
DUNEMP	12	72	10.70
DUNEMP	1	73	10.43
DUNEMP	2	73	10.31
DUNEMP	3	73	10.30
DUNEMP	4	73	10.89
DUNEMP	5	73	10.57
DUNEMP	6	73	9.90
DUNEMP	7	73	10.72
DUNEMP	8	73	10.43
DUNEMP	9	73	10.74
DUNEMP	10	73	10.50
DUNEMP	11	73	10.59
DUNEMP	12	73	9.65
DUNEMP	1	74	10.70
DUNEMP	2	74	10.30
DUNEMP	3	74	11.70
DUNEMP	4	74	11.90
DUNEMP	5	74	11.10
DUNEMP	6	74	11.70
DUNEMP	7	74	11.60
DUNEMP	8	74	12.50
DUNEMP	9	74	13.90
DUNEMP	10	74	12.60
DUNEMP	11	74	13.70
DUNEMP	12	74	13.80
DUNEMP	1	75	16.40
DUNEMP	2	75	16.00
DUNEMP	3	75	19.50
DUNEMP	4	75	18.50
END			

HSPL74	1	71	0.00
HSPL74	2	71	0.00
HSPL74	3	71	0.00
HSPL74	4	71	0.00
HSPL74	5	71	0.00
HSPL74	6	71	0.00
HSPL74	7	71	0.00
HSPL74	8	71	0.00
HSPL74	9	71	0.00
HSPL74	10	71	0.00
HSPL74	11	71	0.00
HSPL74	12	71	0.00
HSPL74	1	72	0.00
HSPL74	2	72	0.00
HSPL74	3	72	0.00
HSPL74	4	72	0.00
HSPL74	5	72	0.00
HSPL74	6	72	0.00
HSPL74	7	72	0.00
HSPL74	8	72	0.00
HSPL74	9	72	0.00
HSPL74	10	72	0.00
HSPL74	11	72	0.00
HSPL74	12	72	0.00
HSPL74	1	73	0.00
HSPL74	2	73	.75
HSPL74	3	73	.90
HSPL74	4	73	1.00
HSPL74	5	73	.90
HSPL74	6	73	.75
HSPL74	7	73	.40
HSPL74	8	73	.20
HSPL74	9	73	0.00
HSPL74	10	73	0.00

END

MICIPA	1	71	.96
MICIPA	2	71	.96
MICIPA	3	71	.96
MICIPA	4	71	.95
MICIPA	5	71	.95
MICIPA	6	71	.94
MICIPA	7	71	.92
MICIPA	8	71	.92
MICIPA	9	71	.92
MICIPA	10	71	.92
MICIPA	11	71	1.17
MICIPA	12	71	1.40
MICIPA	1	72	1.45
MICIPA	2	72	1.45
MICIPA	3	72	1.44
MICIPA	4	72	1.43
MICIPA	5	72	1.44
MICIPA	6	72	1.42
MICIPA	7	72	1.39
MICIPA	8	72	1.40
MICIPA	9	72	1.40
MICIPA	10	72	1.40
MICIPA	11	72	1.40
MICIPA	12	72	1.38
MICIPA	1	73	1.49
MICIPA	2	73	1.49
MICIPA	3	73	1.48
MICIPA	4	73	1.47
MICIPA	5	73	1.47
MICIPA	6	73	1.43
MICIPA	7	73	1.41
MICIPA	8	73	1.42
MICIPA	9	73	1.42
MICIPA	10	73	1.48
MICIPA	11	73	1.47
MICIPA	12	73	1.46
MICIPA	1	74	1.45
MICIPA	2	74	1.45
MICIPA	3	74	1.45
MICIPA	4	74	1.44
MICIPA	5	74	1.42
MICIPA	6	74	1.38
MICIPA	7	74	1.35
MICIPA	8	74	1.35
MICIPA	9	74	1.35
MICIPA	10	74	1.51
MICIPA	11	74	1.51
MICIPA	12	74	1.48
MICIPA	1	75	1.48
MICIPA	2	75	1.49
MICIPA	3	75	1.46
MICIPA	4	75	1.47
MICIPA	5	75	1.46
MICIPA	6	75	1.43
MICIPA	7	75	1.42
END			

