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(6) ARMY COST MODEL STRUCTURE AND FLOW,

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PREFACE

This Memorandum is one of a series documenting the Army cost model developed by RAND on behalf of the Programming Office of the Assistant Secretary of Defense (Comptroller). Described in this Memorandum are the computer programs, the coding system, and the major data flows. The primary emphasis is on these data flows - in the context of the logic of the costing process. Only a cursory treatment of the costing process is provided in this publication, the primary source being Army Cost Model Data: Part 1, Sources and Analysis, fully referenced below.

Computer programs and the coding system are described in nontechnical language. Technical programming procedures will be described in another publication of this series currently in preparation. Also to be issued is an operator's manual.

Related RAND publications already available are the following:

Grosse, R. N., Army Cost Model, RM-3446-ASDC, December 1962.

Grosse, R. N., and A. Proshan, Uses of Automated Force Cost Models, RM-3608-ASDC, April 1963.

Meltsner, A. J., Information Requirement Problems for Army Force Structure Cost Analysis, RM-3468-ASDC, February 1963.

Meltsner, A. J., R. A. Martyn and J. J. Pringle, Army Cost Model Data, RM-3639-ASDC, June 1963.

Baker, C. N., Army Cost Model Programmers' Reference Manual, RM-3721-ASDC, To be published.

Pringle, J. J., and P. R. McClenon, Army Cost Model Operators' Manual, RM-3679-ASDC, June 1963.

SUMMARY

↓
This **Memorandum** describes the computer programs, the coding system, and the major data flows of an Army cost model designed for rapid costing of alternative force structures and the determining of major item requirements. Several appendixes have been included to supplement the text.

The total model consists of ten individual computer programs. Each program is individually initiated through a job control card. Five programs are required for the costing process and must be executed in a prescribed sequence. The remaining five programs are concerned with additional output reports and may be executed as desired. The programs consist of highly flexible basic structures that guide the flow of data according to the coding system. Extensive use is made of subroutines to allow facile modification of data flows. All programs are written for the IBM 7090 computer and employ SCAT (SHARE compiler-assembler-translator) for translation. ↑

One coding system (described in section III) is used throughout the model. The coding system is highly structured, completely defines data items, and allows for both fixed and variable length data records. The coding system and program structure together determine the operations performed on all data items. Input data is strictly ordered on formalized input sheets - described in section II.

The operation of the model proceeds in three distinct phases. The first phase is the description of all units of the force in precise and comparable terms. Each force unit must be specified in a sufficiently

rigorous form to allow the consistent application of cost estimating relationships. The process of force unit specification is described in section V.

The second phase is the application of cost estimating relationships to the derived force unit specifications. The application of cost estimating relationships depends upon the characteristics of each individual requirement of a force unit. Certain requirements can be costed wholly on the basis of the specification of each force unit (described in section VI). On the other hand force unit requirements for transferable or inheritable assets must be adjusted to reflect net total force requirements (described in section VII).

The third phase is the organization of computed costs into a set of readable and meaningful reports. Different output reports are available at different points in the operation of the model and at different levels of force aggregation. The process of obtaining output reports is described in sections IV and VIII.

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I. INTRODUCTION

The process of operating an automated force cost model is one of transforming inputs of data pertaining to force structures, allowance statements, cost and other estimating relationships, etc., to outputs expressing resource and cost requirements - in sufficient detail and in a form appropriate for review and analysis. The total model consists of many programs with extensive use being made of "subroutining" within the individual programs. All the individual programs are based upon a common structure and are normally executed in a continuous single operation. A series of prepared input forms has been developed for convenient entry of the thousands of items of data required. One coding system is employed throughout all programs of the model.

All programs of the model may be described as "know-nothing entities," consisting only of the basic structures guiding the flow of data. The forms of cost estimating relationships are written into the program in a manner permitting easy alteration and major additions and deletions. No parametric values and no English descriptions, with the exception of the table of cost elements of the output report, are written into the program. Parametric values (or input quantities) must be specified on the input forms. English descriptions are input both through the data input forms and through a dictionary listing.

Over-all control is vested in ten programs, which may be considered as independent and distinct. Within the total ADP process the ten major

programs are performed in a sequence which is determined by "job cards" that are part of the input data for each machine run. For five of the ten major programs, outputs form the inputs required for the execution of another major program. Within these restrictions the ordering of the ten programs is free.

All routines at lower levels are completely under control of the major programs. Once a job card assigns control to a major program the execution is automatic and complete, through the entire hierarchy down to the lowest-order subroutine. In the execution of a routine at some given level, control may be transferred to a single lower order routine many times. As a general rule the lower the level the more often a routine will be executed. An operation at the lowest level, such as interpreting an ID or code number, may be performed thousands of times.

A large proportion, roughly 90%, of the individual instructions and of machine operating time involves moving data between locations within the machine, keeping records of current data locations, interpreting the meaning of data items, and setting up proper formats for printed output reports. A small fraction of the total program involves arithmetic operations actually calculating requirements and costs; it is these which are described in this memorandum.

The ten major ADP programs are as follows: input lister, input calculations, requirements sums, requirements print, materiel annex, program totals, cost allocation, output calculations, output totals, and aggregation. The arrangement of this text conforms, however, to the logic of the costing process. At places the logical structure of costing will necessarily diverge from the major programs of the ADP model. The reason for this divergence is quite simple. The ADP model,

although containing all the logic of the costing process, is tailored to the internal logic structure and capacity of the machine. There is no reason why the structure and divisions of the model, as it is tailored to ADP, should be coincidental with that structure which most clearly examines the logic of the costing process.

Figure 1 on the following page is a schematic representation of the data flow structure.

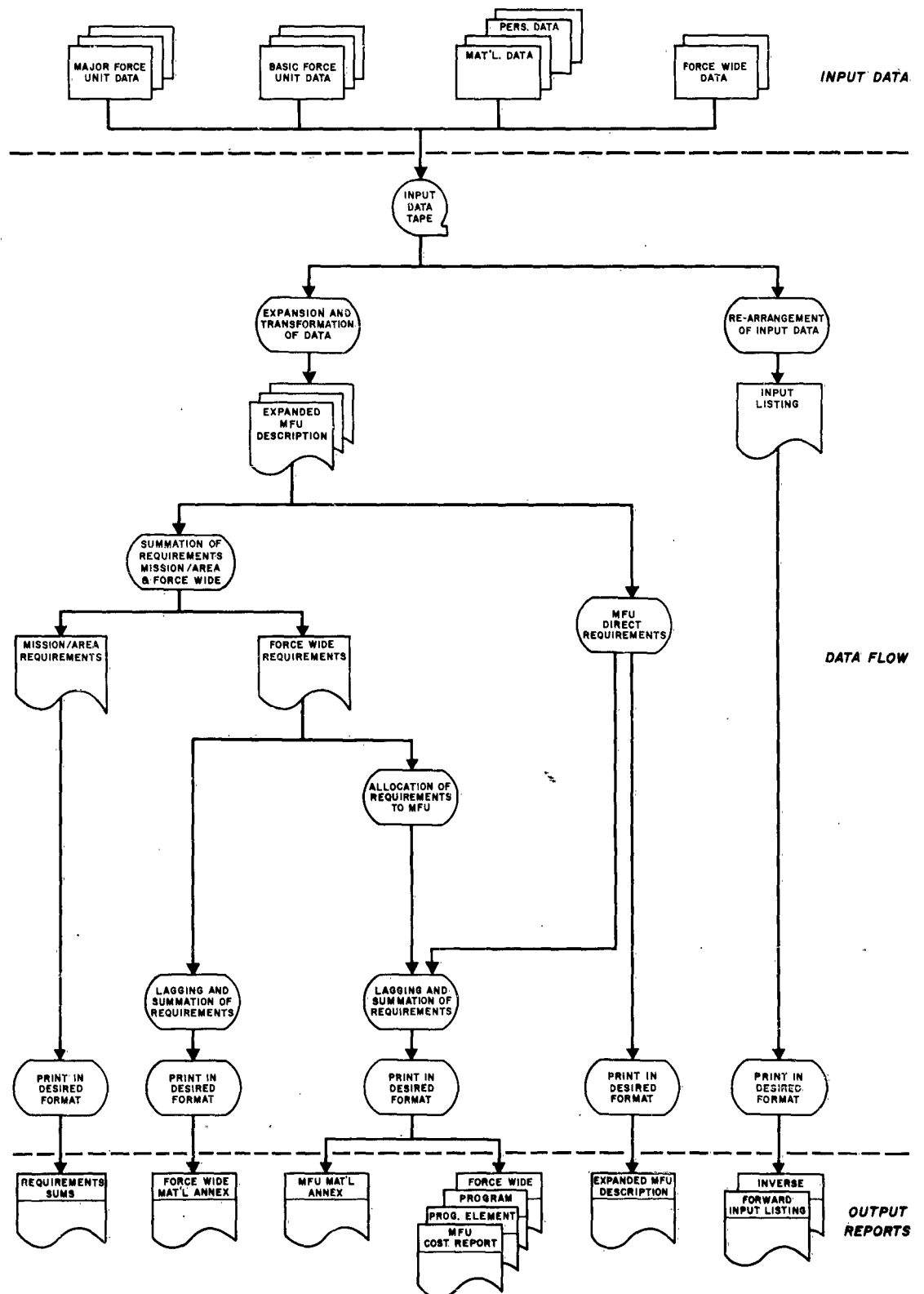
After a review of the input forms and the coding system, the major cost stages are described as indicated below.

- Input listing program
- Expansion of Major Force Unit specification
- Major Force Unit dollar requirements determined directly
- Major Force Unit dollar requirements involving force-wide allocation factors
- Major Force Unit final output reports and aggregations

Several appendices have been included to complement the text.

Three terms to be used frequently are defined here. "Read" means any operation which introduces information into the machine, either from punched cards or magnetic tape. Information may be read in any language the machine is able to understand at the time of the reading: alphabetic characters, numerical decimal, octal, or binary. "Write" means any operation which causes information to be passed from the machine to an outside recording medium, usually magnetic tape. The information may be written in any language which the outside device is able to record. "Print" means the recording of information on paper by machine printers.

FIGURE 1
DATA FLOW STRUCTURE



II. INPUT FORMS

A series of input forms is used for entering the original data required in the execution of the complete costing process. These input forms are numbered in five classes, each of which has one or more kinds of forms. Below is a description of the forms; the forms themselves are provided in appendix A.

Form I. Major Force Unit Data. The Major Force Unit (MFU) is defined as the lowest force level at which cost outputs can be reported. It is described in terms of time-phased numbers of lower-order force units which comprise for the model the basic building blocks. These are designated as the Basic Force Units (BFU), and represent packages of resources described in the Form IIs (see below).

Not only does the form provide for entry of the number of each kind of Basic Force Unit in each year, but for the entry of direct materiel and personnel allowances for the MFU, associated requirements expressed in dollar terms, and certain adjustment factors.

The form is arranged for a varying number of entries from MFU to MFU, of the BFUs and the other items listed above. This data will therefore enter the program as "variable length" data.*

Form II. Basic Force Unit Data. The description of the BFU is quantified in terms of its time-phased personnel and equipment allowances, such as officer, enlisted, rifle, tank, etc. This is

*For the characteristics of variable length data and fixed length data see appendix B.

similar to the TOE except that allowances are specifically stated for each year covered by the cost model; also, allowances are not at theoretical levels, but at realistic levels at which the Army has in the past and intends in the future to operate. The Basic Force Unit, being smaller, is a more stable collection of resources than the Major Force Unit, which often varies in its composition of lower-order force units. The use of Basic Force Units in the model is therefore a more efficient method of developing the resource implications of a Major Force Unit than would be achievable by a direct statement in terms of manpower types and individual equipment items.

Entries are also made on this form for associated requirements expressed in dollar terms, and for certain adjustment factors.

Form II accommodates all of the types of variable length information acceptable to input form I, with the exception that a BFU may not reference another BFU.

In general the series III forms can be considered as describing the cost-generating properties of the particular resources identified and quantified in forms I and II. The individual form descriptions follow.

Form III.A. Materiel Phasing Schedule. Entered on this form are sets of percentages that denote, for each general type or generic class of equipment specified on forms I and II, the relative quantity of each exact type and/or model in each unit's allowance.

In effect, then, this form is a means of further specifying unit allowances. As the equipment items in the allowances of various units change over time due to modernization or for some other reason, only one form III A needs to be changed rather than the forms I and II for each affected unit.

The form is arranged for a varying number of entries and the data will therefore enter the program as variable length data. The only permissible references are to specific items of equipment by exact type and/or model.

Form III.B. Materiel Data. On this form are entered for each major materiel item, the cost-affecting characteristics by year, e.g., stock levels and peacetime consumption factors; factors to account for allowances of force units not specified in the cost model; and allowance data on related equipment such as ammunition.

Related equipment is of two kinds: ammunition and "other related equipment" (not used in the Mark I version of the cost model). An item of equipment may require more than one specific ammunition type. Total requirements of a given related equipment type are determined as the product of the quantity required per unit of using equipment and the total numbers of the various types of using equipments. All data items specifying related equipment are entered as variable length data.

A form III B is completed for each specific type and/or model of equipment scheduled to be held in inventory during the time period covered by a model run.

On this form all data lines, with the exception of ammunition and other related equipment data sections, are fixed length data.

Form III.C. Material Cost Data. For each major material item, the unit costs by year are shown. While only one materiel costing method is currently used (yearly average unit cost), space is provided for adding data needed in alternate costing methods.

A form III C is completed for each specific type and/or model of equipment to be newly procured during the time period covered by a model run.

This form consists only of fixed length data.

Form III.D. Military Personnel Data. Contains the characteristics of the various personnel types specified in forms I and II. A form III D is completed for each type of personnel specified. All data entered on this form is fixed length, and space is provided for additional specification of personnel estimating relationship parameters.

Form III.E. Unspecified Unit Personnel Allocation Schedule. Since the units specified on input form I do not exhaust the total of all Army units, percentage factors are provided for application to the MFU personnel allowances. These provide for the personnel allowances of the unspecified units. All data entries are variable length. Permissible references are limited to specified types of personnel.

The series IV forms are in effect extensions of the series III forms. When cost-generating properties are identical for large

aggregates of particular resources and for large aggregates of force units, one entry of data properly coded is sufficient. All data items are necessarily fixed length.

Form IV.A. World Wide Data. This form contains those cost characteristics and coefficients which apply unconditionally to the total force and which apply to the individual mission/areas in the absence of differential specification of mission/area characteristics.

Form IV.B. Mission/Area Data. This form contains those cost characteristics and coefficients which apply differentially to individual mission/areas.

Form IV.C. Deliveries to T.O.A. Schedules. This is in the form of table listings. Each item of equipment is referred to one line of the table to obtain lagging factors for converting equipment deliveries to total obligational authority (TOA) streams.

The series V forms are for entering data changes - updating of program data and estimating specifications.

Form V.A. Program Add/Change Data. This is used in changing existing data lines or inserting new data lines.

Form V.B. Program Delete Data. This is used in deleting (zeroing out) existing data lines.

