RAND RESEARCH MEMORANDUM

ELECTRONIC DATA PROCESSING CONTROL OF AIR FORCE SPARE PARTS INVENTORIES

Compiled by
S. L. Pollack

RM-2013 November 14, 1957

in brief

STAT

This Research Memorandum describes the functional steps that are required to control Air Force inventories of spare parts. It explains the exercise of these functions in the context of an electronic data processing system such as the Air Force is now seeking to develop.

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In any complex management system, much of a manager's time tends to be occupied with digesting and interpreting a large volume of information; this is certainly true for the present Air Force inventory system. The state-of-the-art of electronic data processing equipment (EDPE) has now advanced to a point where much of the work can be done automatically according to rules specified by management. This enables management to devote its full attention to special reports and to those exceptions that cannot be handled by electronic gear.

All inventory control of spare parts involves five functions:

1. Input Data Control--data processing actions for detecting and correcting errors in format and fact, and for routing data to further processing.

2. Substitution and Allocation--the data processing actions required to execute the distribution policies for spare parts that have substitute and interchange relationships.

3. Transaction Posting and Management Review--the data processing actions required to maintain records reflecting the current inventory position.

4. Due-In--the maintaining of records reflecting the status of materiel on order from activities outside the particular system.

5. Shipment Control--the monitoring of records reflecting the status of materiel being transported to or from activities within the system.

These functions relate to the control of spare parts inventories, a subsystem of logistics management. Other logistics management functions, e.g., requirements calculations and master repair scheduling, are not directly part of the data-processing system for inventory control. They furnish inputs for the inventory control system, and in turn use its outputs.

The functions discussed in this Research Memorandum form a necessary part of any system of Air Force inventory control, regardless of whether EDPE is employed in the system. The potential improvements resulting from the use of EDPE are, nevertheless, very large. The nature of these improvements is in the increased accuracy, timeliness, and completeness of results, and in the increased opportunity to consider all pertinent information for each decision. The greatly increased ability to exploit fully the substitute relationships which exist in the inventory is one of the major potential improvements. Long recognized by the Air Force, this problem could not be met satisfactorily by non-EDP techniques. As described, the use of EDPE will enable the inventory control manager to exploit these relationships efficiently.

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U. S. AIR FORCE
PROJECT RAND

RESEARCH MEMORANDUM

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Assigned to ______________________

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SUMMARY

This Research Memorandum describes the functional steps that are required to control Air Force inventories of spare parts. It explains the exercise of these functions in the context of an electronic data processing system, such as the Air Force seeks to develop. The study illustrates ways and means of applying electronic data processing equipment (EDPE) to Air Force inventory control.

In any complex management system, much of a manager's time tends to be occupied with digesting and interpreting a large volume of information; this is certainly true for the present Air Force inventory system. The state-of-the-art of EDPE has now advanced to a point where much of the work can be done automatically according to rules specified by management. This enables management to devote its full attention to special reports and to those exceptions that cannot be handled by the EDPE.

All inventory control of spare parts involves the following five functions:

1. Input Data Control -- the data processing actions for detecting and correcting errors in format and fact, and for routing data to further processing.

2. Substitution and Allocation -- the data processing actions required to execute the distribution policies for spare parts that have substitute and interchange relationships.

3. Transaction Posting and Management Review -- the data processing actions required to maintain records reflecting the current inventory position.

4. Due-In -- the maintaining of records reflecting the status of materiel on order from activities outside the particular system.

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These functions form a necessary part of any system of Air Force inventory control, regardless of whether EDPE is employed in the system. The potential improvements resulting from the use of EDPE are, nevertheless, very large. The nature of these improvements is in the increased accuracy, timeliness, and completeness of results, and in the increased opportunity to consider all pertinent information for each decision. The greatly increased ability to exploit fully the substitute relationships which exist in the inventory is one of the major potential improvements. Long recognized by the Air Force, this problem could not be met satisfactorily by non-EDP techniques. As described in this paper, the use of EDPE will enable the inventory control manager to exploit these relationships efficiently.

A RAND study of B-47 airframe parts, primarily Category I, has shown that groupings of parts based on interchangeability, rather than the individual part number, should be the basic unit in demand analysis and forecasting.[1] In accordance with this conclusion and stated Air Force policy, proper development of the Substitution and Allocation (S&A) function is necessary. Management of the spare parts inventory will be significantly more efficient when it is based on the relationships developed for the S&A function.

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[1] T. A. Goldman, Relationships between Program Elements and System Demand for Airframe Spare Parts, The RAND Corporation, Research Memorandum RM-1858, 22 January 1957.

Many other new management policies that have been proposed to and by the Air Force could not be implemented because of lack of adequate data processing facilities. With the ability to get timely and accurate data by means of EDP, these proposed policies, after a proper test, could be implemented by the Air Force.

Project ELECTRO LOGS, the objectives of which have been described in a previous Research Memorandum,[2] represents the EDPE application of many of these fundamental ideas to the B-52/KC-135 weapon system package on behalf of the Weapon System Manager at the Oklahoma City Air Materiel Area (OCAMA). This project provides many of the examples of the functions described in this paper.

EDPE, by virtue of its purpose of handling large masses of data, is the focal point for data from and to various sources. The term "data processing center" (DPC) is applied to the EDPE and the attendant organization that accomplish the data processing function for a multi-point inventory system. A DPC may exist at a base where the EDPE processes data from such sources as Maintenance, Supply, and Operations; or it may exist in a weapon system complex where the EDPE processes data from such sources as bases and storage sites. Whatever the level of the DPC, the changeover from decentralization of data processing to centralization implies a significant change in supply procedures for the organizations involved.

Whereas the examples for the various functions of an EDP system for Air Force inventory management pertain mostly to a weapon system comprising

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[2] M. A. Geisler, J. A. Postley, Research and Development of New Data-Processing System for Air Force Logistics, The RAND Corporation, Research Memorandum RM-1639-1, 13 June 1956.

storage sites and bases, it should be clear that the principles discussed in this paper apply to property class management and to higher and lower level management systems as well. For example, for those bases which have an inventory management problem of sufficient complexity and volume to require EDPE, this paper can serve as a guide for developing a suitable EDP system.

The speed and accuracy of the input-output for EDP should be consistent with the scope of its goal, inventory management, and the equipment that is used. EDP has a very definite need for high accuracy and rigid format control for the input-output data. To this end, an EDP system should have a data specialist with appropriate responsibility and authority stationed at data generation, file maintenance, and data communication organizations in the system. Also, it will probably be necessary in the future to require that the manufacturers of aircraft spare parts (at least the large ones) collect data for new parts specifically for EDP applications.

The characteristics of input data control by manual, electric accounting machine (EAM) and EDPE means are described. Evaluation of the characteristics leads to two conclusions: 1) in an EDP system, input data control by EDPE supplemented by manual checking of some errors is necessary in view of its superiority over manual or EAM input data control, and 2) supply management should assign the function of input control to the EDP manager. The need for input and output data controls, as well as extensive operational checkout of the EDP system, cannot be over-emphasized.

Contrary to the widely held belief that vast improvements in Air Force communications are needed to match the speed of EDPE, this paper concludes that the transceiver and private teletypewriter networks, which are under expansion, supplemented by telephone facilities and postal service, appear to be generally adequate for present-day EDP systems. Little can be said about the long range data processing communication needs since they depend on future EDP developments.

Since the procedures for executing the functions of an EDP system and the EDP equipment employed in the system are closely interdependent, careful consideration must be given to both at all stages of the system development. Procedures that are planned without due regard for EDPE characteristics may require EDPE that is expensive and/or inefficient with respect to the logistic objectives of the system. EDP equipment that is selected without proper consideration of the system functions is likely to hinder rather than help the performance of those functions.

This paper is intended for management people who have responsibility for the control of spare parts inventories. In addition, it should be profitable for appropriate specialists, such as statistical services, supply, and systems development personnel, to study those chapters of the paper dealing with their particular responsibilities.

FOREWORD

The development of an Electronic Data Processing System (EDPS) for the control of complex Air Force inventories requires a combination of skills in digital computer engineering, systems analysis, digital computer programming, economic and mathematical analysis, and Air Force logistics knowledge. The authors of the several studies which are reported on in this paper -- Arnold Anex, James Crupper, Anthony J. Dowkont, Leon Gainen, Raymond J. Mason, and Howard Trescott -- have sought to provide this combination. The studies were carried out in the Logistics Department of The RAND Corporation under the direct supervision of John A. Postley.

Two of the authors, Howard Trescott and James Crupper, were assigned to RAND from the Oklahoma City Air Materiel Area (OCAMA) to provide Air Force logistics knowledge. In addition, since the beginning of the study in the summer of 1955, close liaison was maintained between the study group and the staff of the Logistics Data Processing Development Office (LDPDO) at OCAMA. The contributions of the LDPDO staff to the study were significant. In turn, the principles set forth in this paper have guided the OCAMA LDPDO in its creation of an EDPS for the management of the B-52/KC-135 spare parts inventory.

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Chapter I

THE CONCEPT OF ELECTRONIC DATA PROCESSING

A. Introduction

Management of Air Force spare parts inventories has proven to be a complex of many jobs. The use of EDP equipment for this purpose can enable management to concentrate on the important job of dealing with non-routine situations.

This paper contains a discussion of the major functions which should be carried out in order to control Air Force inventories with EDP equipment and techniques, regardless of the management system (e.g., weapon system or commodity management) or the organizational level (e.g., base or depot) and almost without regard to the size of inventory or the volume of activity. The functions are discussed in a moderate amount of detail. Examples are presented in terms of large scale EDPE although most of the functions described can be performed with medium or small scale equipment typically found at smaller installations and need be done on large scale equipment only to the extent that complexity and volume require.

The following chapters deal with inventory control of spare parts comprising some subsystem (called simply the "system") of the total Air Force spare parts inventory complex. This system may comprise spare parts under the control of a property class manager, a commodity manager, a weapon system manager, or a base supply officer. The spare parts may be at a single location such as a depot, at a complex of locations such as a group of weapon system storage sites, or perhaps at Air Force bases stocking parts for the weapon system. Whenever a portion of the data processing operations occurs at a single point for stocks located at one or more geographical points, that portion of the operation is said to be "centralized," and the data processing point is referred to as the Data Processing Center (DPC).

While it is clear that certain data processing activities must be carried out at the stockage locations to supplement the DPC activities in a multi-point system, this paper discusses the functions in terms of the DPC.

It is well to stress that this paper does not present a system for EDP control of Air Force spare parts inventories. It is rather an attempt to describe the functions that must be considered in developing such a system. The examples given illustrate these functions and are not necessarily representative of a preferred system.

References pertaining to the design and implementation of an EDPS are given at the end of the paper.

B. Description of Inventory Control

Inventory control encompasses maintaining records of spare parts inventories and positioning those spares in such a way as best to meet the needs of potential users. Serviceable inventory is accumulated by buying from commercial contractors, transferring from other government inventories, or repairing reparables already in the inventory. The users may be flight line mechanics, spare parts repair facilities, or major aircraft overhaul lines.

The fundamental purpose of the data processing system is to carry out, as precisely as possible, the inventory policies established by management. To this end, a file of information is established reflecting facts pertinent to the character of the inventory, that is, catalog data such as stock number, unit price, and unit pack. Other basic information pertains to the quantity of each item in the inventory and is liable to change as a result of the day-to-day activity. Relevant transactions are processed against this information according to the inventory policy established by management. The use of EDPE for this purpose suggests that the information file be automatically accessible to the machine and that the processing be carried out by an electronic computer system. This process may be thought of as consisting of two parts: 1) inventory record-keeping and 2) inventory management based on these records. It is useful to consider the objectives of these two parts separately.

1. Inventory Record-Keeping

Inventory record-keeping involves the establishment of records reflecting the inventory position of the spare parts for which the "system" is responsible. In order to reflect the true inventory position, the records must be accurate and timely.

An important objective of introducing EDPE into the record-keeping operation is to displace manual and electric accounting machines (EAM) record-keeping which has proven to be inadequate for the volume of work encountered and the timeliness and accuracy required. Manual and EAM methods often fail completely to provide all the pertinent information about an item of inventory which is needed in the management process described below. The essence of EDP control of Air Force inventories is to avoid the failures of decision-making for lack of all facts pertinent to the decision.

2. Inventory Management

Management of inventories is that portion of inventory control relating to decision-making. In non-EDP systems this decision-making is typically carried out at all operating levels by people who deal with data of one kind or another. While certain important decisions are made by such top-level people as the director of supply, the weapons system manager, the property class manager, and their immediate staffs, certain other (sometimes equally) crucial decisions are made by clerks with limited experience and knowledge in Air Force logistics. There are two problems here: 1) decisions are often made without consideration of all of the pertinent data and 2) decisions, especially at the lower decision-making levels, often are not in exact accordance with the policies established to cover the situations.

C. Objectives of Introducing EDP

By introducing EDP techniques, dual objectives - decision-making based on all relevant data and decision-making in strict accordance with the rules - can be achieved. The latter is accomplished simply by "mechanizing" those decisions which can be made properly by mere reference to the data at hand - usually those decisions made at the lower decisinn-making levels. The computer always adheres to the rules by which it is programmed. There remain, however, those decisions which must be made by management, usually at the higher decision levels.

In the case of both the mechanized and the non-mechanized decisions, the EDPE plays a key role in making the proper data available at the decision point. The computer can be programmed in such a way that it refers automatically to the relevant data in its memory. At this point the computer itself either makes the decision ("solves the formula") or performs the functions of seeking, obtaining, and making available to the human decision-maker all of the accessible information he needs to make the decision.

It is highly desirable to assign as many of the so-called "routine" decisions as possible to the computer. The machine can be counted on to interpret the decision rule exactly as programmed whereas people cannot. Situations in which it is more desirable for people to make decisions are: those where the data or knowledge for the decision are not accessible to the computer, those which are so rare as not to warrant interpretation in computer language, and other exceptions which are identified as such by the computer. In the interest of efficient data processing practice it is essential that non-automatic decision-making be limited to a very small percentage of the transactions introduced into the system.

D. EDPE Highlights

A few remarks about EDPE seem in order. There are three fundamental parts to the hardware: 1) input/output, 2) storage (memory), and 3) computer (processor). The input section usually consists of several units, such as punched card and punched tape readers, which enter coded information pertaining to operating data and the specified mode of operation into the system. Upon extracting information from the EDP system, the output section employs such units as printers and card perforators to record results of actions by the EDP system. The storage units are magnetic or electronic devices which store information in "computer language" so that the rest of the system can gain automatic access to it - much like a file clerk would operate in a non-mechanized system. The data so stored are termed "file data." The computer is a device which does the following: 1) makes "yes" or "no" type decisions, based on the data, by means of electronic switches, 2) carries out numerical operations electronically, in the manner of the familiar desk calculator, and 3) controls the sequence of operations performed according to pre-specified instructions (the "program") subject to alteration on the basis of decisions related to the data encounterd.

The system used for storing file information used for decisions in EDPE is of import. There are two major systems: 1) serial access and 2) random access.

Serial access equipment is equipment that requires information to be stored in some alphabetical or numerical sequence corresponding to stock number or other description. Magnetic tapes are typically used for this kind of storage. The total storage space required in the magnetic tape itself corresponds directly to the size of the file; however, the total hardware required to make that information serially available to the data processor is a function of EDPE considerations and not of file size. The entire file is likely to involve many magnetic tapes filled with information. The true "serialness" of the file is thus limited to each tape while the selection of a particular tape is not dictated by this same serial feature.

Random access equipment is equipment that enables information to be made available to the data processor in a sequence unrelated to any in which it must be filed. This fact creates an indexing problem, defined as the problem of placing the location in which the information is filed in one-to-one correspondence to the "key" (e.g., stock number) by which it is identified. In contrast to the serial situation the size of the file corresponds directly to the amount of information which must be stored. Hence, the cost of storage increases at the same rate as the size of the file. The main advantage of a random access file over a serial one is that the hardware need refer only to the information actually wanted for a particular operation and need not refer to the information (often voluminous) not required at this time; the disadvantages include decreased reference rate for large volumes of references and increased cost.[1]

Operating as a single logical unit this equipment can receive and present information in large volume, sort data in vast quantities, and operate at prodigious rates. A typical large scale configuration of this kind of equipment might represent a capital investment well in excess of $1,000,000 or a corresponding rental commitment. Such a major financial obligation can be justified only by the expectation that one or more of the advantages of better data processing, reduced personnel requirements, and lower overall costs of the job will be achieved. It is not unlikely that all three objectives can be achieved.

E. Inventory Control Functions of an EDP System

The chapters that follow describe the functions of inventory control in terms of five major subdivisions:

1. Data flow and EDP input data control -- the movement of data to the EDPE, and the data processing actions required to detect errors in format and fact and to enable the data to be properly routed and processed by the EDPE program.

2. Substitution and allocation -- the data processing actions required to execute the distribution policies for spare parts that have substitute and interchange relationships.

3. Transaction posting and management review -- the data processing actions required to maintain records reflecting the current inventory position.

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[1] For a further discussion see J. A. Postley, File Reference, The RAND Corporation, Paper P-691, 11 September 1955.

4. Due-in -- the data processing actions required to maintain records reflecting the status of materiel on order from activities outside the particular system.

5. Shipment control -- the data processing actions required to maintain records reflecting the status of materiel being transported to or from any activity of the system.

All of the fundamental subfunctions arising in the control of Air Force spare parts inventories are discussed in this paper. This paper is intended to assist middle and top management people concerned with the problem of specifying those functions which must be dealt with whenever EDPE is employed in Air Force inventory control.

Chapter II

DATA FLOW AND INPUT DATA CONTROL

A. Introduction

This chapter describes the fundamental characteristics and the generation, format and coding, and communication of EDP input data. It also discusses EDPE file data and output data.

B. EDP Input Data

The enormous processing capabilities of EDP demand high speed input techniques, e.g., magnetic tape, punched cards, or paper tape. Without such techniques much of the potential value of EDPE is lost. It would be nonsense, for example, to consider a manual keyboard entry into EDPE of several thousand transactions per day. Entry time would be of the order of 15 seconds or more per transaction, whereas net computing time might be on the order of 0.1 seconds per transaction; the result would be a costly waste of computing facilities. Therefore, efforts should be made to generate EDP input data in a machine-readable state. If input data are not converted into such a form, the subsequent manual handling and transcriptions become costly and tend to introduce errors into the data.

The necessity for promoting accurate data and data flow will be discussed further in the section on the Input Data Control function. Rigid format controls are required since the relative location of data within a record or transaction is significant in terms of what the data represent or mean. An example is the "quantity requested" field (an aggregate of alpha-numeric characters) on a requisition. On a manually prepared form the exact location of the quantity digits is unimportant; if a quantity of 123 is being requested, "123" is written or typed in anywhere in the "quantity requested" column of a requisition, e.g., Air Force Form 104B. In contrast, a punched card requisition for EDP, e.g., Air Force Form 104P-1, must have the "123" digits punched in a specific location on the card for correct interpretation by the computer. Further, if there are six digits allowed for quantity, "123" would probably be entered as "000123." Any deviation from format rules would result in an error.

For the above reasons, an EDP system should have DPC representatives stationed at data generation and data communication points throughout the system. These representatives must assume the primary responsibility for accurate data flows to the Data Processing Center (DPC) and must promote a system (as opposed to location) attitude. Error correction, advice on data generation, and coordination of duplicate balance records are specific examples of what a DPC monitor might do. Such a person with EDP experience and orientation would be especially useful at Air Force bases where little, if any, EDP knowledge exists.