OPTST0	1	71	0.00
OPTST0	2	71	15.00
OPTST0	3	71	17.00
OPTST0	4	71	24.00
OPTST0	5	71	25.00
OPTST0	6	71	28.00
OPTST0	7	71	29.00
OPTST0	8	71	30.00
OPTST0	9	71	30.00
OPTST0	10	71	39.00
OPTST0	11	71	39.00
OPTST0	12	71	39.00
OPTST0	1	72	41.00
OPTST0	2	72	47.00
OPTST0	3	72	47.00
OPTST0	4	72	47.00
OPTST0	5	72	47.00
OPTST0	6	72	71.00
OPTST0	7	72	71.00
OPTST0	8	72	71.00
OPTST0	9	72	71.00
OPTST0	10	72	107.00
OPTST0	11	72	131.00
OPTST0	12	72	131.00
OPTST0	1	73	131.00
OPTST0	2	73	131.00
OPTST0	3	73	131.00
OPTST0	4	73	131.00
OPTST0	5	73	131.00
OPTST0	6	73	131.00
OPTST0	7	73	131.00
OPTST0	8	73	131.00
OPTST0	9	73	131.00
OPTST0	10	73	133.00
OPTST0	11	73	133.00
OPTST0	12	73	133.00
OPTST0	1	74	133.00
OPTST0	2	74	133.00
OPTST0	3	74	133.00
OPTST0	4	74	133.00
OPTST0	5	74	133.00
OPTST0	6	74	133.00
OPTST0	7	74	133.00
OPTST0	8	74	133.00
OPTST0	9	74	134.00
END			

PAIDTV	1	71	0.00
PAIDTV	2	71	0.00
PAIDTV	3	71	46.00
PAIDTV	4	71	62.00
PAIDTV	5	71	50.00
PAIDTV	6	71	0.00
PAIDTV	7	71	0.00
PAIDTV	8	71	0.00
PAIDTV	9	71	0.00
PAIDTV	10	71	0.00
PAIDTV	11	71	0.00
PAIDTV	12	71	0.00
PAIDTV	1	72	0.00
PAIDTV	2	72	0.00
PAIDTV	3	72	0.00
PAIDTV	4	72	0.00
PAIDTV	5	72	0.00
PAIDTV	6	72	0.00
PAIDTV	7	72	0.00
PAIDTV	8	72	0.00
PAIDTV	9	72	0.00
PAIDTV	10	72	0.00
PAIDTV	11	72	0.00
PAIDTV	12	72	0.00
PAIDTV	1	73	0.00
PAIDTV	2	73	0.00
PAIDTV	3	73	0.00
PAIDTV	4	73	0.00
PAIDTV	5	73	0.00
PAIDTV	6	73	0.00
PAIDTV	7	73	0.00
PAIDTV	8	73	0.00
PAIDTV	9	73	0.00
PAIDTV	10	73	0.00
PAIDTV	11	73	0.00
PAIDTV	12	73	0.00
PAIDTV	1	74	0.00
PAIDTV	2	74	0.00
PAIDTV	3	74	0.00
PAIDTV	4	74	0.00
PAIDTV	5	74	0.00
PAIDTV	6	74	0.00
END			

PASURG	1	71	0.00
PASURG	2	71	0.00
PASURG	3	71	0.00
PASURG	4	71	0.00
PASURG	5	71	0.00
PASURG	6	71	0.00
PASURG	7	71	0.00
PASURG	8	71	0.00
PASURG	9	71	0.00
PASURG	10	71	0.00
PASURG	11	71	.50
PASURG	12	71	1.00
PASURG	1	72	.50
PASURG	2	72	.25
PASURG	3	72	0.00
PASURG	4	72	0.00
END			