III. CODING SYSTEM

The use of a computer places certain restrictions on the form in which data may be recorded for machine processing, and on the form in which this desired processing may be specified. The development of automated translation routines has removed many of these restrictions. The function of such a translation routine is to bridge the gap between the language used and understood by man and the different type of language required by the hardware of a particular machine. The automated Army Cost Model is written for the IBM 7090, and uses SCAT (SHARE Compiler-Assembler-Translator) as the language bridge for specifying the processing to be performed.

A significant part of this processing is concerned with removing restrictions on the form of the data which are to be processed. With every item of input data, there must be a set of signals which allows the translation program to recognize the characters on the input sheets, and convert them to a form which the machine is able to understand and to process. These signals are the basis of the language used to transmit all data to be processed. Collectively, these signals are known as the Coding System for the data.

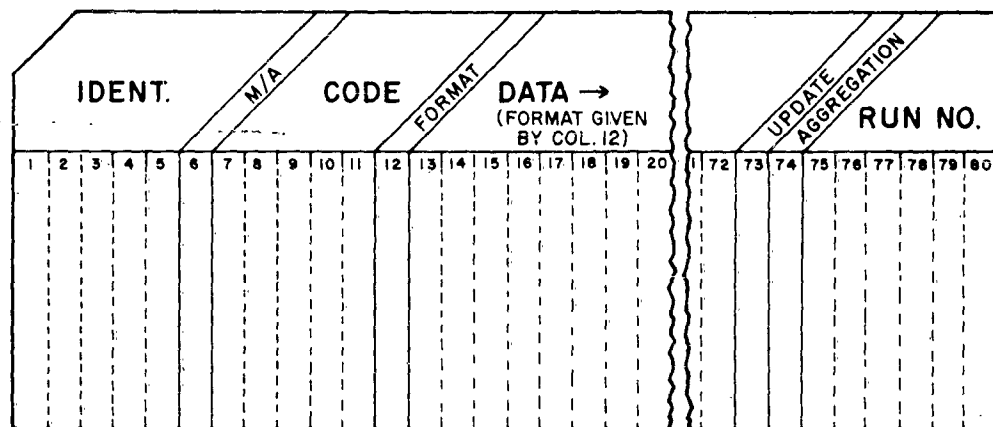
All information concerning each item of input data must be completely identified and explained by the coding system, i.e., the format of the data, any scale factor of the data, the identity of the data, what the data is identified with, what is to be done with the data, etc. The coding system must also be appropriate for internal use by the machine

during processing, to allow the stored program to identify, call from memory, operate on, and assign and store each data item.

All input data is punched on eighty column cards. The standard card format is illustrated in Figure 2.

Figure 2

Standard Card Format - All Cards



Columns are used as follows:

- 1 - 12 Coding system
- 13 - 72 Input data
- 73 Signal for data file updating
- 74 Signal for MFU cost report aggregation
- 75 - 80 Program run number

The coding system, occupying positions 1 through 12, which has been designed for the Army Cost Model consists of four distinct symbols,

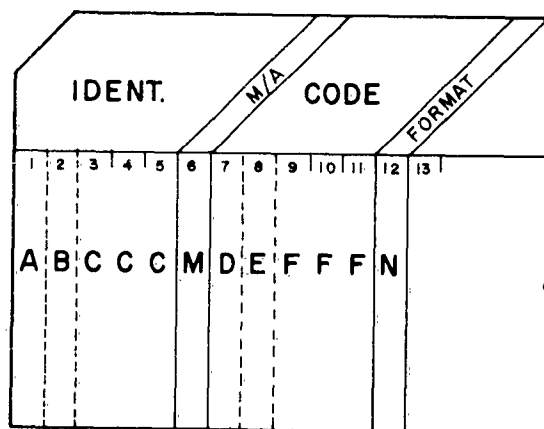
which will be used through this report. They are:

- ABCCC The identification number.
- M The mission/area identifier.
- DEFFF The code number.
- N The data format identifier.

Each item of data is uniquely identified by specific values of these four symbols, which are attached to the item throughout the entire machine processing cycle. The position of the four parts of the coding system is shown by Figure 3.

Figure 3

Coding System Format



IDENTIFICATION NUMBER

The first five digits of the coding system are denoted as the identification number (ID). The ID identifies the associated data as comprising part of the description of a particular force unit, of a materiel or personnel type, or of data pertaining to desired cost

estimating relationships. The first digit of the ID, (A), assigns data to one of these broad types. The second digit, (B), is a further assignment of data types, but the meaning of the value of (B) is dependent upon the accompanying value of (A). The digits (CCC) complete the identification. The value of (CCC) specifies a unique entity of the type given by the values of (A) and (B), and for each different combination of (A) and (B), a given value of (CCC) identifies a separate and distinct entity. The implications of the possible combinations of A and B which are recognized by the model are given in Tables 1 and 2.

The sixth digit (M) is the Mission/Area designator. This symbol may be thought of as part of the ID, but is treated as a distinct part of the coding system because the program operates on this symbol in a fashion different from its handling of the first five digits of the ID. An explanation of the concept and use of the mission/area symbols is given below.

CODE NUMBER

Digits 7 through 11 of the coding system are denoted as the code number (Code). The code designates the exact feature, of the particular entity given by the ID, which the associated data describes. Unlike the ID, the exact meaning of a particular code can be determined only within the context of the particular type of entity being described. Two distinct uses of the code are employed in the model, and must be carefully distinguished at all times.

Table 1
ID NUMBER TYPES

ID	Type	Remarks
00000	Dictionary Entries	Used only by programs which result in printed reports. Ignored, if present, by other programs.
00001	Force/Wide & M/A Data	Must be present. First M/A must be World/Wide (M/A = A) Data. Other M/A's optional. Fixed Data Codes only may appear. Codes 00001 through 00999 for M/A = A. Codes 00001 through 00099 for other M/A's.
00002 } 09999 }	Not Assigned	Ignored if present.
1BCCC	Major Force Unit Data	Must be present. Each ID must have one M/A only. Fixed and/or Variable Codes may appear. Codes 00001 through 00199 allowed.
2BCCC	Basic Force Unit Data	Must be present. Fixed and/or Variable Codes may appear. Codes 00001 through 00199 allowed.
30CCC	Phasing Schedules	Optional. Fixed Code 00001 only may appear, but is ignored. Variable Codes only are recognized.
3BCCC	Materiel Data	Must appear. Fixed and/or Variable Codes may appear. Codes 00001 through 00054 allowed.
40000	Personnel Ratios	Optional. Fixed Code 00001 only may appear, but is ignored. Variable Codes only are recognized.
40CCC	Not Assigned	Ignored if present.
4BCCC	Personnel Data	Must appear. Fixed Codes only may appear. Codes 00001 through 00015 allowed.
50000 } 99999 }	Not Assigned	Ignored if present.

Table 2
IDENTIFICATION NUMBER STRUCTURE

Given The Identification Number ABCCC		
If A =	And B =	Then ABCCC Identifies
1	program designator	A Major Force Unit contained in the submission program identified by the value of B.
2	any value	A Basic Force Unit.
3	0	An equipment item of a generic type, i.e., a medium gun tank.
	1	An equipment item of a particular model which is to be included in the materiel annex - normally a standard A item in the current Army program, i.e., an M-60 tank.
	2	An equipment item of a particular model which is not to be included in the materiel annex - normally other than a standard A item in the current Army program, i.e., an M-48 tank.
	3	A related equipment item of a particular model which is to be included in the materiel annex. (See note below)
4	0	Unspecified unit personnel allocation schedules (CCC = 000 only)
	1	A particular type of military officer personnel
	2	A particular type of military enlisted personnel
	3	A particular type of civilian personnel
0	0 (only)	Force wide data (CCC = 000 only)

Note:

The integrity of the number CCC breaks down in consideration of the ID of related equipment. Here the particular item is identified by the first two digits of CCC. The final digit = 0.

Case I. The Code as a Referent. If the leading digit, (D) of the code is a number other than zero, then the code number serves as a referent to data which is identified by the same number. That is, a given value of the code number of this type denotes a reference to the complete set of data for an entity which is identified by an ID with this same value. This use of the code conveys an "is contained in" specification. The various meanings assigned to the associated data are given in Table 3 on the following page.

Case II. The Code as a Descriptor. If the leading digit, (D) of the code is equal to zero, then the code number serves to describe exactly the associated data. The nature of the description is a function of value of (E) of the code. If this value is non-zero, the data is a dollar factor or value chargeable to a particular cost category given by the value of (FFF) of the code.* If the digit (E) is zero, the meaning of the associated data is particular to the corresponding ID, and is given in Table 3 and in appendix D.

Where the values of both (D) and (E) are zero the code reference is to fixed length data. All other code references are to variable length data.**

Certain restrictions are placed upon what combinations of ID and code are possible or permissible. These restrictions derive from logical consideration of the costing process, the hierarchy of data

* Appendix C contains a listing of all cost elements of output and their codes.

** The distinction between fixed length and variable length data is given in appendix B.

Table 3
CODE NUMBER STRUCTURE

Given The Code Number DEFFF		
If D =	And E =	Then DEFFF References
2	any value	An ID number whose value of ABCCC = DEFFF
3	0	An ID number whose value of ABCCC = DEFFF
	1	An ID number whose value of ABCCC = DEFFF
	2	An ID number whose value of ABCCC = DEFFF
	3	i, if the final F (of FFF) is zero and a, if the associated ID is 1BCCC or 2BCCC, an ID number whose value of ABCCC = DEFFF b, if the associated ID is 3BCCC, combat consumption rate of the related equipment item with ID number whose value of ABCCC = DEFFF ii, if the final F (of FFF) is unity, the training consumption rate of the related equipment item with ID number whose value of ABCCC = one less than DEFFF
4	0	Total military personnel (FFF = 000 only)
	1	An ID number whose value of ABCCC = DEFFF
	2	An ID number whose value of ABCCC = DEFFF
	3	An ID number whose value of ABCCC = DEFFF
0	0	Fixed length data whose meaning and application are determined by the first two digits (A and B) of the ID number associated with DEFFF
	1	Not used
	2	Dollar flow data for PEMA materiel annex expenditures where the value of FFF identifies the materiel item
	any value between 3 and 7	Dollar flow data whose application is determined by the value of the second digit (E) and whose cost element chargeability is determined by the value of FFF

Note: For specified materiel items, code 31FFF, and materiel dollar data, code 02FFF, the value of FFF uniquely identifies the materiel item. No duplicate values of FFF are allowed for these codes.

types, and the underlying nature of the coding system. The nature of the code as an "is contained in" statement leads to the general rule that an ID may not refer to a code which quantifies data at a higher or equal level (of aggregation). Appendix D contains a systematic listing of IDs and their associated codes noting all non-allowable ID/code combinations.

FORMAT DESIGNATOR

The last digit of the coding system is the format statement. The value of this digit determines the form of the information following in the data fields. By form is meant whether the data is numeric or alphabetic, the length of the data (number of machine words), etc. If the information to be entered is numeric the format statement further specifies whether the data is "yearly" or "no-year" data (whether twelve data entries or one are to be written) and the decimal magnitude of the data (units, thousands, etc.). Table 4 specifies all the format statements currently being used.

MISSION/AREA DESIGNATOR AND DATA "TREETING"

The mission/area in addition to being useful in force structure composition and analysis and cost allocation rules, serves an additional purpose. The requirement for resources by the same force unit in different mission/areas may be different. A well known example of this is overseas pay allowances. Other examples of such differences can be found in the present operation of the forces, and postulates of differences can be made to quantify the effect on force costs arising from them. For

Table 4
FORMAT CODE INDEX

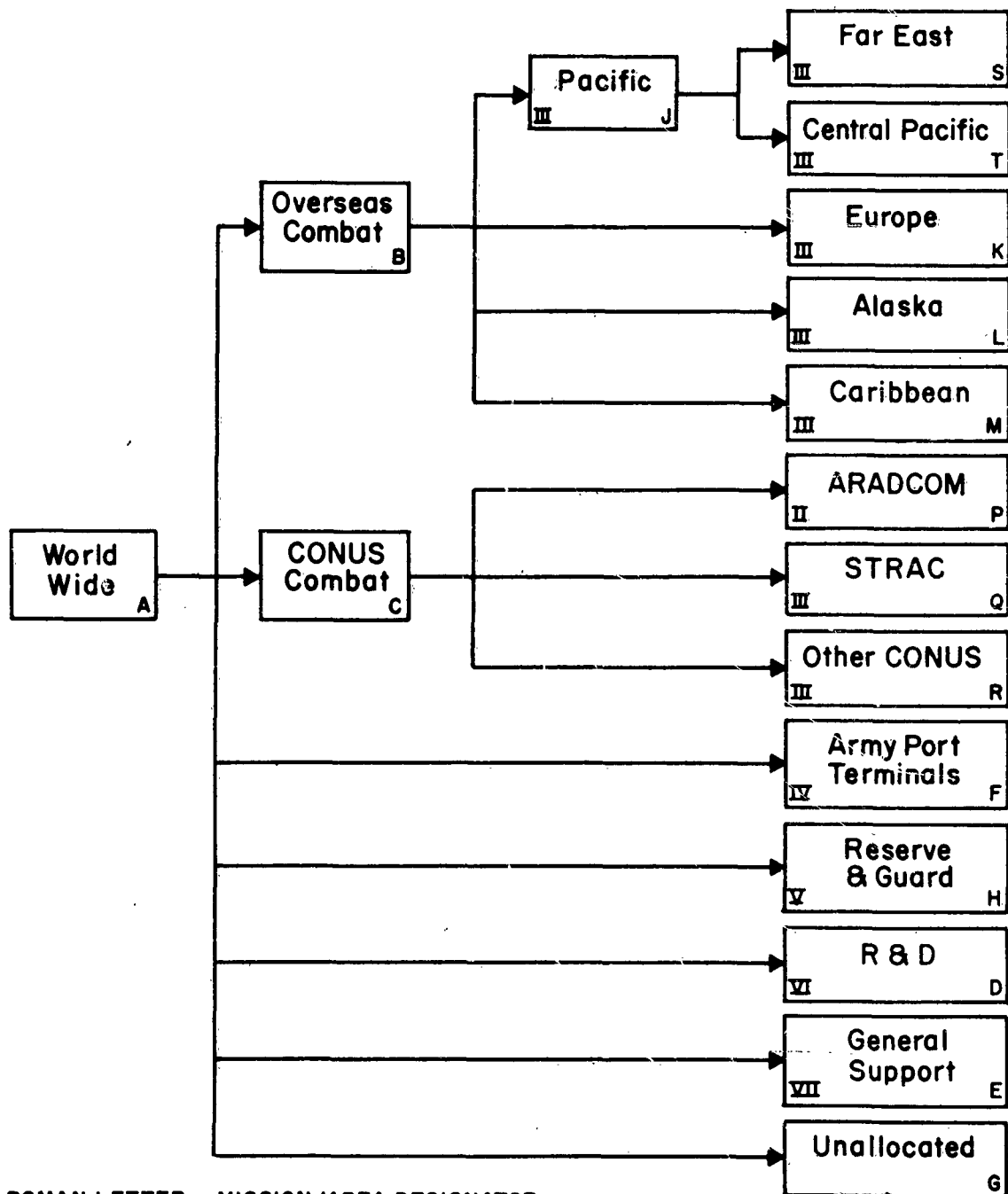
Format Code	Interpretation	Value if field is blank for	
		Extreme Left Hand Field	All Other Fields
1	12 Numeric fields of (X.XXXX)	1.0	Prior Field
2	12 Numeric fields of (XXXXX.)	0.0	Prior Field
3	12 Numeric fields of (XXXX.X).(10 ³)	0.0	Prior Field
4	12 Numeric fields of (XXXX.X).(10 ⁶)	0.0	Prior Field
5	12 Numeric fields of (X.XXXX)	0.0	Prior Field
6	12 Numeric fields of (XXX.XX).(365)	0.0	Prior Field
7	7 Numeric fields of (X.XXXX)	0.0	0.0
8	7 Numeric fields of (X.XXXX)	0.0	0.0
A	6 Alphabetic characters		
B	12 Alphabetic characters		
C	24 Alphabetic characters		
D	36 Alphabetic characters		
E	48 Alphabetic characters		
F	60 Alphabetic characters		
J	24 Alphabetic characters plus 12 numeric fields of (XXX.)	0.0	Prior Field
S	1 Numeric field of (X.XXXX)	0.0	
T	1 Numeric field of (XXXX.)	0.0	
U	1 Numeric field of (XXXXX.):(365)	0.0	
V	1 Numeric field of (X.XXXX).(12)	0.0	

example, what is the difference in resource requirements if the level of combat consumption stocks is increased in Europe but not changed in any other theatre?