Logistics data for EDP can be considered as being either operational data, e.g., issues reported by bases, or management information, e.g., changes in allocation levels. All logistics data prepared for input into EDPE are defined as transactions. In the balance of this section "input data" and "transactions" are used interchangeably.

1. Generation

Because there are significant differences in base procedures, base processing capabilities, and base mechanization programs, many problems in transaction generation need to be solved. Whereas today the bases maintain their own accounting records (serviceables, reparables, issues, etc.), under centralized data processing the DPC will assume a major share of the responsibility. This means that for a centralized EDP system a base must generate transactions that report a major portion of base supply activity either as a separate procedure over and above existing procedures or as a by-product of what probably would have to be an entirely new base supply system. For both mechanized and unmechanized bases EDP results in a significant departure from its present supply actions. This is not an easy task; peculiarities of base size (in terms of supply activity), organization, and command complicate efforts to get uniform transaction reporting from all bases.

2. Format and Coding

The format and the coding structure of transactions are important, but not necessarily crucial, considerations. A transaction code is a set of symbols (numeric and/or alphabetic) that denote the type of logistics activity being reported; for example, the symbol "6c" might be used to indicate that an off-base receipt is being reported, and "2b" might denote the issue of a part to a using unit. The use of these codes must be consistent and accurate. An important coding advantage of EDP over most electric accounting machine (EAM) processing is that a code, once assigned in EDP for the system, is standard throughout the processing whereas the code may change from one stage of EAM processing to another. The format of a transaction is the ordering of groups or fields of data. For example, on a transaction reporting an issue the first 19 characters might be the stock number, the next 6 characters the quantity issued, the next 2 an abbreviation of the unit of issue, and so on. Once again, accuracy and consistency are of prime importance; the actual format configuration or field ordering is of lesser import.

3. Communication

There are many methods available for transmitting transactions to and from the DPC. Punched card transceivers, teletype, paper tape-to-tape, magnetic tape-to-tape, facsimile, and voice telephone are examples of electrical techniques; mail and courier-type services are non-electrical methods. The choice of a particular communication system depends upon many factors — speed, volume, accuracy, cost, availability, etc. Of these, the only universally required EDP characteristic is accuracy; speed in itself does not matter, but depends on the time value function of the data.

Other questions need to be answered. For example, should logistics data processing communications requirements be met with an Air Force-wide common user net, or should they be handled by a private network? Further, if a separate logistics net is considered desirable, should all logistics data be transmitted by it, or should Supply, Transportation, etc. have their own nets if volume permits?

AMC today has a private wire transceiver network and a private teletypewriter network, both under expansion. Commercial telephone facilities and the postal service are also used for logistics communications. For short-range EDP projects, these facilities (or their expanded versions) appear to be generally adequate. The priority transactions which require immediate communication in the B-52/KC-135 Weapon System at OCAMA are at present only about 250 per day out of a total of about 3000. Little can be said about the long-range picture since the future data communication needs are largely unknown.

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C. Input Data Control Function[1]

The DPC has to perform its Input Data Control function during each processing cycle of the EDPE;[2] i.e., during each set of actions that are performed on a specified group of transactions. The three major subfunctions of Input Data Control are: 1) error detection and correction, 2) rearrangement of input data, and 3) classification of input data. The primary purpose of the first is obvious; the second and third are for EDPE processing convenience. The Input Data Control function may either be performed as a distinct operation for certain EDP systems or it may be performed in conjunction with other functions.

1. Error Detection and Correction

From an EDPE procedural point of view, input data errors fall into two broad classes: 1) those errors that are directly related to the Air Force stock number and 2) those that are independent of the stock number. An example of the former is an improper unit of issue for a given stock number, and an example of the latter is an incorrect base stock record account number. The discussion that follows applies to these two classes of error.

There are two possible courses of action when an error has been detected by the computer: 1) the computer may correct the error and continue processing or 2) the computer may reject the transaction containing the error and go on to processing the succeeding transactions.[3] Some of the

[1] See Figure 1 for logical block diagram.

[2] See Table 1 for examples of the possible kinds of transactions to be processed by the DPC.

[3] See Paragraph 2a, Section 2, Volume III Air Force Manual 67-1.

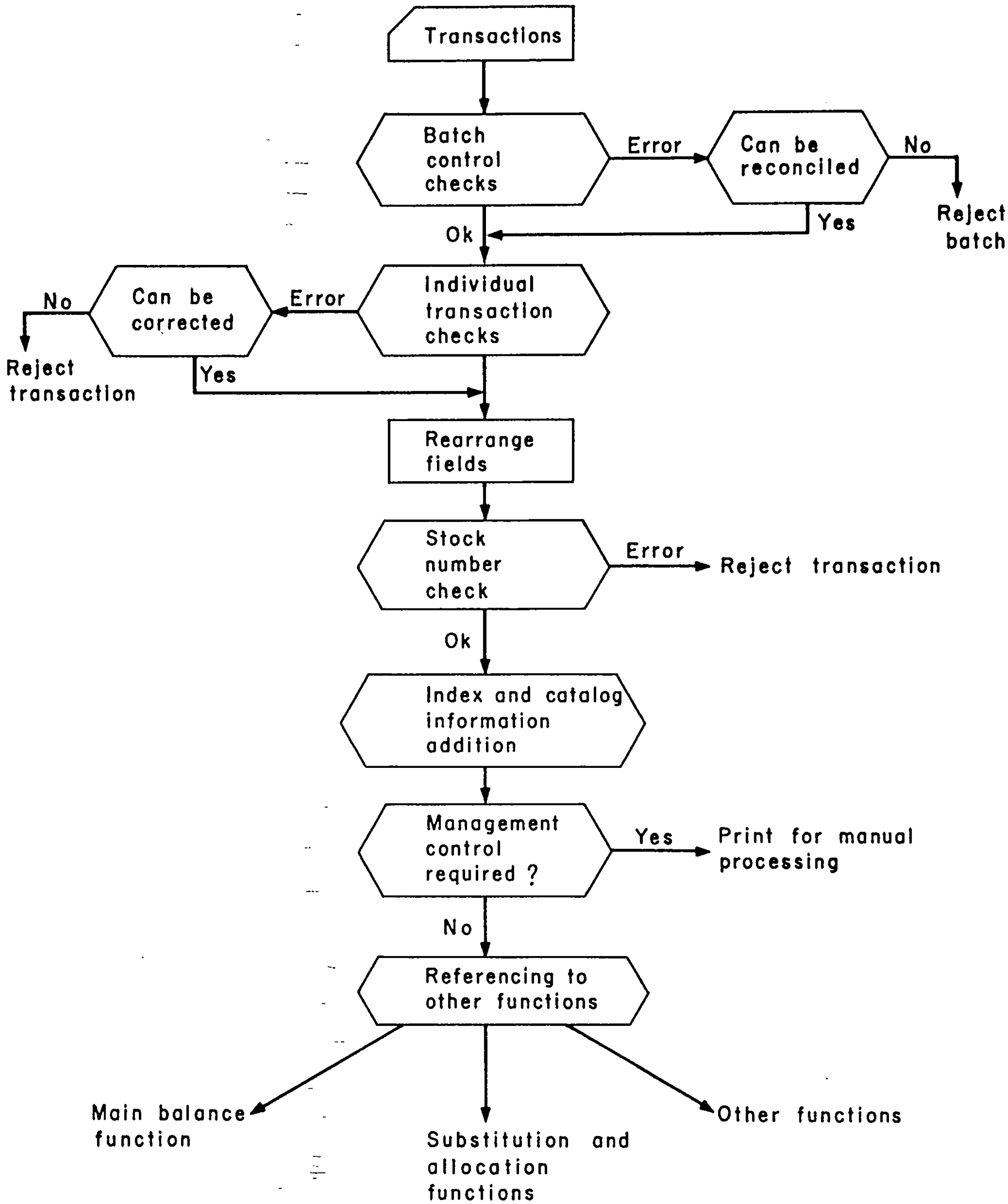

Fig. 1—Logical block diagram of input data control

factors that need to be considered for determining which of these two actions will be taken for a particular kind of error are: 1) frequency of occurrence, 2) computer storage capacity, and 3) relative importance of the transaction involved.

Table 1

EXAMPLES OF POSSIBLE TRANSACTIONS TO BE REPORTED TO A DPC

From DPC Controlled Activities

Balance Increases

Turn-ins from using organizations (e.g., serviceable return)
Receipts from depots and WSSS's (e.g., automatic resupply)
Inventory adjustments

Balance Decreases

Issues to using organizations (e.g., maintenance squadrons)
Shipments to depots (e.g., reparables to Parts Repair Depot)
Inventory adjustments

Balance Transfers

Between condition balances (e.g., serviceable to reparable)
Between ownership accounts

Others

Requisitions
Follow-ups on requisitions
Consumption data (e.g., condemnations of turn-ins)

From Non-DPC Controlled Activities

Stock List Changes

Additions (e.g., new items)
Deletions (e.g., obsolete items)
Revisions (e.g., change in unit price)

Contract Information

Due-in schedule and changes
Shipment control data

In the error detection and correction subfunction two kinds of checks are made: one is related only to the information on a single transaction; the other is concerned with the completeness of a group or batch of transactions.

a. Transaction Checks

Several methods of checking are employed for each transaction. Perhaps the simplest of these is the test for the presence of certain fields, depending on the type of transaction being processed. This is essentially a format or completeness check and is done in order to insure that each transaction has the minimum required amount of information in it; as such, it is a quantitative and not a qualitative type of check.

When checking for the presence of a field, it may be possible to check also for the type of characters which should be in that particular field. For example, a quantity field must be composed of numeric characters; if alphabetic characters are present, the entry is in error. The reasons for doing this are manifold: for instance, if a non-numeric entry (e.g., "BEA" instead of "251") for quantity on a requisition were processed, a request for an erroneous quantity might be filled, or a meaningless shipping directive on a Weapon System Storage Site (WSSS) for a quantity of "BEA" might be written.

Another check would be to make certain a field, such as a transaction code, is valid. This is done by comparing the transaction code field against a table of all such valid code configurations. The transaction code is very important since it identifies the type of transaction and the DPC action to be taken on it. If the code is in error, incorrect processing may occur, or even worse, a machine program or file record in memory may be ruined and remain undetected for some period of time.

Still another example might be a range test used to ascertain whether or not a given figure is within known valid limits -- since the present Air Force priority field on a requisition must be a number which ranges from one through sixteen, a priority outside this established range means that the requisition should not be processed.

A final example is the checking of stock numbers. A master file is maintained by stock number and contains among other things the current stock number of an item and the stock numbers it may have replaced.[4] Thus if a stock number shown in a transaction is not in the master file, it is rejected as an error. If it is an "old" stock number, the master file indicates the "new" stock number and allows the transaction to be processed. In addition, a notice is sent to the originating activity reminding it of the stock number change.

b. Batch Control

Between the point where a group of transactions was generated (e.g., at an Air Force base) and the processing of this batch of transactions at the DPC, a transaction may have been lost or a foreign transaction may have been picked up. Batch controls are used to preserve the desired completeness of each batch; the more important controls consist of: 1) a transaction count, 2) a control total, 3) serial numbering of the transactions, and 4) the restricting of each batch to one source organization.

The simplest of the batch controls is the restriction of batching by source organization, an almost natural follow-on in any logistics system. A case in point might occur with the individual batching of transactions by an Air Force base and their separate transmission to a DPC; these

[4] See Table 2. Items 2 and 4 are the stock number that has been replaced and the "new" stock number, respectively.

Table 2

EXAMPLE OF A RECORD FOR AN EDP MASTER FILE

Item No.	Description	Number of Characters
1.	Ownership Account Number	1
2.	Stock Number	19
3.	Family and Subfamily Number	6
4.	Stock Number (change to)	19
5.	New Family and Subfamily Number	6
6.	Unit of Issue	2
7.	Unit Cost	8
8.	Cost Category	1
9.	Common or Peculiar Item Code	1
10.	Dated Item Code	1
11.	Procurement Source Code	1
12.	Regulated Item Code	1
13.	Special Shipping Order Instruction Code	1
	a. Handling Code	
	b. Freight Class Code	
14.	Maximum Allowable Quantity	4
15.	Suspended Action Code	1
16.	Stock List Change Authority	6
17.	Date of Last Demand	4
18.	Action Code	1
	a. Good Serial Number	
	b. Change to New Serial Number	
	c. Local Purchase	
	d. Local Manufacture	
	e. Obsolete	
	f. Consolidate with	
	g. Broken down into	
	h. Class 27 (USAF Excess)	

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transactions would not be commingled with those of another base for transmission to the DPC. Thus, the DPC is able to check each transaction in a batch for source organization consistency by ascertaining that every card in the batch has the same organizational identification number.

An only slightly more complex batch control is the transaction count. When a group of transactions are prepared for transmission to the DPC, they are counted, and this count information is then incorporated with the batch for forwarding. A recount is made at the DPC and is compared to the original figure made by the originating organization.

A more elaborate instance of batch control is to add up a given numeric field (or portion thereof) on each transaction in a particular batch prior to its transmission. The same total is taken again at the DPC and compared with the total arrived at by the sending activity. This control, or "hash total," is not significant and is used primarily to detect electrical transmission garbles, particularly when the information is transmitted by teletype.

A powerful but cumbersome control is the serial numbering of each transaction in a batch just before transmission. Upon receipt of such a batch at the DPC, a sequence check of this serial control number is made; this sequence check will detect, for example, missing transactions, duplicate transactions, etc. The drawbacks in the use of such a control are the burden of preparation by the originating organization and the use of potentially valuable logistics information space in these transactions.

With certain EDPE it is possible to check each transaction in a batch and to perform the batch control checks on the entire batch before the transactions proceed to the next operation or function. This permits the rejection of an entire batch of transactions which may be suspect, even though some of the individual transactions appear to be correct.

Batch controls are necessary to insure that complete, correct transmission of transactions takes place. Centralized inventory record keeping demands that all transactions affecting centralized records be received by the DPC. The omission of transactions or the inclusion of foreign transactions results in erroneous centralized records and impairs the supply effectiveness of the logistics system. If, for example, a receipt transaction reported by a WSSS were lost, one consequence would be that the filling of requisitions would be needlessly postponed.

c. Rejection of Errors

When errors in individual transactions and batch errors are detected, the problem arises of rejecting either a single transaction or an entire batch of transactions. For example, if an error in transaction code were found, the transaction would have to be rejected, since the action to be taken would be unknown. If, however, an error in the date (e.g., six months ago) were detected, it would not be obvious whether to accept or reject the transaction; the error might be one of preparation or possibly this transaction was reported six months ago and is now being re-sent by mistake. Similarly, when the number of transactions received in a batch does not agree with the control count accompanying the batch, the acceptance or rejection of the entire batch is a debatable question. Rigid rejection criteria must be selected; these criteria depend largely on the nature of the logistics system (or subsystem) being developed.

d. Machine Peculiar Checks

In most, if not all, EDP systems, checks have to be made which are peculiar only to the equipment itself. Such checks, if not made, can result, for example, in the garbling of a main balance record. An example of this type of check is the screening of EDPE input data for misplaced EDPE control characters used during processing.

2. Rearrangement of Input Information

The rearrangement of input information in a form convenient for EDP machine processing is a subfunction of Input Data Control. The DPC, for example, may accept punched card requisitions on existing Air Force forms. The arrangement of data on such forms may not be the same as that for other transactions or for master file records. In order to facilitate processing, the key information, e.g., Air Force stock number and transaction code, is rearranged so as to be common for all transactions. Generally speaking this function permits varied data formats, when desirable, in input, file and output records and yet preserves processing capability.

Record assembling is part of rearrangement; in many cases the characteristics of EDP equipment require that long records on magnetic tape be assembled from a series of smaller input records.

3. Classification of Input Data

When the input data have been cleared of errors and rearranged in suitable form, the Classification subfunction processes them so that they can be referred to the other functions for further processing. Classification comprises five subfunctions: 1) indexing of input data, 2) catalogue information additions to transactions, 3) referring input data to appropriate functions, 4) management controls, and 5) control of non-DPC items.

a. Indexing of Input Data

Indexing locates the master record of the stock number specified in the transaction. If the line item has substitution and/or interchangeability relationships,[5] the index, Family and Subfamily number,[5,6] is extracted onto the transaction. This results in the pertinent information being available for the Substitution and Allocation function.

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[5]See Chapter III.

[6]See Table 2, Item 3.

b. Catalogue Information Additions to Transactions

The subfunction, Catalogue Information Addition to Transactions, reduces to a minimum the information put onto a transaction by an originating activity with a consequent reduction in data preparation and transmission error. It is accomplished by maintaining the catalogue information as part of the computer file and extracting the appropriate information to each transaction during initial processing at the DPC. The unit cost of an item, for example, does not have to be recorded on the transaction by the originating activity; it can be obtained from the computer file. Similarly, from the account number of the consignee the DPC can construct the complete shipping address required for processing by Transportation.

c. Referring Input Data to Appropriate Functions

This subfunction is the mail clerk of the system. It looks at the transaction code, the field that tells the processing action to be accomplished, and the index to determine what function will apply to the transaction. Having determined the function, it makes arrangements for the transaction and pertinent file information to be available when the function is to be executed. For example, this subfunction might put all the requisition transactions for line items that have substitutes or interchangeables onto a magnetic tape that is to be processed as part of the S&A function.

d. Management Controls

EDP is governed by the policies and procedures dictated by management. These policies and procedures are normally general in nature and apply to general categories of items under normal operating conditions. For example, if a requisition is for a line item whose stock balance is between certain stock levels previously established, the machine can make the decision, based on the criteria established by management, whether to issue or to backorder the request in question. In many instances management will desire to exercise special controls on certain individual items outside the usual rules regardless of the priority of the request, stock status, or stock levels. Such controls can be achieved as separate functions. Some examples of line items requiring special control follow:

(1) Air Force regulated-type items
(2) Prime depot regulated-type items
(3) Weapon system regulated-type items
(4) Critical items
(5) Materiel purchased for a particular organization or project
(6) Requisitions for items in which the quantity requested is excessive
(7) Requisitions from organizations outside the system complex

Exercising such controls for the manager is considered the Management Controls subfunction. If the manager can delineate his rules for any of the above controls, EDPE can handle it as a routine processing job; otherwise the transaction involved is transmitted to the manager by the DPC.

e. Control of Non-DPC Items

In some EDP systems, e.g., Weapon System Management, it is required to exercise partial control over requests for items of supply which are not included in the system complex. To elaborate, in a Weapon System all requests from activities within the system are sent to the DPC (as agent for the WSM). Requests for line items not stocked at the WSSS need to be forwarded to the appropriate Property Class Manager (PCM). Since the DPC maintains no accountable records for such items, requests for them would ordinarily be rejected by the DPC. Because there is a large volume of this kind of transaction, a procedure is needed for automatically routing these requests to an appropriate prime depot.

This is accomplished by maintaining in the computer a list of subclass codes, e.g., 1AML and its corresponding prime depot, SAAMA. This list, denoted as Classification Directory, is referred to when any stock number has been found not to belong in the system. It is only when the subclass code of the non-system stock number is not in the Classification Directory that the transaction is rejected.

D. Evaluation of Manual, EAM, and EDPE Input Data Control

Whether to use manual methods, EAM, or EDPE for Input Data Control is a question that needs to be resolved by data processing systems people. This section gives the characteristics of each and draws some conclusions.

