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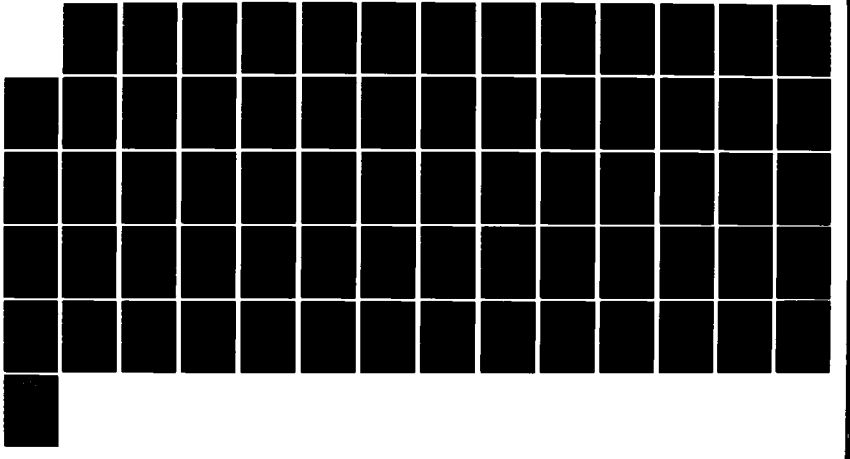

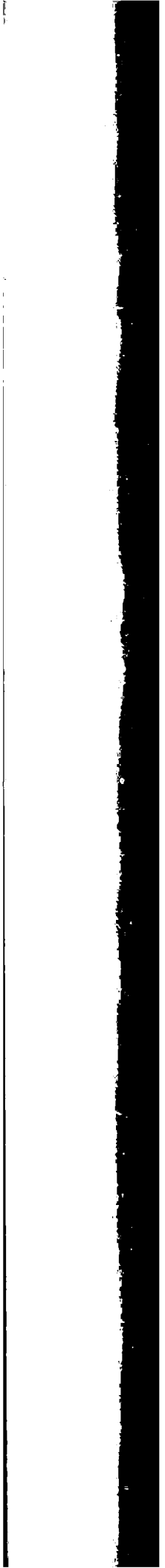

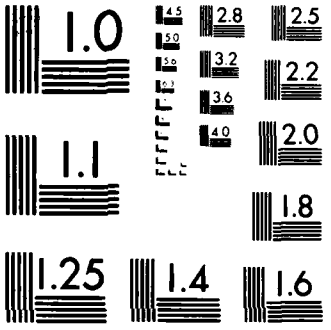

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AD-A155 365

AN EVALUATION OF THE C-E COST ALLOCATION ALGORITHMS III: DEPOT MAINTENANCE AND REPLACEMENT INVESTMENT

by

Patricia H. Weber
Gregory J. Zunic
Robert L. Gardner

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Applied Research in Statistics - Mathematics - Operations Research

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This report by Desmatics, Inc. is the third in a series documenting findings of a study conducted for the Office of VAMOSC, Air Force Logistics Command. This study constitutes an assessment of the cost allocation algorithms employed within the Communications-Electronics (C-E) subsystem of VAMOSC, the Air Force Visibility and Management of Operating and Support Cost system. This volume evaluates algorithms used to allocate costs for depot maintenance and replacement investment to end-items. Recommendations are made in these areas to correct omissions and misallocations identified by the study.

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EXECUTIVE SUMMARY

This report by Desmatics, Inc. is the third in a series of volumes which review procedures used by the Communications-Electronics (C-E) subsystem of VAMOSC to allocate operating and support costs to ground communications-electronics and meteorological equipment. It presents the results of an examination of the algorithms and data used by the C-E system to allocate Depot Maintenance (including Mobile Depot Maintenance) costs, and Replacement Investment costs.

Desmatics recommends altering the current practice of reporting depot maintenance costs as a single line item, and providing instead separate visibility for the four major subcategories of this cost (Organic, Contract, Interservice, Mobile) as well as for various elements or groups of elements within each of these subcategories. With this improved visibility the C-E O&S cost reports will be more useful and informative, and will also conform more closely to the CAIG guidelines.

For the same reasons, Desmatics recommends reporting modification costs in a separate major category. In addition, Desmatics outlines a proposed method for separately collecting and allocating modification labor and materiel costs at both the base and depot levels. Implementation of this method would permit separate reporting visibility for these four subcategories of modification costs.

The C-E system is currently designed to report O&S costs only for equipment owned by active duty units. Desmatics has determined, however, that cost and inventory data from several input sources for equipment owned by Air National Guard (ANG) and Air Force Reserve (AFR) units is

being selected and processed by the C-E system. Desmatics has identified the processing changes necessary to eliminate this information and thus correct the reporting errors which result from incorporation of this ANG and AFR data.

Desmatics recommends a number of changes to the Depot Maintenance cost selection process in the C-E system. These changes involve selecting only those costs from the H036B system which are legitimate C-E depot maintenance costs, and will thus result in a more accurate portrayal of these costs.

The method used by C-E to map recoverable components to end items for the computation of Recoverable Allocation Factor (RAF) numerators and denominators may be suboptimal. Desmatics therefore recommends testing this procedure with actual TMSs to ensure that an adequate percentage of all recoverable components is being processed. In addition, the D041 data file used to identify recoverable-application pairs should be expanded to include interchangeable and substitutable (I&S) component data. This will ensure more complete selection and more accurate allocation of Depot Maintenance and Replacement Investment costs.

Desmatics proposes new methods for processing both Depot Maintenance and Replacement Investment costs which do not require Recoverable Allocation Factors. With these new procedures costs can be directly assigned to end items, and only those maintenance actions initiated in a given year will be costed in that year.

To improve the reporting of Replacement Investment costs Desmatics recommends including all investment materiel costs in this category rather than in their present category of Depot Maintenance cost, and in-

cluding condemnation costs only for replenished items. In addition, the Office of VAMOSC should encourage efforts to improve the accuracy of the reported unit prices used to compute replacement costs.

In summary, Desmatics makes a number of recommendations for changes in the C-E system processing for Depot Maintenance and Replacement Investment costs. Desmatics also proposes new methods for processing costs for these two categories and outlines a method for selecting and allocating C-E equipment modification costs for separate reporting. All of these changes should improve the C-E processing of these costs, increase the utility of the C-E O&S Cost Reports, and also provide closer compliance with the CAIG reporting guidelines.

TABLE OF CONTENTS

I. INTRODUCTION

Desmatics, Inc., under Contract No. F33600-82-C-0466, is conducting an evaluation of the cost allocation algorithms employed in the Ground Communications-Electronics (C-E) subsystem (Data Systems Designator (DSD) D160A) of the Air Force Visibility and Management of Operating and Support Costs (VAMOSC) System. This is the third in a series of volumes which discuss the scope and findings of Desmatics' evaluation efforts.

This report presents the results of evaluations of the Depot Maintenance and Replacement Investment cost allocation algorithms. These appraisals are to determine if the D160A system adequately collects the costs and allocates them to the C-E end items at the Type Model Series (TMS) level in a reasonable manner. Also included are an evaluation of the Recoverable Allocation Factor, which is currently used in both algorithms, and an overview of the "end item within end item" problem. Although it is beyond the scope of Desmatics' current contract efforts to solve this particular problem, a discussion of this situation and some suggestions are presented for informational purposes. Specific recommendations are enumerated in the last section of this report. The Office of VAMOSC comments accompany each recommendation. It should be noted that the terms "TMS" and "end item" are used interchangeably in this volume.

The Statement of Work under which this study was initiated calls for the evaluation of the C-E system algorithms as set forth in the C-E User's Manual (AFR 400-31, Volume III) draft of 1 July 1981. The

evaluations in this volume, however, are based on the latest edition of the manual, dated 12 August 1982.

The D160A data system has evolved almost continually since its inception. Improvements were made in virtually every aspect of the original baseline system prior to the first production run in September 1982. Modifications and enhancements continue to be made, and more are planned for the future. Desmatics recognizes that to restrict its evaluation to the July 1981 baseline would significantly limit the usefulness of its findings. Accordingly, Desmatics has kept pace with the evolution of the C-E system and has attempted to reflect the significant system changes, specifically in those instances where a given cost was computed by different algorithms in two years. As a result, the documentation of Desmatics' findings is more complex than might otherwise be the case. For clarity, relevant portions of the discussions are specifically identified to the fiscal year(s) to which they apply.

Desmatics has endeavored to have this volume reflect the current status of the Depot Maintenance and Replacement Investment cost allocation algorithms within the C-E system. The authors feel that this has been accomplished. However, the reader must realize that should future changes impact on these algorithms, portions of this report may become outdated.

II. BACKGROUND

The allocation procedures evaluated in this volume involve the costs of depot maintenance and replacement investment. Because the D160A system is unable to obtain these costs at the Type Model Series (TMS) level directly from available data, the costs must be computed and/or allocated on some reasonable basis. The allocation algorithms are described in the following documents: (1) the C-E User's Manual (AFR 400-31, Volume III) [16], (2) the C-E System Specification, D160A [17], (3) C-E User/Final Operational Evaluation (FOE) Conference Handouts, 1983 [5], and (4) relevant Data Automation Requirements.