The mission/area concept is used in conjunction with a process called "treeing." The mission/area tree, as presently constituted, is illustrated in figure 4. Assume that a particular force unit, deployed in Europe, requires helicopter pilots as part of its allowance. If no information is available to the program as an input for the particular resource, helicopter pilots stationed in Europe, the program will search for the closest substitute, e.g., helicopter pilots in overseas combat units. The cost characteristics of helicopter pilots in overseas combat units will then be used to calculate the resource requirements resulting from the particular force units allowance of helicopter pilots. If no information were to be found for closest substitute the program will look for information on the next closest substitute.

Input data requirements can be decreased through the use of treeing. If the cost or allowance generating characteristics of a particular resource item or force unit were identical in different mission/areas a separate input sheet for each M/A would not be required. Suppose the BFU, "Infantry Battle Group" contained identical allowances wherever they were found overseas. An input form II with a mission/area (B) designation (overseas combat) would be sufficient to pick up and determine the requirements of all overseas units. A good example of this similarity is in the cost of new equipment. Regardless of where an item of newly produced equipment is initially deployed its production cost is the same, and hence, the

Figure 4
MISSION / AREA TREE



ROMAN LETTER - MISSION/AREA DESIGNATOR
ROMAN NUMERAL - MAJOR PROGRAM

input form for materiel cost data (III C) is pre-printed with mission/area (A).

Any type of input information, with the exception of major force unit data, may employ treeing. Because the major force unit is the ultimate level at which all resource requirements are reckoned and because the M/A designation of MFUs is integral to the specification of the force, all major force units must carry mission/area designations at the lowest level of aggregation.

One restriction is present in the use of treeing to avoid duplication of input effort. This restriction is as follows: Once any data set is entered into the machine (i.e., once a particular ID-M/A number combination appears) all data pertaining to that same ID-M/A must be filled out on an input sheet. Where data is not entered the machine will interpret the information as though zeros had been entered.

IV. INPUT LISTING PROGRAM

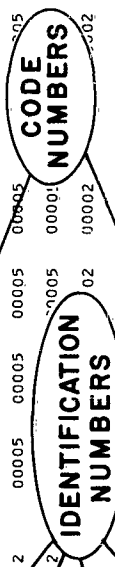
All input data are initially recorded on the input forms. The data entries of the input forms are first put on punched cards, and then transferred to magnetic tape. From the tape the input listing program develops two types of listings (forward and inverse) providing more convenient access to the input data than is afforded by the original forms. Such continued access is necessary for post-run analysis and in devising program iterations and data improvements, as well as for other reasons.

In the forward listing each MFU, BFU, materiel item, etc. is printed on a separate sheet and all the data associated with the particular entity is listed on the sheet. In physical layout the forward listing sheet closely resembles the input load sheets. It is much more convenient, however, since it can be duplicated indefinitely; it is on a smaller-sized sheet which is easier to handle; and it is printed and easier to read. For every ID, all data items appear in the strict numerical order of their code numbers; and hence this listing may be characterized as being code numbers sorted on ID numbers. A sample forward listing is displayed on the following page, Figure 5.

As contrasted with a forward listing, the inverse listing is characterized as being ID numbers sorted on code numbers. Here the listing will begin with the lowest code number found for any input (00001). All IDs which contain this code will then be listed in the numerical order of ABCCC M. This listing is especially useful in checking on or determining particular data values used in programs. A sample inverse listing is displayed in Figure 6.

Figure 6
SAMPLE INVERSE INPUT LISTING

ARMY COST MODEL - SAMPLE OUTPUT												RUN 001234	FEB.-13,1963				PAGE 452
													1969	1970	1971	1972	1973
COMPUTER SET AN/TYK-5													----				----
21120 K 30401	2	00006	00006	00006	00006	00006	00006	00006	00006	00006	00006	00006	00006	00006	00006	00006	00006
21170 J	2	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002
21200 I	2	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007
21200 Q	2	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007
21200 R	2	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007	00007
21280 J	2	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005
21280 K	2	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005	00005
21530 H	2	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002	00002
21960 J	2	00009	00009	00009	00009	00009	00009	00009	00009	00009	00009	00009	00009	00009	00009	00009	00009
22110 Q	2	00004	00004	00004	00004	00004	00004	00004	00004	00004	00004	00004	00004	00004	00004	00004	00004
ELECTRONICS COUNTERMEASURES SETS AN/ALQ-37 AND AN/VLQ-1													----				----
13284 G 30403	2	00012	00012	00012	00012	00012	00012	00012	00012	00012	00012	00012	00012	00012	00012	00012	00012
15040 H	2	00457	00457	00457	00457	00457	00457	00457	00457	00457	00457	00457	00457	00457	00457	00457	00457
21450 J	2	00021	00021	00021	00021	00021	00021	00021	00021	00021	00021	00021	00021	00021	00021	00021	00021
21630 Q	2	00018	00018	00018	00018	00018	00018	00018	00018	00018	00018	00018	00018	00018	00018	00018	00018
MULTIPLEXER SET AN/TCC-45													----				----
13284 G 30405	2	00635	00635	00635	00635	00635	00635	00635	00635	00635	00635	00635	00635	00635	00635	00635	00635
15040 H	2	00113	00113	00113	00113	00113	00113	00113	00113	00113	00113	00113	00113	00113	00113	00113	00113
20320 J	2	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039
20320 K	2	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039
20320 Q	2	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039	00039
21600 K	2	00052	00052	00052	00052	00052	00052	00052	00052	00052	00052	00052	00052	00052	00052	00052	00052
													----				----
													000013 CARDS				00004 00004
													000004 CARDS				000004 CARDS



For rapid changing of data contained on the data tape, a set of "program update" routines is employed. With these routines only a minimum of input sheet writing and card punching is required. Change information is entered on sheets designed for this purpose (the series V forms), and cards need be punched only for those data lines to be changed. When these cards are ordered in a proper sort, the update routine directly iterates the existing input data tape and writes a new tape.

The update routines also cause an update listing to be written. This listing is in the same general format as the forward input listing, but lists only the changed data items with their new values. The update listing then becomes a supplement to the input listings and can be used to hand-write the changes on the original listings.

V. EXPANSION OF MAJOR FORCE UNIT SPECIFICATIONS

The first major computational program of the model details the description of Major Force Units specified on form I. As entered on form I the description may contain references to generalized resource groupings (Basic Force Units and generic materiel classes). Similarly, the descriptions of Basic Force Units entered on form II may contain references to generalized resource groupings (generic materiel classes). All references to generalized resources must be replaced by specific resource references (exact type/models for materiel and types of personnel) before any requirements levels may be determined.

Major Force Unit characteristics listed on form I contain modifiers which must be accounted for before exact resource levels are known. Other modifiers are listed on form II. These are the adjustment factors, all of which must be applied before a given MFU's allowance of men and materiel is determined. Other adjustment factors which apply to MFU equipment levels are found on forms IV A and IV B. These other adjustment factors are also subject to application in this phase of the program.

In a majority of cases the equipment allowances specified by MFUs and constituent BFUs lead to additional allowances, which take three forms: war reserve stocks of equipment; inventories of related equipment, i.e., equipment whose allowances can be determined only by reference to allowances of other equipments; and allowances of personnel and equipment items known to be required by units which are not explicitly included in

the force structure statement.* The determination of these other inventories is covered in detail at a later point in this section.

The process of Major Force Unit expansion described below yields a detailed allowance position of each MFU for each year of the program. From this are developed requirements in terms of delivery quantities of specified materiel and personnel. The use of the term allowance is limited to describing asset positions at a point of time. The term requirement is limited to describing the change in asset position between two points of time, i.e., deliveries over a period of time.

Dollar flows resulting from the application of cost estimating relationships to allowance levels and delivery quantities occur in the two succeeding model phases (1) Major Force Unit dollar requirements determined directly and (2) Major Force Unit dollar requirements involving force-wide allocation ratios.

APPLICATION OF MAJOR FORCE UNIT ADJUSTMENT FACTORS

The first step in this program involves the reading of all Major Force Unit records into the machine. Each MFU record is read and the program then operates to apply the MFU adjustment factors - officer, enlisted, civilian, and equipment to each applicable item that is specified on an MFU record. The equipment adjustment factor is applicable to all lines of data codes 3EFFF. The officer adjustment is applicable to all data lines coded 41FFF, the enlisted to lines coded 42FFF, and civilian to lines coded 43FFF. The adjustment process is a simple

* Units of a type known to exist in the force but which cannot be quantified or units for which individual specification is not desired.

multiplication of the data value of each year and the value of the applicable adjustment factor for that year. As this operation is completed for each MFU, a new MFU record is written on tape.

A second operation occurs at this time which is important for the next step of the program. As each MFU record is surveyed, each of its references to BFUs is noted and recorded in a table which is internally constructed and stored in the machine. The ordering of BFU references in this table is the basis for the BFU sorting operation described below, which places the BFUs in the sequence in which they will be called by the set of all MFUs. The MFUs are read into the machine in the order in which they will appear in the output cost report.

BASIC FORCE UNIT ADJUSTMENT AND SORT AND MERGE

The data entries of the main body of form II are adjusted by the values entered in the adjustment factor lines at the bottom. The codes to which each adjustment factor are applicable are the same as in the case of the four MFU adjustment factors. As this process occurs the adjustment factors are eliminated from each BFU's record.

The actual process is one of reading the BFU records one at a time from the data input tape. As the adjustment factors are applied the adjusted BFU records are placed in memory. The set of all BFU data is greater than the memory capacity of the machine. At certain stages in the process of reading and adjusting the records, the machine's capacity will be reached. At this time the reading will stop. All BFU records in memory will be sorted (internally) so that all BFUs in memory appear in the sequential order they will be called on by the force structure's MFUs. This sorted block of BFUs is then written on tape.

When the writing operation is completed, the machine returns to reading and adjusting BFU records. When the machine's capacity is again reached, the BFU records are sorted and written, as above, on a different tape. This process is repeated until all BFU records have been read, adjusted, sorted, and written on tapes.

At the time of completion of the BFU adjustment, the adjusted BFU records are on a series of tapes in sorted blocks. More than one block of BFU records may be written on one tape, and each block is internally sorted only. The next step is to merge all the blocks of BFU records into one block which is necessarily ordered into the desired sequence. The data size of the current Army program requires the simultaneous operation of five tape units to perform the BFU sort and merge operations.

ELIMINATION OF BFU REFERENCES AND CONSOLIDATION OF MFU RECORDS

The completion of the BFU merge operation produces a single tape containing all BFUs in the exact order they will be called for by each MFU.* At this point MFU records are read one at a time into the machine. At the same time data records for those BFUs called for by the MFU are read from the merge tape. For each BFU referenced by the MFU, the number of force units allowed in each year is multiplied by the number of specified resource items contained in the BFU's allowance for that year. When this process is completed for each item in the BFU's allowance for each year, the MFU no longer contains a reference (code)

* In those cases where one BFU is called for by more than one MFU, the BFU record will appear more than once on the merge tape. Each appearance will be in the order required by the ordered MFU listing.

to the BFU. Instead of the BFU, the MFU now references each item of the BFU's allowance. This is repeated for each BFU referenced. At the conclusion the MFU has eliminated all references to BFUs (codes of 2EFFF).

All items of equipment and personnel newly added to each MFU's record will be adjusted by the MFU adjustment factors for officer, enlisted, civilian, and equipment; thus all BFU data coded 3EFFF and 4EFFF are adjusted twice.

The MFU record will now contain a long list of references to generic families and particular items of equipment, personnel, and input dollar flow requirements (codes of 06FFF and 07FFF) which have been transferred from each BFU in its turn. In this long list there will surely be repetitions of references, as in the case of the hand-carried rifle, which is part of the equipment allowance of almost every BFU. This long list of references is consolidated through a "consolidation routine" in which the program searches the current MFU record and, in each year, sums all quantities with identical codes, and drops from the record all lines of data which have been added to another line. The use of this device eliminates the necessity for searching for a possible previous occurrence of a given data item which is to be added to the MFU record, while at the same time keeping the MFU record length to a minimum.

When the consolidation is completed the next MFU in order is taken and the same operations performed. This is continued until all MFUs have been processed.

SPECIAL PROCEDURE FOR DOLLARS PER BFU INPUT DATA

Calculation across two adjacent years are required for codes 06FFF and 07FFF (the 06FFF code specifies dollar requirements per average BFU; and the 07FFF code specifies dollar requirements per positive incremental BFU). The dollar values specified under code 06FFF for each BFU are to be multiplied by the average number of BFUs contained in the MFU. The dollar values specified under code 07FFF for each BFU are to be multiplied by the (positive) incremental number of BFUs contained in the MFU. Both require consideration of quantities in adjacent years. However, operations between values in different years will not occur until the final stages of MFU expansion, by which time all references to the BFUs themselves will have been lost. The special restriction imposed on 06FFF and 07FFF data provides the answer (see appendix D, Basic Force Unit ID).

The usual method of computing dollars per average or incremental unit is to find the average or incremental number of units and multiply this by the dollars per unit value.

$$(S_1) \left(\frac{A_n + A_{n-1}}{2} \right) \quad \text{for average, and}$$

$$(S_2)(A_n - A_{n-1}) : (A_n - A_{n-1}) > 0 \quad \text{for incremental.}$$

where S_1 = Dollars per average unit

S_2 = Dollars per incremental unit

A_n = Number of units in year n

A_{n-1} = Number of units in year (n-1)

However, if the values of S_1 and S_2 are not allowed to vary between years the same answer is obtained by the following operations.

$$\frac{(S_1)(A_n) + (S_1)(A_{n-1})}{2} \quad \text{for average, and}$$

$$(S_2)(A_n) - (S_2)(A_{n-1}) : (S_2)(A_n) - (S_2)(A_{n-1}) > 0 \quad \text{for incremental.}$$

The arithmetic involved in eliminating BFU references finds the values of $(S_1)(A_n)$ and $(S_2)(A_n)$ for each year. The operation is completed during that later part of the major force unit expansion operation which calculates all averages and increments.