1. Manual Input Data Control

Manual Input Data Control in the present Air Force logistics system is characterized by: 1) the necessity for manually editing all information whether correct or not, which involves an excessive expenditure of clerical resources which could be better utilized in checking the exceptions only; 2) applying judgment-type checks based on experience: the detection of a priority which appears to be too high for a particular base is an example; 3) the high degree of redundancy in input information which is present in order to aid control; and 4) the inability to ascertain whether or not a clerk executes all of the required checks.

2. EAM Input Data Control

Input Data Control in the present logistics system is characterized by: 1) similarity of Input Data Control on EAM to manual Input Data Control,

2) the difficulty, if not impossibility, of performing complex checks on EAM, 3) the relative inaccuracy of EAM as compared to EDPE, and 4) the high error potential of manual handling of punched cards in EAM processing.

3. EDPE Input Data Control

In EDPE Input Data Control: 1) routine checks are made rapidly without manual aid; 2) judgment-type checks can be programmed if they can be logically stated - the example, previously given, of the maximum legal priority for a base can be programmed as a check if desired; 3) only those exceptions which cannot be conveniently handled by EDPE need be manually edited -- this permits a more intensive manual check of errors detected by EDPE; 4) every required check is applied without fail since they are machine programmed; 5) errors are usually detected before they result in file garbles or undesirable logistics actions; 6) machine peculiar checks are requisite; 7) many Input Data Control functions which are not, but should be, performed in the manual operation must be done by EDPE; 8) a high degree of redundancy is not required and not necessarily useful -- there are fewer possible opportunities for error when redundant information is obviated; 9) EDPE error checks have the second order effect of reducing actual errors -- the return of erroneous transactions to the originating agency tends to promote the generation of more accurate transactions; and 10) regardless of the amount and degree of the manual or EAM checking performed, every check which can conveniently be done on EDPE must be executed, even though a similar manual check has been made.

The relative inaccuracy of manual clerical operations and of EAM cannot be tolerated in EDP applications. Studies of clerical data handling operations indicate that an error rate of one error per hundred operations is typical. RAND experience with one large scale EDPE is on the order of one error in 25 million computer operations; EDPE reduces the net amount of error incidence in a system.

4. Input Data Control Responsibility

For the reasons just discussed it is apparent the EDPE Input Data Control, supplemented by manual checking of error exceptions, is superior to manual or EAM Input Data Control. Although supply organizations need to insure that all supply information input is checked, the checks do not have to be made manually by supply personnel. If a DPC can perform the Input Data Control function more efficiently and thoroughly, it should be utilized by supply management for that purpose.

E. File Data

1. Description

Many different files of information, such as a main balance file, are integral parts of an inventory control EDP system. These files usually consist of records of information containing a significant key which can be used to order the records within the file. The stock number is an example of such a key. In contrast, a table of data usually comprises a simple compilation of such key or reference data. A list of base stock record account numbers is an example of such a table. One example of file data is the record that must be maintained by stock number for every item of supply which has ever been designated for control by the center and has not been deleted from the stock list catalogue, regardless of its present status. Such a record should contain, but need not be limited to, the following information relative to the identified item of supply:

(1) Identifying stock number
(2) Index number[7]
(3) New stock number (only if identifying stock number has been changed)
(4) Catalogue data (Examples: unit of issue, unit cost)
(5) Management controls -- codes to indicate that special review of transactions against these particular items prior to issue are required either by machine or manually. (Example: regulated or critical items)
(6) Special instructions (Example: handling or freight classification codes)
(7) Stock list change authority
(8) Status code -- a code to indicate the present status of the identifying stock number. (Examples: active stock number, changed to another stock number, changed to local purchase, obsolete)

An example of a format that may be used in a master record which contains the above data is that of Table 2.

2. Collection of Initial File Data

In order to have a data file at all, the data in the file must be collected for DPC use; this collection task is enormous. Often there is more than one source for a particular kind of information; as a result, an official source must be designated. For example, the unit of issue for a line item appears in many Air Force documents; the determination could be that the unit of issue should be provided by an appropriate cataloguing section, acting under the direction of its WSM (or PCM). The compilation, purification, and transcription into EDP media of file data appear to be costly and time consuming.

Perhaps the most serious problem in this area is the preparation and transcription of file data into the desired EDP media and formats. This is still true, even though most of the data are already on punched cards.

[7] See Section C,3,a of this Chapter

OCAMA experience is interesting: it took at least 20,000 manhours (some estimates are as high as 50,000) to prepare some of the file data for 6,000 stock numbers in the 02I property class for a computer application. Even though some of the data were in existing punched card files, the desired data were copied by hand onto forms in the desired format and then keypunched into cards. Such experience indicates a need for preparing those data files which may later be used in an EDP system (e.g., manufacturer's part information files) not only in EDP media, but also in a form which will facilitate file preparation for DPC use. It is typical for manufacturers to use several punched card decks or files, such as a provisioning parts breakdown file, a parts deck, and an illustration index, in their operations. In the future it may be necessary to require that, originally, the spare parts manufacturers (at least the large ones) assemble data for new parts specifically for EDP applications.

3. File Maintenance

Once a file is created it must be maintained, i.e., updated and corrected. File correction is largely the changing of static or indicative (i.e., non-balance-type) information, such as changing the unit of issue from "each" to "pair." Just as it is desirable to generate file data for EDP use, it is important to generate file change information in a form directly usable by EDPE.

A file should be periodically purged of erroneous or out-of-date records which have crept into it. If, for example, an erroneous stock number were entered accidentally on a file, there would never be any future activity against this stock number record. By using techniques such as recording and periodic checking of the data of last activity such incorrect records can be detected and erased.

F. Output Data

Output Data is defined[8] in one of two ways: 1) information transferred from the internal storage of a computer to secondary or external storage (for subsequent computer use) or 2) information transferred to any device exterior to the computer (for manual use). Output data is generally thought of as having only the latter meaning. In technical discussions, however, it is convenient to have both and allow the context to show which is the appropriate one. Hence, either will apply in the remainder of this paper. The output data of each function will be discussed; this does not imply that the same output data will occur for all EDP systems that use these functions. As a matter of fact, the generation of output data is closely related to the methods employed. For example, in in-line processing most of the output data is for manual use only because most or all functions are performed on the transaction while the transaction is in the internal storage of the computer. In off-line processing the bulk of the output data of one function is the input data of another function since a group of transactions are operated upon individually by each function in turn.

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[8] Committee on Nomenclature, Association for Computing Machinery, "First Glossary of Programming Terminology," 2 June 1954.

Chapter III

SUBSTITUTION AND ALLOCATION FUNCTION FOR AIR FORCE INVENTORY MANAGEMENT

A. Introduction

Air Force inventories must be managed so that there will be spare parts on hand for filling requests of high priority as they occur, and at the same time requests of lower priority will be filled as far as possible. This implies the need for an efficient procedure for allocating spare parts. Since substitute relationships exist between many of the spare parts, the management of the inventory would be more efficient if these relationships were taken into consideration for purposes of allocating spare parts. It does not really accomplish much to allocate a part in a certain manner while ignoring the fact that the part has certain substitutes or is, itself, a substitute for other parts in the system. Consequently, procedures are needed which allocate the parts by taking into account the substitute relationships between them.

This chapter will describe the procedures and considerations which are necessary to handle the Substitute and Allocation (S&A) function[1] of a logistics data processing system. In the beginning the definitions of terms used will be given; later a typical S&A procedure will be shown using as a basis for the example the highlights of an S&A computer routine worked out for the B-52/KC-135 weapon system management project at OCAMA. Much of the subject matter is not new; it is to a large extent what has been done -- or at least what has been attempted -- manually and on EAM. But whatever is handled manually can be done much more thoroughly, accurately, and speedily

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[1] See Figure 2, for logical block diagram.

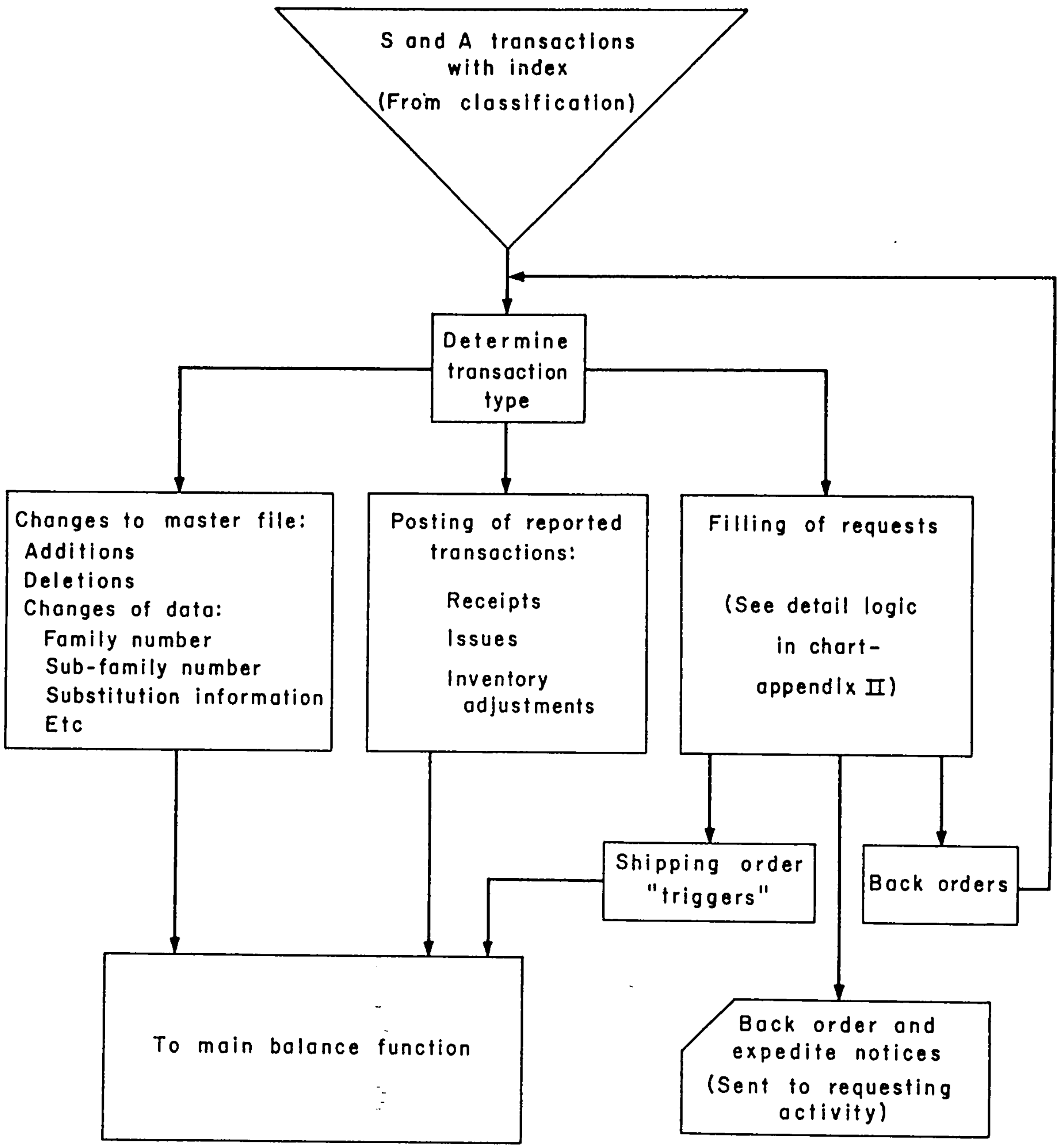

Fig. 2—Logical block diagram of the substitution and allocation function

on EDPE. In order that such equipment can be programmed to handle the work the job must be broken down into its various components regardless of how small or trivial they may seem. In such a breakdown certain segments may look extremely simple, but these are usually statements of what has been done manually for a long period of time. No matter how simple or obvious some of the elements may seem, they must still be stated in such a manner as to be translated into machine language for the EDPE.

B. Substitute and Allocation (S&A) Procedures

1. Definition of Terms

To describe a system capable of handling most types of S&A procedures which might be prescribed by a supply manager, certain terms must be defined. In general the parts with substitute relations are classed into two broad groups: interchangeable parts and substitute parts.

a. Interchangeable Parts

The term "interchangeable parts" refers to two or more parts which can be substituted for each other in all situations. If Parts A, B, C, and D are defined as "interchangeable," then Part B, C, or D can be used in place of Part A regardless of the application to which Part A might be put; similarly, if there were a request for Part B, C, or D then any of Parts A, B, C, or D could be used to satisfy the request. If for any reason, no matter how slight, a part cannot be used as a substitute for another part in all situations, the two parts would not be termed interchangeables.

In connection with the concept of interchangeable parts, there exists another term, the subfamily; that is, a particular group of interchangeable parts will be known as a subfamily. Thus, in the example given above Parts A, B, C, and D constitute a subfamily. As will be seen later, a subfamily can contain one or more parts.

b. Substitute Parts

A "substitute part" is defined as a part which can be used in place of another part, but the two parts are not interchangeable. For example, Part F may very well be used in place of Part E, but Part E cannot be used in place of Part F. E and F might be two pumps, both capable of performing the same job, but one is larger than the other and cannot be installed in all places that can accomodate the smaller one while the smaller one can be used in place of the larger one in all situations. Part F is a substitute for Part E, but they are not interchangeable parts. Further, there is more than one degree of substitution included in this particular notion. Taking the same example, Part F could be substituted for Part E in all situations (even though Part E is not a substitute for Part F) or Part F could be a substitute for Part E for certain applications only. It is possible that Part F could be substituted for Part E only if the part were to be used on a certain aircraft type and model, or even a certain aircraft type, model, series, and serial number. In the first case, F would be a substitute for E, while in the second case F would be a substitute for E with certain limitations; in other words, it is a "limited substitute."

c. Families and Subfamilies

One more term will be defined: the "family." A subfamily has been defined as a group of parts all of which are interchangeable. A "family" is defined as a group of one or more subfamilies. The reason for grouping certain subfamilies into a family is that there is some substitute relationship which links one or more parts in one subfamily with one or more parts in at least one other subfamily. Take, for example, the following family containing Subfamilies 1, 2, 3, and 4 with their parts represented as follows:

Subfamily Number	Parts			
1	A	B	D	G
2	K	M		
3	L	P	R	
4	C			

In this example any two parts on the same horizontal line (in the same subfamily) are completely interchangeable with each other. If a request is made for a particular part, the part requested or any other part on the same line could be used to fill the request in any situation. The reason Subfamilies 1, 2, 3, and 4 are grouped into the same family is that there are substitute relationships connecting these subfamilies. Part M might be a substitute for Part D in any situation (but D is not a substitute for Part M, otherwise the two parts would be in the same subfamily), or Part M might be a limited substitute for D (based upon aircraft type, model, series, and serial number). Similar relationships exist between two or more parts of different subfamilies which make it desirable to group these subfamilies into one family. In most cases if, for example, D is a substitute for M it would also be a substitute for K (since K is in the same subfamily as M). However, there have been instances where two parts such as K and M are completely interchangeable with each other and yet a part which will substitute for one might not be desirable as a substitute for the other. Situations of this type arose in the B-52/KC-135 Weapon System application. This method of keeping the substitution record serves as a means of handling the situation. Note that Subfamily 4 has only one part. This indicates that C is a substitute for one or more of the parts in Subfamily 1, 2, or 3 or that one or more of the parts in Subfamilies 1, 2, or 3 is a substitute for C and that no part is completely interchangeable with C.

It is entirely possible for a family to consist of just one subfamily. This would indicate a group of parts which are interchangeable with each other and which have no substitute relationship whatever with any parts outside the subfamily.

In general, it can be said that the grouping by family is technically not necessary, but it might be desirable as a means for grouping certain records. This is very useful in data processing where selecting an interchangeable part or a substitute part could be handled easily by carrying together all parts which could possibly have some substitute relationship with each other. Unfortunately, the length of an entire family could be such that its use would be precluded by the type of EDPE being employed.

Grouping by subfamily, on the other hand, is necessary for more than just ease of data handling. The use of the subfamily is required because management needs to manage the parts by subfamily, as will be shown later in this chapter. Even if a subfamily were longer than could be handled conveniently by the EDPE being used, the grouping by the subfamily would be required for supply management. There are two cogent reasons for this: 1) certain decisions will be made based upon subfamily balances and levels,[2]

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[2] See Section C,2 - of this Chapter.

and 2) RAND research[3] has shown that a group of parts having interchangeability relationships is a better basic unit in demand analysis and forecasting than an individual part number. Records for individual stock numbers, however, can be arranged individually (randomly or by stock number), or they can be grouped in some way (by subfamily only or by family and subfamily). When arranged by stock number, the record for each stock number must refer to all possible substitute and interchangeable parts as well as to the record, if any, for the subfamily of which the part is a member. If arranged serially by stock number, there is no problem in finding an individual part's record in the file; if arranged by part, but randomly, an indexing operation is needed whereby the actual location of a part within the file can be found. If arranged by subfamily only, or by family and subfamily, there will also be a need for an indexing operation which will give, for a particular stock number, the number of the group record in which it can be found (whether a subfamily number or a family and subfamily number). The indexing operation must work with a master file which is arranged by stock number and which gives, for each stock number, the necessary identifying information which will locate that stock number's record in the file.

A combination of indexing methods could be used. In the B-52/KC-135 weapon system, for instance, items which have substitute relationships are arranged by families and subfamilies while others are arranged by stock number. In the former case the indexing operation applies the family and subfamily number of each part for each transaction while, in the latter

[3] T. A. Goldman, Relationship Between Program Elements and System Demand for Airframe Spare Parts, The RAND Corporation, Research Memorandum RM-1858, 22 January 1957.

case, indexing leaves the stock number as given; this is carried out in the Input Data Control function.

2. The Use of Management Levels and Priority Ratings

To manage the inventory of spare parts so as to be certain of filling urgent requests, a system for allocating the parts is needed; the allocation can be accomplished by a system of "priority ratings." The priority rating system which probably does this best would be based upon mission category and urgency of need of the requesting party. A possible priority rating system[4] is one in which one of five different priority ratings is assigned to each request, not including routine resupply. This rating is applied automatically at the DPC, since it is a function of mission category and urgency of need, both of which must appear on every request. The priority rating is then used for determining whether or not a request should be filled in the event that stocks of the requested part are below some specified level as discussed below. This is done by using assigned priority ratings in conjunction with a series of management levels.[5]

If filling a request would bring the item's total system stock (amount on hand after filling the request plus amounts in transit and en route)[6] to below the War Reserve Level, no issue can be made since the War Reserve Level is inviolate under AFM 67-10. If filling the request would bring the system stock below the Allocation Level (but not below the War Reserve Level) then the request can be filled only if it is of a high priority,

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[4] See Appendix I.

[5] For a fuller discussion of levels see Chapter IV and Air Force Manual 67-10.

[6] See Section D, 1 of this Chapter for definitions of "in transit" and "en route."

i.e., Priority 0 or 1. If filling the request would drop system stock to below the Warning Point Level (but not below the Allocation Level) then the request can be filled only if it is of Priority 0, 1, or 2. Finally, any request can be filled if by so doing the system stock of the item will not fall below the Warning Point Level. The site levels are used in a similar manner when determining whether or not a site should be directed to make an issue, but not as a part of the S&A function.

At first glance this seems to be an over-simplification of the present Air Force priority system which has sixteen priority ratings. However, upon closer inspection it will be noted that the Air Force actually has only five different ratings which are based upon mission category while the breakout into sixteen different ratings is largely for purposes of the transportation used in shipping the spare parts. The "date of need" is still available in the system being proposed, and if a special breakdown for transportation purposes is still desired, it can be handled without upsetting the Priority system as suggested in this paper and shown as Appendix I.