Ground communications-electronics-meteorological (CEM) equipments (including those which are costed by the D160A system) vary widely in function and mission. As a result, the structure of the depot maintenance activities associated with this equipment is rather complex. As outlined in TO 00-25-108 [18], depot maintenance for most types of CEM equipment is performed at the Sacramento Air Logistics Center located at McClellan AFB, California. Certain other (noncryptologic) items are maintained at the other Air Logistics Centers. Depot-level maintenance of cryptologic-related equipment, which is currently not costed by the C-E system, is performed at the Air Force Cryptologic Support Center (AFCSC) at Kelly AFB, Texas. Also, Mobile Depot Maintenance (MDM) teams travel to field sites to provide depot-level maintenance for many types of equipment. Several CEM systems and equipments are maintained by contractors or other military services.

Replacement investment cost, as defined in the D160A system, arises

as a result of replacing condemned end items or recoverable components lost from the Air Force inventory. Recoverable components are integral elements of an end item which can be removed, replaced, and repaired separately.

III. DEPOT MAINTENANCE

In the C-E system, depot maintenance costs are the direct and indirect costs incurred for maintenance or modification of C-E end items and their recoverable components at centralized Department of Defense (DOD) repair depots and contractor repair facilities, or on site with mobile depot maintenance teams. Included are costs for personnel, materiel, and contractual services [16].

A. PROCESS DESCRIPTION

The algorithm for developing depot maintenance costs for C-E end items is described in AFR 400-31, Volume III [16]. There were no changes to this algorithm between FY81 and FY82.

The source for organic and contract depot-level maintenance costs is the Depot Maintenance Industrial Fund (DMIF) Accounting Production Report, Data Systems Designator (DSD) H036B. Costs are reported in H036B for recoverable components of C-E end items or the end items themselves by National Stock Number (NSN) for twenty-four separate cost elements. The C-E system includes all but one of these elements, unfunded General and Administrative (G&A) expenses, in the Depot Maintenance cost allocation algorithm. Cost records from H036B are selected if the NIIN (National Item Identification Number) portion of the NSN being costed matches that of one of the NSNs in the C-E Recoverable Data Base [17]. This latter file contains all master subgroup recoverable records from the D041 (Recoverable

Consumption Item Requirements) System which have a C-E FSC (Federal Stock Class) represented on the D160A C-E end item list. The C-E I list is provided by the Office of VAMOSC. Some of these FSCs also clude items other than ground CEM equipment items.

Mobile depot maintenance costs are supplied by the Air Force Communications Command (AFCC) Engineering/Installation Management S (EIMS), DSD C003K. Costs in this system are reported and selected SRD (Standard Reporting Designator) for four separate elements: la stock fund materiel, bench stock materiel, and temporary duty (TDY)

The C-E system currently costs only those TMSs in the system TMS-NSN Table; these TMSs are referred to as reportable TMSs. The Depot Maintenance cost for any reportable TMS_i, defined as D_i, is g by:

$$D_i = M_{dep_i} + M_{mob_i}$$

where M_{dep_i} = organic and contract depot maintenance costs for TMS_i (from H036B),

and M_{mob_i} = mobile depot maintenance costs for TMS_i (from C003K).

The organic and contract depot maintenance costs for the TMS, M_{dep_i} are determined by summing the allocated costs for all reparable com ponents of the TMS and the TMS itself, as follows:

$$M_{dep_i} = \sum_j N_j RAF_{TMS_{ij}}$$

where N_j = organic and contract depot maintenance costs for NSN (the end item or reparable component of the end item

and $RAF_{TMS_{ij}}$ = Recoverable Allocation Factor for NSN_j and its appli cation TMS_i.

The Recoverable Allocation Factor is discussed in Section IV of this report. The total organic and contract depot maintenance costs, N_j, for the end item or any reparable component of the end item are given by:

$$N_j = L_{C_j} + L_{M_j} + M_{D_j} + M_{C_j} + G_j + I_j + C_j + M_{S_j}$$

where: L_{C_j} = civilian maintenance personnel cost for NSN_j,

L_{M_j} = military maintenance personnel cost for NSN_j,

M_{D_j} = direct materiel cost for NSN_j,

M_{C_j} = contract maintenance services costs for NSN_j,

G_j = general and administrative costs for NSN_j,

I_j = indirect costs for NSN_j,

C_j = contract maintenance costs, excluding government furnished materiel (GFM) and government furnished services (GFS), for NSN_j,

and M_{S_j} = GFM and GFS costs for NSN_j.

The Mobile Depot Maintenance costs for TMS_i, M_{mob_i}, are given by:

$$M_{mob_i} = \sum_k m_{mob_k}$$

In this equation m_{mob_k} denotes the mobile depot maintenance costs for SRD_k assigned to TMS_i and is defined as follows:

$$m_{mob_k} = L_k + M_{SF_k} + M_{BS_k} + T_k$$

where L_k denotes labor costs for SRD_k,

M_{SF_k} denotes stock fund materiel costs for SRD_k,

M_{BS_k} denotes bench stock materiel costs for SRD_k,

and T_k denotes temporary duty cost for SRD_k.

B. EVALUATION

Various aspects of C-E Depot Maintenance costs relating to data inputs, cost selection, and reporting, are discussed in this section. Selection of relevant costs for inclusion and reporting visibility for component costs are discussed in reference to the Cost Analysis Improvement Group (CAIG) guidelines [1] for these costs, and with regard to utility to C-E system users.

1. Selection and Reporting of Depot Maintenance Costs

Depot-level maintenance costs are currently displayed on the C-E Operating and Support Cost Report as a single line item. Desmatics contends that the utility of these reports could be significantly enhanced if these costs were broken down into four major subcategories (Organic, Interservice, Contract, Mobile), with separate visibility for selected elements or groups of elements within these subcategories. Because of the level of detail available in the input data from the H036B and C003K systems, this visibility can be achieved in a relatively straightforward manner. The reporting format recommended by Desmatics is shown in Figure 1. In Figure 2 the various cost elements Desmatics recommends including in each component within the subcategories are listed. Desmatics also recommends omitting certain costs which are currently included by the C-E system. These are:

Depot Maintenance

- Organic
  - Labor
  - Expensed Materiel
  - Other
- Interservice
- Contract
  - Contractor
  - Government Furnished Support
- Mobile
  - Labor
  - Materiel
  - TDY

Figure 1. Recommended Reporting of Depot Maintenance Costs for the C-E System

Depot Maintenance Subcategory	Element	Cost Fields - H036B
Organic	Labor	Civilian Direct Labor, Production Civilian Direct Labor, Other Military Direct Labor, Production Military Direct Labor, Other
	Expensed Materiel	Direct Materiel, Funded Direct Materiel Expense, Unfunded
	Other	Direct, Other, Funded Direct, Other, Unfunded Operations Overhead, Funded Operations Overhead, Unfunded G&A, Funded G&A, Unfunded
Interservice		Contractor/Interservice
Contract	Contractor	Contractor/Interservice
	Government Furnished Support	Government Furnished Materiel, Expense

Figure 2. Recommended Components and Cost Elements for Subcategories of Depot Maintenance Costs

1. Direct investment materiel, unfunded
2. Direct exchange materiel, unfunded
3. Government furnished investment materiel
4. Government furnished exchange materiel
5. Direct materiel, modification kits, unfunded
6. Government furnished materiel, modification
7. Maintenance support, funded
8. Maintenance support, unfunded
9. Government furnished services, funded
10. Government furnished services, unfunded

In addition, Desmatics suggests including unfunded General and Administrative (G&A) costs which the C-E system currently excludes.

Desmatics has omitted the unfunded direct investment materiel, and unfunded direct modification kit materiel because, according to the CAIG, these costs should be included in the Replacement Investment cost category [1]. For the same reason government furnished investment materiel costs and government furnished modification materiel costs should also be included in Replacement Investment. Although the C-E system processing is designed to select these latter costs for Depot Maintenance, it is expected that they will not be available until FY84.

An average cost to repair any individual end item or reparable component which has undergone depot-level maintenance in any given year is computed in the H036B system. Any defective reparable components in items undergoing repair are generally replaced with serviceable components; the unserviceable components are batched for repair at a later date. The most current average cost to repair these lower-level reparable components, inflated to allow for possible condemnation at the time they are repaired, is then charged as a direct exchange investment materiel cost against the item being repaired. To later allocate a portion of the repair costs and condemnation costs associated with these components to their end item

applications, as is currently done in the C-E system, amounts to double-costing for both Depot Maintenance and Replacement Investment. This double-costing can be avoided by excluding unfunded direct exchange materiel costs and government furnished exchange materiel costs in summing depot maintenance costs. For this reason Desmatics has recommended excluding these two cost elements from Depot Maintenance in the C-E system.