APPLICATION OF MATERIEL PHASING SCHEDULES

Materiel item allowances quantified in terms of a generic group on forms I and II and coded 30FFF must be replaced with references to particular models and items of equipment (codes 31FFF, 32FFF, and 33FFF).

The process of eliminating MFU references to generic equipment is the same as that for eliminating references to BFUs. First the materiel phasing schedules written for each generic equipment group by mission/area and identified by 30CCC|M are read into memory.* Then each MFU record is read in, one at a time. The MFU record is scanned for references to generic materiel groups (codes 30FFF). When a reference is found the set of materiel phasing schedules is scanned for an ID (30CCC) whose

* In point of fact, the automated program takes one MFU, eliminates its BFU references and applies materiel phasing schedules before moving to the next MFU. These operations are performed at one time due to the large capacity of the machine, but they are logically two distinct and disjoint operations. The nature of the operation is clearer when they are treated individually.

value of CCC is equal to the referent's value of FFF.* When the proper ID is found the MFU's allowance in each year is multiplied by the values of the data items lines following under the given ID. The code 30FFF is replaced by the codes of the data lines which fell under the ID 30CCC (only codes 31FFF and/or 32FFF and/or 33FFF are allowable).

The particular items of materiel falling in any generic group are not necessarily unique to the given generic item. Therefore after the application of phasing schedules to the MFU is completed, duplicate materiel codes may appear in the MFU record. To eliminate these duplicates the consolidation routine is applied again to the MFU record.

CODE PREFIX SYSTEM

After completion of materiel phasing all major force unit references to basic force units and to generic equipment types have been eliminated.**

* It should be remembered that in addition to the equality CCC = FFF the program will look for a match in the mission/area designator (M). If matching mission/areas are not found, the program will search for FFF equal to CCC at the next higher level of mission/area aggregation.

** Variable length data codes contained in MFU records remaining at this time may consist of the following:

- 31FFF - specific materiel item 31FFF, a materiel annex item
- 32FFF - specific materiel item 32FFF, not a materiel annex item
- 33FFF - specific related materiel item 33FFF, a materiel annex item
- 41FFF - military officer personnel type 41FFF
- 42FFF - military enlisted personnel type 42FFF
- 43FFF - civilian personnel type 43FFF
- 02FFF - dollar flow requirement for materiel type 02FFF a materiel annex item
- 03FFF - dollar flow requirements for cost category 03FFF, something other than a materiel annex equipment item
- 04FFF - dollar flow requirements per average military person chargeable to cost category 03FFF
- 05FFF - dollar flow requirements per incremental military person (positive only) chargeable to cost category 03FFF
- 06FFF - dollar flow requirement per average specified BFU in the MFU chargeable to cost category 03FFF after the first step in processing (see page 34)
- 07FFF - dollar flow requirement per incremental specified BFU (positive only) in the MFU chargeable to cost category 03FFF after the first step in processing (see page 34)

The next step determines additional materiel and personnel allowances generated by that portion of the total force which has not been stipulated as part of the force structure statement, i.e., the unspecified units; and determines the requirements or flows of materiel and personnel to individual major force units (including the allocations of unspecified units' allowances).

This phase of the program marks the first time calculations result in requirements statements, e.g., deliveries of equipment items and personnel to the MFUs. All prior calculations have resulted in statements of allowances only.

Where requirements are noted the coding system goes through a slight alteration. Data codes (DEFFF) for materiel and personnel requirements retain the same numerical values, but they are prefixed to denote (1) that the data represents a requirement and (2) the nature of the requirement. The prefix structure is shown in Table 5.

Table 5
Code Prefixes

For Data Codes 3EFFF and 4EFFF	
Code Prefix	Item
0 or No Prefix	Inventory or allowance
1	Requirement, delivery basis, physical quantity
3	Requirement, delivery basis, \$ investment
7	Requirement, delivery basis, \$ operating
11	Requirement, TOA basis, physical quantity
13	Requirement, TOA basis, \$ investment
17	Requirement, TOA basis, \$ operating

CALCULATIONS OF UNSPECIFIED UNITS' ALLOWANCES AND MFU INTERNAL REQUIREMENTS

The determination of the unspecified units' allowances of personnel and materiel charged to specified MFUs and of total MFU requirements is accomplished in a single operation. All data from input forms III B, III D, and III E (materiel data, personnel data, and unspecified unit personnel allowance schedules) are read into memory at one time, and calculations, MFU by MFU, are made on all data sets in one pass. For purposes of clarity the operations involved in determining personnel requirements, materiel requirements, and related materiel requirements will be treated separately.*

Personnel Requirements

As indicated above, all personnel data and unspecified unit personnel allowance ratios (forms III D and III E for all personnel types) are read into memory. The numbers of military personnel of various classifications specified in the one MFU record are summed for each year to determine total military personnel. Total military personnel is internally assigned the code number 40000. The unspecified unit ratios for each classification of personnel in each year are multiplied by the total military personnel thus determined for each year. Upon completion, the MFU record will contain new data lines of military personnel allowances which may have the same code as those personnel originally specified. To eliminate these duplicate entries the consolidation routine is performed. When this is completed the MFU record will show that number of personnel for which requirements will

*The computer program, in fact, reads in all data from input forms III B, III D, and III E and makes the remaining calculations of the MFU expansion phase and all the calculations of the next phase

be computed. A new value for total military personnel (code 40000) is calculated which replaces the previous total. The new yearly values of military personnel, by type and total personnel, are written on the MFU tape.

The requirements of each MFU for deliveries or assignments of personnel are now computed for each personnel type in each year. For each personnel type, requirements are generated from two sources: (1) the change in the number of personnel assigned to the major force unit from one year to the next (incremental personnel); and (2) the normal attrition due to personnel leaving active service (turnover personnel).

Incremental personnel required is the difference between the year-end requirements in two adjacent years. Turnover personnel is based on the application of a turnover rate to average personnel. Total requirements are then equal to their sum:

$$T_n^* = \frac{(Y_n + Y_{n-1})(R)}{2} + (Y_n - Y_{n-1})$$

where T_n^* = Total personnel requirement of MFU in year n for a particular personnel type (code 1-4EFFF of MFU tape)

Y = Year-end personnel allowance of MFU (code 4EFFF of MFU tape)

R = Turnover rate (code 00012 of input form III D)

Personnel required is computed immediately after unspecified unit personnel allocations are made to each MFU.

Materiel Requirements

As indicated above, all materiel data (form III B for all materiel items) are read into memory. The calculating routine which gives the total materiel requirement (deliveries required) is here broken down into

a number of smaller steps to make the operation easier to follow.

The first step is to calculate a factor (pure number) which expresses the specified allowances plus the allowances for combat consumption and maintenance float.

$$1 + (C)(D)(A) + F$$

where C = Combat consumption rate (code 00037 of input form III B)

D = Days of combat stock (code 00027 of input form IV A or IV B)*

A = Combat consumption stocks level adjustment factor (code 00041 of input form IV A or IV B)

F = Maintenance float factor (code 00038 of input form III B)

The next step is the calculation of a factor which takes into account the allowances of those units which are not specified in the force structure statement.

$$1 + U$$

where U = Unspecified units' equipment allowance factor (code 00023 of input form III B)

The third step is the multiplication of the results of the two prior operations.

$$(1 + U) \left[1 + (C)(D)(A) + F \right]$$

When this value is multiplied by the major force unit's year-end operational inventory (Y) (code 3EFFF of MFU record) the result (T) is the total allowance of equipment due to and chargeable to the particular MFU.

$$T = (Y)(1 + U) \left[1 + (C)(D)(A) + F \right]$$

This is calculated for each of the twelve program years.

The next series of steps calculates replacement/consumption chargeable to each MFU. The first step is to add the year-end operational

* The calculation of materiel requirements and related materiel requirements implies access to force-wide data (form IV series). The program calls for this information to be read in as the first operation of the program. Hence, it is always available for use.

allowances for each two adjacent years (including unspecified units' allowances).

$$E_n = (1 + U_n)(Y_n) \quad \text{and} \quad E_{n-1} = (1 + U_{n-1})(Y_{n-1})$$

where the subscripts n = this year

$n-1$ = previous year

Next an adjusted replacement/consumption rate is calculated.

$$R_n = (H)(B_n)$$

where H = Replacement/consumption rate (code 00039 of input form III B)

B = Replacement/consumption adjustment factor (code 00121 of input form I)

The total requirement of the MFU for the given item of equipment in each year (n) is given by the expression,

$$T_n^* = (T_n - T_{n-1}) + \frac{(R_n)(E_n + E_{n-1})}{2}$$

where T_n^* = Year's requirement of MFU for the given equipment item (code 1-3EFFF)

This calculation routine is repeated for each of the eleven years of the program for which adjacent years' values can be found (T_n , T_{n-1} , and E_n , E_{n-1}).

Related Materiel Requirements

Any related equipment item (code 33FFF) can be specified directly on input form I and II, but its complete allowance cannot be determined

until the total allowances of using weapons are known.* This cannot be known until the BFU and MFU equipment adjustment factors have been applied and until all phasing schedule operations have been completed and the unspecified units' allowances allocated to MFUs. For each materiel item, the various specified related materials are quantified, one by one, for each year on input form III B lines coded 33FF0 and 33FF1.

The requirement for related materiel is composed of changes in combat consumption stocks plus peacetime consumption, e.g., firing of ammunition for training. The calculation of changes in combat consumption stocks proceeds in the same manner as for materiel items. An allowance position is obtained for each year, and the change in allowances measures the resource requirement. The combat consumption stock level(s) is:

$$S = (Y) (1 + U)(C)(D)(A)$$

where Y = Year-end operational allowance of the given materiel item (code 3EFFF on MFU record where E#3)

U = Unspecified units equipment allowance factor for the materiel item (code 00023 of input form III B)

C = Combat consumption rate of the related materiel (code 33FF0 of input form III B)

D = Required days of supply of the related materiel (code 00028 of input form IV A or IB B)

A = Related materiel adjustment factor (code 00109 of input form I)

*The ability to specify related equipment on form I and II (and in phasing schedules, III A) gives the model an added degree of flexibility. Items other than ammunition may be found that fit the characteristics of related equipment and, in particular, there may be equipments which possess the characteristics of both related equipment and independent equipment. In this case it is essential that it be possible to specify the item on form I and II to determine its allowance as independent equipment.

The requirement for combat consumption stocks is:

$$S_n^* = S_n - S_{n-1}$$

Peacetime consumption is determined from the average operational allowance of the materiel item over two adjacent years: E_n and E_{n-1} (see above) and the product of a peacetime consumption rate and an adjustment factor for the related equipment item:

$$V_n^* = \frac{(E_n + E_{n-1}) (G_n)(B_n)}{2}$$

where V^* = Peacetime consumption requirement

G = Peacetime consumption rate of the related materiel item (code 33FF1 of input form III B)

B = Training consumption adjustment factor for the related materiel (code 00133 of input form I)

The total requirement for related materiel, calculated for eleven years, is:

$$T_n^* = S_n^* + V_n^*$$

where T_n^* = Year's requirement of MFU for one related materiel item computed on one materiel item only (code 1-33FFF)

For a given materiel item the requirement for each item of specified related materiel is found as above. The program then proceeds to the next materiel item specified in the MFU record and repeats the processes of (1) calculating the materiel requirement (required deliveries) and (2) calculating the requirements for all specified related materiel items.

When this is done the MFU record is consolidated to eliminate duplicate related materiel item entries, i.e., duplicate codes. In this process all related materiel items (all 33FFF codes) directly specified on input form I or II are consolidated with the derived requirements. The new MFU record is written on tape and the next MFU called for.

EXPANDED MAJOR FORCE UNIT RECORD

The expanded major force unit specification record will contain allowance and requirements data which fall into three classes:

	<u>Input dollar flow requirements</u> *
02FFF	Input dollar flow requirement for materiel annex equipment type FFF
03FFF	Input dollar flow requirement chargeable to cost element 03FFF
04FFF	Input dollar flow requirement per average military person chargeable to cost element 03FFF
05FFF	Input dollar flow requirement per incremental military person chargeable to cost element 03FFF
06FFF	Input dollar flow requirement related to average BFUs chargeable to cost element 03FFF
07FFF	Input dollar flow requirement related to incremental BFUs chargeable to cost element 03FFF

	<u>Allowance levels of materiel items and personnel</u>
31FFF	Allowance of materiel annex equipment item FFF
32FFF	Allowance of non-materiel annex equipment item FFF
33FFF	Allowance of materiel annex related equipment item FFF
40000	Allowance of total military personnel
41FFF	Allowance of military officer type FFF
42FFF	Allowance of military enlisted type FFF
43FFF	Allowance of civilian type FFF

	<u>Quantity requirement levels (internal to the MFU) of materiel items and personnel</u>
1-31FFF	Quantity requirement of materiel annex equipment item FFF
1-31FFF	Quantity requirement of non-materiel annex equipment item FFF
1-33FFF	Quantity requirement of materiel annex related equipment item FFF
1-41FFF	Quantity requirement of military officer type FFF
1-42FFF	Quantity requirement of military enlisted type FFF
1-43FFF	Quantity requirement of civilian type FFF

* Input dollar flow requirements coded 06FFF and 07FFF are input items allowable on form II only. In the elimination of BFU references these data are operated on such that the data values will refer to dollars for the major force unit (see page 34).

The first class consists of cost coefficients which enter into cost estimating relationships. The second and third classes consist of quantities which enter into cost estimating relationships.

APPLICATION TO COST ESTIMATING RELATIONSHIPS

The operations described to this point involve the specification of each Major Force Unit in a form sufficiently rigorous to allow the consistent application of cost estimating relationships.

Some cost estimating relationships can now be applied on the basis of the data already developed. These are described in the next chapter.

In the case of inheritable assets, such as equipment items or trained personnel, an additional operation is required before cost estimating relationships can be applied. This operation consists of developing allocation factors to provide a basis for assigning net force costs to individual Major Force Units. This process and the application of cost estimating relationships are described in the chapter following the next.