The four system stock levels have been established for the purpose of controlling issues of spare parts. These levels are also used for the control of entire subfamilies.

The fourth system level, the Requirement Level, is a point at which management desires a notice so that steps can be taken, if necessary, to avoid reaching the next lower (Warning Point) level; this level does not enter into decisions regarding the filling of requests.

With the use of the four different levels and six different priority ratings, the management of the spare parts inventory is handled in two ways: by subfamily and by individual part.

a. Management by Subfamily

Since all of the parts in a subfamily are completely interchangeable for all applications, it would seem that there should be a means of managing such parts as though they were all the same part. Thus, there exists a need for subfamily levels and balance totals. The use of these levels and balances provides extra assurance that urgent requests for any part in the subfamily will be filled even if the serviceable balance of that particular part (stock number) is zero. If there were no subfamily management, it would be possible to fill a low level request for Part A, itself in sufficient supply, only to discover later that this part is needed later as an interchangeable for Part B which is in critical supply and for which a high priority request has been received. Management by subfamily level checks makes the assumption that all parts in a subfamily are really only one part.

Another use for management by subfamily is in the area of consumption and demand statistics. Since all parts in a subfamily are, in a sense, merely one part, statistics might be compiled by subfamily as well as by individual part; statistics by subfamily would be useful in computing requirements, procurement, and repair schedules.

b. Management by Individual Stock Number

In addition to managing parts by subfamily, there is a need for managing parts individually, which means levels must be established for each part in the subfamily as well as for the entire subfamily. It is sometimes held that if the subfamily quantity is such that an issue can be made from this subfamily to fill a particular request, then a check need not be made of its individual parts' balances since there will be a sufficient balance in the subfamily regardless of which parts in the subfamily are used to fill the request. There may be, however, situations where the supply manager desires to manage one or more parts within a subfamily differently from the others, and this can be done only by setting levels for individual parts. In some cases certain governmental regulations force the purchase of identical parts from several different manufacturers. When this happens, the manager must insure that the individual parts are issued in such a manner that the system does not exhaust the parts manufactured by one company and accumulate a large stock of items manufactured by another. This can be handled by establishing levels for individual parts and issuing the parts in a subfamily in accordance with a desired goal. In short, levels for individual parts give us the flexibility of being able to force the issue of certain parts or to save certain parts allowing others to be used first. It may be that this individual part level management is not needed at all times, but it is desirable to have the capability built into the system.

Thus, in determining whether to fill a request, a check should first be made on the subfamily levels and balance; if this test is passed, then a check is made on the part requested before the part is actually issued. If the individual part test is not passed, then an interchangeable is searched for, always checking appropriate levels and balances before issuing.

3. Required Substitutes

Another subfunction which must be part of the S&A function is the ability to handle required substitutes. A "required substitute" is the part which the supply manager desires to issue whenever a certain part is requested regardless of the balance on hand of the requested part. There are probably two main reasons for requiring that a part be used as a substitute.

First, it may very well be that, although the required substitute is usable, it is desirable to phase it out of the system, e.g., because there are newer parts which have the same use but which are made of different material. In such a case it might be desirable to use up the old part first, and this can be done by requiring that this part serve as a substitute for any of the newer parts. This objective can be attained by setting all levels for the required substitute to zero; then, when this part is referred to as a required substitute, it will be issued without restriction until depleted.

On the other hand, a part may be denoted as a required substitute merely because there is an excess of it in the sytem. In such a case instead of setting the levels of the part to zero, such levels would be set to an amount which would rid the system only of the excess amount in stock.

The handling of required substitutes by varying the levels as desired can be done only if levels are carried for individual parts; this is further reason for not limiting the levels used in the S&A procedures to subfamilies only.

4. Disallowance of Substitutions

A situation which can be looked upon as being the opposite of that mentioned in the previous section (Required Substitutes) is that in which a request is made for a part for which no substitute can be accepted. This can arise when the part is going to be put to a rather special use and, consequently, a specific stock number is needed. For example, a special modification, which the squadron commander feels is too recent to be known by the DPC, may have been made to an airplane and he might know that no part will substitute for the part requested; or in some instances a squadron commander may insist on equipping his airplanes with certain parts and not accept substitutes. While this may be undesirable, we should recognize that it will no doubt happen and must be handled in some way. These situations are handled by the use of a "No Substitution" code which must be placed on these transactions when the requests are initiated. If the computer is unable to issue a requested part, and the request contains a "No Substitution" code, the request must be backordered. If no such code is present, the usual method of attempting to issue interchangeables and substitutes will be employed.

5. Filling Requests with More Than One Part

It is quite possible that a request might be filled with several parts. Due to the additional trouble inherent in filling a request with more than one part number, such a procedure is desirable for the higher priority items only, probably Priorities 0, 1, or 2 where the "days of need" is 20 days or less.[7] In such cases the request could be filled with the part requested, an interchangeable part, a suitable substitute, or with any combination of these as is deemed necessary.

Since Priority 3 and 4 requests represent a need for spare parts in not less than 21 days, no harm would result if these requests were backordered for the one part rather than filled with more than one part.

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[7]Using the priority system defined in Appendix I.

This is especially apparent when it is realized how backorders are handled, i.e., that the "days of need" on a backordered request is decreased by one day each day that the request is backordered, and eventually (when "days of need" becomes less than 21) that a Priority 3 or 4 will become a Priority 1 or 2 respectively at which time requests can begin to be filled by any combination of parts necessary. There is always the chance that, before a request's priority changes from 3 to 1 (or 4 to 2), the appropriate items will come into the system thus making it possible to fill the request with one part only.

6. Routine Replenishment

In the chart of priorities[8] it will be seen that in addition to those requests having Priorities 0 through 4 there is a Priority 5 which is labeled "routine replenishment." This is the rating assigned to requests that are usually initiated by the system itself when bringing the balance of a particular part at a given location up to a required level. Very rarely will a request for routine replenishment come to the Data Processing Center from an outside location, since by having preset levels for all parts for all locations, it is possible to prepare automatically those requests which will result in the shipment of sufficient quantity of an item to bring a location's balance of that item to the required level.

In filling requests for routine replenishment it should be remembered that the establishment of a Priority 5 level is generally for the purpose

[8] See Appendix I.

of restocking a location and not for supplying a particular aircraft with an item. Consequently, there should be less cause for substitution in these cases. Under Priority 5 the only allowable substitutes (assuming the part requiring routine replenishment is not available) should be interchangeable parts, inasmuch as there may be limitations based on particular aircraft. If it is desired, however, to issue a substitute part from a different subfamily for routine replenishment, it can be done by making certain that the part being substituted can be used wherever the part being replenished (and every part in its subfamily) can be used. This can be accomplished by comparing the application limitations for all parts involved; a better way might be to include, along with the subfamily information, a listing of possible substitutes that could be used for every part in the subfamily. Making certain substitutions for routine replenishment does, however, create a major complication -- keeping track of the situation so that repeated attempts will not be made to replenish the subfamily for which the substitute part was selected.

7. Notices to Management

In the course of carrying out the S&A function situations will arise that necessitate management decisions, or at least notices to management. Such notices can be handled automatically by the DPC; examples of such notices follow.

Since the four different levels are of importance to inventory management, the computer should automatically print notices to management each time the system balance of any subfamily or any individual part drops below one or more of the four levels. This requires the determination of the balance of each subfamily and of each part in relation to their respective levels at the beginning of the posting cycle, and then a comparison of the ending balances with all respective levels at the end of the cycle. If any levels are reached, notices indicating this will be printed. Where a subfamily balance has reached a level, the notice will show in addition all balances for all parts in the subfamily, for all conditions (serviceable, reparable, TOC, etc) and locations for the parts so that management can make appropriate procurement, repair, or shipping decisions. If an individual part in a subfamily reaches a level, the same practice will hold true, i.e., balance information for all parts in the subfamily, as well as for the subfamily itself, will be printed out since the parts are interchangeable and should be considered as a unit when making a decision concerning any individual part.

Other management notices can be printed out as needed, but those mentioned above will probably be the most useful notices that the S&A function of the inventory control problem will provide.

C. Data Requirements for S&A Procedures

1. Substitute Relationships and Their Limitations

For the S&A function to operate successfully certain data are necessary. The most obvious data which must be collected consist of all of the interchangeable and substitute relations. These data are obtained largely from aircraft manufacturers; but, the Air Force itself also accumulates information which augments that of the contractor. Hence, a system is required that will funnel these inter-relationships, from whatever source, into the S&A file. In addition to the collection of data which describe the interchangeability and substitutability of the spare parts, there must be collection data on limitations of applicability of any part by aircraft, model, series, and if necessary, serial number. In some cases it might be necessary to carry such limitations by appropriate higher assembly rather than by end item (or even a combination of appropriate higher assembly and end item). For example, in a missile supply system there are many cases of one part, say A, being a substitute for another, say B, when B is to be used on an assembly, say C; yet A might not be a substitute for B if A were to be used on another assembly, say D. Obviously, when such a part is requested from the DPC, unless the appropriate higher assembly on which the part is to be used is used is specified, no substitution can be made.

It is apparent that the substitution information does not have to be complete for the S&A function to operate; actually, such a file is never 100 per cent complete at any one time. But the more substitution data are known and used, the better the S&A function can be performed. It is certainly true that not all substitute relationships are known today; yet the Air Force is operating with what it does know. The system employed should readily accomodate the addition (or deletion) of substitution data as required.

The Air Force, today, may not be using effectively all of the substitute relationships on which it has data because of the difficulty in handling these data manually or by EAM. Once a computer is programmed to include this information, the relations which are known and given to the computer will always be used, whereas, in a non-electronic system they may be forgotten or ignored.

2. Management Levels for Parts and Subfamilies

In addition to substitute relationships there are the various management levels which are needed for each part and each subfamily. Since these levels are for the two-fold purpose of keeping management informed on the status of each individual part and subfamily, and for processing issues in certain ways, they must be determined by the supply manager. The supply manager could compute the levels himself and merely furnish them for use in the computer as might very well be the case in the beginning of such an automatically controlled system. It is hoped, however, that ultimately a refinement can be added whereby the manager merely states how he would like the levels to be computed, giving detailed procedures and describing factors to be used in such computations, and that the actual periodic computations will be made automatically. Automatic computations will no doubt mean that the levels can be computed as often as desirable, taking into account more factors and more advanced techniques than if they were done manually. In addition, the use of machines for computations makes possible the use of more differentiated computational techniques and greater degree of accuracy.

D. The B-52/KC-135 S&A Procedure, An Example

What type of procedure can be developed that will provide a quantitative interpretation of the criteria implied by the policies of management in such a way that EDPE can carry out these policies? An example based upon actual work performed in the EDP system development for the B-52/KC-135 weapon system at Oklahoma City Air Materiel Area will be given. The procedure developed there allows for the handling of virtually all situations which could arise in making substitutions and allocations. There are sufficient decision points in the procedure to give the manager a great amount of flexibility in managing his stock. As will be seen, the manager can vary his management methods considerably by altering such things as levels, order in which substitutes are listed, etc.

In following the procedure to be explained reference will be made to the charts described in Appendix I, Distribution, Short Supply, and Back-order Policies, Appendix II, General Procedure for Handling Requests, and Appendix III, Family Record for the B-52/KC-135 Weapon System.

1. Maintenance of System Balances

An EDPE record in the B-52/KC-135 weapon system S&A file consists of a family of parts. The individual parts in a record are arranged by subfamily. In order to manage parts by subfamily, as well as individually, the four different levels mentioned above are maintained for each subfamily and for each part in a subfamily. In addition, certain balances are carried for each subfamily and part. These balances are the quantities: 1) on hand (OH), i.e., the total amount of a part which is physically on hand at all locations being controlled, 2) in transit (IT), i.e., the total amount actually moving within the system from one controlled location to another controlled location, and 3) en route (ER), i.e., that amount which has been shipped from a place outside the system and is due to arrive at a location within the system. In the beginning phase of B-52/KC-135 weapon system data processing the DPC is to maintain balances for weapon system storage sites (WSSS) only and not for the various bases; so, at this point the quantity on hand refers to that amount at storage sites, in transit refers to the quantity being shipped from one storage site to another, and quantity en route indicates the amount shipped from outside the B-52/KC-135 weapon system (probably from a vendor or AMA) and due to arrive at one of the system storage sites. In addition to the balances which are maintained for both subfamilies and parts, a balance is carried which indicates, by subfamily only, the amount of the part which was backordered, i.e., the amount of unfilled requests for parts in each subfamily. It must be borne in mind that all management levels and balances which are carried in support of the S&A functions are for the system as a whole; they do not refer to any individual location within the system.

2. Description of Family Record

It is advisable to look at the actual record which is being used in the B-52/KC-135 weapon system and to explain those items which have not been previously discussed. This record is found in Appendix III; reference to this appendix is made by item number.

a. Weapon System Information

The first part of the record consists of information pertinent to the entire record as a part of the weapon system. Item 4 identifies the family record as to weapon system, i.e., B-52 or KC-135. Item 5 (length of entire record) is merely a figure needed for purposes of programming for the EDPE; there are many such programming aids throughout the record.

b. Family Information

The next class of information pertains to the family itself, and Items 10 and 13 are the only ones which will be discussed here. Item 10 identifies the family by number; this number is applied to all transactions during the Classification procedures. Item 13 is updated each time a change (other than the posting of a receipt, disbursement, or adjustment) is made to the file and is used as an auditing aid in providing a means for tracing all such changes through the appropriate transaction registers. All other items of "family information" are merely programming aids.

c. Subfamily Information

The subfamily information includes the four levels (Items 28, 29, 30, 33) and three balances (Items 26, 27, and 34), which have already been discussed, as well as Items 20, 25, 32, and 35. Item 20 is the subfamily number which is added to all transactions as a part of the Classification procedure as is the family number. Item 25 consists of the unit of issue for all parts in the subfamily (it should be pointed out here that no two parts can be in the same subfamily if they have different units of issue). Item 32 consists of a listing of all of the aircraft (by type and model only) on which the parts in this subfamily can be used; detailed applications by serial number are given under the individual parts. The broader breakdown for the subfamily as a whole supplies a means for the more rapid elimination of those subfamilies which do not contain possible substitutes than would the examination of detailed applications for each part in the subfamily. Item 35 identifies that part in the subfamily which is considered the master part for the subfamily.

d. Part Information

As for the information carried for each part, the following items of information are cited: Items 44, 45, 46, 48, 49, 50, 59, and 51, all of which have been discussed in preceding sections, plus Items 41, 52, 54, and 71. Item 41 is the actual part number, and it will be noted that the part number is carried only once for each part, i.e., it is not carried where the part is listed as a substitute. Item 52 consists of a listing of all required substitutes (using codes), while Item 54 lists all other possible substitutes for the part (again using codes). It is necessary to bear in mind that the required substitutes and other substitutes for any part will always be in the same family as the part.

Item 71 consists of nothing more than a listing of "from's - to's" which are referred to by Item 56. This comprises any of those type, model, and serial number limitations which may apply to a particular part. Before issuing a part as a substitute for a requested part, the Item 56 for the possible substitutes is checked for references to the table of limitations. If there are any references, all such references are examined to make certain that the part can actually be used on the aircraft for which the request is made. All items not described are needed for programming purposes.

3. Posting of Transactions

A typical example of the B-52/KC-135 S&A routine will now be given. Before the posting of any transactions, all transactions (receipts, issues, requests, changes, adjustments) must first be processed through the Classification procedure in which, among other things, it is determined whether each transaction is for a part which belongs to a family or for a part which does not have any possible substitute relationship with another part. If the latter is the case, the transaction is made to bypass the S&A function and is routed directly to the Main Balance procedure where the detailed records by location are maintained. If, however, a transaction is for a family item, then the index number (family number plus subfamily number) is applied.

The transactions entering the S&A routine are then sorted into types by weapon system and family so as to be handled in the following order:

Type 1 -- Receipts for the entire family
Type 2 -- Issues for the entire family
Type 3 -- Adjustments for the entire family
Type 4 -- Changes to file for the entire family
Type 5 -- Requests - arranged by priority - and including previous requests which had been backordered

The procedure is for transactions of Types 1 through 4 to be posted to the entire family. Thereafter requests will be filled, if possible.

4. Processing of Requests

The chart of Appendix II is a reference for the discussion that follows:

a. Standard Routine

Starting at the center top of the chart (Box 1), assume that a request for a part needs to be satisfied. Assume further that the family record to which this individual part belongs is in the working memory of the computer. The first step consists of locating the part in the family and checking Item 52 for this part to determine if a substitute is required (Box 2). Assuming no substitute is required an attempt will be made to "issue" the part.[9] The next step is to compare the subfamily (Box 3), the total of quantity on hand plus in transit plus en route minus quantity requested equals S.S. (i.e., the entire subfamily system stock after filling the request) with the appropriate management level for this particular priority request. The chart of appropriate

[9] The term "issue" is used in the sense of triggering issue as a part of the main balance procedures since actual issues are not included in the functions of S&A.

levels used in the B-52/KC-135 system is shown in Appendix I. If this subfamily test is passed, the request can probably be filled from this subfamily, that is, from the requested part or an interchangeable part.

A check is then made (Box 4) on the individual part requested by comparing the system stock (on hand plus en route plus in transit) less the amount requested with the appropriate level. Assuming this test is passed, it must be determined, even though there is a sufficient quantity of the item in the system, if there is actually enough in supply bins awaiting issuance. This is done in Box 5 where the quantity requested is compared with the quantity actually on hand. If this test is passed, the actual issue is made (Box 6), and we return to Box 1 to handle the next request.

The procedure just described should be the standard one for the majority of cases (Boxes 1, 2, 3, 4, 5, 6, and back to 1); however, as seen on the chart, when there is a decision to be made, it is possible to depart from this particular routine. The branches leading from Boxes 2, 3, 4 and 5 are now discussed.

b. Deviations from the Standard Routine

In Box 2 it is determined whether there is a required substitute. If the answer to this is yes, then the routine branches off to the left. Remembering that required substitutes might exist for two different reasons:

(1) to rid the system entirely of the required substitute, in which case its levels would be zero, or

(2) to reduce the quantity in the system to a specific amount, in which case the levels will have a value other than zero,

it must first be determined on this required substitute branch whether the levels of the required substitute are zero (Box 16). If so, as much of the item as is necessary will be issued even if the stock is depleted (Box 20). If the request is not completely filled, we return to Box 2 to attempt filling the unfilled portion by checking first for other required substitutes. If, on the other hand, there are specific non-zero levels stated for the required substitute, then the required subfamily test must be made, followed by the individual part test and an on hand test (Boxes 17, 18, 19). If any of these tests are not passed, we return to Box 2; if they are, the issue is made (Box 6), and then back to the beginning (Box 1). Now the branches from Boxes 3, 4, and 5 are examined.

At Box 3 the "no" branch leads to the routine of looking for substitutes for the parts requested (it is known that no interchangeables are available for this request, inasmuch as the subfamily test was not passed). The substitutes are found by examining Item 54 for the requested part (Box 7). If there are substitutes listed, the first one will be tried by making the subfamily and part tests (Box 7 returns to Box 3, but for the new subfamily). If the question asked in Box 7 reveals no substitutes, then attempts will be made to satisfy the request from more than one part (if the priority is 0, 1, or 2) or else the request is backordered after decreasing the "days in need" and increasing the priority of the request if such is warranted.

Box 4 has a branch which indicates that even though the subfamily test may have been passed the individual item test has not been passed. Here three different things could happen depending upon whether the item tested in Box 4 was the part requested, an interchangeable part, or a substitute for the part requested.