The CAIG recommends excluding fixed overhead at depot repair facilities from operating and support (O&S) cost estimates [1]. In the H036B system these costs include the funded and unfunded G&A costs [10]. The C-E system currently excludes unfunded G&A costs. In order to comply fully with the CAIG guidelines, funded G&A costs would have to be excluded as well. Desmatics does not concur with excluding any G&A costs for depot maintenance in the C-E system. By not allocating a portion of all G&A costs to end items, as is effectively done in the H036B system, the C-E system in reality understates the true cost of depot maintenance. Fixed overhead costs are certainly embedded in charges levied by contractors and other government services for repair of Air Force equipment, and therefore are included in any costs reported in these subcategories on the C-E O&S Cost Reports. Desmatics has therefore added G&A costs to the "Other" element of the "Organic" subcategory (See Figure 2).

Desmatics recommends giving separate visibility to Interservice costs. These services, like commercial depot maintenance services, are provided on a contractual basis. The CAIG recommends separate visibility for commercial depot activities if they represent a significant cost in

the estimate for depot-level maintenance costs [1]. Desmatics is in favor of separate visibility for all four subcategories listed in Figure 1 (Organic, Contract, Interservice, Mobile) regardless of their relative significance (this will most certainly vary depending on the TMSs involved). This visibility will provide additional useful information to the user, particularly for cost comparisons and trade-off studies involving the available options for depot maintenance.

Costs on H036B records are further classified by Work Performance Category (WPC) codes. These are job designators which specifically identify the type of maintenance being costed. A list of WPCs with brief descriptive titles, obtained from AFLCR 66-60 [9], is shown in Figure 3. This regulation also provides detailed descriptions of the functions encompassed by each code. The C-E system currently disregards these WPCs in the selection of H036B records for costing depot maintenance.

In the Department of Defense Cost Accounting and Production Reporting Handbook for depot maintenance and maintenance support costs [4] a clear distinction is maintained between the maintenance support costs reported in H036B (WPC codes Q and R [9]) and depot maintenance costs. Two other WPC codes, P and S [4], which were also used at least up to FY82 (there are records in the H036B four quarter tape file with these two WPCs), do not appear on the current list of WPCs [9]. However, the new descriptions for codes Q and R appear to include the functions formerly described for P and S [9,4]. Also, it is recommended that the associated functions be costed as maintenance support and not as depot maintenance [4]. In addition, the CAIG guidelines recommend including costs

Code	Title
A	Major Overhaul
B	Progressive Maintenance, Programmed Depot Maintenance (PDM)
C	Conversion
D	Activation of Stored Major Items
E	Inactivation, Storage Preparation, and In Storage Maintenance of Major Items
F	Renovation/Proof Testing
G	Analytical Rework
H	Modification
I	Repair
J	Inspection and Test
K	Manufacture and Fabrication
L	Reclamation
M	Storage
N	Technical Depot Assistance
Q	Maintenance Technical and Engineering Support
R	Development of Technical and Engineering Data
T	Nonmaintenance Work
U	Repair of Industrial Facilities
W	Reliability Centered Maintenance (for future use)

Figure 3. Work Performance Category Codes

for these types of maintenance support in the General Depot Support cost category [1]. Desmatics accordingly favors reporting these maintenance support costs in General Depot Support along with costs for the other depot nonmaintenance functions reported there. Many of the maintenance support costs on the FY82 H036B records examined by Desmatics were reported by Federal Stock Class (FSC) rather than by the full NSN. The C-E system currently selects records by the National Item Identification Number (NIIN) portion of the NSN and is therefore currently bypassing these records. The C-E record selection criteria will therefore have to be changed in order to collect these particular costs.

Funded and unfunded government furnished services also constitute forms of maintenance support which should not be costed as depot maintenance [2,4]. Desmatics therefore recommends that these costs also be bypassed by the C-E system for costing depot maintenance and be included instead in the General Depot Support cost category. It is expected that these costs, which were not available prior to 1983, will be available for FY84 reporting.

Desmatics also recommends bypassing H036B records with WPC code C (Conversion) in costing depot maintenance. This code applies to Class V Modifications which the CAIG guidelines do not consider to be O&S costs since they result in operational capabilities other than those originally specified for the associated TMSs. Additionally, WPC codes can be used to identify and select other modification costs for which the CAIG recommends separate visibility. This topic is discussed in detail in Section V.

In Desmatics' opinion any costs associated with WPCs L (Reclamation Efforts), T (Nonmaintenance), and U (Repair of Industrial Facilities)

should also be excluded by the C-E system. Reclamation efforts involve labor costs which more properly accrue to the disposal phase of an asset's life cycle and not to the operating and support cost phase. Any serviceable components retrieved in the process are returned to the supply inventory. Code T is used simply to ensure complete costing of depot maintenance activities [4]. However, it is unlikely that WPCs of either T or U would appear on any records currently selected by the C-E system.

All other WPCs apply to functions which in one way or another serve to ensure continued serviceability of equipments and are therefore legitimate depot maintenance costs for allocation to C-E end items. It should be noted that unfunded direct exchange materiel cost is calculated based only on costs in WPCs A and I [4]. Desmatics concurs with this representation for this cost.

Cost records in H036B also contain Reimbursement Source Codes [8] which identify depot maintenance activity customers. Air Force customers represented are assigned customer code 7F for depot maintenance costs reported in H036B. All current Air Force customers and their Reimbursement Source Codes are listed in Figure 4. The C-E system does not currently restrict selection to records coded 7F. To prevent processing costs and quantities for non-Air Force items, this restriction needs to be implemented. For FY82 the C-E system processing was changed to bypass H036B records for Military Assistance Pact (MAP) and Foreign Military Sales (FMS) costs. These are identified by reimbursement source codes L, M, and T [8] and represent charges for equipment purchased by or donated to foreign governments. Desmatics concurs with this change since these charges are not relevant for inclusion in the costing of depot maintenance

Reimbursement Code	AF Customer
A	Direct Air Force
B	Air National Guard
C	Air Force Systems Command (P3010, 3020, 3080, 3400)
E	Airlift Service Industrial Fund
J	Defense Security Assistance Agency DAF-10
K	(All Reimbursables)
P	Air Force Systems Command (P3600 Maintenance)
R	Stock Fund - General Support Division
S	Stock Fund - Testing Aviation Fuels
U	Disposal - Organic
W	Stock Fund - Systems Support Division
X	Government Furnished Aerospace Equipment
Z	U.S. Air Force Reserve
0	(not identified)
1	Mfr of Centrally Procured Aircraft Spares - Appr. 3010
3	Manufacture of Centrally Produced Missile Spares - Apr 3020
4	Military Assistance Program - Grant Aid - Reimbursable Engines
5	Manufacture of Centrally Procured Munition Spares Appr. 3080
6	Manufacture of Centrally Procured Vehicle Spares Appr. 3080
7	Manufacture of Centrally Procured Communications Spares Appr. 3080
8	Manufacture of Centrally Procured Other Spares Appr. 3080

Figure 4. Reimbursement Source Codes [8]

for the C-E system. One other code which should also be excluded is Code U (Disposal-Organic); this code identifies sales and salvage activities associated with item disposal. Although there are other codes in this list which are irrelevant to the C-E system, records containing them are not likely to contain C-E NSNs and will therefore automatically be bypassed.

2. Depot Maintenance Costs-Air National Guard and Air Force Reserve

The C-E system currently is intended to provide visibility of operating and support costs only for equipment owned by active duty organizations. These units are listed in the PAS/ORG table; Guard and Reserve units are not. In addition, Guard and Reserve personnel are not included in the C-E MPC extract. However, depot maintenance costs for equipment owned by Air National Guard (ANG) and Air Force Reserve (AFR) units are currently included in the reported total depot maintenance costs for C-E end items. Since the inventories of these items are also considered in the computations to develop the Recoverable Allocation Factors [16], the cost allocations are currently being done correctly. This assumes, of course, that equipment owned by Guard and Reserve units requires the same level of repair effort as that owned by active units.

The total depot maintenance costs portrayed on the O&S cost reports are overstated by the amounts chargeable to Guard and Reserve equipment. It is not completely clear from the C-E system processing description [17] whether the quantities reported are for the Air Force

wide or active unit inventories; it appears to be the former, however. The inventory figures reported in the C-E History Extract Tables 1, 3-4, 5, and 6-7 for FY81 include Guard and Reserve equipment, and these are the inventory quantities used to compute normalized costs. Thus all normalizations involving base level costs will be understated since these costs are computed only for active unit equipment. Normalized depot level costs should, however, be correct.

Depot maintenance costs for AFR and ANG equipment can be identified by reimbursement codes B and Z on the H036B records in the four quarter tape file [8]. These records can readily be bypassed in the C-E system processing. In addition, to avoid including their inventories, records for ANG and AFR organizations should be deleted from the Assets by Organization and C-E Inventory and Other Inventory Files before processing the RAFs. Furthermore, total inventory counts in the C-E system should be the sum of the D039 Format 100 inventory counts for a TMS for only active duty units (i.e., those organizations in the PAS/ORG table), and not the D039 Format 50 inventory counts currently used (which include AFR and ANG equipments).

Since condemnations are reported by NSN in the D041 system and refer to Air Force wide inventories, condemnation counts will have to be adjusted in order to compute Replacement Investment costs correctly. This is discussed further in Section V of this report.