VI. MAJOR FORCE UNIT DOLLAR FLOW REQUIREMENTS
DETERMINED DIRECTLY

Major Force Unit dollar flow requirements not involving force-wide computed allocation factors are determined by applying cost estimating relationships relating costs to allowance levels. The operations involved may be grouped according to the basis of requirement: (1) dollar value per military man, with no regard to the specification of type of military person (code 40000 for total military personnel and codes 04FFF and 05FFF for dollars per man as the cost coefficient (average and incremental); (2) dollar value per average military by type of military person (code 4EFFF); and (3) dollar value per basic force unit (codes 06FFF and 07FFF for average and incremental)*

CODE STRUCTURE OF FINAL COMPUTED COSTS

For codes with an initial digit of zero and a non-zero second digit, the last three digits specify (with one exception) the cost element in the final output report to which the data item will be charged.** This identification will remain unchanged as operations proceed and 04FFF, 05FFF, 06FFF, and 07FFF codes are changed to 03FFF codes, signifying a final output value. In the course of model operations, eventually all data items which contribute to costs in the final cost reports will be assigned a code of 03FFF.***

* Input dollar flow requirements coded 06FFF and 07FFF are input items allowable on form II only. In the elimination of BFU references these data are operated on such that the data values will refer to dollars for the major force unit. See page 33.

** For the one exception see the meaning of items coded 02FFF, below.

*** The set of all final cost codes is given in appendix C.

THRUPUT DATA ITEMS

Data items initially coded 03FFF are essentially not operated on in the model but are merely carried through the model to the final MFU output. This is strictly true of items entered on the MFU input sheet. For items entered as BFU data the data values are multiplied by the number of BFUs in the MFU for each year's set of data. The execution of the consolidation routine assures that only one line of data coded 03FFF (for each unique value of FFF) is contained in a MFU record at the conclusion of the major force unit expansion program.

Data coded 02FFF is handled in an identical manner during the expansion program. Since the numeral (2) signifies that the data is an input dollar flow requirement for equipment to be included in the materiel annex report, identification will be required at subsequent stages of processing, until all materiel annex operations have been completed. The configuration of FFF identifies the materiel for which the expenditure is made and also the ordering of the item in the materiel annex report. It should be noted that for all equipment items and equipment levels of expenditure which are to appear in the materiel annex reports (codes 31FFF and 02FFF) the value of the final three digits must be unique for each equipment item or expenditure level.

COST BASED ON TOTAL MILITARY PERSONNEL

Calculations based upon dollar value per military man, without regard to specification of type of person, involve codes 04FFF and 05FFF. If cost per average military man is called for (code 04FFF) total military personnel (code 40000) is averaged for each pair of adjacent years. The averages

obtained are then multiplied by the corresponding dollars per average man value of the data for each year (the data values of each line coded 04FFF). If cost per incremental military man is called for (code 05FFF) the difference in total military personnel is found for each pair of adjacent years. If personnel allowed the MFU is greater in the second year of a pair, the positive difference is multiplied by corresponding dollars per incremental man value of the data for that year. If the difference is negative, it is treated as though it were zero and no cost results. As each operation is performed the codes are changed to 03FFF.

One other cost item is computed on the basis of average total military personnel, the cost of Budget Program 2000, Operating Forces, of Operations and Maintenance. The procedure is the same as for 04FFF data except the dollar per man value is force-wide data. As MFU cost is calculated for this item it is coded 03656 and carried in the MFU record.

COSTS BASED ON MILITARY PERSONNEL BY TYPE

Three categories of cost are computed on the basis of average military personnel where the cost per man may differ between different personnel types: (1) military pay and allowances; (2) replacement and deficiency construction; and (3) per man unspecified item procurement from the PEMA budget (see input form III D). In each case average personnel of each specified type is calculated and multiplied by the related cost coefficients. After these operations have been completed for each personnel type, the values are summed over all types and the proper output codes (03FFF) assigned.

COSTS BASED ON BASIC FORCE UNIT COMPOSITION

For items coded 06FFF and 07FFF, the partial solutions obtained early in the major force unit expansion program modify the calculations required at this stage. For each 06FFF and/or 07FFF code the data input into this operation are in terms of the MFU's requirement.* For each cost per average (06FFF), the values in each two adjacent years are averaged and the resulting value charged to the latter of the two years with the code changed to 03FFF. For each cost per increment (07FFF), the values in each two adjacent years are subtracted (the earlier year from the later). If this difference is positive it is charged to the later year with code charged to 03FFF. If the difference is negative it is not charged, i.e., it is treated as zero.

At the conclusion of all operations thus far the machine, upon command, will print a report of all individual MFU records and the summations of MFU records into mission/area totals, major program totals, and total of all major programs.

* It will be remembered that the partial solution involved multiplying each entry of 06FFF and 07FFF from each input form II by the quantity of the particular BFU in the MFU for each year. This quantity is a year-end value. The consolidation routine executed shortly after sums all identical 06FFF and 07FFF entries into a major force unit total.

VII. MAJOR FORCE UNIT DOLLAR FLOW REQUIREMENTS INVOLVING
FORCE-WIDE ALLOCATION FACTORS

Major Force Unit requirements can be determined only by reference to the total force in the case of items characterized by inheritability or transferability between units of the force, both within and between mission/areas. Tangible physical entities are involved - movable equipment, properties, trained personnel. Such items are denoted with IDs and codes of 3XXXX and 4XXXX.

The process of determining Major Force Unit requirements for inheritable assets involves the force-wide netting of all MFU positive requirements and surpluses and the allocation of total force net requirements back to the individual MFUs. This process divides logically into three steps. The first consists of the determination of Army-wide requirements using the major ADP program "requirements sums." The second step is the determination of the allocation ratios by which Army-wide requirements are charged back to individual MFUs; this is accomplished through the major ADP program "materiel annex". The third step is the allocation of Army-wide requirements to individual MFUs; this is accomplished through the major ADP program "cost allocation".

DETERMINATION OF ARMY-WIDE REQUIREMENTS

The internal MFU requirements for each item of equipment and each personnel type are added in two ways. Each MFU record is, one at a time, read into the machine. Beginning with the first MFU, for each requirement of an item of equipment or personnel read (codes 1-3EFFF and 1-4EFFF), two entries are made in machine memory for each program year. The first

entry records the magnitude of the requirement, either positive or negative. The second records the magnitude of the requirement if, and only if, it is positive. In this process the mission/area identity of the requirement is maintained.

When all the requirements of the first MFU have been read, the machine moves to the next MFU. If the second MFU is located in the same mission/area as the first, when a requirement is recorded (positive or negative) for an item that was also required by the first MFU the magnitude of the new requirement is added algebraically to the requirement of the first MFU. If the requirement is positive it is also added to the positive requirement of the first MFU. In this way the machine builds a listing of the requirements of each equipment item and personnel type in each mission/area for each program year. This listing may be visualized as table 6.

Table 6
Mission/Area Sums

Equipment or Personnel Item	Mission/ Area	Yearly Values for 11 Years
#1	Europe	Algebraic sum of MFU requirements
#1	Europe	Sum of positive MFU requirements
#1	Pacific	Algebraic sum of MFU requirements
#1	Pacific	Sum of positive MFU requirements
⋮	⋮	
⋮	⋮	
⋮	⋮	
#2	Europe	Algebraic sum of MFU requirements
#2	Europe	Sum of positive MFU requirements
#2	Pacific	Algebraic sum of MFU requirements
#2	Pacific	Sum of positive MFU requirements
⋮	⋮	
⋮	⋮	
⋮	⋮	

When all MFUs have been read in and the table completed, it contains an ordered pair of lines of entries for each asset item by each mission/area and for each year. The first line of each pair shows the number of items required (positive or negative) by all MFUs in the mission/area as a whole, i.e., net mission/area requirements. The second line shows the number of items required to be delivered to all the MFUs in the mission/area which have positive requirements. This is the first level of aggregation of requirements.

The second level of aggregation of requirements is analogous to the first except that mission/area net requirements are added to form world-wide totals which may be visualized as table 7. The first line of each pair shows the number of items required (positive or negative) throughout the total force. The second line shows the number of items to be delivered to all mission/areas which have positive requirements. These figures will subsequently be used in the formation of allocation ratios.

Table 7
World-Wide Sums

Equipment or Personnel Item	Yearly Values for 11 years
#1	Algebraic sum of mission/area requirements
#1	Sum of positive mission/area requirements
#2	Algebraic sum of mission/area requirements
#2	Sum of positive mission/area requirements
#3	Algebraic sum of mission/area requirements
#3	Sum of positive mission/area requirements
⋮	⋮
⋮	⋮
⋮	⋮

In addition to materiel and personnel requirements, the routines of "requirements sums" pick up all data entries coded 02FFF. These data items are originally input in terms of dollar flows required; these requirements do not share the characteristics of transferability. The only purpose for including them in requirements sums is to have them available at this time for inclusion in the Army-wide materiel annex report. Since all data coded 02FFF is positive, the algebraic sum will always equal the sum of positives. Thus only one line of data (instead of two as in the case of inheritable assets) is required for each item.

DETERMINATION OF ALLOCATION RATIOS*

The calculations of "requirements sums" yield the following values for each specified materiel item, related materiel item, and personnel type in each mission/area for each year:

W_1 = Algebraic sum of requirements of all mission/areas (table 7)

W_2 = Sum of requirements of all mission/areas with positive requirements (table 7)

M_1 = Algebraic sum of requirements of all MFUs in a given mission/area (table 6)

M_2 = Sum of requirements of all MFUs in the given mission/area with positive requirements (table 6)

These values are written on tape at the conclusion of the program. This tape is read into memory at the beginning of "materiel annex". Similarly the cost per unit (C) for each specified materiel item or personnel training is available (code 00011 from input form III C and code 00013 from input form III D).

* An explanation of the derivation of the allocation ratios is given in Appendix E.

During the execution of "materiel annex" the following value is determined for each materiel item and personnel type in each mission/area for each year.

$$A = (C) \left(\frac{\overline{W_1}}{W_2} \right) \left(\frac{\overline{M_1}}{M_2} \right) *$$

A single value of A (expressed in dollars) is established for all MFUs within a given mission/area, to serve as the mission/area allocation rate to major force units. **

During the execution of "materiel annex" all values for A are written on tape.

FORCE-WIDE MATERIEL ANNEX REPORT

The execution of "materiel annex" also calculates and writes on tape all data contained in the force-wide materiel annex report. For each specified materiel item denoted for inclusion (codes 1-31FFF and 1-33FFF), force-wide quantity requirements on a delivery basis are obtained from the output tape of "requirements sums". *** Force-wide yearly delivery-cost requirements are obtained as the product of (1) the algebraic sum of requirements of all mission/areas (table 7) and (2) the yearly average unit cost (code 00011 from input form III C); provided that (1) above is positive - otherwise it is treated as zero.

*Overlined variables symbolize that only positive values are considered, i.e., negative values are treated as equal to zero.

**In more exact terms, for each equipment item or personnel type and within each mission/area and in each year there exists a single value for A which is applicable to all major force units. It will be noted that a necessary condition for A to be other than zero is that both $\overline{W_1}$ and $\overline{M_1}$ are greater than zero. Also, since C, W_2 , and M_2 are always greater than zero, the term A may never be negative.

***The program is selective in rejecting materiel items coded 1-32FFF from these operations.

In the current model all specified items are costed in this fashion. Were more complex cost estimating relationships to be employed, all input cost data would still be specified on input form III C. Thus all data requirements would be met regardless of the complexity of the estimating equation.

Delivery-basis quantity and dollar requirements are then lagged to produce quantity and dollar requirements on a TOA basis.* The lines of data containing delivery-basis quantities and dollars are preserved. Materiel item dollar and quantity requirements on both a TOA and a delivery basis will be shown in the force materiel annex.

For input dollar flow requirements data coded 02FFF the output tape of "requirements sums" is passed unchanged to the materiel annex report.

When the lagging routines have been executed, all data required for the force-wide materiel annex have been calculated and assembled for writing on tape and for later printing. A sample materiel annex is displayed as Figure 7.

ALLOCATION OF ARMY-WIDE REQUIREMENTS

At the beginning of the major program "cost allocation" the tape containing the mission/area allocation rates is read into machine memory.

*For the computational procedures of lagging see Appendix F.

Figure 7
SAMPLE MATERIEL ANNEX REPORT

MATERIEL ANNEX ITEM	ARMY COST MODEL - SAMPLE OUTPUT										PAGE	46
	1963	1964	1965	1966	FISCAL YEAR		1969	1970	1971	1972		
					1967	1968						
REDEYE MISSILE	TOA (MIL. \$)	1.6	10.8	18.1	7.9	.0	.0	.0	.0	.0		
	QTY (UNITS)	251	2,428	5,886	3,072	0	0	0	0	0		
	DEL (MIL. \$)	.0	.7	9.9	19.1	8.9	.0	.0	.0	.0		
REDEYE - OTHER	QTY (UNITS)	0	55	2,014	6,160	3,413	0	0	0	0		
	TOA (MIL. \$)	.2	1.0	.6	.0	.0	.0	.0	.0	.0		
	QTY (UNITS)	2.3	7.1	11.3	11.3	9.9	.5	.5	.5	.5		
GUN MACHINE CAL .50 M85	TOA (MIL. \$)	969	2,962	4,690	4,700	4,103	206	206	206	206		
	QTY (UNITS)	1.9	1.8	6.7	11.3	11.3	11.0	.5	.5	.5		
	DEL (MIL. \$)	801	768	2,770	4,687	4,718	4,536	206	206	206		
RIFLE 7.62MM	TOA (MIL. \$)	10.9	9.4	9.0	6.6	1.7	.9	.9	.9	.9		
	QTY (UNITS)	96,964	83,915	80,741	58,720	15,388	8,403	8,399	8,399	8,399		
	DEL (MIL. \$)	10.6	10.9	9.1	9.0	6.2	.9	.9	.9	.9		
TRUCK UTILITY 1/4 TON M151	QTY (UNITS)	94,820	97,343	81,545	80,599	54,859	8,423	8,399	8,399	8,399		
	TOA (MIL. \$)	17.6	13.4	16.3	14.7	13.7	13.9	8.3	8.3	8.3		
	QTY (UNITS)	5,313	4,051	4,942	4,441	4,141	4,202	2,500	2,500	2,500		
CTG 7.62MM NATO ALL TYPES EXCEPT BLANKS	DEL (MIL. \$)	1,729	5,382	4,003	4,967	4,457	4,134	14.2	8.3	8.3		
	QTY (UNITS)	8.6	10.6	12.2	12.9	12.6	12.6	12.6	12.6	12.6		
	TOA (MIL. \$)	95,552	117,346	135,245	142,873	140,312	139,970	139,806	139,730	139,730		
CHG PKOP M51E1 FOR 155MM PROJ	DEL (MIL. \$)	6.6	9.1	10.9	12.5	13.0	12.5	12.6	12.6	12.6		
	QTY (UNITS)	73,406	101,089	121,410	138,703	143,915	139,411	140,109	139,730	139,730		
	TOA (MIL. \$)	1.7	2.5	2.5	.7	.0	.0	.0	.0	.0		
	QTY (UNITS)	43,127	61,610	61,610	18,483	0	0	0	0	0		
	DEL (MIL. \$)	.0	2.5	2.5	2.5	.0	.0	.0	.0	.0		
	QTY (UNITS)	0	61,610	61,610	61,610	0	0	0	0	0		

This tape may be visualized in tabular form as table 8.