PRTMED	1	71	17.00
PRTMED	2	71	23.00
PRTMED	3	71	38.00
PRTMED	4	71	10.00
PRTMED	5	71	7.00
PRTMED	6	71	14.00
PRTMED	7	71	0.00
PRTMED	8	71	17.00
PRTMED	9	71	20.00
PRTMED	10	71	28.00
PRTMED	11	71	34.00
PRTMED	12	71	17.00
PRTMED	1	72	30.00
PRTMED	2	72	28.00
PRTMED	3	72	28.00
PRTMED	4	72	32.00
PRTMED	5	72	27.00
PRTMED	6	72	25.00
PRTMED	7	72	23.00
PRTMED	8	72	20.00
PRTMED	9	72	22.00
PRTMED	10	72	32.00
PRTMED	11	72	23.00
PRTMED	12	72	18.00
PRTMED	1	73	19.00
PRTMED	2	73	18.00
PRTMED	3	73	23.00
PRTMED	4	73	23.00
PRTMED	5	73	24.00
PRTMED	6	73	19.00
PRTMED	7	73	15.00
PRTMED	8	73	30.00
PRTMED	9	73	50.00
PRTMED	10	73	47.00
PRTMED	11	73	52.00
PRTMED	12	73	36.00
PRTMED	1	74	48.00
PRTMED	2	74	42.00
PRTMED	3	74	45.00
PRTMED	4	74	22.00
PRTMED	5	74	55.00
PRTMED	6	74	50.00
PRTMED	7	74	9.00
PRTMED	8	74	14.00
PRTMED	9	74	11.00
PRTMED	10	74	12.00
PRTMED	11	74	12.00
PRTMED	12	74	5.00
PRTMED	1	75	4.00
PRTMED	2	75	8.00
END			

RECP	1	71	2212.00
RECP	2	71	2319.00
RECP	3	71	2356.00
RECP	4	71	2500.00
RECP	5	71	2538.00
RECP	6	71	2764.00
RECP	7	71	2851.00
RECP	8	71	2923.00
RECP	9	71	3187.00
RECP	10	71	3430.00
RECP	11	71	3657.00
RECP	12	71	3783.00
RECP	1	72	4006.00
RECP	2	72	4212.00
RECP	3	72	4404.00
RECP	4	72	4464.00
RECP	5	72	4827.00
RECP	6	72	4749.00
RECP	7	72	4684.00
RECP	8	72	4678.00
RECP	9	72	4605.00
RECP	10	72	4561.00
RECP	11	72	4536.00
RECP	12	72	4570.00
RECP	1	73	4446.00
RECP	2	73	4671.00
RECP	3	73	4326.00
RECP	4	73	4355.00
RECP	5	73	4280.00
RECP	6	73	4160.00
RECP	7	73	3835.00
RECP	8	73	4149.00
RECP	9	73	4276.00
RECP	10	73	4366.00
RECP	11	73	4456.00
RECP	12	73	4546.00
RECP	1	74	5149.00
RECP	2	74	4956.00
RECP	3	74	5005.00
RECP	4	74	5199.00
RECP	5	74	5072.00
RECP	6	74	4959.00
RECP	7	74	4696.00
RECP	8	74	4594.00
RECP	9	74	4668.00
RECP	10	74	4733.00
RECP	11	74	4794.00
RECP	12	74	5096.00
RECP	1	75	5032.00
RECP	2	75	4999.00
RECP	3	75	5019.00
RECP	4	75	5063.00
RECP	5	75	4954.00
RECP	6	75	4887.00
RECP	7	75	4686.00
RECP	8	75	4599.00
END			