3. Mobile Depot Maintenance

The total mobile depot maintenance cost reported in C003K has four

components: labor, stock fund materiel, bench stock materiel, anc porary duty. In discussions with the Office of VAMOSC and LME, It was learned that there are no bench stock materiel costs reported It is not clear whether these costs are simply not included or whe are somehow embedded in the stock fund materiel costs. The Office VAMOSC is attempting to resolve this question. Since the labor, s fund materiel and TDY costs are available individually, Desmatics reporting these three costs separately.

Desmatics cannot determine from the available documentation w or not mobile depot maintenance costs for equipment owned by ANG a units are included in the C003K file used by C-E. If they are inc they must be removed.

IV. RECOVERABLE ALLOCATION FACTOR

The H036B system reports costs by NSN for recoverable components of end items or end items themselves. Since recoverable components can have application NSNs which are simply higher level assemblies below the end item level and can, in addition, be applied to more than one C-E end item, a factor for allocating depot maintenance costs for any given recoverable component to all of its end item applications is required. The Recoverable Allocation Factor (RAF) developed for this purpose is defined as "... the ratio of the quantity of a particular recoverable subassembly installed in a particular C-E end item ... to the total quantity of the subassembly installed in all applicable end items" [16].

A. PROCESS DESCRIPTION

The recoverable allocation factor for a given recoverable NSN_j and a given end item application TMS_i, $RAF_{TMS_{ji}}$, is given by the following equation:

$$RAF_{TMS_{ji}} = \frac{Q_{ji} \times A_{ji} \times I_i}{(Q_{j1} \times A_{j1} \times I_1 + \ldots + Q_{jn} \times A_{jn} \times I_n)}$$

where Q_{ji} denotes the quantity of NSN_j installed in TMS_i,

A_{ji} denotes the percentage of the end item (TMS_i) inventory in which NSN_j is installed,

I_i denotes the Air Force inventory of TMS_i (from D039),

and n denotes the number of different TMSs in which NSN_j is installed.

It is assumed that any given recoverable component requires the same amount of maintenance regardless of end item application.

Recoverable components are not identified to an application NSN in the H036B system. The C-E system must therefore map each recoverable component to all of its end item applications to develop the numerators and denominators for all RAFs. There are two possible approaches to removing levels of indenture to relate recoverable components to their end item applications: top-down and bottom-up. In the C-E system the top-down approach is used [17].

The first step in processing the RAFs in the C-E system involves creating an Assets by Organization file from the Equipment Items Requirements System (D039). This file contains only end item NSNs from C-E Federal Stock Classes (FSCs) specified for inclusion by the Office of VAMOSC. These C-E assets are further divided into a C-E Inventory File containing reportable TMSs (TMSs on the TMS-NSN Table) and an Other Inventory File containing all other TMSs with C-E FSCs, by matching C-E NSNs from the D039 file to the NSNs in the TMS-NSN Table. The D041 system (Recoverable Consumption Item Requirements System), which lists recoverable NSNs with their next higher application NSNs and the quantity per application, is also truncated to produce a file with C-E FSCs only. This truncated D041 file contains only records for the preferred item (master stock numbers) in interchangeable and substitutable (I&S) subgroups.

In the first step of the mapping process, the application NSNs of the C-E Inventory File are matched to those in the truncated D041 file. Recoverable NSNs from the matched records of the D041 file

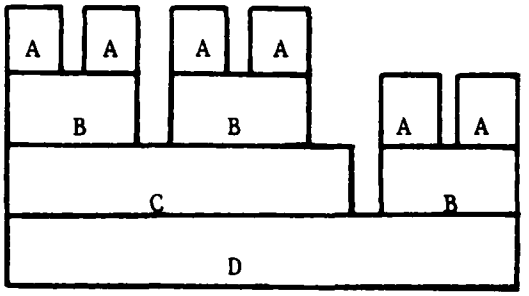
become the application NSNs for the next pass of these records against the unmatched records. After each pass the end item NSN is substituted for the application NSN in the matched records and RAF numerators are computed. After four passes through the data in this manner the remaining unmatched records are matched against the Other Inventory File. Only one pass is made with this data. RAF numerators are computed for the recoverables on the matched records for use in the RAF denominators. The Recoverable Allocation Factors are then computed for each recoverable component of each TMS as in the equation described previously.

In the bottom-up mapping method, the process is reversed. The lowest level recoverable components (those which are never listed as an application of another recoverable) are matched to all their applications. These applications are then matched as recoverables to their applications. The processing continues until all links between recoverable components and end items are established.

B. EVALUATION

The top-down approach used to develop RAFs in the C-E system can result in inaccurate factors for recoverables of other recoverable components found at more than one level of indenture below the end item. This problem is a consequence of the processing procedure used by the C-E system in application of the top-down approach. That procedure discards matched records at each stage of processing, thereby creating the potential for missed linkages. This is illustrated in Figure 5 which compares top-down and bottom-up approaches to mapping recoverables A,

TMS D
Configuration



D041 Data

Rec.	App.	QPA	Total in D
A	B	2	6
B	C	2	3
B	D	1	
C	C	1	1

REMOVAL OF LEVELS OF INDENTURE

Top Down Procedure

Pass	Non-Matches	Matches	No. Recoverables Selected		
			A	B	C
First	A-B	B-D		1	
	B-C	C-D			1
Second	-	A-B-D	2		
		B-C-D		2	
			2	3	1

Bottom Up Procedure

Pass	Non-Matches	Matches	No. Recoverables Selected		
			A	B	C
First	B-C	A-B			
	B-D				
	C-D				
Second	C-D	A-B-C			
		A-B-D	2	1	
Third	-	A-B-C-D	4	2	1
			6	3	1

Figure 5. Comparison of Top-Down and Bottom-Up Procedures for Mapping Recoverables to C-E End Items

B, and C contained in a hypothetical TMS D to this end item. It can be seen that the top-down method, as currently implemented, does not pick up records for the A recoverable components within those B components found one level below the first level of indenture. If the procedure is modified to maintain all records (both matched and unmatched), each linkage in any TMS configuration would be considered. Figure 6 provides the results of top-down processing applied to the hypothetical TMS D when no records are discarded. As can be seen, the number of recoverables selected is correct.

Another potential problem with the present mode of implementation of the top-down approach within the C-E system is that a maximum of four passes is made through the data base. Whether, in fact, four passes are enough is a moot point. Even if this were the case for the current inventory (which cannot be checked without a detailed examination of the TMSs), new end items may be of sufficient complexity to require more than four passes. To be on the safe side, the processing should be revised to continue until the stage is reached at which no matches are obtained.

In making only one pass through the Other Inventory File, the C-E system captures recoverable components with nonreportable TMS applications only if they are one level below the end item. In addition, the current processing uses only those D041 records which were not matched in the regular level of indenture removal. This results in many lower-level recoverable links being lost, as these records are not present in this stage of processing. This causes the RAF denominators to be understated for lower-level recoverables with reportable and nonreportable applications, resulting in inflation of the costs allocated to the reportable TMSs. In

Pass	Matches	No. of Recoverables Selected		
		A	B	C
First	B-D		1	
	C-D			1
Second	A-B-D	2		
	B-C-D		2	
Third	A-B-C-D	4		
		6	3	1

Figure 6: Results of Top-Down Processing When No Records Are Discarded

order to correct these problems, processing of the Other Inventory File should be identical to the regular level of indenture removal. All D041 records should be used to match against this file and should not be discarded. Also, processing should be continued until no further matches are made.

The overall findings of the Desmatics research effort indicate that a better procedure for obtaining Depot Maintenance costs exists. (See the following section.) However, in the event the Office of VAMOSC should choose to continue using the current RAF allocation algorithm rather than implementing the suggested procedure, Desmatics has a major recommendation. Specifically, either the bottom-up approach should be adopted or the current top-down processing should be revised to retain all records (i.e., not discard matched records) and to stop only after all matches are made (i.e., not after an arbitrary number of passes). Desmatics feels that modifying the current top-down processing would be most cost-effective. Furthermore, passes through the Other Inventory File should not be limited, and these should be made using the same D041 file which is used in the regular level of indenture removal process, without discarding matching records.

As discussed in Section III, both costs and inventories for AFR and ANG equipment should be excluded before processing Recoverable Allocation Factors. Also, the D041 file used by the C-E system should be expanded to include interchangeable and substitutable component NSNs. With this data, which is available from the D041 system [6], the C-E system would have a more complete listing of legitimate recoverable-application pairs. This would result in the development of more accurate RAFs and more accurate

allocation of depot maintenance costs. There is some further discussion of this problem in Section V.

C. ALTERNATE METHOD FOR DETERMINATION OF DEPOT MAINTENANCE COSTS

There are several problems associated with the current method of collecting and allocating depot maintenance costs in the C-E system. Because recoverable components are commonly batched for repair, all of the associated repair costs may not be reported in the same fiscal year in which the maintenance actions were initiated. The development of the Recoverable Allocation Factors and allocation of costs with these factors is a cumbersome process. Also, unless RAF numerators are computed for all equipment applications of each recoverable NSN, the RAF denominators will be understated. The result of this is to unfairly burden reportable C-E TMSs with costs which should be applied elsewhere.