(1) Part Requested

If it was the requested item, it must be determined whether there are interchangeables listed. If so, the path will be from Box 8 to Box 9 to Box 15, and then back to Box 4 for the next part to be tried. (A subfamily test is not needed again since it has already been made for the subfamily.) If not, Box 9 will take us to Box 7 where the process of looking for substitutes begins.

(2) Interchangeable

If the Box 4 test was for an interchangeable item, Box 9 determines if there are more interchangeables to be tried. If so, Box 9 leads to 15 to 4 where the part test is tried again; if not, Box 9 leads to Box 7 where the search for substitutes begins.

(3) Substitute

Going back to Box 4 assume that the part tested was a part tried as a substitute. In this case Box 8 will lead to Box 10 where it is determined if there are more substitutes to be tried; if so, back to Box 3 to start the subfamily and part tests; if not, to Box 11. Box 11 determines the priority of the request, and it is then either backordered, or attempts are made to fill the request from more than one part as explained in an earlier section.

One more branch which must be mentioned is that from Box 5, and it is apparent that this is a situation similar to a "no" answer in Box 4; hence, the branch from 5 leads into the "no" branch from 4.

c. Routine Replenishment

The above covers the procedure for handling requests except for Priority 5 (routine replenishment). The chart shows dotted lines coming from Boxes 3 and 9; these lines are for Priority 5 only, and they follow the procedure of issuing the part needed or an interchangeable, but never a substitute which is the best that can be done when the parts are for stock and not a specific aircraft. As mentioned previously, procedures can be developed for issuing substitutes even for routine replenishment.

d. Order of Selection of Alternate Parts

The general order of filling requests can be summarized as follows:

(1) attempt to issue a required substitute, if any;
(2) attempt to issue the part requested; if that fails,
(3) try to locate an interchangeable part; and
(4) try a substitute part.

If none of these can be issued, the request has the "days of need" updated; it is backordered and then processed in a similar way in the next S&A cycle.

5. Deletions and Exceptions

This section has given a general description. The intent was merely to show the overall procedure which is being followed in the B-52/KC-135 weapon system problem. Details have been omitted, such as the way a request is filled from more than one part (which is largely a programming technique). The use of the "No Substitution" code is an item not mentioned in connection with this description, but it is certainly a part of the system as developed. Also, it might be noted in the flow charts that Boxes 2 and 7 use the words "appropriate" required substitute and "appropriate" substitute. By "appropriate" it is meant that before a required substitute or substitute is issued, Item 56 for the part is first checked, and if necessary, the limited applicability table is examined to determine that the part will work on the particular aircraft for which the request is made. It should also be pointed out that, whenever a substitute is considered, the unit of issue is checked before the substitute is issued to make certain it is the same as that of the requested part; if it is not, the more common conversions will be handled by the computer while the less common ones will be printed out for manual conversion.

The supply manager can vary his management techniques by changing sub-family and/or part levels and by listing the interchangeables, required substitutes, and substitutes in the way he desires since these items are handled in the order listed in the file.

One must remember that the same S&A function could have been handled in many other ways. The entire family record was used here because of the type of EDPE employed. Other configurations of equipment might make it desirable to re-arrange records so as to use the equipment effectively.

Chapter IV

TRANSACTION POSTING AND MANAGEMENT REVIEW

A. Introduction

This chapter describes a number of file-keeping procedures which are minimal requirements in the accomplishment of the Main Balance (MB) function[1] of the EDP system. The chapter also shows how these procedures, supplemented by appropriate analysis and data handling tools, can provide management control of materiel in an EDP system covering the materiel on hand in the system, materiel moving between activities of the complex, and materiel moving into the system.

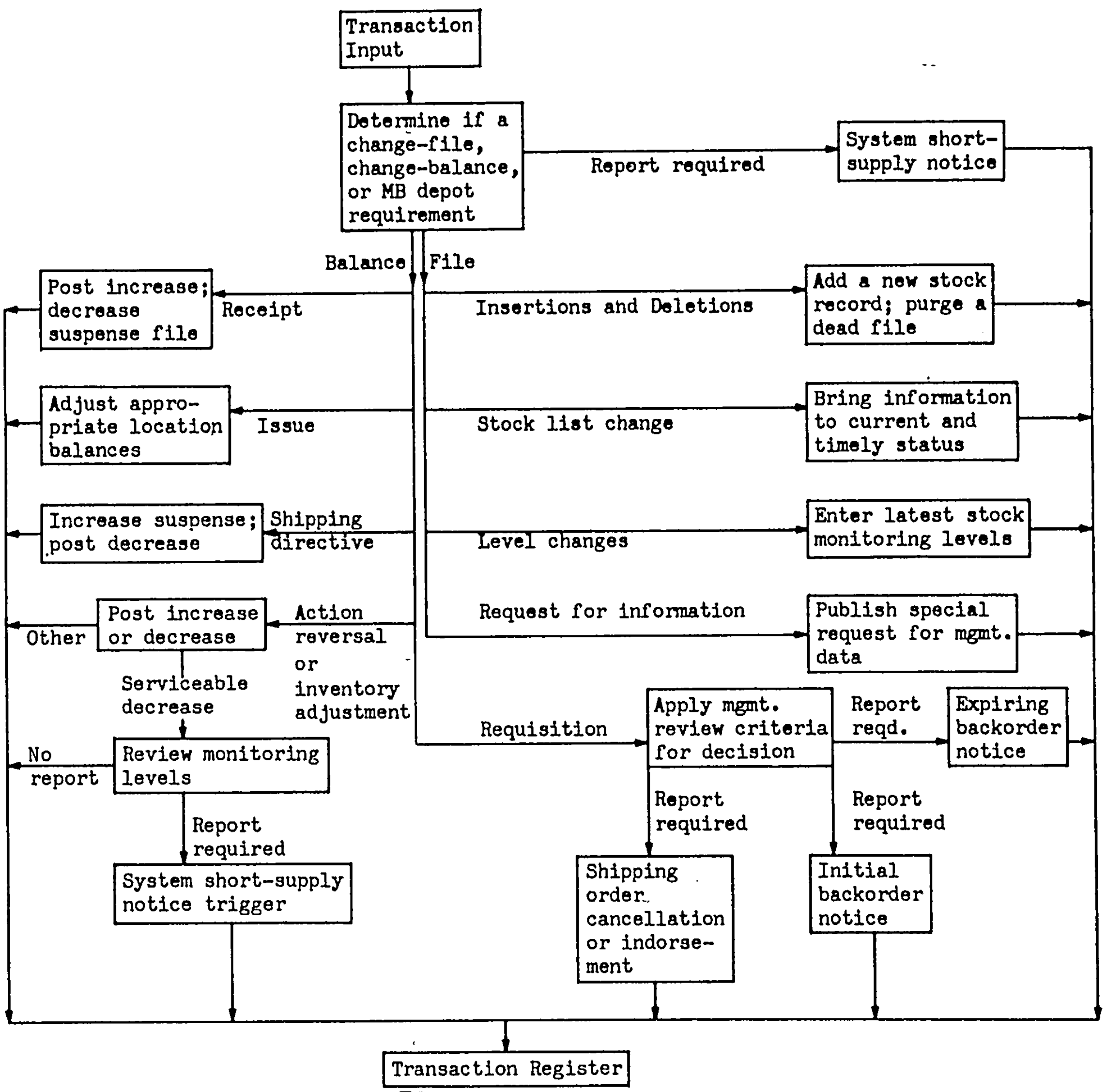
Since the system asset position is the primary concern of the supply manager, any EDP system must insure that timely and accurate data reach the various managerial levels. To accomplish this, the MB function maintains, for each item in the inventory, a consolidated stock record account by location (storage sites, bases, overhaul points, etc.). The composition of the stock record account is described in this chapter. In addition, managerial monitoring levels, providing complete and continuous management-review capability for each item in the inventory, are carried with the actual balance data on the consolidated record, so that necessary allocation action may be taken as required to forestall shortages either at a location or for the system itself.

The Main Balance file (MBF) and its maintenance are described. Some of the more important facets of MBF, e.g., the inputs required to update the file, the types of transactions that affect it, and the reports that evolve from the MBF, are discussed.

[1]See Figure 3, page 60 for logical block diagram.

Figure 3

LOGICAL BLOCK DIAGRAM OF THE MAIN BALANCE FUNCTION



B. Main Balance File (MBF) Data

An inventory-management process is based on a record of inventory; balances for each part in the inventory are consolidated on a single master record to include all system locations and are kept on an appropriate EDPE medium, e.g., magnetic tape reels, magnetic drums, or magnetic discs. These balances are accessible in sequence either directly or by indexing. Management-review information must also be filed in each consolidated record. During the posting to the site and base balance records, each location's balance record is examined so that management can evaluate both the system and the location stock status for each stock item that has experienced activity.

The information needed to record the supply activity and to initiate managerial review of the supply position of the system for each stock item belongs to one of the following classes: 1) fixed indicative data, 2) system summary data, or 3) location data. Table 3 is a reference for the following discussion.

1. Fixed Indicative Data

Among the catalog-type information contained within each consolidated stock record is the stock number, including sub-class code and index[2] (family/subfamily number); this is the basic information for the posting operation. Other catalog-type data enable the EDPE to exercise a form of "class knowledge" in the analysis phase of management, e.g. some codes that denote expendability and repair (ERC), regulated items, class 27 items, and dated items. All of these permit differential processing possibilities within the computer. Finally, because shipping orders need to be written as a result of

[2]For more detailed discussion, see Chapter II.

Table 3
EXAMPLE OF A CONSOLIDATED INVENTORY RECORD
FOR AN EDP MAIN BALANCE FILE

Fixed Indicative Information

1. Family Number)
2. Subfamily Number) Index Number
3. Stock Number
4. Peculiar- or Common-Item Code
5. ER Code
6. Dated-Item Code
7. Regulated-Item Code
8. Noun
9. Unit of Issue
10. Unit Pack
11. Cost
12. Cube
13. Weight
14. Procurement-Source Code

Weapon-System Summary Information (Repeated for each weapon)

1. Weapon Account Code
2. Requirement Level
3. Warning-Point Level
4. Allocation Level
5. War Reserve Level
6. Serviceable Summary
7. In Transit Summary
8. En Route Summary
9. TOC Summary
10. Reparable Summary
11. Backordered Summary

Location Information (Repeated for each site or base)

1. Account Number
2. Area Indicator
3. Next-Area Indicator
4. Date of Last Action
5. Stock-Control Level
6. Reorder Point
7. War Reserve Level
8. Serviceable In Transit
9. Serviceable En Route
10. Special Project Holdings
11. TOC (Awaiting Shipment)
12. Reparable (Awaiting Shipment)
13. Serviceable (If dated item, by date in site records only)
14. Obligation Account Holdings (listed separately for each account held)

action taken during transaction posting, such information as nomenclature, cost, cube, weight, unit of issue, unit pack, and procurement-source code is maintained on this master file. This enables the computer to generate shipping orders that contain all the catalog information needed by the recipients of copies.

2. System Summary Data

In the remainder of this chapter, the term "stock status" will appear often. Stock status is a number defined as serviceable on hand plus serviceable in transit plus serviceable en route, minus backordered.

Definitions and discussion of the items of the system summary data follow.

a. Weapon Account Code

This is a number used to denote the weapon system or designated accountable organization which "owns" the stock.

b. Requirement Level (RQL)

If the system stock status falls below the Requirement Level, there will normally be sufficient time for management to replenish before any critical level, e.g., Warning Point, is reached.

c. Warning Point Level (WPL)

A lower stock level than the RQL, the WPL advises the inventory-control process that a certain degree of criticality exists for this stock item. That is, when the system stock status is equal to, or lower than, the WPL, rationing of materiel should begin. At the very least, long-range requests of the routine-replenishment type ought to be backordered while only high priorities are filled. As in the case when the RQL was reached, printed notices to management alert it to the start of this rationing.

d. Allocation Level (AL)

This is a second stage alert level. When the system stock status is at or below the AL, management is again notified, and more severe rationing begins. Only specified high-priority requests may be honored, and others are backordered until the shortage is alleviated.

e. War Reserve Level (WRL)

This is an inviolate stock level which might reflect special system holding for a particular unit only, or for a favored weapon. It might conceivably be an unassembled kit and table stock held in bins with normally issuable materiel to maintain a degree of "freshness" in the stock, as is necessary in the case of dated items.

f. Serviceable Summary

All of the stock which is in a ready-for-use status at any of the system locations is counted, and this total figure is carried as the Serviceable Summary Balance.

g. In Transit[3] Summary

A count of all materiel which is moving from one location in the system to another location within the complex is recorded as an In Transit Summary Balance. These are system assets which are to be available soon to satisfy requirements. They must, therefore, enter into any analysis of system-asset position.

h. En Route[3] Summary

The sum of all materiel which is in shipment from outside the system to a system location, e.g., a prime Air Force depot shipping directly

[3]For fuller discussion, see Chapters V and VI.

to a WSSS, is noted in the En Route Summary Balance. In addition to differentiating the accountability for the stock, this breakout also allows the consideration as assets of the amount of an item on its way to system locations in the same manner as one uses the In Transit stock.

i. Backordered Summary

The existing backlog of all unfulfilled base-originated requests to the storage sites is summed and carried forward in this balance.

j. TOC Summary

A count of all line items in the system awaiting technical order compliance.

k. Reparable Summary

A count of all line items in the system awaiting repair. (Some EDP systems may desire to count only those above base level.)

It is apparent that the summary data described above are essentially of two kinds: 1) system-monitoring levels (b through e) and 2) system balances (f through k). A discussion of each type follows.

The system-monitoring levels can be considered as guideposts which are checked during each processing cycle. By comparing the system stock status with the levels, clear-cut supply decisions can be made. For example, when a shortage for a particular part exists in the system such that the system stock status is equal to or below the WPL, but above the AL, only priority requests are allowed to be filled. Another set of decisions involving replenishment are determined to a large degree by the first three levels (RQL, WPL, AL). When the system stock status is at or below RQL but above WPL, there is normally sufficient time to replenish; when the system stock status is at or below WPL but above AL, replenishment must be done with some urgency; and when the system stock status is below AL, early replenishment is imperative. These levels must of course be changed periodically to conform more closely to a change in the operational program of the weapon, and the analysis criteria may vary with different categories of stock in accordance with the desires of the manager. What can be assured to administrative echelons of inventory controllers is the uniform application of their policies, even though they may vary from line item to line item; for, once a rule is specified for a given line item, all system locations are supervised to guarantee the satisfaction of the rules.

The backbone of any supply system is its record of balances. Those listed in f through k above are those used in the Air Force today. At present, quantitative reports of assets in transit between depots and bases and between depots within the zone of interior are gathered only for the Hi-Valu items. Although the need for such data has long been recognized, they are extremely difficult and expensive to obtain. The maintenance of the In Transit and En Route balances by the DPC should overcome many of the difficulties and appreciably lower the cost of collection.

A few words need to be said here about the system Stockage Objective (S.O.) -- the total quantity of supplies needed to meet issue demands for a predetermined period of time. The S.O. is used in one of two ways; 1) to measure system excesses (if any), or 2) to determine the quantity to be reordered when replenishment is required. In the former case, the checking for excesses is done periodically; in the latter, the RQL is checked in each cycle, and the S.O. used if the decision is made to replenish. The S.O. is obtained by a requirements calculation, periodically and when designated levels are reached. An example is the Logistics Early Warning System (LEWS) at SMAMA.

3. Location Data

The DPC is the agent for keeping the records for all locations in the system complex; therefore, the consolidated stock record must list, for all these locations and for all possible conditions, the balances of stock on hand. These balances include serviceable, reparable, TOC, on-work-order, and Defective Materiel Report (DMR) items. Further, any obligated stock, such as "F" Account, "T" Account, and the like, requires an entry in the record for any location holding such materiel. Then, just as there were system entries for In Transit and En Route balances, so must there be entries of this type in each of the location records. The need for this information becomes apparent once it is recognized that management-review procedures which are possible for the whole system, with the RQL, WPL, AL, and the WRL available for comparison with the system stock status, can be accomplished for each of the locations in the very same way. Of course, this requires a Stock Control Level (SCL), a Reorder Point (RP), and a Minimum Reserve Level (MRL) to be specified by management for each of the bases and sites. Just as soon as the base stock status (computed with the same formulas as above, but not including base backorders) reaches the Reorder Point of that base, a routine replenishment shipping order will be written by the EDPE, thus relieving base supply of the burden of preparing the replenishment requisition. At bases and at sites, only stock-locator records need be kept, with only an approximate inventory indicated for each item in stock. With each base action for all stock items being reported to the DPC for posting to the consolidated record, it is possible for the DPC to compute the SCL for these bases; furthermore, the individual SCL for each location in the system can be set with due regard to the entire system supply of an item. For example, if adequate stock of a given item is on hand in a storage site, the SCL of the bases may be arbitrarily increased over what their normal consumption data indicate this number to be, a procedure which reduces the probability of stockouts at the bases and, therefore, decreases the incidence of high-priority requisition activity. Since the knowledge of stock location remains with the DPC, the bases, in addition to protecting themselves from unexpected stouckouts, are acting as dispersed stockage points from which materiel may be repositioned, if need arises, by a DPC-directed shipping order.

C. Main Balance Processing

In order to keep stock records "current," a period of updating must be established and adhered to. The limitations to maintaining master files current for logistical use should be well known to supply managers: files purporting to contain identical data are scattered over many offices, and little or no reconciliation is attempted among them; day-to-day requirements for using the files make it less likely that known revisions of the qualitative type are posted until there is a "break" in the activity requiring the file, e.g., the addition of a new substitute part number to a substitution record; the necessity for going through "proper" channels of communication for approval of revisions impede the prompt entry of changed information. Keeping the files "current" is also made difficult by the steps involved in the use of the records: a task may be rather complicated, as when one starts tracking down a suitable substitute part for a particular aircraft application; processes may be time-consuming, as when ten thousand actions must be posted daily to forty thousand different stock records; a particular activity may not be able to be accomplished in a desired time because special rules may necessitate appeal to an authority higher than the posting clerk who is using the records.

As regards MB processing for the weapon system, the proper use of electronic computing and data-processing equipment will add more currentness both to the keeping and to the using of the manager's records. This is due to the large magnetic-tape storage capacities and the rapid rates of calculating and data handling. Nevertheless, some of the same factors which reduce the "instantaneous responsiveness" of a non-electronic system of record-keeping and management-review may inadvisedly be carried over to the EDP system. For example, if the managing echelon is reluctant to impart to computing equipment its routine decision rules, it may force the machine, instead of the posting clerk, to halt an action which would make the information in the files more current. Just as the clerk now appeals to higher authority for approval, so the computer would have to reject a transaction for management review.

It is important to stress that MB processing can be made to achieve any desired degree of currentness, given enough computing machines, communication links, authority in the EDP to make decisions, etc. Just what is practicable is limited by the usual factors of manpower, money, and mission obligation. In trading off between these factors, it is strongly suggested that the following question remain uppermost in mind: How much timeliness is really needed for the inventory-management and -review function?

There need be no exhaustive justification for requiring transaction reporting from weapon-system locations in the case of centralized record-keeping. The necessity is self evident: if the records must be kept, the updating data must be sent. How soon after the occurrence of an event, which changes a balance at a system location, the notice should be dispatched to the DPC is a question of timeliness and needs to be decided by management. With regard to how soon file information transactions ought to be relayed to the DPC, it is more desirable to have the recordkeeping center informed of these changes, insertions, and deletions even before informing the system locations; the DPC records would then be a true reflection of reality. The DPC might even act as the agent for dissemination of this information to the using locations, since the DPC has the means of acting as a translator between old and new information[4] when time lags or errors cause transaction notice inputs to be in the old information form, e.g., a requisition for an item whose stock number had changed the previous month.