RECASS	1	71	0.00
RECASS	2	71	0.00
RECASS	3	71	0.00
RECASS	4	71	0.00
RECASS	5	71	0.00
RECASS	6	71	0.00
RECASS	7	71	111.00
RECASS	8	71	110.00
RECASS	9	71	116.00
RECASS	10	71	130.00
RECASS	11	71	153.00
RECASS	12	71	70.00
RECASS	1	72	56.00
RECASS	2	72	43.00
RECASS	3	72	84.00
RECASS	4	72	146.00
RECASS	5	72	238.00
RECASS	6	72	377.00
RECASS	7	72	416.00
RECASS	8	72	403.00
RECASS	9	72	331.00
RECASS	10	72	186.00
RECASS	11	72	103.00
RECASS	12	72	127.00
RECASS	1	73	0.00
RECASS	2	73	0.00
RECASS	3	73	0.00
RECASS	4	73	0.00
RECASS	5	73	0.00
RECASS	6	73	0.00
RECASS	7	73	0.00
RECASS	8	73	0.00
RECASS	9	73	0.00
RECASS	10	73	0.00
RECASS	11	73	0.00
RECASS	12	73	0.00
RECASS	1	74	0.00
RECASS	2	74	0.00
RECASS	3	74	0.00
RECASS	4	74	0.00
RECASS	5	74	0.00
RECASS	6	74	0.00

END

TIME	1	71	1.00
TIME	2	71	2.00
TIME	3	71	3.00
TIME	4	71	4.00
TIME	5	71	5.00
TIME	6	71	6.00
TIME	7	71	7.00
TIME	8	71	8.00
TIME	9	71	9.00
TIME	10	71	10.00
TIME	11	71	11.00
TIME	12	71	12.00
TIME	1	72	13.00
TIME	2	72	14.00
TIME	3	72	15.00
TIME	4	72	16.00
TIME	5	72	17.00
TIME	6	72	18.00
TIME	7	72	19.00
TIME	8	72	20.00
TIME	9	72	21.00
TIME	10	72	22.00
TIME	11	72	23.00
TIME	12	72	24.00
TIME	1	73	25.00
TIME	2	73	26.00
TIME	3	73	27.00
TIME	4	73	28.00
TIME	5	73	29.00
TIME	6	73	30.00
TIME	7	73	31.00
TIME	8	73	32.00
TIME	9	73	33.00
TIME	10	73	34.00
TIME	11	73	35.00
TIME	12	73	36.00
TIME	1	74	37.00
TIME	2	74	38.00
TIME	3	74	39.00
TIME	4	74	40.00
TIME	5	74	41.00
TIME	6	74	42.00
TIME	7	74	43.00
TIME	8	74	44.00
TIME	9	74	45.00
TIME	10	74	46.00
TIME	11	74	47.00
TIME	12	74	48.00

TIME (cont'd)

TIME	1	75	49.00
TIME	2	75	50.00
TIME	3	75	51.00
TIME	4	75	52.00
TIME	5	75	53.00
TIME	6	75	54.00
TIME	7	75	55.00
TIME	8	75	56.00
TIME	9	75	57.00
TIME	10	75	58.00
TIME	11	75	59.00
TIME	12	75	60.00
TIME	1	76	61.00
TIME	2	76	62.00
TIME	3	76	63.00
TIME	4	76	64.00
TIME	5	76	65.00
TIME	6	76	66.00
END			