Desmatics has developed an alternate method for the determination of depot maintenance costs for the C-E system. This proposed method is based on counting base-level maintenance actions resulting in the shipment of items to the depot. These actions are assigned Maintenance Action Taken Codes 1-8 [13] on the transaction history records in the Standard Base Supply System (SBSS), DSD D002A. These records also contain the NSN and application SRD of the item. The D002A system currently provides base maintenance materiel costs to the C-E system through the Component Support Cost Subsystem (CSCS) of the VAMOSC system. This additional information is thus available to the C-E system and can be combined with cost data from the H036B system to develop depot maintenance costs for C-E end items.

This method also requires a table (discussed in Volume II of this series) which matches the organization code in the document identification number on the SBSS records [13] to the C-E organizations in the PAS/ORG Table to limit the selection to records for these latter organizations.

In the following algorithm the variable notation used in the process description in Section III is retained wherever possible. Costs are developed only for reportable TMSs from C-E organizations in the PAS-ORG Table. For a given reportable TMS_i (SRD_i) in a given fiscal year, the Depot Maintenance costs, M_{dep_i}, are given by:

$$M_{dep_i} = \sum_{j=1}^{n} d_{ji}$$

where d_{ji} = depot maintenance costs for NSN_j applied to SRD_i for the year,

and n = number of different NSN_j's from SRD_i sent to the depot during the year (with Maintenance Action Taken Codes 1-8, from D002A).

The depot maintenance costs, d_{ji}, for each NSN_j from SRD_i (for the year) are given by:

$$d_{ji} = q_{ji}(1-r_j)\frac{N_j}{Q_j}$$

where q_{ji} = quantity of NSN_j from SRD_i with Maintenance Action Taken Codes 1-8 (from D002A) sent to the depot from C-E organizations,

r_j = depot condemnation rate of NSN_j (from D041),

N_j = total depot maintenance costs for NSN_j (from H036B),

and Q_j = total quantity of NSN_j repaired (from H036B).

Mobile Depot Maintenance costs by SRD, as determined by the algorithm described in Section III, would then be added to M_{dep_i}. The total depot maintenance cost for TMS_i would be obtained by summing over all applicable SRDs.

In this method, N_j includes all costs listed in Figure 2 plus the two categories of exchange investment materiel (direct and government furnished). In addition, costs for all WPCs previously recommended for inclusion should be selected. Exchange investment materiel costs must be included in this method because costs for lower level recoverable components which are replaced cannot be identified to actual end item applications. Desmatics also recommends that these exchange investment materiel costs be adjusted downward by the amount they have been inflated by H036B. As mentioned previously, the inflation of these costs, which is to allow for possible condemnations, causes double-costing with Replacement Investment. The separate visibility for the various elements of Depot Maintenance costs, previously recommended, can be achieved by applying this algorithm separately to each element to be reported.

As mentioned before, this method does not require Recoverable Allocation Factors, and costs only those depot maintenance actions initiated during the fiscal year. In addition, charges incurred on behalf of recoverables from non-reportable applications (including non-ground C-E applications) and AFR and ANG owned equipment will not be levied against reportable end items from active duty units.

V. REPLACEMENT INVESTMENT

Replacement Investment cost, as defined in the D160A system [16], is incurred through the replacement of both recoverable components or entire end items which are beyond economical repair. When a component or end item is in such a state it is condemned at the base or depot. Items which are still usable but no longer required may be condemned by administrative action [7,12].

A. PROCESS DESCRIPTION

The Replacement Investment costs for recoverable components and end items are developed in a similar manner. The costs for recoverable components, for both FY81 and FY82, as described in AFR 400-31, Vol. III [16], are given by:

$$ri_j = (C_D + C_B) \times p \times RAF_{TMS_j}$$

where ri_j denotes the replacement investment cost of a particular component (by NSN) attributable to TMS_j,

C_D denotes the number of the given NSN condemned at the depot (from D041 Format 8 records),

C_B denotes the number of the given NSN condemned at bases (from D041 Format 5 records),

p denotes the unit price of the component (from D041 Format 1 records),

and RAF_{TMS_j} denotes the recoverable allocation factor (as discussed in Section IV).

These costs are summed over all recoverable components identified for a given TMS in D041, and are reported at the worldwide level for the TMS.

The corresponding cost for end items was developed using the following equation for FY81:

$$ri_x = INV \times r_c \times p$$

where ri_x denotes the annual replacement investment cost for TMS_x,

INV denotes the average annual inventory of the TMS (from D039 Format 50 records),

r_c denotes the condemnation rate for the TMS (from D039 Format 50 records),

and p denotes the unit price of the TMS (from D039 Format 50 records).

As detailed in the C-E User/FOE Conference Handouts of April 1983 [5], beginning with FY82 reporting the end item replacement cost was computed as:

$$ri_x = c \times p$$

where ri_x and p are defined as above,

and c denotes annual number of base and depot condemnations (from D039 Format 50 records).

B. EVALUATION

The following section discusses various aspects of the Replacement Investment Cost algorithm. The Recoverable Allocation Factor (RAF_{TMS}) is

discussed in Section IV.

1. Unit Prices

The D160A system obtains the unit price of a recoverable component from the D041 system. This price generally represents the unit price at last procurement, automatically adjusted for inflation. The item manager of a given component can alter this price. Manually-adjusted prices remain effective for only the current quarterly processing cycle (unless there is an accompanying change to a D041 feeder system) [7]. Nevertheless, there is a strong possibility that these unit prices are not representative of the actual replacement costs of the various components. It may cost much more to replace discontinued or one-of-a-kind parts than any inflation-adjusted last procurement price would indicate. This price may not reflect such factors as previous quantity discounts vs. present low-quantity purchases, or high retooling expenses to remanufacture discontinued parts. Indeed, it is also possible that as a result of technological advances an item may cost less than the last procurement price.

Any dissimilarity between the D041 unit price and the actual replacement cost makes an accurate portrayal of replacement investment costs difficult, especially for older systems which are not currently being manufactured and deployed. At present, though, the D041 data system is the only source of this price information for the C-E system (and for the remainder of the Air Force, for that matter). Therefore, Desmatics recommends that the Office of VAMOSC continue to use these prices in this algorithm.

A similar situation occurs with the D039 system and its unit pr for end items. The item manager can update the prices with more rec contract information, if available, or estimates [6]. These prices the same weaknesses as were mentioned for the D041 prices. However, is the only source of such price information. Desmatics recommends these prices continue to be used. It is postulated that while the a cost for replacement investment may not necessarily be portrayed by C-E system, the costs currently reported in this category can provid evidence of general trends in equipment performance.

2. D039 Condemnations

The definition of the Replacement Investment cost category in tl C-E User's Manual [16] states that this category is intended to port: "the cost incurred through replacement of recoverable components of (end items ...." The CAIG guide cost category, Replenishment Spares, which most closely corresponds with Replacement Investment, is defin the cost of replenishing spares and repair parts that are normally r and returned to stock. Based on these definitions, a major conclusi may be reached concerning the C-E system's development of Replacement vestment cost. This is that any condemnations of end items (from DO should not be costed by C-E.

End item condemnations should not be costed for several reasons. The first and most obvious reason is that costs computed for such co demnations do not fit the definition of the cost category given in tl C-E User's Manual or the CAIG guide. More importantly, such costs a

not relevant to the O&S cost portion of an item's life cycle. It is clear that when an end item is condemned, for any reason, it has reached the end of the O&S portion of its life cycle. The "replenishment" of a TMS damaged beyond repair is an acquisition cost, and the beginning of a new life cycle. It is inappropriate to levy this cost against the O&S portion of the TMS's life cycle as the C-E system currently does. Next consider the case of end items which are condemned but are still serviceable. Such items are not going to be replaced, and no further O&S costs are going to be incurred.

The C-E system is currently costing both types of end item condemnations in the Replacement Investment cost algorithm. Desmatics recommends that the C-E system eliminate these types of costs by bypassing all TMS condemnations (from D039) in the computation of Replacement Investment cost.

3. Condemnations from ANG and AFR

The D039 and D041 data systems contain data on all Air Force inventory, including items at Air National Guard (ANG) and Air Force Reserve (AFR) units [6,7]. The D160A system is presently designed to portray costs for equipment at active duty units. It is therefore necessary to alter the Replacement Investment Cost algorithm in the D160A system to reflect this important difference. Otherwise, the Replacement Investment costs will include those costs attributable to ANG and AFR units.

Desmatics recommends that this be accomplished by utilizing the following algorithm for the recoverable component portion of these costs:

$$ri_j = (C_D + C_B) \times p \times RAF'_{TMS_j} \times \frac{I'}{I}$$

where ri_j = the replacement investment cost a particular component (by NSN) attributable to TMS_j,

C_D = the number of the given NSN condemned at the depot (from D041 Format 8 records),

C_B = the number of the given NSN condemned at bases (from D041 Format 5 records),

p = the unit price of the component (from D041 Format 1 records)

RAF'_{TMS_j} = the revised Recoverable Allocation Factor for active duty inventory (as discussed in Section IV),

I' = active duty inventory of TMS_j,

and I = total Air Force inventory of TMS_j.