Table 8
Mission/Area Allocation Rates

Equipment or Personnel Item	Mission/ Area	Yearly Value for 11 Years
#1	Europe	Mission/Area alloc. rate to MFU
#1	Pacific	Mission/Area alloc. rate to MFU
#1	Alaska	Mission/Area alloc. rate to MFU
⋮	⋮	
#2	Europe	Mission/Area alloc. rate to MFU
#2	Pacific	Mission/Area alloc. rate to MFU
⋮	⋮	

The MFU records are then read into the machine, one by one. The MFU record currently being processed is scanned for data signifying quantitative materiel and personnel requirements.

For each positive materiel requirement entry (code 1-3EFFF) found in the MFU record, the calculation below is performed to determine the cost allocation to the MFU.

$$Z = (\overline{U_x}) (A)$$

where U_x = Internal requirement of major force unit x for the particular item

A = Mission/area allocation rate to major force unit

If the materiel requirement (U_x) is negative, the MFU cost for the item is considered as zero. The MFU cost, when calculated, is coded with a prefix of 3, i.e., 3-3EFFF, signifying delivery-basis dollars for initial investment.

For each personnel allowance entry (code 4EFFF) found, incremental personnel is calculated for each two adjacent years. Incremental personnel, if positive, is multiplied by the mission/area allocation rate (as above $Z = (\overline{U_x})(A)$; where A = incremental personnel). The result of the multiplication is the MFU's initial training cost for the particular personnel type, i.e., cost associated with the training of the incremental personnel. This item is then assigned the code 03270 which is the code for a final output value.

For each personnel requirement entry (code 1-4EFFF) found which is positive, the calculation ($Z = \overline{U_x} \cdot A$; where A = personnel requirement) is performed. The dollar requirement so found is total training cost (both initial and annual). Initial training cost is subtracted from total training to obtain annual training cost, i.e., cost associated with training new personnel to replace turnover personnel. When found, annual training cost is coded 03680.

Since each MFU record may contain more than one personnel type there may be more than one entry coded 03270 and more than one entry coded 03680 after the cost allocation operations are completed. The consolidation routine is applied at a later point to yield the initial and annual training costs chargeable for all personnel types.

VIII. MAJOR FORCE UNIT FINAL OUTPUT REPORTS AND AGGREGATIONS

With one exception, all MFU cost requirements have been determined by the time the allocation of force-wide determined costs has been completed.

The records now available are a mixture of costs on different time bases. Materiel item requirements for which allowances are specified on MFU and BFU input data forms are on a delivery basis, while items for which dollar requirements are specified on the input forms are in terms of TOA.* Conversion of requirements to a common time base is a necessary condition for meaningful requirements statements.

The MFU records are not in a form which is easily readable and suitable for analysis. They carry no English descriptions of cost elements, as the model operates wholly on the basis of the coding system for identification. Also the records contain no totals at this point.

The remainder of the program is concerned with converting delivery basis costs to a TOA basis and in rearranging the data into final cost reports and materiel annexes, including the provision of titles in English. These operations are accomplished in the "output calculations" program.

EXECUTION OF LAGGING AND SUMMATION OF MFU RECORDS

Lagging schedules (input form IV C), world-wide data (input form IV A), and materiel cost data (input form III C), will previously have been read

*In particular, requirements coded 02FFF, 03FFF, 04FFF, 05FFF, 06FFF, and 07FFF.

in and will be available. MFU records, one by one, are read in, and data items are tested and operated on as indicated below.

If a data line is coded 02FFF a new data line is written which duplicates the value of the old line and is coded 03230, the code number for PEMA (investment) in the final cost report. The original data line is preserved for inclusion in the MFU materiel annex.

Where data lines are coded 03FFF no further operations are performed (it will be noted that by this stage all data which had originally been coded 04FFF, 05FFF, 06FFF, or 07FFF will have been converted to 03FFF codes).

Data items coded 3-3EFFF (materiel dollars on a delivery basis) will be lagged as indicated in appendix E. For each line which is lagged, a new line of data will appear, coded 13-3EFFF, which will contain as data, materiel dollars on a TOA basis. Each line of data coded 13-3EFFF is multiplied year by year by unity plus the corresponding year's "unspecified PEMA items cost coefficient" (input form IV A code 00065); and the line thus derived is coded for final output (03230).

Training costs, which were determined Army-wide and allocated to individual MFUs, have been carried in the MFU records as total initial and total annual, with a cost entry for each type of personnel required by the MFU. Each year's value for each data line coded 3-4EFFF and 7-4EFFF is multiplied by the four "training cost appropriation allocation rates" (input form IV A, codes 00013, 00014, 00015, and 00016); and each resulting line is coded with the proper 03FFF code. New data lines coded for output are written for total training cost (03270 initial and 03680 for annual).

FINAL OUTPUT FORMAT

At the completion of the above operations all cost elements will have been coded for final output, i.e., all cost values which will appear in the final cost report have been coded 03FFF.* However, these operations will have resulted in there being many data lines bearing the same code number. Each MFU is therefore consolidated to eliminate duplicate codes, and totals at various levels of aggregation are computed (total operation and maintenance - 03650, total operations - 03600, and total - 03000).

At this point there is set into the proper format for printing other information to be displayed on the MFU output report:** (1) personnel allowances, both military and civilian; and (2) non-operative data.

In each record have been preserved the personnel allowances (including the allocations of personnel of unspecified units) determined in the MFU expansion phase. A routine is now performed which totals officer personnel of all types, enlisted personnel of all types, total military personnel, and total civilian personnel in each year, for printing as part of the MFU output report.

Non-operative data is information which is included in the output reports to be printed in exactly the same form in which originally input on form I and IV A plus data not first written on input forms, such as the machine run date and number identification.

*The set of all final cost codes is displayed by appendix C.

**Before this point in the program is reached routines have been performed which set up formats and English titles for the output reports.

Input form I contains three items which are directly printed as output - the Major Force Unit title, the three lines of comments, and the three lines allowed for force structure. These are purely memorandum type entries for the use of the analyst in identifying the MFU and in noting particular items of interest or usefulness about the unit. Comments associated with Basic Force Units (form II) are printed only on the input listings. A sample final cost report is displayed as figure 8.

MAJOR FORCE UNIT MATERIEL ANNEXES

MFU materiel annexes are written at the same place in the program where the MFU records are summed and placed in the format of the final output report. The format is the same as for the Army-wide annex (page 57).

Among other items the MFU record (before lagging and summation) contains data lines describing the MFU's allocated initial delivery-dollar requirements for each item of specified materiel (codes 3-3EFFF and codes 02FFF). The yearly average unit costs of all specified materiel items will be available in memory. For each item of equipment, delivery dollar requirements are divided by per-unit cost in each year, resulting in delivery quantities of newly produced materiel (for materiel items coded 31FFF and 33FFF only).

Both delivery dollar requirements and delivery quantities are then lagged to produce TOA dollar requirements and quantities (codes 13-3EFFF and 11-3EFFF).^{*} Input dollar flow requirements data coded 02FFF is

^{*} Note that the data lines for specified materiel items on a delivery basis (1-3EFFF and 3-3EFFF) have been preserved. Materiel item quantities and dollars on both a delivery and a TOA basis will be used for writing the materiel annexes of the individual MFUs.

Figure 8
SAMPLE MAJOR FORCE UNIT COST REPORT

ARMY COST MODEL - SAMPLE OUTPUT													
HYPOTHETICAL BATTALIONS													
FORCE STRUCTURE-NUMBER OF UNITS, Y.E.													
TOTAL Y.E. BNS													
FISCAL YEAR													
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included in the MFU materiel annex. As it is an input in terms of TOA it requires no lagging and is passed unchanged to the materiel annex report.

AGGREGATIONS OF OUTPUT COST REPORTS

Total force costs are completely allocated by MFU; hence MFU records in their final form can be aggregated at different levels as indicated below with no loss of data.

- Major force unit
- Program element
- Mission/area
- Major program
- Selected combination of major programs
- Total all major programs

Each unit at a given level is wholly contained within a particular unit at the next higher level.

A random aggregation may be required consisting of all Major Force Units with given or pre-selected characteristics, i.e., all infantry battle groups world-wide, or all MFUs with a particular item of equipment in their allowances.

Each of these aggregations is obtained by summing on major force unit cost report records, i.e., the MFU output tapes. Major program totals and total all major programs are produced by the major ADP program "output totals". All other aggregations are produced by the major ADP program "aggregation".

I

MAJOR FORCE UNIT NUMBER

											CODE		FORMAT				
											7	8	9	10	11	12	
TITLE											0	0	0	0	1	F	
SEC. DEF. NO.											0	0	0	1	1	E	

FORCE STRUCTURE	7	8	9	10	11	12
	0	0	0	1	3	J
	0	0	0	2	9	J
	0	0	0	4	5	J

COMMENTS	7	8	9	10	11	12
	0	0	1	5	7	F
	0	0	1	6	7	F
	0	0	1	7	7	F

[illegible]

ADJUSTMENT FACTORS	OFFICER	0	0	0	6	1	1
	ENLISTED	0	0	0	7	3	1
	CIVILIAN	0	0	0	8	5	1
	EQUIPMENT	0	0	0	9	7	1
	RELATED EQUIPMENT	0	0	1	0	9	1
	REPLACEMENT / CONSUMPTION	0	0	1	2	1	1
	TRAINING CONSUMPTION	0	0	1	3	3	1
		0	0	1	4	5	1



6

I

PAGE 1 OF 1

FISCAL YEAR: N= _____[illegible][illegible]

O	O	0	6	1
O	O	0	7	3
O	O	0	8	5
O	O	0	9	7
O	O	1	0	9
O	O	1	2	1
O	O	1	3	3
O	O	1	4	5
O	O	1	8	7

1	2	3	4	5
2				

ALL CARDS

MISSION / AREA

A  ALL
CARDS

CODE					FORMAT
7	8	9	10	11	
0	0	0	0	1	

TITLE

COMMENTS

7	8	9	10	11	12
0	0	1	5	7	F
0	0	1	6	7	F
0	0	1	7	7	F

[illegible][illegible][illegible][illegible][illegible][illegible][illegible]

ADJUSTMENT FACTORS	OFFICER
	ENLISTED
	CIVILIAN
	EQUIPMENT

0	0	0	6	1	1
0	0	0	7	3	1
0	0	0	8	5	1
0	0	0	9	7	1
0	0	1	0	9	1
0	0	1	2	1	1

ASIC FORCE UNIT DATA

II

MISSION / AREA ☐
ALL
CARDS

RUN NUMBER

--	--	--	--	--	--

 ALL CARDS

PAGE 1 OF _____

FISCAL YEAR: N° _____

FISCAL YEAR																					
N	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10											
22	23	27	28	32	33	37	38	42	43	47	48	52	53	57	58	62	63	67	68	72	73

2

III A

GENERIC TYPE NUM

MISSION/AREA	CODI			
	7	8	9	0
A	0	0	0	0

GENERIC NAME

MISSION / AREA NAME	MODEL NAME
WORLD WIDE	

MISSION/AREA	7	8	9	0
	3			
	3			
	3			

MISSION/AREA	7	8	9	0
	3			
	3			
	3			

MISSION/AREA	7	8	9	0
	3			
	3			
	3			

MISSION/AREA	7	8	9	0
	3			
	3			
	3			

MISSION/AREA	7	8	9	0
	3			
	3			
	3			

MISSION/AREA	7	8	9	0
	3			
	3			
	3			

MISSION/AREA	7	8	9	0
	3			
	3			
	3			

MISSION/AREA	7	8	9	0
	3			
	3			
	3			



69

III A

PAG

AG 2

[illegible]

III B

MATERIEL DATA

MATERIEL NUMBER

1	2	3	4	5
3				

ALL CARDSMISSION / AREA

6
AL
CAR

CODE												FORMAT													
MATERIEL NAME												F													
YEARLY DATA	UNSPECIFIED UNITS EQUIPMENT ALLOWANCE FACTOR											5	N - 1				N				N + 1				I
	REPLACEMENT / CONSUMPTION RATE (/ YEAR)											5													
NO-YEAR DATA	COMBAT CONSUMPTION RATE (/ MONTH)											V	N - 1				N				N + 1				I
	MAINTENANCE FLOAT COEFFICIENT											S													
AMMUNITION DATA																									
AMMUNITION NAME		DATA										6	N - 1				N				N + 1				I
		COMBAT CONSUMPTION RATE (/ DAY)										6													
		TRAINING CONSUMPTION RATE (/ YEAR)										2													
		COMBAT CONSUMPTION RATE (/ DAY)										6													
		TRAINING CONSUMPTION RATE (/ YEAR)										2													
		COMBAT CONSUMPTION RATE (/ DAY)										6													
		TRAINING CONSUMPTION RATE (/ YEAR)										2													
		COMBAT CONSUMPTION RATE (/ DAY)										6													
		TRAINING CONSUMPTION RATE (/ YEAR)										2													
OTHER RELATED EQUIPMENT DATA																									
												3													
												3													
												3													
												3													
												3													
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												3													
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												3													

Appendix A, contd.
INPUT FORMS

MATERIEL DATA

III B

MISSION / AREA ☐ ALL CARDS

RUN NUMBER ☐ 75 ☐ 76 ☐ 77 ☐ 78 ☐ 79 ☐ 80
ALL CARDS

PAGE 1 OF _____

FISCAL YEAR: N = _____

FISCAL YEAR										
N	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10
22	23	27	28	32	33	37	38	42	43	47
48	52	53	57	58	62	63	67	68	72	

FISCAL YEAR										
N	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10
22	23	27	28	32	33	37	38	42	43	47
48	52	53	57	58	62	63	67	68	72	

2

III C

MATERIEL NUMBER

CODE

MATERIEL NAME

7	8	9	10	11
0	0	0	0	1

YEARLY AVERAGE UNIT COST

YEARLY DATA

7	8	9	10	11
0	0	0	1	1

DELIVERIES TO T.O. A. INDEX

DELIVERIES TO EXPENDITURES INDEX

NO-YEAR DATA

7	8	9	10	11
0	0	0	3	5
0	0	0	3	6



III C

PAGE 1 OF _____

FISCAL YEAR: N = _____

CODE					FORMAT	
7	8	9	10	11	12	
0	0	0	0	1	F	

[illegible]

												FISCAL YEAR																		
7 8 9 10 11							N-1 13 17		N 22		N+1 27		N+2 32		N+3 37		N+4 42		N+5 47		N+6 52		N+7 57		N+8 62		N+9 67		N+10 72	
0	0	0	1	1																										

[illegible]

MILITARY PERSONNEL TYPE, NUMBER

1	2	3	4	5
4				

ALL CARDS

						MISSION/AREA	CODE	FORMAT					
						6	7	8	9	10	11	12	13
MILITARY PERSONNEL TYPE, NAME						A	0	0	0	0	1	F	

[illegible][illegible]

YEARLY DATA											N - 1										N										N + 1									
NO-YEAR DATA	PAY & ALLOWANCES \$/P _m																																							
	TURNOVER RATE																																							
	REPL./DEF. CONSTRUCTION \$/P _m																																							
	UNSPECIFIED PEMA ITEMS \$/P _m																																							



MILITARY PERSONNEL DATA

III D

RUN NUMBER

75	76	77	78	79	80

ALL CARDS

PAGE 1 OF _____

FISCAL YEAR: N=_____

[illegible][illegible][illegible][illegible]