1. Types of Transactions

There are two types of transaction notices required by the DPC to adjust its records to correspond with reality: 1) notices which indicate a balance change, and 2) notices which indicate a file change. Each is discussed in turn.

a. Change-Balance Transactions

1) Inventory Adjustment

The amount of materiel in any stock status may be adjusted by an actual count to a figure different from that on record at the DPC. If this is a Serviceable adjustment, the necessary reduction or increase must be posted to both the Location and the System Summary balances, and, in the case of a decrease, management review of the "stock status vs. levels" will be

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[4] See Chapter II for fuller discussion.

initiated. This will be automatic, regardless of where in the system the adjustment is initiated.

2) Issues

Whether an issue of materiel at a system location is made to "F" account, to FAK, to TOC, etc., or to a using operational unit, the simultaneous double posting, i.e., decreasing one location balance and increasing the other affected balance, will be made. If Serviceable materiel is to be sent outside the system, the system summary totals will also be decreased, again inaugurating a "stock status vs. levels" management review. The presence of all system locations balances in a consolidated record provides for an ease and speed of posting these events which, in itself, provides the capability of maintaining complete records of all conditions of stock that have a bearing on the related inventory-management problems of requirements, optimal distribution of materiel, and financial accounting. Since requirements must be computed by management, taking into account the various uses of stock items, e.g., to support maintenance, FAK, tables, normal wearout, and UAL, these balances appear on the consolidated record of the MBF and require transaction reporting to be kept up to date.

3) Receipts of Serviceable Stock

Any stock entering the system from contractors or prime Air Force depots must be posted to the system's account; the proper entries are achieved by having the consignee of the shipment send a notice of the amount received to the DPC. The System Summary balances, as well as the Location balances, of both the Serviceable and En Route amounts are adjusted to correspond to the number of items received, En Route being reduced by this figure. In the event that this is an overshipment or an undershipment, this fact will be corrected by a notice from the Shipment Control function,[5] which would then cause the System and Location En Route balances to be adjusted accordingly. If materiel is moving within the system, as in the case of a shipment from a site to a base, the transaction notice the base sends to the DPC will be posted as above, but the In Transit balances, instead of the En Route balances, will be adjusted as above.

4) Requisitions

The action to be taken in answering requests from using organizations, i.e., bases, contractual maintenance facilities, depot overhaul points, etc., depends upon a number of factors. These may be enumerated as:

a) the amount of issuable stock in the system relative to the requirements of the system;

b) the mission category of the requesting unit or organization;

c) the precedence rating of the requesting unit;

d) the need date for the materiel;

e) the time of arrival of the requisition at the DPC.

It is important that time of arrival be discussed first in any procedure for the processing of requisitions by a data-processing procedure in which EDPE plays a dominant role.

It is basic to the Air Force supply procedure for answering requests for materiel that "high priority" requests be processed in shorter periods of time than are allotted to "low priority" and "routine" or "replenishment"

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[5] See Chapter VI for fuller discussion.

requests. Air Force Manual 67-1, Volume XIX, defines the Air Force depot stock levels which must be maintained as insurance against requisitions of the Immediate- and Intermediate- and the Routine-need categories; however, both Immediate- and Intermediate-need requests for mission categories 1, 2, and 3 users are allowed to draw upon depot stocks to zero days of materiel, and all other requests may draw upon depot stocks to a 30-day retention level. If action to fill a request is initiated as soon as it arrives at the DPC, on an on-line basis with respect to time of response, then, in the sense that each request is getting the preferential treatment desired for the "high priority" demands, the priority system fails to protect the higher-precedence user. This is particularly true in view of the lack of dissimilarity in the retention levels for different priorities of requests, e.g., down to 30 days for Priority 15 and Priority 4 requests. In the situation where critical items, or items which are in system short supply, are being requested, adhering to the above time- and retention-level criteria tends to cause high precedence units within operational commands to be relatively unprotected.

Begging the arrival-time question, rules for the DPC to follow in answering requisitions can be set down. In any given interval of time, a ranking of existing requests is possible so that the currently most urgent need will be filled, and then the next, etc., until all outstanding requests are either filled by the writing of a shipping order, backordered, or otherwise indorsed in accordance with the amount of issuable materiel in the system.

5) Shipping Directives

Allowing for management-directed shipments of materiel on an exceptional basis, Shipping Directives are input to the MB processing operation.

The Shipping Directive is a method of bypassing the ordinary rules of responding to requisitions, as described above, thereby providing flexibility to materiel management in extraordinary circumstances. If, for example, a request for an unusual amount of materiel is made by a base because of an urgent modification program, the normal processing procedure would be to monitor this request and reject it, setting it aside for managerial intervention, even though the proper justification coding appears on the requisition. If the request is approved, the Shipping Directive is written, and then reentered into the data flow and posted to the proper consignee and consignor balances without further analysis. Filling requests for Air-Force-regulated items may necessitate this sort of human intervention into automatic management techniques and may result in the writing of Shipping Directives for approved cases.

6) Action Reversals

Any transaction may be reversed for valid reasons. Those that can be successfully intercepted will be reverse-posted to the master records; where the reversal cannot be accomplished, as in the case of a requisition already filled, the reversing location must be notified by EDPE output to cancel the Reversal. Without reversal capability, clerical errors and those of the electrical communication variety would be difficult to correct when detected.

b. Change-File Transactions

1) Insertion, Deletion

Allowing for communication with the EDPE to expand or contract the size of the master files makes the maintenance of these files just another processing step to be accomplished concurrently and routinely with other transaction posting. Once effected, the records are in the status desired by the manager at the controlling site; the DPC can now become the focal point for disseminating this information throughout the system.

2) Stock-List Changes

A form of information change which affects only a part of the Fixed Indicative Data in a master record is the Stock-List Change. For example, an item may be declared Hi-Valu by the publication of a new TO, which would necessitate changing the cost-category coding in the MBF. Since these data in the file are deemed necessary to accomplish a complete list of desirable logistical actions, e.g., Stock Balance and Consumption Reports, differential processing for differently coded items, mode of transportation scheduling, etc., Stock-List Changes are a vital transaction input for maintaining a current set of records.

The stock number itself is a field of information which is subject to change, either in the form of a consolidation with another existing stock number, or a complete modification, as in the case of the introduction of the Federal Cataloging process. The entire Federal Supply Classification (FSC) renumbering, with the use of individual Stock-List-Change transaction inputs to the information flow of the DPC, becomes a very orderly, exceedingly simple, process, which is easily monitored by the Classification function[6] of the DPC to assure compliance at all using levels in the system. As in the case of the Insertion and the Deletion transactions, the "as of" date of the stock-number change becomes the day on which all activity is recorded against the new number merely by entering the single transaction into the processing

[6] See Chapter II for fuller discussion.

operation at the start of the processing cycle for that day. There need be no suspense file or any other form of interruption to normal logistical activity during the changeover.

3) Level Changes

Changes in system or base requirements are transmitted to the records in the form of corrected monitoring levels. If the system stockage objective for a part changes, the Requirements Level, if not all the system monitoring levels, would be adjusted to this change. Similarly, bases may desire to adjust their Stock Control Level. As a management-initiated input, level changes enter the processing cycle, and, instead of a posting action to the MBF, a replacement of the old by the new levels takes place.

A word about requirements computation is apropos, since the management monitoring levels are no more than a reflection of the gross system-wide requirements for each item. At the instant that these requirements are incorporated with the stock records for each item managed at the DPC, the computation of either the net deficiency that exists in the system or the excess stock of an item is made, using the up-to-date summaries of system stock in all categories as brought forward in the records under System Summary Data. Management is advised of forthcoming shortage under the condition, for example, that a deficiency exists which is not to be overcome by contractual due-in; outstanding due-ins may call for renegotiation in the case of existing overages if there exist maintenance or procurement contracts that are current. Any Level Change transaction automatically triggers this type of analysis, which provides management the use of inventory and associated records as a true management tool, and not merely a set of records to be brought up to date as an end in itself.

c. Requests for Information

In any large inventory-management system, a means must be provided for interrogating the master files in order to view bits and pieces of relevant data not available soon enough, if ever, from a routine report. A Request for Information is a transaction input to the processing cycle that defines, by appropriate coding, the specific type of data required as a printed listing or a typewritten notice. Without any more effort than it takes for the machine to post an issue of an item out of stock at a base, this transaction provides to the managing echelon an adequately rapid answer to any query it may have with regard to any of the information in the set of DPC consolidated records. Stored on high-speed electronic or magnetic devices, this information is not visible, except on demand through the use of the Request for Information. Where this random inquiry of a file on an infrequent basis replaces the regular printing of a complete report, which is to be referred to on an infrequent basis, the ability to make a Request for Information serves management well and relieves what could be an unnecessarily time-consuming burden on the DPC.

2. Main Balance Outputs

As mentioned previously, the outputs of the Main Balance processing may be reports or action notices. A discussion of each follows.

a. Reports

1) Main Balance File (MBF)

The MBF is considered a report even though it is rarely, if ever, put out in its entirety; parts of it are reported, e.g., when answers to Requests for Information involving the MBF are given or when Stock Balance and Consumption Reports are issued. In a very real sense, therefore, the MBF is a continual report to management.

2) Transaction Register

Each input to the MB processing function will generate at least one output, i.e., an entry to the Transaction Register (TR) for the processing cycle. To be sure, additional information might be placed on this original input, in order that the aggregated TR, when it is published for some period longer than one cycle, may show a history of transaction processing for each of the locations in the weapon system. In the case of the issues, receipts, etc., where balances have changed, the new balance caused by posting is added to the transaction before it is placed on the TR. In the case of requests for materiel, action coding is added to the original input to indicate the DPC action in response to the request. For the entire set of transactions which never change balances, DPC control procedures might dictate the desirability of endorsing the input before entering it to the TR. In any event, there ideally exists a traceable line of actions starting with the input, indicating the action taken, and ending with a TR for each cycle, which is available to a manager either in separate-cycle or in periodically-aggregated form for a number of cycles, and which gives him a picture of the business he is doing by item, by location, by condition of stock, or by any significant form of breakout.

3) System Short-Supply Notices

Previously, in discussing the information contained in each consolidated stock record on the MBF, the use of the system monitoring levels was described and mention was made of the warning provided to indicate impending, or existing, criticality within the system for given stock items.

Essentially, the MBF is being used in the manner indicated under the description of the file itself as a report, but this is such a significant use, and is so much an intrinsic part of the inventory-keeping and management-review function, that special emphasis must be given to the System Short-Supply Notice.

The System Short-Supply Notice is written as soon as a review of the stock status against any of the system monitoring points, i.e., the Requirements Level, the Warning-Point Level, the Allocation Level, and the War Reserve Level, indicates that one of these points has been reached. This output for management review can include:

a) Serviceable Stock on Hand in the System;
b) Stock In Transit in the System;
c) Stock En Route to the System;
d) Backordered Summary Systemwide;
e) Each of a), b), and c) for Each Location in the System;
f) A List of All Monitoring Levels for the System.

This information, in conjunction with both consumption reports and the due-in schedule for the affected item, accomplishes three things: (1) gives the complete set of data required for expediting procurement, maintenance or shipment from prime sources in order to overcome these shortages, (2) provides definite knowledge of the stock status at each location, thus allowing for repositioning stocks between locations to meet emergency needs pending arrival of due-in materiel, and (3) allows for a recomputation of the monitoring levels to determine if, indeed, a shortage exists under the demands of the latest known programmed requirements.

If the item which reached a monitoring level was in a subfamily, then the Substitution and Allocation function,[7] would have written individual

[7]See Chapter III.

transactions to the MB function to have the Short-Supply Notice written out for each member of the subfamily. In this case, the notice also lists a summarization in each of the above six items in terms of the entire subfamily, i.e., Subfamily Serviceable Stock on Hand in the system, Subfamily Requirement, Warning-Point Level, etc. Because of the nature of a subfamily, wherein all items are completely interchangeable for all applications, it is only by compiling a report on the total subfamily assets that the manager can be provided with a clear asset-position picture.

Occasionally, these notices will be generated when one item falls below a monitoring level while the total subfamily stock is not in critical position. The following table is indicative of such a situation:

	Stock Status	Monitoring Levels			
	(OH + IT + ER - BO)[8]	RQL	WPL	AL	WRL[8]
Subfamily Total:	49	36	18	6	2
S/N AAA	31	16	9	3	2
S/N AAB	10	9	4	1	0
S/N AAC	8	11	5	2	0

Only S/N AAC has reached a status which ostensibly requires management review; the RQL is 11, and there are only 8 available in the system. The protection provided by the ample store of AAA parts, which are interchangeable with AAC, leaves the system in good operating condition, i.e., the subfamily total system status shows 49, while the first management-review level, the RQL, is only 36.

[8] Abbreviations: OH - On Hand Balance, IT - In Transit Balance, ER - En Route Balance, BO - Back Order Balance, RQL - Requirements Level, WPL - Warning Point Level, AL - Allocation Level, WRL - Warning Reserve Level, and S/N - Stock Number.

In this case, it might be desirable for the computer to suppress the printing of any System Short-Supply Notice, since the manager may consider the entire subfamily to be a single stock item for the purpose of making distribution decisions. In most cases, the system subfamily levels provided by management become more meaningful if an alert for stock-control purposes is sounded only when one of these has been reached, regardless of the asset position of an individual item in the subfamily. In these cases, the subfamily levels provide the protection formerly provided by the individual-item levels.

A special case of a System Short-Supply Notice is that of the system stocks for a part falling to zero, regardless of the monitoring levels involved. The use for a notice in this case is to rid the system of records for those items for which there is no corresponding stock.

4) Initial Backorders, Expiring Backorders

Under the priority rules set down by the manager, certain requests for materiel may have to be backordered pending an improvement in the stock status for the item requested. When this action is taken by the DPC, notification to the base will occur (see below), and the request will be written on the Initial Backorder File. At some future time, and after having been merged in order of priority and days of need with previous backorders for the same item, the backorder file is reprocessed, and an attempt is made to fill these requests. The notification of a receipt of this item into the system may be the trigger which initiates the calling up of outstanding backorders.

Because requisitioning does not halt when backordering on any item starts, it is necessary to survey the Backorder File to update the priority, insofar as the number of days of need is a factor in determining the priority of a request. This assures that current requests of the same priority are not filled before an old backorder that is due for a priority updating.

As a by-product of this updating process, the backorders which progress out of the Intermediate-need category into Immediate-need (by virtue of the fact that the numbers of days to their need date has become less than eight) are listed on the Expiring Backorder File, allowing up to seven days for expedite action or cancellation by the appropriate management monitor. This regular reminder points out the really troublesome items of the inventory and is a forceful method of assuring that action is being taken on items which really require managerial interest; the others, routinely processed by the electronic computer, require no exceptional concern.

b. Action Notices

1) Short-Supply Triggers

A companion action to the System Short-Supply Notice may be required under conditions which make impossible the publication of all the information listed as management-review output without calling on other files in addition to the MBF. Such is the case, for example, if the due-in portion of the master files is independent of the inventory assets at each location and is maintained on a separate management basis.

The greater part of any master due-in file is a long-range projection of anticipated receipts. A short-range extraction from this file into a working file to be used in evaluating the asset position for a close-in period may be desirable; however, when the total asset picture has to be known to a manager, the inventory holding plus in transit plus long- and

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short-term due-in data must be assembled in a consolidated publication. The Short-Supply Trigger is written at the time the Short-Supply Notice is created. The Short-Supply Trigger is used as a transaction input to cause a report to be printed from each master file that has any management information which must be added to the Short-Supply Notice to complete the asset picture. When management data are scattered over a number of functional master files, a Short-Supply Trigger is required to create a consolidated report for management review.

2) Backorder Notices, Cancellation Notices

In the process of backordering a request for materiel, a document is written by the EDPE for transmission back to the originating base or organization. This Backorder Notice is the only indorsing document that need be returned to the requisitioning organization unless a management-directed Cancellation Notice is issued for a portion or all of a particular request. Any other indorsement, such as extracting materiel from a prime commodity depot, requires that the action taken on the requisition be communicated from another agency. Of course, if the shipment will be made from a system organization, an advanced shipping document will be sent by the shipper. The interest of the system is served by providing a closed-loop procedure in the requisitioning cycle, and not by providing for a flow of paper through the system at every handling station. Therefore, the requisitioning organization receives either (1) a Backorder Notice, (2) a Cancellation Notice, or (3) an advanced copy of a shipping document from the system organization, or alternatively, (4) some notification from the organization to whom the original request has been signed over. Thus informed as to the disposition of its request, the base supply organization has ample information to plan its action, and adequate control is provided at each point of responsibility to either monitor the activity required to ship the materiel where it is required, or to tell why that is not possible.

3. Shipping Orders

Perhaps the most significant action-notice product of the inventory-control and management-review function is the Shipping Order. This is the document issued by the DPC, under the authority of the manager, directing a storage site, contractor or other location storing or using system materiel to effect a shipment of a specific quantity of a stated item to a designated consignee in such a manner as to arrive before a given date. Such entries as the date of need at the receiving point, the quantity to be shipped, and the consignee, are either given with the original requisition, if the Shipping Order is in answer to a base-originated request, or are available from the base's portion of the master stock-number record, if the Shipping Order is a DPC-initiated routine resupply. However, an extremely important entry on the Shipping Order is the consignor, the choice of which is made from MBF data.

The problem of choosing a consignor for an isolated shipment of materiel to a given location from an assortment of possible shipping points can assume various degrees of complexity dependent upon the numbers of factors which are determined to be significant in the decision process. Many of the basic factors in the decision are purposely part of the consolidated master record of the MBF. The quantities on hand ready for shipment at each of the possible shipping points is important and is part of the MBF. A shipping-area pair of indicators which ranks each of three possible storage site locations in a preference order to each base location is also a part of each base record in the MBF. If the decision rule in selecting a consignor is limited to:

> 1) Select the area storage site if any stock is available, then select the next-preferred storage site, and, as a last resort, choose the last storage site;

or, if the statement on consignor choice is given as:

> 2) Always choose the area storage site, unless excess stocks exist at one of the other sites, in which case, choose that site;

then the assignment of shipping source is clearly a function of the Main Balance posting process. The master record, which contains all the necessary information for selecting from among the possible consignors, also contains the consignee data with which to set up in transit amounts and in every other way complete the posting and preposting required with every Shipping Order preparation. Hence, it is the relatively simple set of rules, primarily the limitation of the choice of consignor to the storage site only, which makes possible the filling of a requisition immediately simply by considering the inventory balances and appropriate codes contained in the MBF.

The decision process may be augmented with other criteria, e.g., when base-excess stocks of an item are made available for redistribution. Then the rule which may be desirable in filling requests for materiel from a base might be as follows:

> 3) Select the area storage site if any stock is available, then any excess stock from any other base in the same area, then the next-preferred storage site, then any base in that area having excess stock, etc.

Insofar as the rules set down for assigning the consignor do not embody optimization techniques for choosing between alternate modes of transportation or ideal lot size of shipments, analysis of the consolidated master record should produce a reasonably appropriate consignor for any required shipment.