The quantity, I', is developed by matching the D039 Format 100 records against the PAS-ORG table to determine the quantity of a TMS at active duty organizations. One assumption in the use of this algorithm is that the recoverable components used by the ANG and AFR equipment will not have a significantly different condemnation rate from the same item in active duty use. This is nearly impossible to verify without sampling.

As mentioned earlier in this section, Desmatics recommends that Replacement Investment cost no longer be computed for TMS condemnations. If this recommendation were not carried out by the Office of VAMOSC, Desmatics would recommend that the C-E system use the FY81 algorithm which utilizes condemnation rates rather than actual condemnation figures. One other change is necessary to correct that algorithm, however. The quantity, I', mentioned above should replace the inventory used previously. This is needed to compute costs for only active duty inventory.

4. Modification Cost Visibility

Desmatics recommends that the C-E system be expanded to add a category for modification costs at base and depot level, as is recommended by CAIG. Modifications are done to correct deficiencies in an item or to provide additional capabilities beyond the original design. The costs of modification are presently contained under other cost categories within the C-E system, but without the desired separate visibility. The materiel costs of investment-type base-level modification kits are considered as base maintenance materiel. In its Technical Report No. 118-2 [3], Desmatics determined that the corresponding transaction records may be identified in the Standard Base Supply System (D002A) interface. The records (which contain a "K" in the fifth position of the NSN) are identified to SRD, and in-turn to TMS by the D160A system. Desmatics recommends the costs computed with these records be given visibility in a Modification cost category.

The other repository for modification kit materiel costs is the category of Depot Maintenance. Modification materiel costs are now added into the other costs which comprise this category in the D160A system (see Section III). It is possible to allocate the mod kit costs separately to the TMS level since the Depot Maintenance Industrial Fund Cost Accounting Production Report (H036B) interface provides cost elements for modification kit materiel costs, which are now allocated to the TMS level by the RAF_{TMS}. These costs appear in H036B under several Work Performance Category (WPC) codes, not just code "H" (modification). This is because modifications are often accomplished with other repairs, according to AFLCR 66-60 [9].

These modification materiel costs will be coded under WPCs other than H if the modification represents a subordinate portion of the man-hours expended on an item. Desmatics recommends that costs in the H036B elements of unfunded direct modification materiel and government furnished modification materiel be reported in the Modification cost category if they occur under all WPCs other than "C". A WPC of "C" indicates a conversion, which is a modification which alters the basic characteristics of an item, in essence creating a new end item. The CAIG guide [1] indicates that such modifications should be excluded from O&S costing. Desmatics is in agreement with this view and recommends that WPC "C" cost records in H036B be excluded from both Replacement Investment and Depot Maintenance.

The labor costs associated with modifications are now contained in the categories of Base Maintenance Personnel and Depot Maintenance. The base-level maintenance man-hours expended in the performance of a modification can be identified by Type Maintenance Designator codes of "T" and "Z" [15]. These codes are contained in the D056 interface to D160A. In order to determine the costs associated with the man-hours, a change must be made in the Base Labor Allocation Factor. In addition, a separate Modification Man-Hour Allocation Factor will need to be developed.

The first step is to segregate the code "T" and "Z" man-hours from the other codes in the D056 data. Then, develop the following ratios for each TMS:

(1) Base Labor Allocation Factor (revised),

$$L'_B = \frac{H'}{N \times H_{ST}}$$

where L_B' denotes the revised Base Labor Allocation Factor,

H' denotes maintenance man-hours in all Type Maintenance Designator codes except "T" and "Z" reported in D056 for a TMS, plus the support general standard hours for that TMS,

N denotes the number of personnel in the maintenance AFSC group associated with that TMS worldwide,

and H_{ST} denotes the annual available duty hour factor developed by the Office of VAMOSC.

(2) Modification Man-Hour Allocation Factor

$$L_M = \frac{H''}{N \times H_{ST}}$$

where L_M denotes the Modification Man-Hour Allocation Factor

H'' denotes maintenance man-hours in Type Maintenance Designator codes "T" and "Z" for a TMS,

and N, H_{ST} are as defined in (1).

The first ratio is used to allocate base maintenance labor costs other than modification labor. The second ratio will then allocate the base-level modification labor cost to the TMS level when multiplied by the personnel cost by AFSC group. A complete description of the D160A Base Maintenance Personnel Algorithm may be found in Desmatics' Technical Report No. 118-1 [19].

Depot-level modification labor costs can be identified in H036B data. As was mentioned earlier in this section, modification materiel which is subordinate to other depot repairs is reported under the WPC of the major category of the work [9]. However, the labor costs for modification will be recorded with WPC H (Modification) unless the costs are inconsequential.

Desmatics recommends that the following costs contained in H036B WPC H records be considered in the Modification cost category:

1. Civilian Direct Labor, Production
2. Civilian Direct Labor, Other
3. Military Direct Labor, Production
4. Military Direct Labor, Other.

Several cost elements other than direct labor and investment materiel must also be considered. Overhead and indirect depot costs are allocated to the NSN level by H036B. Many of the corresponding costs at base level are now subsumed in Base Maintenance Personnel cost and Maintenance Material cost. In Desmatics' opinion, it is infeasible to accurately identify and allocate these indirect modification costs in base-level costs. It is therefore recommended that these indirect costs not be given separate visibility at either base or depot level. Any cost elements on WPC H records not already categorized as being contained in the proposed Modification Cost category should be categorized as Depot Maintenance costs or Replacement Investment costs based on the criteria mentioned in the corresponding sections of this volume. It should be sufficient to present the direct costs only with separate visibility.

5. Other Replacement Investment Costs

As mentioned earlier in this section and in the Depot Maintenance section, Desmatics recommends that several investment materiel costs now considered as Depot Maintenance costs by the D160A system be reclassified as Replacement Investment. These are the H036B cost elements of Unfunded Direct Investment Materiel and Government Furnished Investment Materiel. In Desmatics' opinion, these costs are better categorized as replacement

investment, as they represent the cost of repair parts to replace those lost from Air Force inventory [2]. This should be accomplished by allocating these costs to the TMS level with RAF_{TMS}, and then adding them to the costs developed by the Replacement Investment Cost algorithm.

Based on the discussions in this section Desmatics recommends a revised reporting format on the D160A system output. This new format is presented in Figure 7. This should provide a more useful presentation of the costs, and will closely conform to CAIG guidelines.

6. Interchangeable/Substitutable Components

As mentioned in Section IV, the D041 system interface to D160A contains master recoverable application NSNs. Components which are interchangeable/sustitutable (I&S) with the master recoverables will not be mapped to the end item by the C-E system. As a result, replacement investment costs arising from condemnations of thse I&S components will not be allocated by the C-E system.

Since these I&S replacement investment costs are legitimately allocable, Desmatics recommends that the Office of VAMOSC obtain data to identify I&S NSNs for use in the processing of D041 condemnation data in this algorithm. I&S NSN information is available from the D041 system also [7]. The C-E system can incorporate this data into RAF_{TMS} processing as was mentioned in Section IV. Once RAF_{TMS} have been determined for the I&S components, the D041 data can be searched for those particular I&S NSNs. If any are condemned, Replacement Investment costs can be computed and allocated using the RAF_{TMS} for that particular application/recoverable

	DETAIL COST	CATEGORY SUBTOTAL
REPLACEMENT INVESTMENT*		$xxxxxx
MODIFICATION		xxxxxx
Depot		
Labor	xxxxxx	
Materiel	xxxxxx	
Base		
Labor	xxxxxx	
Materiel	xxxxxx	

*Includes costs computed based on condemnations, and Direct Investment Materiel and Government Furnished Investment Materiel.

Figure 7. Recommended Revised Reporting for D160A System O&S Cost Report.

pair. If the revised algorithm for Replacement Investment discussed in Section V.3 is used, it will be necessary to use rates rather than condemnations. If rates are not available from D041 for the I&S component, the rate for the master item will need to be used.

C. AN ALTERNATE METHOD FOR THE DETERMINATION OF REPLACEMENT INVESTMENT COSTS

As was mentioned in this section, there are several problems associated with the current method of computing and allocating Replacement Investment cost. In Section IV, several further problems are mentioned with respect to RAF_{TMS}. The Replacement Investment Cost algorithm shares some of these problems. For example, when items are batched for repair at the depot, the condemnations which occur when these items are actually repaired may appear in a different year than when they are sent to the depot. Any problems with RAF_{TMS} will affect the Replacement Investment Cost algorithm in kind. For these reasons, Desmatics has developed an algorithm to develop these costs to the TMS level in a more direct manner.

As was mentioned in Section IV, data on base-level maintenance actions by application SRD and recoverable component NSN is available from the D002A system. Base-level condemnation actions are identifiable by an Action Taken code [12] of "9". The recoverable component NSN on the record can be matched against the D041 Format 1 records to determine unit price. The total base level condemnation cost may then be determined as follows:

$$BRI_j = \sum_i (q_{ij} \times p_i)$$

where: BRI_j = base-level replacement investment cost for SRD_j,

q_{ij} = quantity of NSN_i condemned at the base level with application SRD_j, from D002A records,

and p_i = unit price of NSN_i, from D041 Format 1 records.