TYOPT	1	71	0.00
TYOPT	2	71	0.00
TYOPT	3	71	0.00
TYOPT	4	71	0.00
TYOPT	5	71	0.00
TYOPT	6	71	0.00
TYOPT	7	71	0.00
TYOPT	8	71	0.00
TYOPT	9	71	0.00
TYOPT	10	71	0.00
TYOPT	11	71	0.00
TYOPT	12	71	0.00
TYOPT	1	72	0.00
TYOPT	2	72	0.00
TYOPT	3	72	0.00
TYOPT	4	72	0.00
TYOPT	5	72	0.00
TYOPT	6	72	0.00
TYOPT	7	72	0.00
TYOPT	8	72	0.00
TYOPT	9	72	0.00
TYOPT	10	72	0.00
TYOPT	11	72	0.00
TYOPT	12	72	0.00
TYOPT	1	73	0.00
TYOPT	2	73	0.00
TYOPT	3	73	0.00
TYOPT	4	73	0.00
TYOPT	5	73	0.00
TYOPT	6	73	0.00
TYOPT	7	73	0.00
TYOPT	8	73	0.00
TYOPT	9	73	0.00
TYOPT	10	73	.20
TYOPT	11	73	.50
TYOPT	12	73	.60
TYOPT	1	74	1.00
TYOPT	2	74	1.00
TYOPT	3	74	1.00
TYOPT	4	74	1.00
TYOPT	5	74	1.00
TYOPT	6	74	1.00
TYOPT	7	74	1.00
TYOPT	8	74	1.00
TYOPT	9	74	1.00
TYOPT	10	74	1.00
TYOPT	11	74	1.00
TYOPT	12	74	1.00
TYOPT	1	75	.80
TYOPT	2	75	.50
TYOPT	3	75	.50
TYOPT	4	75	.50
TYOPT	5	75	.50
TYOPT	6	75	.25
TYOPT	7	75	0.00
END			

TYOPTN	1	71	0.00
TYOPTN	2	71	0.00
TYOPTN	3	71	0.00
TYOPTN	4	71	0.00
TYOPTN	5	71	0.00
TYOPTN	6	71	0.00
TYOPTN	7	71	0.00
TYOPTN	8	71	0.00
TYOPTN	9	71	0.00
TYOPTN	10	71	0.00
TYOPTN	11	71	0.00
TYOPTN	12	71	0.00
TYOPTN	1	72	0.00
TYOPTN	2	72	0.00
TYOPTN	3	72	0.00
TYOPTN	4	72	0.00
TYOPTN	5	72	0.00
TYOPTN	6	72	0.00
TYOPTN	7	72	0.00
TYOPTN	8	72	0.00
TYOPTN	9	72	0.00
TYOPTN	10	72	0.00
TYOPTN	11	72	0.00
TYOPTN	12	72	0.00
TYOPTN	1	73	0.00
TYOPTN	2	73	0.00
TYOPTN	3	73	0.00
TYOPTN	4	73	0.00
TYOPTN	5	73	0.00
TYOPTN	6	73	0.00
TYOPTN	7	73	0.00
TYOPTN	8	73	0.00
TYOPTN	9	73	0.00
TYOPTN	10	73	.20
TYOPTN	11	73	1.00
TYOPTN	12	73	1.00
TYOPTN	1	74	1.00
TYOPTN	2	74	1.00
TYOPTN	3	74	1.00
TYOPTN	4	74	1.00
TYOPTN	5	74	1.00
TYOPTN	6	74	1.00
TYOPTN	7	74	1.00
TYOPTN	8	74	1.00
TYOPTN	9	74	1.00
TYOPTN	10	74	1.00
TYOPTN	11	74	1.00
TYOPTN	12	74	1.00
TYOPTN	1	75	.80
TYOPTN	2	75	.50
TYOPTN	3	75	.50
TYOPTN	4	75	.50
TYOPTN	5	75	.50
TYOPTN	6	75	.25
TYOPTN	7	75	0.00
END			