Shipping orders can result not only from answering a request for materiel submitted with proper priority by a base, but from routine-replenishment needs at a base as well; this replenishment is automatically triggered at the DPC when the reorder level is reached in the course of transaction posting and or preposting. In this case, the same procedures as listed above may apply, or, if desired, differential processing action may be taken. Since the reorder quantity is a factor maintained in every base record in the consolidated master record, and the "days of need" is known for replenishment needs, the data processor, in effect, creates a request for the routine replenishment. Perhaps the choice of consignor for this type of shipment is limited to in-area storage sites only, in which case the EDPE is limited, in its analysis, to checking the availability of stock at this single location only. However, whatever the rule may be, if the Shipping Order is written, i.e., if a backorder does not result from this analysis, it will be completed as soon as the need is made known to the system. This constant surveillance of stock levels by the EDPE, and prepositioning materiel for expected needs, will reduce the system-wide use of priority requisitioning by bases.

Chapter V

THE DUE-IN FUNCTION

A. Introduction

This discussion of the "Due-In" function[1] considers its relationship with the other functions, the reasons for maintaining Due-In records, and the subfunctions that it comprises. The discussion is applicable to most EDP systems regardless of their magnitude or method of implementation.

The Due-In function is concerned with maintaining current records of items that are on order from suppliers, contractors, and other Air Force activities to the various stockage locations within the system. This function encompasses more than "Procurement Status," which is used presently at the depot level to identify the records of materiel due in from contractors only. A weapon system manager has items due in from depots and from contractors in his Due-In file; these items are from outside his EDP system although not necessarily outside the Air Force system. Similarly, the property class manager will have items due in from the maintenance operations as well as from contractors in his Due-In file.

The Due-In function can be thought of as occurring between the time when the supply manager initiates a request for new procurement or triggers the repair of reparables and the time when notification is received that the materiel has been received at the stockage point or that a shipment record has been entered in the Shipment Control file.[2] The Due-In function

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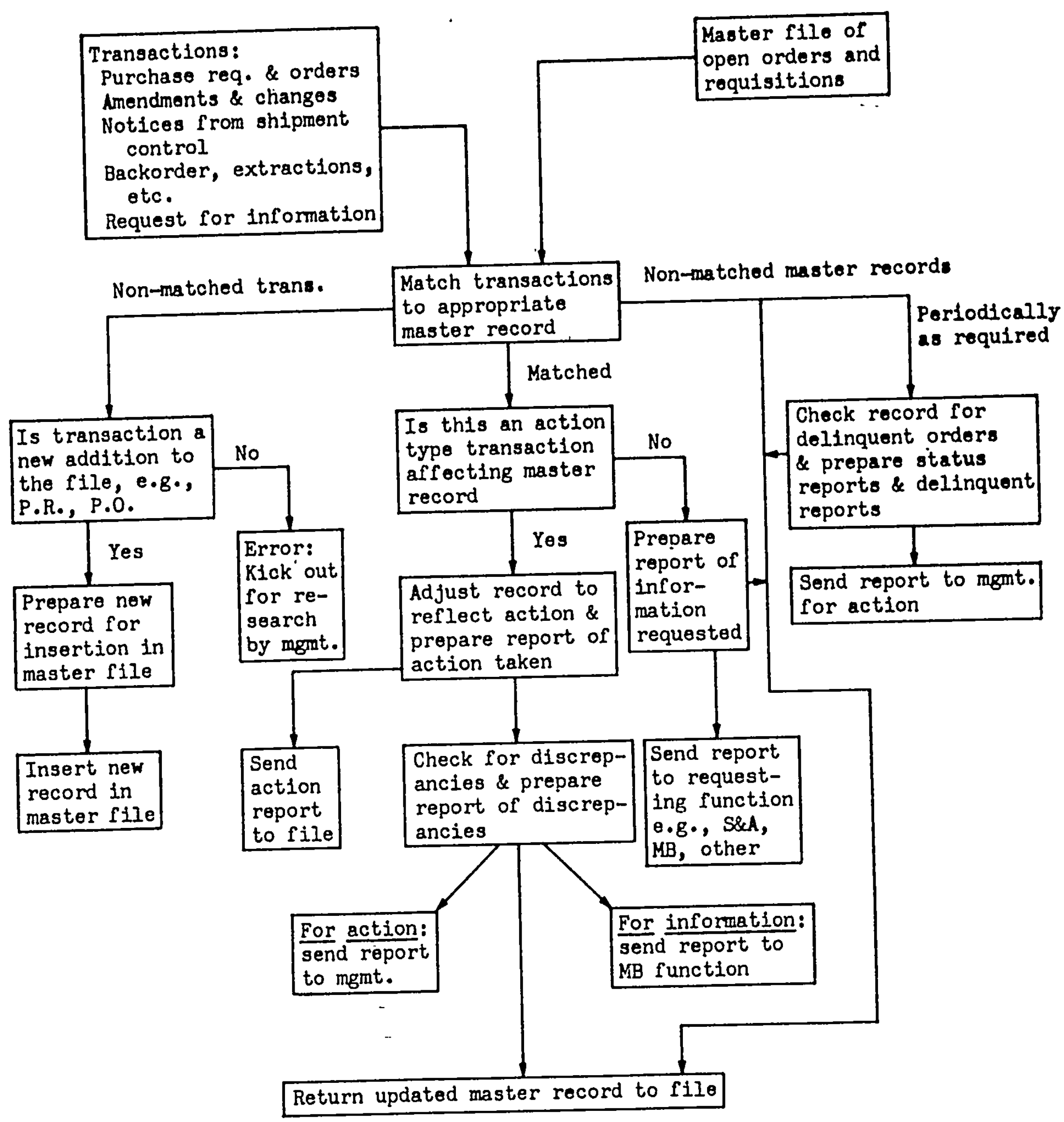
[1] See Figure 4, Page 88 for logical block diagram of the Due-In function.

[2] See Chapter VI for fuller discussion.

Figure 4

LOGICAL BLOCK DIAGRAM OF THE DUE-IN FUNCTION



must furnish on-order information to the requirements function so that meaningful net requirements can be calculated. The Due-In function must also receive the same receipt information as the MB function since the latter periodically requires information from the former. This shows a specific detailed tie-in at each end of the operational sequence. This sequence is described in more detail.

B. Purpose and Need for Due-In Records

The necessity for keeping the records of on-hand balances of materiel at various stockage locations is always recognized, while the maintenance of timely and accurate records of the on-order status of the materiel destined for these same locations is often ignored. If the picture of the stock position is to be complete, proper records of the on-order status records must be maintained.

It is recognized by the Air Force that the job of maintaining accurate and timely records of due-in's has not been accomplished effectively in the past.[3] With the early prospect of using EDPE for inventory control, an effective Due-In operation becomes possible. Because the Due-In function is both complex and necessary to the other functions, it must be performed on EDPE along with them.

An important part of the Due-In function is the generation of reports for the various levels of management. As an example, when the requirements function computes the gross requirements for a part over the next time period, the result must be adjusted both by the assets on hand and those due in. If the Due-In records are inaccurate or not available, the procurement for

[3] See Air Force Manual 67-10.

the next time period will be in error. This type of error must be eliminated in order to produce meaningful net time phased requirements. Further, when the scheduled deliveries shown by the Due-In records do not arrive at the stockage points on time, the Due-In function informs management of the impending short supply. When suppliers are too far in advance of the due date, the resultant early shipments can cause a critical shortage of storage space. The Due-In function informs management so that possible warehousing strain on the system can be averted.

C. Due-In Subfunctions

The Due-In function comprises three subfunctions: 1) recording original requirements schedules, 2) processing transactions affecting the original requirements schedules, and 3) preparation of reports for management. A detailed discussion of each follows:

1. Recording Original Requirements Schedules

The requirements schedules that are provided to the EDP system are in one of two forms: 1) a copy of a purchase request to procurement to purchase the item from contractors -- in the case of the property class management, or 2) a copy of a requisition on a property class depot -- in the case of the weapon system management. In either case the Due-In record is established from the source data immediately as these data are originated; this enables the Due-In reports to reflect information correctly for all users. The pertinent information about each order must be recorded so that it is readily accessible, i.e., it can be updated easily and requires few manhours to make it available to management.

The information to be retained in this file will vary to some extent with the limits of the particular EDP system to be served; there are, however, certain basic elements which must be recorded in any Due-In record:

(1) Identification number and/or name of the item.
(2) Total quantity of the original order, as amended.
(3) Scheduled quantities and dates for specified locations.
(4) Document identification number for internal and external communciations.

Other data, such as unit price, ledger account, mode of transportation, etc. may also be included.

2. Processing Transactions Affecting Original Requirement Schedules

The original requirements schedules are changed by two types of transactions: 1) amendment-type and 2) action-type.

a. Amendment-type

The original record is usually subject to additions, corrections, and deletions before the materiel on order has been completely delivered. The change of the record from a purchase requisition to a firm contract record is one example of a normal addition of pertinent information.

Adjustments to the original quantities and/or to schedule dates may occur because 1) the entire program for which the requirements were computed has been altered, 2) the same program may be in effect, but the usage rate for the item has changed due to an undetermined cause, 3) the source of supply has been unable to meet the original delivery schedule or delivered more than originally anticipated, or 4) an error has been corrected. It should be emphasized that the volume of these changes is likely to be considerable. Under some circumstances an unprocessed backlog of amendments may develop to the degree that the records cannot reflect the true situation, and the quality of the information obtained from these records would necessarily be lowered. Therefore, the amendment of schedules must be treated with the same importance as the establishment of the original records.

b. Action-type

Given an initial accurate record in the Due-In file the posting of all subsequent action-type notices, e.g., receipt of the items at stockage locations or the return of items to the source of supply, becomes a straightforward bookkeeping job. Much of the information furnished to management from the Due-In operation is generated as a result of the routine review of the Due-In file during this posting cycle. Many of the discrepancy-type situations can be detected only when an action is posted to the records. For example, an overshipment can be determined only when receipt of the overshipped items is posted. Another example, when there is an attempt to post a receipt action notice to a missing record, the EDPE refers the discrepancy to the attention of management.

This type of information, which is available as a by-product of the normal posting cycle, is referred to as "cycle reports" and is discussed below.

It should be pointed out that the volume of discrepancies grows considerably when the preceding subfunctions, i.e., the recording of information and the processing of amendments to the record, are not accomplished accurately or on time. It must also be remembered that these discrepancies may necessitate diagnostic action on the part of some individual, since EDPE cannot do as efficient a job of diagnosis in many cases.

3. Preparation of Reports for Management

The product of the Due-In operation is information furnished to aid in management decisions. This product is of three types: 1) cycle reports

2) periodic, or recurring, routine reports, and 3) reports answering specific requests for information. Where applicable, the frequency of reports and the time allowed for response to requests is included in the discussions below.

a. Cycle Reports

Cycle reports note the occurrence of any situations concerning the Due-In records. These are recognized during the normal posting operation and may be either the completion of an order due to receipt of the last shipment, the overshipment of the delivery schedule or of the complete contract, or a receipt action notice which cannot be matched to an order. These reports require some type of action by management. In most cases feedback information will be required in order to correct discrepancy situations. Usually, the information contained in the cycle reports requires some positive action by someone outside the record-keeping operation. It is assumed that any corrective action will be transmitted to the EDPE to be reflected in the records.

The frequency of the operating cycle for the Due-In function is contingent upon management's decision as to how soon it wants to take action on a short supply notice issued by the Main Balance function.[4] For instance, if management decides that it wants to act on short supply notices by the end of each day, the Due-In function must provide the necessary up-to-date due-in data, i.e., the Due-In function would have to have a one-day operational cycle. Where there is no need for the short supply notices to be acted upon within a day, the operating cycle of the

[4] See Chapter IV.

Due-In functions then becomes dependent upon such factors as volume of due-in transactions, EDPE constraints (storage capacity, speed, etc.), and timelag between date of receipt of shipping order by DPC and actual shipping date.

b. Periodic Reports

By definition the only information included in the cycle reports pertains to those records that have some action during the operational cycle. At less frequent intervals all records in the file must be examined and reports furnished to management. These reports could include such information as 1) each record, 2) selected records, and/or 3) summaries thereof, e.g., current undelivered balance, quantity behind schedule by some time periods, next scheduled delivery date and quantity, or quantity due in within the next ninety days. This type of information is current as of the time prepared and can be sufficiently accurate for a period of time determined by its usage. For example, the quantity due in within the next ninety days would remain the same for one month, since most deliveries are scheduled in monthly increments.

Since periodic reports are, for the most part, status reports, the frequency with which they should be prepared is dependent upon the magnitude of the status changes and, more important, the effect of these changes on the usefulness of the information presented. For example, in a report which presents the behind-schedule information about due-in's scheduled monthly, the status picture will not be any "worse" (further behind schedule) until one month later. The only change in this information during this month might be that it will be "better" (some of the delinquent materiel has come in). In this case it does not seem that much could be gained by providing the behind-schedule report more frequently than monthly.

c. Special Reports

Certain due-in information, not included or not current enough in the regular reports, is often required by management. An excellent example of this is the case where information is needed because the balance of an item in the system is critically low. Before the manager can decide on the proper course of action, he must know of the complete on-order position of the item at that time. A special report will show the quantities due in to each of his storage locations by specified dates from each of the sources of supply. Given this position, he can decide whether to expedite a shipment into the system, place an additional order with a source of supply, or divert a shipment to a different location.

The situation for items in extremely long supply also requires special attention. In this instance, before the manager can decide the source of supply from which he must cancel or delay shipment, he must have the complete due-in information. There are other situations which will require that special reports be prepared from the Due-In records, but management should be made aware of the fact that special reports are not a free commodity to be asked for merely because they can be made.

It is most desirable in terms of EDP efficiency and convenience to furnish the special reports at the same frequency as the cycle reports, i.e., at the end of each operating cycle. Any special information should not be required with greater frequency then an operating frequency of once per day. For example, the requirements people want to know the total on-order quantity for a part or the manager needs to know the best source of supply to expedite shipments. Each of these actions may at first seem to require an immediate answer; in some cases, however, it may take weeks to place the order. Each situation must be studied individually in order to determine the best overall policy for furnishing special information, and the complete use of the information must be studied to determine the necessary EDPE response time.

CHAPTER VI

THE SHIPMENT CONTROL FUNCTION

A. Introduction

This chapter presents the basic purpose of Shipment Control, and then describes the necessary subfunctions. Shipment Control,[1] as distinguished from mere shipment recording, is the monitoring of the total file of shipments, i.e., closing the records for completed shipments, initiating action on delinquent shipments, and providing management with the desired statistics on transit times and other relevant factors.

Although Shipment Control applies to the shipment of materiel in various conditions (e.g., serviceables, reparables, TOC's), the discussion in this chapter mentions only serviceables. The stated principles, however, apply to the other conditions as well.

B. Purpose and Need for Shipment Control

Since supply management cannot use those serviceables which it "owns" but which are being transported within the EDP system, it is important that management monitor the movement of serviceables while they are being transported. For shipments going from the EDP system to some other system, it is necessary to maintain accounting records and provide proper follow-up.

As regards those serviceables coming into the EDP system from other systems, their status, until they arrive at their destination, needs to be a part of the due-in record. This knowledge will avoid unnecessary

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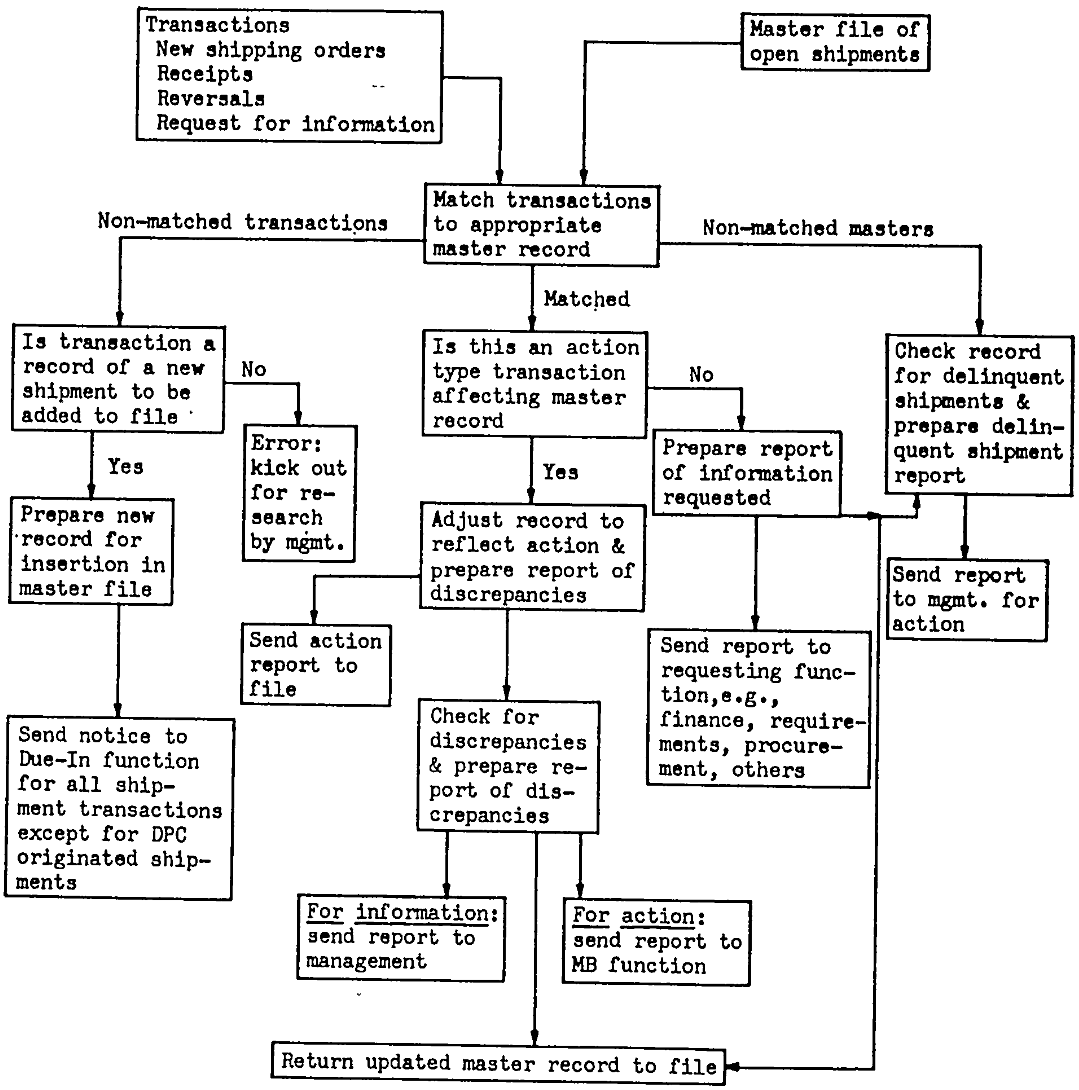
[1] See Figure 5, page 98 for logical block diagram of the shipment control function.

Figure 5

LOGICAL BLOCK DIAGRAM OF THE SHIPMENT CONTROL FUNCTION



redistribution of stocks or overstatement of requirements because serviceables in shipment were not considered.

While shipment control is being accomplished data accumulate that can be analyzed. If more shipment control data need to be generated for analysis, they can be obtained at little extra cost. This will be explained in two sections: 1) control of three classes of shipment and 2) accumulation of analysis data.

1. Control of Three Classes of Shipments

a. From In-System to In-System

The shipment of materiel from one location within the system to another location within the same system is defined as "in transit." It involves serviceables already "owned" by (on the stock record account of) a stockage location within the system. While the materiel is still serviceable in the technical sense, it is no longer serviceable-on-hand materiel.