These records should not be selected for ANG and AFR organization codes, and for only C-E organizations. This is discussed in Section IV.

In order to determine the corresponding costs at the depot level, the following algorithm should be used:

$$DRI_j = \sum_k (q_{jk} \times p_k \times r_k)$$

where DRI_j = depot-level replacement investment cost for SRD_j,

q_{jk} = quantity of NSN_k sent to depot with Action Taken codes 1-8 [12] (see Section IV) with application SRD_j, from D002A non-ANG and non-AFR records,

p_k = unit price of NSN_k, from D041 Format 1 records,

and r_k = depot condemnation rate of NSN_k, from D041 data.

The condemnation rate, r_k, represents the percentage of the total quantity of a given NSN shipped to the depot which is condemned at the depot. By mapping the SRD to the TMS via the TMS/NSN table, these base-level and depot-level costs are identified directly to the end item without any allocation.

As was mentioned in this section, Desmatics recommends that end item condemnations not be costed for Replacement Investment. The same holds true for this revised algorithm. This may be accomplished by deleting

from further processing any DOC2A records which have a NSN which matches a NSN on the TMS/NSN table (i.e., an end item has been NRTSed and may be condemned at the depot, or has been condemned at the base level.)

The H036B costs of direct investment materiel and government furnished investment materiel would be added directly to the above algorithm, having been identified to the TMS level by the revised Depot Maintenance Cost algorithm discussed in Section IV. This would also be the procedure for modification costs. Once identified to the TMS level by the revised depot algorithm, they should be given the separate visibility recommended earlier in this section.

VI. END ITEM WITHIN END ITEM PROBLEM

During the course of its research into the various aspects of the C-E system, Desmatics has become aware of what can be termed the "end item within end item" problem. What this term refers to is the situation in which integral recoverable components of one TMS (along with the TMS itself) are considered end items by the Equipment Item Requirements Computation System (D039) and, consequently, by the C-E system.

One example of this problem is the AN/TPS-43E radar set. According to AFP 100-14 [14], this radar set contains two AN/UPA-62C indicator groups. These indicator groups are considered end items, along with the entire radar set, by both the D039 and D160A systems. These indicator groups can also be used in other radar sets. Desmatics refers to such end items within end items as "quasi TMSs."

Such situations impact on the manner in which the D160A system collects and reports O&S costs, possibly in every cost category. For instance, when one examines a C-E cost report for an item, it is unclear whether the various costs are for the entire system including the quasi TMSs, for the system exclusive of these items, or most likely, a mixture of both cases. For example, the Base Maintenance Personnel cost category for a TPS-43E contains costs for the maintenance of the UPA-62C when used in a TPS-43E, as it is work-unit-coded under the TPS-43E. However there is no Depot Maintenance cost for the UPA-62C when used in a TPS-43E, because the UPA-62C is not considered a recoverable of the TPS-43E by D041, and in turn by the C-E system. Therefore, there is a mixed presentation of the operating and support costs of this radar

system, which is not readily apparent to a user of the C-E system.

Desmatics recommends that the costs attributable to a quasi TMS be removed from the costs of the highest assembly, and be reported against the quasi TMS. In the case of the TPS-43E, any costs attributable to the UPA-62C (such as the aforementioned Base Maintenance costs) should be removed from the TPS-43E costs, and be added to the UPA-62C cost report. Further, in order to aid the user, the relationship between the UPA-62C and TPS-43E should be indicated on the TPS-43E report to allow users to build system costs. This procedure requires a study of the configurations of the TMSs to identify end item within end item situations, and then a study of the algorithms and input data to determine which costs must be moved. It is anticipated that a factor similar to the Recoverable Allocation Factor (currently used by the D160A system) would be needed to allocate costs in these quasi TMS situations. This must be accomplished in order to provide reports in which costs are reported cleanly.

VII. CONCLUSIONS, RECOMMENDATIONS AND OFFICE OF VAMOSC COMMENTS

This volume has presented an evaluation by Desmatics of the C-system's cost allocation algorithms for Depot Maintenance, Mobile D Maintenance, and Replacement Investment Costs. The methodology cur used in developing Recoverable Allocation Factors was also evaluate These factors are used to allocate both Depot Maintenance and Repla ment Investment costs.

A. SUMMARY

In Desmatics' opinion the utility of the C-E O&S Cost Reports be significantly enhanced if separate visibility were provided for major components and subcomponents of depot maintenance costs. Des also recommends changes to the cost selection process to eliminate evant costs, avoid double-costing, and report certain costs in othe categories where they more properly belong.

Alternate methods for determining Depot Maintenance costs and placement Investment costs more directly are proposed. These new m do not require the use of allocation factors and eliminate some of problems associated with the current methods.

The current method of mapping recoverable components to end it processing Recoverable Allocation Factors may not be optimal. Desm therefore recommends testing the procedure and altering it should i unsatisfactory for actual recoverable component-TMS configurations.

The validity of Replacement Investment costs computed in the C

system depends heavily on the correctness of the unit prices provided by the D039 and D041 systems. Although there is some question as to the accuracy of these prices, Desmatics recognizes the lack of alternate sources for this data, and recommends that these figures continue to be used. In another data matter, it is apparent that the TMS condemnation data supplied by the D039 system is composed almost exclusively of those actions which do not result in replacement of the item. Desmatics is of the opinion that such costs should not be included in the C-E system, and recommends that this particular aspect of the algorithm be eliminated.

The C-E system is intended to exclude the costing of Air Force Reserve (AFR) and Air National Guard (ANG) applications of C-E end items. In order to accomplish this, ANG and AFR equipment data from several input sources, which is being selected and processed by the C-E system, must be removed. Desmatics recommends several algorithms to accomplish this.

The C-E system can more closely conform to CAIG guidelines and provide more useful information by altering its reporting of modification costs. Desmatics recommends that modification labor and materiel costs be given separate visibility. In addition, the cost of direct investment materiel and government furnished investment materiel, now considered Depot Maintenance costs, are better classified as Replacement Investment costs. Finally, Desmatics is aware of the very important end item within end item problem. This situation requires extensive studies of both the configurations of the end items costed by the C-E system, and the data and algorithms used by the C-E system, in order to solve this problem.

B. RECOMMENDATIONS AND REPLIES

This section lists Desmatics' conclusions and recommendations regarding the Depot Maintenance, Mobile Depot Maintenance, and Replacement Investment Cost allocation algorithms. The responses or comments of the Office of VAMOSC are appended to these conclusions and recommendations.

1. Reporting of Depot Maintenance Costs (See pages 8-13)

Conclusion: The utility of the C-E O&S Cost Report could be significantly enhanced if separate visibility were provided for major components of depot-level maintenance costs. At the same time, the C-E system could be made to conform more closely to the CAIG guidelines for reporting of these costs.

Recommendations: The Office of VAMOSC should consider breaking out various components of depot maintenance costs as depicted in Figure 2, including those cost elements in each as shown in Figure 3.

Office of VAMOSC Comments: "Concur. Change will be submitted. Estimated implementation date is FY85."

2. Recategorization of Direct Investment Materiel Costs (See page 11)

Conclusion: The costs contained in H036B records for direct investment materiel and government furnished investment materiel are now considered under Depot Maintenance. In Desmatics' opinion these costs are better categorized as Replacement Investment.

Recommendation: The Office of VAMOSC should remove these costs from the Depot Maintenance cost category and add them to Replacement Investment.

Office of VAMOSC Comments: "Concur. Estimated implementation date is FY85."

3. Exchange Investment Materiel (See pages 11-12)

Conclusion: Unfunded direct exchange investment and government furnished exchange investment materiel costs represent the average cost to repair (inflated to allow for possible condemnation) defective recoverable components replaced on higher level items undergoing repair. Including these exchange investment materiel costs results in double-costing both for Depot Maintenance and Replacement Investment in the current method for processing these costs.

Recommendation: To avoid double-costing within the repair and condemnation costs for recoverable components, the Office of VAMOSC should exclude unfunded direct exchange materiel and government furnished exchange materiel from Depot Maintenance costs in the C-E system.

Office of VAMOSC Comments: "Concur. Estimated implementation date is FY85."

4. Fixed Overhead (G&A) Costs (See pages 5,12)

Conclusion: Unfunded G&A costs are excluded from Depot Maintenance costs in the C-E system. Funded G&A costs are, however, included. The CAIG guidelines recommend excluding all fixed overhead at depot repair facilities from O&S cost estimates. In Desmatics' opinion, excluding fixed overhead costs from depot maintenance effectively understates the true cost of depot-level repair for C-E end items.

Recommendation: The Office of VAMOSC should include both funded and unfunded G&A costs in Depot Maintenance costs in the C-E system.

Office of VAMOSC Comments: "Concur. Estimated implementation date is FY85."