UOCCAN	1	71	0.00
UOCCAN	2	71	39.00
UOCCAN	3	71	32.00
UOCCAN	4	71	31.25
UOCCAN	5	71	33.00
UOCCAN	6	71	60.75
UOCCAN	7	71	46.75
UOCCAN	8	71	51.00
UOCCAN	9	71	72.75
UOCCAN	10	71	112.50
UOCCAN	11	71	133.25
UOCCAN	12	71	139.75
UOCCAN	1	72	129.00
UOCCAN	2	72	242.07
UOCCAN	3	72	331.25
UOCCAN	4	72	434.00
UOCCAN	5	72	649.30
UOCCAN	6	72	827.25
UOCCAN	7	72	933.30
UOCCAN	8	72	1192.25
UOCCAN	9	72	929.90
UOCCAN	10	72	717.00
UOCCAN	11	72	608.00
UOCCAN	12	72	513.00
UOCCAN	1	73	505.00
UOCCAN	2	73	483.00
UOCCAN	3	73	494.00
UOCCAN	4	73	485.00
UOCCAN	5	73	557.00
UOCCAN	6	73	575.00
UOCCAN	7	73	509.00
UOCCAN	8	73	686.00
UOCCAN	9	73	650.00
UOCCAN	10	73	540.00
UOCCAN	11	73	861.00
UOCCAN	12	73	1000.00
UOCCAN	1	74	1240.00
UOCCAN	2	74	1532.00
UOCCAN	3	74	1510.00
UOCCAN	4	74	1664.00
UOCCAN	5	74	1684.00
UOCCAN	6	74	1582.00
UOCCAN	7	74	1307.00
UOCCAN	8	74	1206.00
UOCCAN	9	74	675.00
UOCCAN	10	74	563.00
UOCCAN	11	74	559.00
UOCCAN	12	74	346.00
UOCCAN	1	75	250.00
UOCCAN	2	75	250.00
UOCCAN	3	75	72.00
UOCCAN	4	75	243.00
UOCCAN	5	75	285.00
UOCCAN	6	75	273.00
UOCCAN	7	75	86.00
UOCCAN	8	75	86.00
END			

Appendix B

BMD02R TRANSGENERATION CARDS

(Reproduced from Reference 5,
pages 15-21)

B. Transgeneration Cards

The term transgeneration is used to include transformations of input variables and creation of new variables prior to the normal computations performed by the various programs.

The transformations described below are performed on the values of the variables in each case. In these examples, the symbol x_i will denote the i^{th} variable as well as its value.

Examples:

$$\log_{10} X_4 \longrightarrow X_4$$

$\log_{10} X_4$ replaces X_4

$$X_5^c \longrightarrow X_1$$

X_5^c replaces X_1

$$X_2 + X_3 \longrightarrow X_2$$

$X_2 + X_3$ replaces X_2

By successive transformations, more complicated relationships may be obtained. For example:

- (i) To replace X_5 by $\sqrt{X_1^2 + X_3^2}$ four transformations are required:

		Variables as they are stored at each step				
Transformation		X_1	X_2	X_3	X_4	X_5
$X_1^2 \rightarrow X_1$		X_1^2	X_2	X_3	X_4	X_5
$X_3^2 \rightarrow X_3$		X_1^2	X_2	X_3^2	X_4	X_5
$X_1 + X_3 \rightarrow X_5$		X_1^2	X_2	X_3^2	X_4	$X_1^2 + X_3^2$
$\sqrt{X_5} \rightarrow X_5$		X_1^2	X_2	X_3^2	X_4	$\sqrt{X_1^2 + X_3^2}$

In this example, it can be seen that the original values of X_5 are irrelevant. Actually the variable X_5 may be a dummy variable introduced by the program specifically to provide capacity for creating new variables by transgeneration. Dummy variables may be required for intermediate storage in order to effect some transformations.

- (ii) To replace X_1 by $\exp(-1/2 X_1^2)$ three transformations are required:

Transformation		X_1	X_2	X_3
$X_1^2 \rightarrow X_1$		X_1^2	X_2	X_3
$-1/2 X_1 \rightarrow X_1$		$-1/2 X_1^2$	X_2	X_3
$\exp(X_1) \rightarrow X_1$		$\exp(-1/2 X_1^2)$	X_2	X_3

- (iii) To replace X_4 by $X_2 + \log_{10}(X_4 - X_3 + 100)$ four transformations are required:

Transformation		X_1	X_2	X_3	X_4
$X_4 - X_3 \rightarrow X_4$		X_1	X_2	X_3	$X_4 - X_3$
$X_4 + 100 \rightarrow X_4$		X_1	X_2	X_3	$(X_4 - X_3 + 100)$

<u>Transformation</u>	<u>X₁</u>	<u>X₂</u>	<u>X₃</u>	<u>X₄</u>
$\log_{10} X_4 \rightarrow X_4$	X ₁	X ₂	X ₃	$\log_{10}(X_4 - X_3 + 100)$
$X_2 + X_4 \rightarrow X_4$	X ₁	X ₂	X ₃	$X_2 + \log_{10}(X_4 - X_3 + 100)$

The transformations are performed in the order in which the Transgeneration Cards appear, so that, for example, the two transgenerations $2X_1 \rightarrow X_1$ followed by $X_1 - 2 \rightarrow X_1$ will result in $2X_1 - 2$, whereas $X_1 - 2 \rightarrow X_1$ followed by $2X_1 \rightarrow X_1$ will result in $2(X_1 - 2)$.

TRANSGENERATION LIST

Notation to be used in the following transgeneration list:

i, j, k are variable indices (need not be different)

c is a constant

a₁, a₂, a₃, ... are constants

n is the number of cases, or sample size

The mean $\bar{X}_i = \frac{1}{n} \sum_{j=1}^n X_{ji}$

The standard deviation $s_i = \left[\frac{1}{n-1} \sum_{j=1}^n (X_{ji} - \bar{X}_i)^2 \right]^{1/2}$

<u>Code</u>	<u>Transgeneration</u>	<u>Restriction</u>
01	$\sqrt{X_i} \rightarrow X_k$	$X_i \geq 0$
02	$\sqrt{X_i} + \sqrt{X_i + 1} \rightarrow X_k$	$X_i \geq 0$
03	$\log_{10} X_i \rightarrow X_k$	$X_i > 0$
04	$e^{X_i} \rightarrow X_k$	-
05	$\arcsin \sqrt{X_i} \rightarrow X_k$	$0 \leq X_i \leq 1$

<u>Code</u>	<u>Transgeneration</u>	<u>Restriction</u>
06	$\arcsin \sqrt{X_i/(n+1)} + \arcsin \sqrt{(X_i+1)/(n+1)} \rightarrow X_k$	$0 \leq (X_i/n) \leq 1$
07	$1/X_i \rightarrow X_k$	$X_i \neq 0$
08	$X_i + c \rightarrow X_k$	-
09	$X_i^c \rightarrow X_k$	-
10	$X_i^c \rightarrow X_k$	$X_i \geq 0$
11	$X_i + X_j \rightarrow X_k$	-
12	$X_i - X_j \rightarrow X_k$	-
13	$X_i X_j \rightarrow X_k$	-
14	$X_i/X_j \rightarrow X_k$	$X_j \neq 0$
15	If $X_i \geq c$, $1 \rightarrow X_k$; otherwise $0 \rightarrow X_k$	-
16	If $X_i \geq X_j$, $1 \rightarrow X_k$; otherwise $0 \rightarrow X_k$	-
17	$\log_e X_i \rightarrow X_k$	$X_i > 0$
18	$X_i - \bar{X}_i \rightarrow X_k$	-
19	$X_i/s_i \rightarrow X_k$	-
20	$\sin X_i \rightarrow X_k$	-

<u>Code</u>	<u>Transgeneration</u>	<u>Restriction</u>
21	$\cos X_i \rightarrow X_k$	-
22	$\arctan X_i \rightarrow X_k$	-
23	$X_i^{X_j} \rightarrow X_k$	$X_i > 0$
24	$c^{X_i} \rightarrow X_k$	$c > 0$
25	$X_i \rightarrow X_k$	-
26	$c \rightarrow X_k$	(Leave code i blank)
27-39	Not defined	
40	If $X_i = a_1$ or a_2 or $a_3 \dots, a_7$, then $c \rightarrow X_k$; otherwise X_k remains unchanged.	
41	If X_i is blank, then $c \rightarrow X_k$; otherwise X_k remains unchanged.	$(X_i \neq -0)^*$
	*Note that in reading numeric fields, a blank field and -0 are equivalent.	
42	If $X_i = a_1$ or a_2 or $a_3 \dots, a_7$, then $X_j \rightarrow X_k$; otherwise X_k remains unchanged.	
43	If X_i is blank, then $X_j \rightarrow X_k$; otherwise X_k remains unchanged.	$(X_i \neq -0)$