To illustrate this condition in terms of a DPC that maintains stock record accounts for bases, assume that 20 each of Part A are being shipped to Base X from Storage Site Y. The effect on the records is that Storage Site Y has 20 less of Part A in category "serviceable-on-hand." To balance this decrease in the assets of the total system, the assets of the destination Base X must reflect the 20 parts in some manner. These assets are defined "serviceable in transit" or simply "in transit," and are part of the due-in record. It is obvious that the choice of a date for transferring these assets from in transit to serviceable-on-hand will not in the least affect the actual date when the Base X receives the assets and can issue them to the users. For distribution of assets, the only important date is the one when the assets actually go from in transit to serviceable-on-hand status. Since the records are being maintained and the distribution decisions are being made centrally, the location of destination must inform the information center as soon as possible that the assets have been returned to serviceable-on-hand status.

b. From Out-System to In-System

The shipment of materiel from outside locations into the EDP system is defined as "en route." This involves materiel that is shipped in from some stockage location not included in the particular EDP system under consideration. Examples of such materiel in en route status are: in a weapon system context, materiel being shipped from a depot to a weapon system storage site, or from a contractor directly to a base within the system; in a prime property class system, materiel being shipped from contractors to the depots of the system and directly to bases or, possibly, materiel shipped to the bases and depots from maintenance overhaul locations of other depots or contractors.

The need for monitoring shipments coming into the EDP system, even though materiel is not available for issue until it is received at destination, is shown by a few illustrations. In the case where system-wide assets of a part are low, and one particular stockage location is in short supply requiring resupply from another stockage location, it is evident that any materiel which has been shipped will be "lost" to the system during "Supply-to-Supply" time. ("Supply-to-Supply" time is the elapsed time between the moment when a supply organization in the system realizes the need for an item and the moment the needed item becomes available at that organization for issue.) If the manager knew, by means of the Shipment Control file, that these same parts were already "en route" from the contractor to the base needing them, critically low assets within the system would not have to be redistributed. In many instances, the assets due in to the system are taken into consideration in distribution decision-making. With regard to serviceables in shipment status, it is obviously more useful to know that they will be received within a given number of days, than to know only that assets are due in within the next 30 or 60 days. The availability of more precise due-in dates makes the operation of the EDP system more flexible and more responsive to the requirements of the individual stockage locations.

c. From In-System to Out-System

Shipments from locations of the EDP system to locations outside the system are called "outshipments." The necessity for control of outshipments for Hi-Valu items has already been established. There are two good reasons for maintaining outshipment control: 1) pertinent information is made available to process follow-up requests, and 2) it ensures Air Force-wide accountability of the Hi-Valu items.

2. Accumulation of Analysis Data

In executing the Shipment Control function, the EDPE accumulates accurate pipeline statistics for the movement of materiel via the various modes of transport. Analysis of the information can provide a better knowledge of resupply times, an important factor in determining more realistic stockage objectives for stockage locations. These statistics, since they include overall Supply-to-Supply times, should prove much more useful for distribution than those that consider only the transportation time. The Supply-to-Supply time is the pipeline time that is really important in determining realistic resupply standards for distribution decisions.

C. Shipment Control Sub-Functions

The shipment control function comprises basically five sub-functions: 1) recording of shipment data, 2) notification of receipts, 3) non-compliance or reversal of information, 4) file-monitoring, and 5) preparation of reports. Each of these is discussed below.

1. Recording the Shipment Data

Since one purpose of Shipment Control is to monitor all movements of assets of interest to the system manager, the Shipment file must include information about all three types of shipments mentioned earlier. All shipments-to-be should be recorded and the file records (see Table 4) should show the control date, the date when follow-up action is to be initiated. This control date may be established by a simple rule or by a sophisticated formula computed in the machine; the system manager sets the rules by which this follow-up date is computed. Examples of the computation of this date could be as complex as 1) "from Storage Site X to Base Y, allow 20 days for routine, or 4 days for priority shipments of less than z pounds gross weight, and 7 days for priority shipments over z pounds gross weight;" or as simple as 2) "from any site to any base, allow 18 days." The control dates are checked each operational cycle to determine which of the shipments are delinquent and require action. This is discussed later in this Chapter. The control date is computed for each shipment-to-be recorded in the Shipment Control file.

In order to avoid undue emphasis on specific documentation, the standard forms and names will be referred to only as examples in parentheses. The information concerning shipments-to-be which is furnished to Shipment Control is generated by two sources: 1) that internal to the DPC and 2) that from outside the system. The DPC information comprises records of all

Table 4

POSSIBLE ITEMS TO BE INCLUDED IN THE SHIPMENT CONTROL FILE

Stock number of item being shipped
Stock number of item originally requested
Quantity shipped
Unit of issue
Transaction code
Document number
Date shipment requested
Date shipped
Consignee account number
Consignor account number
Weapon system designator
Priority
Date required at destination
Mode of shipment
Parking code
Condition code
Partial shipment code
Control date

shipping directives to the various storage locations. These records normally have a control date, computed for each record. The information from outside the system (control copy of Form DD-250) would be key-punched (if not already on punched cards) and verified before being put into the EDPE for the Input Data Control[2] function. Once the information is part of the Shipment Control records, the establishment of the control date, as well as any appropriate sorting, occurs in the course of the normal DPC operations.

2. Notification of Receipts

Acknowledgement of receipt of materiel at destination is not presently required -- not even for Hi-Valu items. If the EDP system is one that maintains the balances of bases at a DPC, an accurate record of the base balances is needed for the DPC to be able to trigger automatic resupply for its bases. This, in turn, requires that the DPC be notified of receipts by the bases. It is obvious that a method of originating the receipt information which provides a balance between the workload at base level and the necessary degree of stock control will have to be developed. This is a subject that is presently being studied.

The receipts at storage sites or depots do not pose as large a problem as that just described; by their very nature, they are capable of providing the required receipt notifications to the DPC.

3. Non-Compliance or Reversal Information

As is true for the other functions, certain transactions, e.g. shipping directives on sites, are preposted by the DPC. In the event of the inability of the site to follow the prescribed action, the site will have

[2] See Chapter II.

to originate and transmit a reversal notice to the DPC. Also, in the case of an error in a shipping directive, a notice of reversal can be used to correct the error.

4. File Monitoring

File monitoring does more than update the file; it checks the master file of shipping directives to determine the shipments that are possibly lost or delinquent and therefore need to be brought to the attention of management. This is a good example of the principle of management by exception; the shipments which arrive within the expected time are processed automatically and internally by the EDPE; only the shipments that need to be investigated are brought to the attention of management.

5. Preparation of Reports for Management

The three basic reports from the Shipment Control function are: 1) Delinquency Listing, 2) Intra-Computer Discrepancy Reports, and 3) Analysis Information.

a. Delinquency Listings

This report lists the pertinent information when a control date has arrived without the shipment having been completed. This may have occurred for one of the following reasons: 1) the destination location has not forwarded the materiel-receipt list to the DPC, 2) the materiel has been lost or delayed, or 3) errors in the receipt transaction, e.g. wrong quantity or wrong contract number, have occurred. Where materiel has been lost, it is important to dispatch another shipment without delay so that stockouts or priority requisitions are avoided. Where the destination location has failed to originate or has missent the receipt notice after the materiel was received, the tracer would emphasize the delinquency and should aid in the maintenance of data discipline.

b. Intra-Computer Discrepancy Reports

All notices of materiel received which do not have a corresponding shipment record in the file, or the shipment record of which disagrees with the actual quantity shipped must be "reported" to the other functions of the EDP system so that adjustments may be made. This reporting can be accomplished by internal communication in EDPE language. In addition, a printed report of the discrepancy should be prepared for management, so that it can take action to minimize recurrence of such errors. The fact that these corrections are automatic by-products of the machine method is an essential point in this regard. It is most desirable to have a system that is not dependent on human initiative to deal with this kind of exception.

c. Information for Analysis

1) Pipeline Data

The information on the Shipment Control record plus the information on the receipt notice should include the necessary dates, mode of transport, priority, etc., to provide all the raw data for exhaustive pipeline studies. This information can very easily be stored (possibly on a magnetic tape) during the processing cycle. It should not, however, be printed in its raw form since a statistical analysis by EDPE is the desired goal.

The function of sorting, aggregating, or averaging the raw data concerning the time to resupply stockage points does not necessarily need to be accomplished as part of the Shipment Control function. The gathering of the raw data from the routine operation of Shipment Control must be carried out as a part of this function and can be accomplished in the form suitable for the desired analysis. The results of this analysis can aid in the determination of rules or tables for automatically deciding which stockage location should be used to resupply each particular base under normal or priority conditions.

2) Information Requested by Operations Analysis

It is reasonable to assume that the management of most EDP systems will have a group, whatever its name, that will perform operations analysis. What directions the research of that group will take is not readily predictable. The Shipment Control and the Due-In functions should certainly be able to provide the necessary data for some of their research projects. For example, the operations research group might want to determine the dollar value of items that became obsolete prior to having reached the would-be issuing organizations. Part of the required data could be obtained from the Due-In and Shipment Control functions.

CONCLUDING NOTE

Although the various functions required for the control of Air Force spare parts inventories have been discussed independently, the functions are closely interrelated. Their relations to each other have not been emphasized in this paper since the form of interaction is dependent upon the configuration of the EDPE employed and the consequent methodology, a discussion of which was not the intention in this paper.

It is well to re-emphasize at this point that the functions discussed in this paper pertain to the control of spare parts inventories, a subsystem of logistics management. Other logistics management functions, e.g., requirements calculations and master repair scheduling, are not directly part of the data processing system for inventory control. They furnish inputs for the inventory control system, and in turn utilize its outputs.

This paper has been concerned primarily with the functions of a data processing system; it does not show how a specific system is to be implemented. The examples of implementation which have been given illustrate the various functions. They are not necessarily "better" or less costly than alternative methods.

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Appendix I

DISTRIBUTION, SHORT SUPPLY, AND BACKORDER POLICIES

1. Abbreviations

AL — Allocation Level
BO — Quantity on Backorder
ER — Quantity En Route
IT — Quantity In Transit
MRL — Minimum-Reserve Level
OH — Quantity on Hand
Q — Quantity Requested
WPL — Warning-Point Level
WRL — War-Reserve Level

2. Distribution Policy

Priority	Mission Category	Days Required	Storage Site	System
0*	1, 2, 3	0 - 7	WRL	WRL
1	1, 2, 3	8 - 20	WRL	WRL
2	4, 5	0 - 20	MRL	AL
3	1, 2, 3	21 - 50	MRL	WPL
4	4, 5	21 - 50	MRL	WPL
5	Routine Replenishment	---	MRL	WPL

a. System Levels for filling requests (WPL $\geq$ AL $\geq$ WRL)

WPL No Priority 3, 4, or 5 when OH $-$ Q $+$ IT $+$ ER $\leq$ WPL

AL** Only Priority 0 or 1 when OH $-$ Q $+$ IT $+$ ER $\leq$ AL

WRL No issue, except by special permission

b. Site Levels for filling requests (MRL $\geq$ WRL)

MRL Only Priority 0 or 1 when OH $-$ Q $\leq$ MRL

WRL No issue, except by special permission

* Immediate Need.

**The Allocation Level is determined by summing the site MRL's and adding an increment to cover average expected IT + ER.

3. Short Supply and Backorder Policy

a. When writing backorders on backorder tape in the S&A and MB runs, a special code will be written in the first position of the record to indicate less than n (yet to be defined) days on need. This makes possible the listing of these backorders daily, using the tape data selector, for expedite action similar to that for an immediate need requisition.

b. Backorders are retained on the backorder tape without limit. They are removed by cancellation only.

c. Short supply notices, reflecting the system position, are written the first time the following system equations are true:

S&A (subfamily):	$OH + IT + ER - BO \leq L$
S&A (part):	$OH + IT + ER \leq L$
Main Posting:	$OH + IT + ER - BO \leq L$
	(where L equals RQL, WPL, AL, or WRL)

d. Short supply notices, reflecting the system position, are written the first time the site $OH \leq MRL$ and/or site $OH \leq WRL$.

Appendix II

GENERAL PROCEDURE FOR HANDLING REQUESTS

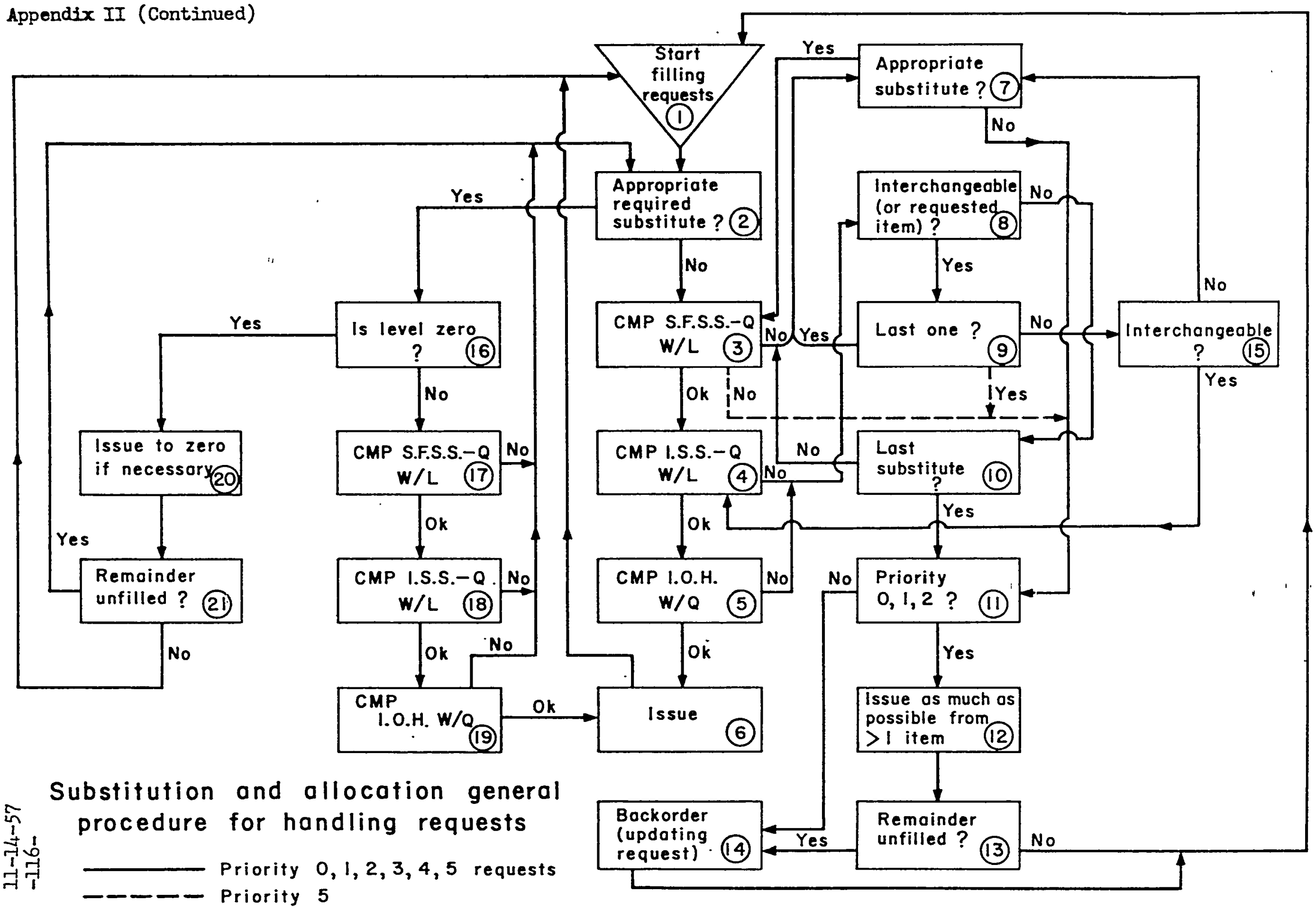
Abbreviations Used on Chart (next page)

Q	Quantity Requested
L	Appropriate Level (see below)
CMP	Compare
S.F.S.S.	Subfamily System Stock (on hand plus in transit plus en route to sites)
I.S.S.	Item System Stock (on hand plus in transit plus en route to sites)
I.Q.H.	Item Quantity On Hand
Priority 5	Routine Replenishment

Appropriate Levels

Priority of Request	System Level
0 or 1	War-Reserve Level
2	Allocation Level
3	Warning-Point Level
4	Warning-Point Level
5	Warning-Point Level

Appendix II (Continued)



Substitution and allocation general procedure for handling requests

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Appendix III

FAMILY RECORD FOR THE B-52/KC-135 WEAPON SYSTEM

Item No.	Description	Number of Characters
	Weapon-System Information	
-	Blank	1
5.	Length of entire record	4
4.	Weapon-System Number	2
	Family Information	
10.	Family Number	5
-	Blank	1
11.	Number of subfamilies in family	2
12.	Number of different parts in family	2
13.	Date of last non-balance change to family	4
-	Blank	1
14.	Address increment to Limited-Applicability Information Table	4
15.	Number of blocks in Limited-Applicability Information Table	3
	Subfamily Information	
19.	Identification Character	1
20.	Subfamily Number	1
-	Blank	1
21.	Address increment to next subfamily[1]	4
22.	Address increment to first Part Number[2]	4
23.	Short-Supply Notice Indicator	1
24.	Number of different parts in subfamily	2
25.	Unit of Issue	2
26.	Total subfamily quantity on hand and in transit (sum of all 44's and 45's)	8
27.	Total subfamily en route to sites (sum of all 46's)	8
28.	Requirement Level for subfamily	8
29.	Warning-Point Level for subfamily	7
30.	Allocation Level for subfamily	7
33.	War-Reserve Level	7
34.	Total backorders	8
35.	Master-Part-Number Code	1
-	Blank	1
31.	Number of applications	2
32.	Applications (Type and Model)	2 times number of applications

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[1]Item 21 is equal to the length of the entire subfamily record.

[2]Item 22 is equal to the length of the subfamily information record.

Item No.	Description	Number of Characters
	Part Information	
39.	Identification Character	1
40.	Part-Number Code	1
41.	Part Number	19
-	Blank	1
42.	Address increment to next Part Number[3]	4
43.	Short-Supply-Notice Indicator	1
44.	Quantity on hand	8
45.	Quantity in transit	6
46.	Quantity en route to sites	6
48.	Requirement Level	8
49.	Warning-Point Level	6
50.	Allocation Level	6
59.	War-Reserve Level	6
51.	Number of required substitutes	2
52.	Number of substitutes	2
55.	Number of limited applications	2
52.	Subfamily and Part-Number Code if required substitutes	2 times number of required substitutes
54.	Subfamily and Part-Number Code of substitutes	2 times number of substitutes
56.	Address increments (from origin of limited-applicability information) to limited applications	4 times number of applications

Limited-Applicability Information Table (Type, Model, Series, Serial Number)

Item No.	Description	Number of Characters
71.	Limited-Application blocks (each block consists of an identifying character followed by "from" - "to" inclusive - 10 characters each)	21 times number of blocks in table

[3] Item 42 is equal to the length of the part-number information record.

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A description of the functional steps required to control Air Force inventories of spare parts and an explanation of the exercise of these functions in the context of an electronic data processing system, such as the Air Force seeks to develop. The ways and means of applying electronic data processing equipment (EDPE) to Air Force inventory control are illustrated. This study may be of interest to management people who are responsible for controlling spare parts inventories and to appropriate specialists in such fields as statistical services, supply, and systems development personnel.

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