5. Maintenance Support Costs (See pages 13-15)

Conclusion: According to the DOD Accounting and Production Reporting Handbook for depot maintenance and maintenance support costs, maintenance support costs identified by Work Performance Categories Q and R (and prior to FY83, P and S as well) on H036B records should not be costed as depot maintenance. Also, the CAIG recommends including costs associated with these maintenance support activities in General Depot Support.

Recommendation: The Office of VAMOSC should include maintenance support costs, identified in H036B by WPCs Q and R, in the General Depot Support Category. Selection of these records will have to be based on FSC since these costs appear to be reported only by the FSC portion of the NSN. An algorithm for the allocation of these costs will be presented in Volume VI of this series.

Office of VAMOSC Comments: "Concur pending receipt of methodology for allocation. Estimated implementation date is two years from receipt of allocation methodology from Desmatics."

6. Government Furnished Services (See page 15)

Conclusion: Funded and unfunded government furnished services represent charges which should be classified as maintenance support.

Recommendation: The Office of VAMOSC should exclude the costs for government furnished services from the Depot Maintenance Cost category in the C-E system, and include them instead in the General Depot Support Cost category.

Office of VAMOSC Comments: "Concur. Estimated implementation date is FY85."

7. Mobile Depot Maintenance-Bench Stock Materiel (See pages 19-20)

Conclusion: It is not clear whether bench stock materiel costs are not included in Mobile Depot Maintenance or are included as part of stock fund materiel costs.

Recommendation: The Office of VAMOSC should determine whether or not bench stock materiel costs are included in Mobile Depot Maintenance costs, and if not, ensure that they are included.

Office of VAMOSC Comments: "Materiel required for Mobile Depot Maintenance is ordered for each job, and this includes those items which would normally be considered bench stock. Therefore, there is no separate visibility available for "bench stock materiel" in MDM."

8. Mobile Depot Maintenance Costs - AFR and ANG (See page 20)

Conclusion: It is possible that the mobile depot maintenance costs from C003K contain costs for equipment owned by ANG and AFR units.

Recommendation: The Office of VAMOSC should verify that only mobile depot maintenance costs for equipment from active duty units are included in the C003K data file.

Office of VAMOSC Comments: "MDM work for AFR/ANG will be included in C003K. Action has been initiated to remove MDM costs for these organizations. Estimated implementation is FY84."

9. Removal of ANG and AFR Depot Maintenance Costs (See pages 18-19)

Conclusion: Although the C-E system is currently intended to produce operating and support costs for equipment owned by active duty units, costs for recoverables and equipment belonging to ANG and AFR units are selected for processing depot maintenance costs.

Recommendation: The Office of VAMOSC should exclude depot maintenance costs for ANG and AFR from the C-E system. These costs are reported in H036B under Reimbursement Source Codes B (ANG) and Z (AFR).

Office of VAMOSC Comments: "Concur. Estimated implementation date is FY83."

10. Removal of Irrelevant Costs (See pages 15-18)

Conclusion: The C-E system currently selects all H036B records containing NIINs found in the C-E Recoverable Data Base. Of these records, those containing customer codes other than 7F, or WPC C (Conversion) or L (Reclamation), or Reimbursement Source Code U (Disposal-Organic) are irrelevant for costing depot maintenance in the system.

Recommendation: To cost depot maintenance in the C-E system, the Office of VAMOSC should include only H036B records with customer code 7F, and exclude from these 7F coded records any other records with WPC C or L or Reimbursement Source Code U.

Office of VAMOSC Comments: "Concur. Estimated implementation date is FY83."

11. Removal of ANG and AFR Inventories (See pages 18-19, 35-36)

Conclusion: The C-E system currently includes ANG and AFR equipment inventory figures in computing normalized costs for TMSs. This equipment is also included in the total reported inventory for each TMS.

Recommendation: The Office of VAMOSC should eliminate ANG and AFR inventory quantities from the C-E system processing. This can be accomplished by excluding records for these organizations (by organization code) from the Assets by Organization File (and consequently the C-E Inventory and Other Inventory files). In addition, inventory counts in the C-E system should be the sum of the D039 Format 100 inventory counts for a TMS for only active duty units (i.e., those organizations in the PAS/ORG table), and not the D039 Format 50 inventory counts currently used (which include AFR and ANG equipments).

Office of VAMOSC Comments: "Concur. This is not a straightforward change since each ANG/AFR organization must be individually identified and removed. Estimated implementation date is FY86."

12. Condemnations from ANG and AFR (See pages 35-36)

Conclusion: The D039 and D041 systems contain condemnation data on all Air Force inventory, including Air National Guard (ANG) and Air Force Reserve (AFR) items. However, the intent of the present C-E system design is to provide costs associated with active duty usage of an item.

Recommendation: The Office of VAMOSC should modify the Replacement Investment cost algorithm to use a ratio of active duty inventory to total inventory to adjust condemnations. The costs should be allocated to the TMS level with a revised Recoverable Allocation Factor (RAF_{TMS}), which should be based on active duty inventory.

Office of VAMOSC Comments: "Concur. Estimated implementation date is one year after implementation of recommendation 11 and this method will be used only until recommendation 19 is implemented."

13. Inclusion of Interchangeable and Substitutable Recoverable Components (See pages 27-28, 41-43)

Conclusion: The C-E system currently uses a file from the D041 system which contains only master subgroups NSNs for recoverable components. Information on interchangeable and substitutable (I&S) components is also available.

Recommendation: The Office of VAMOSC should utilize an expanded D041 system file which includes I&S recoverable NSNs to ensure complete and accurate costing of Depot Maintenance and Replacement Investment in the C-E system.

Office of VAMOSC Comments: "Concur in part. Data for interchangeables is already in D041 and is used by VAMOSC. It is inappropriate to cost substitutes."

14. Methodology for Mapping Recoverable Components to End Items (See pages 21-28)

Conclusion: The top-down method used in the C-E system to map recoverable components to end item applications for developing recoverable allocation factors will not pick up components of those recoverables found at more than one level of indenture below the end item, or any recoverables below the level at which the processing is terminated. For reportable TMSs four levels of indenture are processed, for non-reportables only first level components are mapped.

Recommendation: To ensure complete selection of all recoverable-application pairs the Office of VAMOSC should either adopt the bottom-up procedure for mapping recoverables to end items or modify the processing in the current top-down method. This modification would involve using the entire file of recoverable-application pairs in each step of the processing, and continuing the processing until no further matches are found. This applies to the processing for both reportable and non-reportable TMSs.

Office of VAMOSC Comments: "Concur. Estimated implementation date is FY86."

15. Alternate Method for Determining Depot Maintenance Costs (See pages 28-30)

Conclusion: It is possible to sum depot maintenance costs directly to SRD using data available from the Automated Materiel system interface with the SBSS system and cost data from the H036B system. Use of this method does not require Recoverable Allocation Factors and avoids several other problems associated with the current method of determining these costs.

Recommendation: The Office of VAMOSC should consider implementing this new method (outlined in Section IV.C.) for determining depot maintenance costs for C-E end items.

Office of VAMOSC Comments: "Concur in principle. The Aircraft Component Support Cost System uses DSD D143F to accumulate NRTS actions by SRD and NSN and organization. This methodology will be used by the D160A system. Estimated implementation date is FY87."

16. Unit Prices (See pages 33-34)

Conclusion: The unit prices provided to the D160A system from D039 and D041 may not accurately represent replacement costs. However, these are the only sources of such prices, and while the costs developed using these prices may not be exact, they should indicate trends.

Recommendation: The Office of VAMOSC should continue to use these prices in the Replacement Investment algorithm. However, improvements to the D039 and D041 systems in the area of unit prices should be encouraged.

Office of VAMOSC Comments: "Concur."

17. D039 Condemnations (See pages 34-35)

Conclusion: It is inappropriate to cost the condemnation of an end item against the O&S portion of its life cycle. Any costs to replace condemned end items are acquisition costs, and are not relevant to the C-E system.

Recommendation: The Office of VAMOSC should alter the D160A system to disregard all condemnations from D039 in the computation of Replacement Investment cost.

Office of VAMOSC Comments: "Concur. This recommendation was implemented for FY83 production."

18. Revised Reporting Format for Modification Costs (See pages 37-40, 42)

Conclusion: The D160A system can provide a more useful presentation of Modification costs on the standard cost report product with the format presented in Figure 7.

Recommendation: The Office of VAMOSC should provide a report format for Modification costs in the D160A system which is similar to Figure 7, using the algorithm suggested by Desmatics.

Office of VAMOSC Comments: "Concur. Estimated implementation date is FY85."

19. An Alternate Replacement Investment Cost Algorithm (See pages 43-45)

Conclusion: Replacement Investment costs can be computed directly to SRD, and in turn to TMS, using data available through the D002A system. This would avoid the use of the Recoverable Allocation Factor (RAF_{TMS}) in this computation.

Recommendation: The Office of VAMOSC should consider implementing this revised algorithm (as outlined in Section V.C.) for determining Replacement Investment costs in the C-E system.

Office of VAMOSC Comments: "We will investigate the proposed methodology to determine if it is, in fact, feasible. Estimated implementation date is FY87."

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