When a violation of a restriction in the right-hand column occurs during transgeneration, the program will print a diagnostic message. Most programs will proceed to the next problem, if any. Some programs will delete the case where the violation occurred and continue the computation. Other programs will screen all the input data for additional restriction violations before proceeding to the next problem, if any.

1. Standard Transgeneration Cards

Standard Transgeneration Cards are used with programs which use Standard Data Input (see Section II-C). Let p denote the number of variables in the data matrix and m the maximum number of variables allowed by the program for any problem. Any of the variables $x_1, \dots, x_m$ may be used in transgeneration. The initial values of the first p variables are read from the

input data file (Data Cards or Alternate Input Tape). The initial values of the remaining $m-p$ variables are left over from previous calculations. After transgeneration of a particular case, the values of the first $p+q$ variables for that case are used as the values of the transgenerated variables. If the $p+q$ variables required for the computation are not the first $p+q$, they must be relocated. This may be done by using transgeneration code number 25. The numbers p and q (q may be positive, negative, or zero) are specified on the Problem Card. The indices i , j , and k from the transgeneration list may exceed p or $p+q$ but must never exceed m .

Card Preparation

Col. 1-6	TRNGEN	(Mandatory)
Col. 7-9	Variable index k	
Col. 10, 11	Code from transgeneration list (restricted by availability in particular program)	
Col. 12-14	Variable index i	
Col. 15-20	Variable index j or constant c	
Col. 21-25	Blank	
Col. 26	Number of a_i 's for transformation 40 or 42	
Col. 27-32	a_1 value	
Col. 33-38	a_2 value	
...		
Col. 63-68	a_7 value	

The constants c , a_1 , ..., a_7 are punched with a decimal point if used with variables which have an F-type format and without a decimal point if used with variables which have an I-type format (see Section III-C).

The Standard Transgeneration Cards for the three examples on pages 16 and 17 are:

```
(i)  TRNGEN001100012.0000
      TRNGEN003100032.0000
      TRNGEN00511001000003
      TRNGEN00501005000000
```

(ii) TRNGEN001100012.0000
TRNGEN00109001-0.500
TRNGEN00104001000000

(iii) TRNGEN00412004000003
TRNGEN00408004100.00
TRNGEN00403004000000
TRNGEN00411004000002

2. Special Transgeneration Card

This card is used only in those programs which require transformations of the form $f(Y) \rightarrow Y$. One "Special" Trans-generation Card will specify successive transformations.

Card Preparation

Col. 1-6	SPECTG	(Mandatory)
Col. 7	Number of transformations (≤ 8 for each card)	
Col. 8,9	Code* for the 1st transgeneration	
Col. 10-15	Constant** for the 1st transgeneration (if none, leave blank)	
Col. 16,17	Code* for the 2nd transgeneration	
Col. 18-23	Constant** for the 2nd transgeneration	
...		
Col. 64,65	Code* for the 8th transgeneration	
Col. 66-71	Constant** for the 8th transgeneration	

As an example, if the user desires the transformation

$$(\sqrt{Y^2 - 3} + 100)^2 \rightarrow Y$$

he could accomplish this with the Special Transgeneration Card

SPECTG5102.000008-3.0000100000008100.00102.0000

* Code must be one of the set of permissible codes specified in the individual program description.

** Keypunch decimal point. The decimal point is not required for right-justified integers.

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