17

[illegible]



III E

UNSPECII

TOTAL MILITARY PERSONNEL

1 2 3 4
4 0 0 0
ALL CAR

MISSION/ AREA NAME	PERSONNEL TYPE NAME	MISSION/AREA	CODE				FORMAT	N -
			7	8	9	10		
		4					5	
		4						
		4						
		4						
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		4						
		4						
		4					5	

1

11/15/62

73

III E



FISCAL YEAR: N= _____

[illegible]

MISSION / AREA A⁶
ALL
CARDS

[illegible][illegible]

WORLD WIDE DATA

PAGE ____ OF ____

1 5
1
IDS

MISSION / AREA A
ALL
CARDS

RUN NUMBER

75	76	77	78	79	80

ALL CARDS

FISCAL YEAR: N= _____

FISCAL YEAR																						
-1	N	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10											
17	18	22	23	27	28	32	33	37	38	42	43	47	48	52	53	57	58	62	63	67	68	7

[illegible][illegible]

IV B

NUMBER 0
AL

MISSION / AREA NAME _____	
YEARLY DATA	EQUIP. COMBAT CONSUMP. STOCK LEVEL ADJUST. FACTOR
	RELATED EQUIPMENT STOCK LEVEL ADJUST. FACTOR

MISSION/AREA	CODE											FORMAT
	7	8	9	10	11	12	13	14	15	16	17	
1	0	0	0	4	1	1	1	1	1	1	1	1
2	0	0	0	5	3	1	1	1	1	1	1	1
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

NO-YEAR DATA	SECOND DESTINATION TRANSP. COST COEFFICIENT
	DAYS OF COMBAT STOCKS, EQUIPMENT
	DAYS OF COMBAT SUPPLY, RELATED EQUIPMENT
	OPERATING FORCES, BP-2000 \$/P _m

MISSION/AREA	CODE											FORMAT
	7	8	9	10	11	12	13	14	15	16	17	
1	0	0	0	2	6	S						
2	0	0	0	2	7	U						
3	0	0	0	2	8	U						
4	0	0	0	2	9	T						
5												
6												
7												
8												
9												
10												
11												
12												

MISSION / AREA NAME _____	
YEARLY DATA	EQUIP. COMBAT CONSUMP. STOCK LEVEL ADJUST. FACTOR
	RELATED EQUIPMENT STOCK LEVEL ADJUST. FACTOR

MISSION/AREA	CODE											FORMAT
	7	8	9	10	11	12	13	14	15	16	17	
1	0	0	0	4	1	1	1	1	1	1	1	1
2	0	0	0	5	3	1	1	1	1	1	1	1
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

NO-YEAR DATA	SECOND DESTINATION TRANSP. COST COEFFICIENT
	DAYS OF COMBAT STOCKS, EQUIPMENT
	DAYS OF COMBAT SUPPLY, RELATED EQUIPMENT
	OPERATING FORCES, BP-2000 \$/P _m

MISSION/AREA	CODE											FORMAT
	7	8	9	10	11	12	13	14	15	16	17	
1	0	0	0	2	6	S						
2	0	0	0	2	7	L						
3	0	0	0	2	8	U						
4	0	0	0	2	9	T						
5												
6												
7												
8												
9												
10												
11												
12												

1

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PAGE ____ OF ____

75 76 77 78 79 80
RUN NUMBER

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ALL CARDS

CODE	FORMAT
------	--------

[illegible][illegible]

7	8	9	10	11	12		N - 1		N		N + 1		N + 2		N + 3		N + 4		N + 5		N + 6		N + 7		N + 8		N + 9		N + 10
0	0	0	4	1	1																								
0	0	0	5	3	1																								

[illegible]

2

IVC

DELIVERIES TO T.O.A.

NUMBER

0	0	0	0	1
---	---	---	---	---

ALL CARDS

MISSION /ARE/

INDEX CODE	7	8	9	10	11	12	% OF DELIVERIES IN YEAR											
							N-5				N-5				N-4			
00720	7						13				17				18			22
00727																		
00734																		
00741																		
00748																		
00755																		
00762																		
00769																		
00776																		
00783																		
00790																		
00797																		
00804																		
00811																		
00818																		
00825																		
00832																		
00839																		
00846																		
00853																		
00860																		
00867																		
00874																		
00881																		
00888																		
00895																		
00902																		
00909																		
00916																		
00923																		
00930																		
00937																		
00944																		
00951																		
00958																		
00965																		
00972																		
00979																		
00986																		
00993																		



Appendix A, contd. INPUT FORMS

DELIVERIES TO T.O.A. SCHEDULES

IVC

NUMBER

0	0	0	0	1
---	---	---	---	---

ALL CARDS

MISSION/AREA

A

ALL CARDS

RUN NUMBER

--	--	--	--	--	--

ALL CARDS

INDEX CODE	FORMAT	% OF DELIVERIES IN YEAR N CONTRIBUTING TO T.O.A. IN YEAR						
		N-6	N-5	N-4	N-3	N-2	N-1	N
720	7							
727								
734								
741								
748								
755								
762								
769								
776								
783								
790								
797								
804								
811								
818								
825								
832								
839								
846								
853								
860								
867								
874								
881								
888								
895								
902								
909								
916								
923								
930								
937								
944								
951								
958								
965								
972								
979								
986								
993	7							



77

ΣΑ

PAGE ____ OF ____

[illegible]

COMMENTS ON CHANGES

[illegible]

Appendix A, contd.

INPUT FORMS

УВ

PROGRAM DELETE DATA

УВ

RUN NUMBER CHANGE
FROM _____ TO _____

73
DELETE 
ALL
CARDS

NEW RUN NUMBER

75	76	77	78	79	80

ALL CARDS

EFFECTIVE DATE _____

PAGE ____ OF ____

[illegible]

COMMENTS ON DELETIONS

[illegible]

Appendix B

FIXED AND VARIABLE LENGTH DATA

All data items are entered as either "fixed length data" or "variable length data". An understanding of the distinction between the two is necessary to understand the nature and operation of the model.

The characteristic of fixed length data is that for each and every identification number (MFU, BFU, materiel item, etc.) the number of machine words and meaning of each word of fixed length data is pre-determined and written into the stored program. In each case the meaning and length of fixed length data for each code number is determined by the first two digits of the identification number. It is only for this kind of data that code numbers can be known in advance of the actual entering of data on the input sheets. All fixed length data code numbers are pre-printed on the input sheets. The code numbers signify the amount of machine storage capacity required to carry the data. Thus, the amount of storage capacity to be used by and record for fixed length data is known in advance.

The majority of input data entries are variable length, and no pre-determination of the amount of machine storage required for any or all records is possible. For example, the total amount of storage required to record all the allowance and requirement data for an MFU is equal to the amount of fixed length data (by referring to input form I, 198 words) plus that needed to account for all the personnel, materiel, and other data items occasioned by the direct allowances of the MFU and its

BFU composition. The length of such an MFU record will not be known and cannot be set in advance but must be determined within the program itself. The amount of variable length data contained in any record is subject to change during the execution of a program.

A program designed to operate on variable length data is necessarily more complex than a program required to handle fixed length data only. However, program flexibility and efficiency in the use of storage space gained is great. Were this program to use only fixed length data an exact allocation of storage space would be required in advance for every step on the program and for every MFU, BFU, generic materiel item, personnel item, etc. Exact allocations would have to be written into the stored program which would result in either of two things. One, the stored programs would have to be tightly tailored to the requirements of a single force structure and thus not be capable of handling other force structures without reprogramming. Or, two the programs would have to allocate sufficient storage capacity for each MFU record, BFU record, etc., and allow space for a sufficient number of records to insure compatibility with any force structure which might be operated on. The length of similar type records (MFU records, BFU records, etc.) varies greatly within and between force structures. The length of one record varies greatly between different phases of program execution. Were only fixed length data available a large proportion of the machine's storage capacity would be allocated but unused resulting in an inefficient program which is expensive to operate.

Space for entering variable length data records is found at those lines where codes (columns 7 through 11) are not pre-printed on input

forms I, II, III A, and III F. In addition, the ammunition and other related equipment data sections of form III B are entered with variable length data.

Appendix C

TABLE OF COST ELEMENTS AND CODES

	CODES
Total -----	03000
Research & Development, Total -----	03100
RDT&E (BA 2040) -----	03110
Mil. Const., Research Facil. (BA 2050) -----	03150
Investment, Total -----	03200
Construction -----	03210
Mil. Const., Army (BA 2050) -----	03214
Mil. Const., ANG (BA 2085) -----	03216
Mil. Const., Army Reserve (BA 2086) -----	03218
PEMA (BA 2030) -----	03230
Training, Total Initial -----	03270
Mil. Const., Army (BA 2050) -----	03272
PEMA (BA 2030) -----	03274
Mil. Pers. (BA 2010) -----	03276
O&M (BP 2100) -----	03278
Operations, Total -----	03600
PEMA (BA 2030) -----	03610
Promotion of Rifle Practice (BA 1705) -----	03620
Military Personnel -----	03630
Military Pers., Army (BA 2010) -----	03632
Military Pers., Army Reserve (BA 2070) -----	03634
Military Pers., ANG (BA 2060) -----	03636
Operations & Maintenance -----	03650
O&M, Family Housing (BP 1900) -----	03652
O&M, ANG (BA 2065) -----	03654
O&M, Operating Forces (BP 2000) -----	03656
O&M, Central Supply (BP 2200) -----	03658
O&M, Major Overhaul & Maint. (BP 2300) -----	03660
O&M, Medical Activities (BP 2400) -----	03662
O&M, Army Wide Activities (BP 2500) -----	03664
O&M, Army Reserve & ROTC (BP 2600) -----	03668
O&M, Joint Projects (BP 2700) -----	03670
O&M, Intelligence Activities (BP 2800) -----	03672
O&M, Comm. & Pictorial Serv. (BP 2900) -----	03674
Training, Total Annual -----	03680
Mil. Const., Army (BA 2050) -----	03682
PEMA (BA 2030) -----	03684
Military Pers. (BA 2010) -----	03686
O&M (BP 2100) -----	03688

Appendix D
CODING SYSTEM STRUCTURE

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ID

A B C C C - IDENTIFICATION NUMBER FOR DATA

AS FOLLOWS:

1 B C C C		MAJOR FORCE UNIT DATA (DUPLICATE NUMBERS WITH DIFFERENT MISSION/AREAS NOT ALLOWED) B = PROGRAM (OSD PROGRAM, 2 - 7)
2 B C C C		BASIC FORCE UNIT DATA
3 B C C C	30CCC 31CCC 32CCC 33CCC	MATERIEL DATA, WHERE: PHASING SCHEDULE DATA SPECIFIC EQUIPMENT ITEM DATA - MATERIEL ANNEX ITEM SPECIFIC EQUIPMENT ITEM DATA - OTHER THAN MATERIEL ANNEX ITEM SPECIFIC RELATED EQUIPMENT ITEM DATA - MATERIEL ANNEX ITEM
4 B C C C	40000 40CCC 41CCC 42CCC 43CCC	PERSONNEL DATA, WHERE: UNSPECIFIED UNIT PERSONNEL ALLOCATION RATIOS NOT ALLOWED OFFICER DATA ENLISTED DATA CIVILIAN DATA
0 B C C C	00000 00001	DICTIONARY DATA RUN AND FORCE CONSTANT DATA ALL OTHERS - NOT ALLOWED

Appendix D, Contd.
CODING SYSTEM STRUCTURE

FOR ID

1 B C C C - MAJOR FORCE UNIT DATA

DATA CODES

D E F F F

AS FOLLOWS:

1 E F F F - - - - - NOT ALLOWED - - - - -

2 E F F F	SPECIFIES NUMBERS OF BASIC FORCE UNITS, TYPES 2EFFF, YEAR-END
-----------	---

3 E F F F	SPECIFIES NUMBERS OF NON-BASIC FORCE UNIT MATERIEL ITEMS, TYPES 3EFFF, YEAR-END
-----------	---

4 E F F F	SPECIFIES NUMBERS OF NON-BASIC FORCE UNIT PERSONNEL, TYPES 3EFFF, YEAR-END
-----------	--

0 E F F F	00FFF SPECIFIES FIXED LENGTH DATA AS FOLLOWS:
	00001 MAJOR FORCE UNIT TITLE
	00011 SEC. DEF. NUMBER
	00013 } MFU FORCE STRUCTURE, YEAR-END (3 LINES)
	00029 }
	00045 }
	00061 ADJUSTMENT FACTOR - OFFICER
	00073 ADJUSTMENT FACTOR - ENLISTED
	00085 ADJUSTMENT FACTOR - CIVILIAN
	00097 ADJUSTMENT FACTOR - EQUIPMENT
	00109 ADJUSTMENT FACTOR - RELATED EQUIPMENT
	00121 ADJUSTMENT FACTOR - REPLACEMENT CONSUMPTION OF EQUIPMENT
	00133 ADJUSTMENT FACTOR - TRAINING CONSUMPTION OF RELATED EQUIP.
	00145 } ADJUSTMENT FACTORS - { UNSPECIFIED AND RESERVED
	00187 } FOR FUTURE USE
	00157 }
	00167 } COMMENTS (3 LINES)
	00177 }
	0EFFF SPECIFIES VARIABLE LENGTH DATA AS FOLLOWS:
	02FFF SPECIFIES THRUPUT/OUTPUT DATA: PEMA, MATERIEL ANNEX
	03FFF SPECIFIES THRUPUT/OUTPUT DATA: OTHER
	04FFF SPECIFIES DOLLARS PER AVERAGE MILITARY MAN
	05FFF SPECIFIES DOLLARS PER INCREMENTAL MILITARY MAN
	06FFF NOT ALLOWED
	07FFF

Appendix D, Contd.
CODING SYSTEM STRUCTURE

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FOR ID

2 B C C C - BASIC FORCE UNIT DATA

DATA CODES

D E F F F

AS FOLLOWS:

1 E F F F - - - - - NOT ALLOWED - - - - -

2 E F F F - - - - - NOT ALLOWED - - - - -

3 E F F F	SPECIFIES NUMBERS OF MATERIEL ITEMS, TYPES 3EFFF, PER BASIC FORCE UNIT
-----------	--

4 E F F F	SPECIFIES NUMBERS OF PERSONNEL, TYPES 4EFFF, PER BASIC FORCE UNIT
-----------	---

0 E F F F	00FFF SPECIFIES FIXED LENGTH DATA AS FOLLOWS: 00001 BASIC FORCE UNIT TITLE 00061 ADJUSTMENT FACTOR - OFFICER 00073 ADJUSTMENT FACTOR - ENLISTED 00085 ADJUSTMENT FACTOR - CIVILIAN 00097 ADJUSTMENT FACTOR - EQUIPMENT 00109 } ADJUSTMENT FACTORS - { UNSPECIFIED AND RESERVED 00121 } { FOR FUTURE USE 00157 } COMMENTS (3 LINES) 00167 } 00177 } 0EFFF SPECIFIES VARIABLE LENGTH DATA AS FOLLOWS: 02FFF SPECIFIES THRUPUT/OUTPUT DATA: PEMA, MATERIEL ANNEX 03FFF SPECIFIES THRUPUT/OUTPUT DATA: OTHER 04FFF } NOT ALLOWED 05FFF } 06FFF SPECIFIES DOLLARS PER AVERAGE BFU * 07FFF SPECIFIES DOLLARS PER INCREMENTAL BFU * * RESTRICTED TO DATA WHICH IS CONSTANT PER UNIT OVER TIME
-----------	--

3 B C C C B = 0 - MATERIEL PHASING SCHEDULES

D	E	F	F	F
---	---	---	---	---

1	E	F	F	F	- - - - - NOT ALLOWED - - - - -
---	---	---	---	---	---------------------------------

2	E	F	F	F	- - - - - NOT ALLOWED - - - - -
---	---	---	---	---	---------------------------------

3	E	F	F	F	30FFF	NOT ALLOWED
					31FFF	SPECIFIES RATIO OF SPECIFIC EQUIPMENT ITEM, TYPE 31FFF, TO GENERIC ITEM, TYPE 30FFF
					32FFF	SPECIFIES RATIO OF SPECIFIC EQUIPMENT ITEM, TYPE 32FFF, TO GENERIC ITEM, TYPE 30FFF
					33FFF	SPECIFIES RATIO OF SPECIFIC RELATED EQUIPMENT ITEM, TYPE 33FFF, TO GENERIC ITEM, TYPE 30FFF

4	E	F	F	F	- - - - - NOT ALLOWED - - - - -
---	---	---	---	---	---------------------------------

O	E	F	F	F	00001	GENERIC ITEM NAME ALL OTHERS - NOT ALLOWED
---	---	---	---	---	-------	---

Appendix D, Contd.
CODING SYSTEM STRUCTURE

FOR ID

3 B C C C B#0- MATERIEL DATA

DATA CODES

D E F F F

AS FOLLOWS:

1 E F F F - - - - - NOT ALLOWED - - - - -

2 E F F F - - - - - NOT ALLOWED - - - - -

3 E F F F	30FFF	NOT ALLOWED
	33FF0	SPECIFIES COMBAT CONSUMPTION RATE OF RELATED EQUIPMENT, TYPE 33FF0, PER ITEM OF EQUIPMENT, TYPES 31FFF OR 32FFF
	33FF1	SPECIFIES TRAINING CONSUMPTION RATE OF RELATED EQUIPMENT, TYPE 33FF0, PER ITEM OF EQUIPMENT, TYPES 31FFF OR 32FFF
		ALL OTHERS - NOT ALLOWED

4 E F F F - - - - - NOT ALLOWED - - - - -

0 E F F F	00FFF	SPECIFIES MATERIEL CONSTANTS AND FACTORS AS FOLLOWS:
	00001	MATERIEL NAME
	00011	YEARLY AVERAGE UNIT COST
	00023	UNSPECIFIED UNITS EQUIPMENT ALLOWANCE FACTOR
	00035	DELIVERIES TO TOA INDEX
	00036	DELIVERIES TO EXPENDITURES INDEX
	00037	COMBAT CONSUMPTION RATE
	00038	MAINTENANCE FLOAT COEFFICIENT
	00039	REPLACEMENT CONSUMPTION RATE

Appendix D, Contd.
CODING SYSTEM STRUCTURE

FOR ID

4 B C C C

B=0: ID=40000 ONLY: UNSPECIFIED UNIT PERSONNEL

DATA CODES

D E F F F

AS FOLLOWS:

1 E F F F - - - - - NOT ALLOWED - - - - -

2 E F F F - - - - - NOT ALLOWED - - - - -

3 E F F F - - - - - NOT ALLOWED - - - - -

4 E F F F	40FFF	NOT ALLOWED
	41FFF	SPECIFIES RATIO OF OFFICER PERSONNEL, TYPE 41FFF, TO TOTAL MILITARY PERSONNEL
	42FFF	SPECIFIES RATIO OF ENLISTED PERSONNEL, TYPE 42FFF, TO TOTAL MILITARY PERSONNEL
	43FFF	SPECIFIES RATIO OF CIVILIAN PERSONNEL, TYPE 43FFF, TO TOTAL MILITARY PERSONNEL

0 E F F F - - - - - NOT ALLOWED - - - - -

Appendix D, Contd.
CODING SYSTEM STRUCTURE

FOR ID

4	B	C	C	C
---	---	---	---	---

 - B ≠ 0 PERSONNEL DATA

DATA CODES

D	E	F	F	F
---	---	---	---	---

AS FOLLOWS:

1	E	F	F	F	- - - - - NOT ALLOWED - - - - -
---	---	---	---	---	---------------------------------

2	E	F	F	F	- - - - - NOT ALLOWED - - - - -
---	---	---	---	---	---------------------------------

3	E	F	F	F	- - - - - NOT ALLOWED - - - - -
---	---	---	---	---	---------------------------------

4	E	F	F	F	- - - - - NOT ALLOWED - - - - -
---	---	---	---	---	---------------------------------

0	E	F	F	F	00FFF	SPECIFIES PERSONNEL CONSTANTS AND FACTORS AS FOLLOWS:
					00001	PERSONNEL TYPE NAME
					00011	PAY & ALLOWANCES - DOLLARS PER MILITARY MAN
					00012	TURNOVER RATE
					00013	NEW PERSONNEL TRAINING COST - DOLLARS PER MILITARY MAN
					00014	REPLACEMENT DEFICIENCY CONSTRUCTION - DOLLARS PER MILITARY MAN
					00015	UNSPECIFIED PEMA ITEMS COST - DOLLARS PER MILITARY MAN
						(ALL CONSTANTS AND FACTORS BY TYPE OF MILITARY MAN)

Appendix D, Contd.
CODING SYSTEM STRUCTURE

FOR ID

08CCCC

OBCCC = 00000 - DICTIONARY DATA

DATA CODES

DEFFF

AS FOLLOWS:

1EFFF

MAJOR FORCE UNIT DICTIONARY DATA ITEMS

2EFFF

BASIC FORCE UNIT DICTIONARY DATA ITEMS

3EFFF

MATERIEL DICTIONARY DATA ITEMS

4EFFF

PERSONNEL DICTIONARY DATA ITEMS

0EFFF

FORCE AND RUN CONSTANT DICTIONARY DATA ITEMS

Appendix D, Contd.
CODING SYSTEM STRUCTURE

FOR ID

0 B C C C OBCCC = 00001 - FORCE & RUN CONSTANT DATA

DATA CODES

D E F F F

AS FOLLOWS:

1 E F F F - - - - - NOT ALLOWED - - - - -

2 E F F F - - - - - NOT ALLOWED - - - - -

3 E F F F - - - - - NOT ALLOWED - - - - -

4 E F F F - - - - - NOT ALLOWED - - - - -

0 E F F F	COEFF	FORCE AND RUN CONSTANT DATA AS FOLLOWS:
	00001	RUN NAME
	00011	NOT ALLOWED - RESERVED FOR INTERNAL USE
	00012	TRANSFER TRANSPORTATION COST COEFFICIENT
	00013	TRAINING COST APPROPRIATION ALLOCATION RATE - PEMA
	00014	TRAINING COST APPROPRIATION ALLOCATION RATE - MCA
	00015	TRAINING COST APPROPRIATION ALLOCATION RATE - O&MA
	00016	TRAINING COST APPROPRIATION ALLOCATION RATE - MPA
	00026	SECOND DESTINATION TRANSPORTATION COST COEFFICIENT
	00027	DAYS OF COMBAT STOCKS - EQUIPMENT
	00028	DAYS OF COMBAT SUPPLY - RELATED EQUIPMENT
	00029	OPERATING FORCES - BP-2000
	00041	EQUIPMENT COMBAT CONSUMPTION STOCK LEVEL ADJUSTMENT FACTOR
	00053	RELATED EQUIPMENT STOCK LEVEL ADJUSTMENT FACTOR
	00065	UNSPECIFIED PEMA ITEMS COST COEFFICIENT

APPENDIX E

DERIVATION OF MAJOR FORCE UNIT ALLOCATION RATIOS

One part of the major program "materiel annex" and the major program "cost allocation" provide for the allocation of (1) total force costs for all specified equipment items, and (2) all training costs back to the individual major force units. Logically, cost allocation is an integrated process; it is split between two major ADP programs only to fit the characteristics of the machine.

The derivation below applies both to equipment and personnel training costs. For each item Army-wide costs are first allocated to the several mission/areas. The basis for allocation to each mission/area is the mission/area's positive requirement in relation to the Army-wide requirement. Within each mission/area, mission/area-wide costs are then allocated to each major force unit on the basis of the MFU's positive requirement in relation to the mission/area-wide requirement.

The net effect of this set of allocation rules may be expressed by the product:

$$\left(\frac{\overline{W_1}}{W_2} \right) \left(\frac{\overline{M_1}}{M_2} \right) \quad *$$

* Overlined variables symbolize that only positive values are considered, i.e., negative values are treated as equal to zero.

where W_1 = Algebraic sum of requirements of all mission/areas

W_2 = Sum of requirements of all mission/areas with positive requirements

M_1 = Algebraic sum of requirements of all MFUs in a given mission/area

M_2 = Sum of requirements of all MFUs in the given mission/area with positive requirements.

When this derived number is multiplied by a major force unit's positive requirement, the resulting answer expresses the number of units of the equipment item which must be newly produced to meet the MFU's requirement.* This may be expressed as:

$$\left(\frac{\overline{W_1}}{W_2}\right)\left(\frac{\overline{M_1}}{M_2}\right)(\overline{U_x})$$

where U_x = Internal requirement of major force unit x.

If the expression above is multiplied by the cost per item of equipment (or training) the resulting answer is the dollar requirement chargeable to the major force unit:

$$\left(\frac{\overline{W_1}}{W_2}\right)\left(\frac{\overline{M_1}}{M_2}\right)(\overline{U_x})(C)$$

where C = Cost per unit of the specified item.

An example follows on the formation of the two ratios and their application to an MFU's internal requirement for a specific item.

*Or number of new personnel which must be trained.

The following items of information are required:

W_1 = Algebraic sum of requirements of all mission/areas

W_2 = Sum of requirements of all mission/areas with positive requirements

M_1 = Algebraic sum of requirements of all MFUs in a given mission/area

M_2 = Sum of requirements of all MFUs in a given mission/area with positive requirements

U_x = Internal requirement of major force unit x

C = Per unit cost of the specified item (equipment or personnel training)

For mission/area #1 the first computation gives:

$$\left(\frac{W_1}{W_2}\right)\left(\frac{M_1}{M_2}\right) = \left(\frac{20}{30}\right)\left(\frac{30}{40}\right) = 0.5$$

This factor is multiplied by the internal requirements of each MFU with requirement greater than zero. For all MFUs with internal requirements less than zero the requirement is treated as equal to zero.

	Mission/Area #1	Mission/Area #2	Army Wide	Operation
Internal Major Force Unit Require- ments (U_x)	10 -10 20 10	-10 -10 20 -10		
M_1	30	-10		$\sum U_x$
M_2	40	20		$\sum \overline{U_x}$
W_1			20	$\sum M_1$
W_2			30	$\sum \overline{M_1}$

For mission/area #2 the computation gives:

$$\left(\frac{W_1}{W_2}\right)\left(\frac{M_1}{M_2}\right) = \left(\frac{20}{30}\right)\left(\frac{-10}{20}\right) = -0.33$$

However since the net requirement of the whole mission/area is less than zero, all positive MFU requirements may be met by the surpluses of other MFUs in the mission/area. In this case the requirements of all MFUs are treated as zero. After the adjustment of requirements due to transfers of existing quantities the net requirements of all MFUs are as follows:

	Mission/Area #1	Mission/Area #2
Adjusted } Major Force Unit Require- ment }	5	0
	0	0
	10	0
	5	0

The adjusted requirements may then be multiplied by the per-unit cost (C) of the item to obtain the total dollar flow chargeable to each MFU. Assume per-unit cost equal to \$50.

	Mission/Area #1	Mission/Area #2
Costs } Charge- able to Major Force Units }	\$250	\$ 0
	0	0
	500	0
	250	0

APPENDIX F

PROCEDURE FOR LAGGING OF REQUIREMENTS

The dollar cost output of the model is expressed in terms of total obligational authority (TOA) whereas the force structure is stated in terms of actual force units in being, i.e., the dollar flows of the output show the times that provision of obligational authority is required to obtain the forces in being at the times reflected in the force structure statement. Materiel annex reports require the conversion to a TOA basis of the many force item requirements for which there is a time-gap between obligation and delivery (this operation is in this text called lagging).

The requirements for specified materiel items have been calculated on the basis of the time of delivery to the force. The cost of the materiel which is allocated back to the individual units is similarly timed with the delivery. This class of requirements is one in which authorization lead times commonly occur and, as a result, provision must be made to shift the dollar flows ahead in time.

Lead-time requirements vary from materiel item to item. Each item is assigned a particular set of lag coefficients by a code number entered on input form III C, (code 00035) referring to a particular line in the look-up table given as input form IV C. This table provides a variety of common patterns of lagging from which the one pertinent to a particular item can be selected.

The data fields on input form IV C give the percent of cost of deliveries required to be authorized in years prior to the delivery year (N). This is not meant to convey the idea that for each piece of equipment delivered, authorizations will be spread across prior years in the given exact pattern. Rather, for types of equipment whose deliveries spread across a period of years and where the total delivery is sufficiently large, the continuing flow of deliveries will require the continuing prior flow of authorizations which result from applying the pattern of lag coefficients to the delivery stream. These conditions are normally met in the purchase patterns of the military services.

The application of lag factors is conceptually quite simple. The delivery dollars requirement in year N is multiplied by the coefficients given for the years N to N-6. If the authorization requirement falls wholly within one prior year (i.e., 100% in N-1), for instance, the delivery dollar requirements are simply shifted back, in total, the stipulated one year. However, if the authorization is spread over more than one year the arithmetic becomes tedious, involving summation of derived authorization requirements for several delivery years. Assume a simple lag pattern as follows:

Lag Coefficients

	YEAR		
	N-2	N-1	N
Coefficients	.25	.50	.25

and assume delivery requirements as follows:

Delivery Schedule

	YEAR					
	1962	1963	1964	1965	1966	1967
Delivery Dollars or Quantities	-	-	500	600	700	500

the authorization pattern is determined as follows:

Authorization Requirements

	YEAR					
	1962	1963	1964	1965	1966	1967
Delivery Dollars or Quantities			500	600	700	500
Authorization	125 ← 250 ← 125		↓	↓	↓	↓
Dollars		150 ← 300 ← 150		↓	↓	↓
			175 ← 350 ← 175		↓	↓
				125 ← 250 ← 125		↓
TOTAL	125	400	600	625	425	125

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Delivery basis dollar requirements on the MFU records are coded 3-3EFFF (all equipment procurement is considered as investment). After lagging, a new code entry (13-3EFFF) is made with a prefix which denotes TOA-basis requirements. Delivery-basis quantity requirements are coded 1-3EFFF; after lagging TOA quantities will be coded 11-3EFFF.