# LEVEL

## USER'S MANUAL FOR STRATEGIC SATELLITE SYSTEM TERMINAL SEGMENT LIFE CYCLE COST MODEL.

JANE E. COX and DAVID B. PETERS

MARCH 1981

Prepared for

DEPUTY FOR COMMUNICATIONS AND INFORMATION SYSTEMS
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Hanscom Air Force Base, Massachusetts

DTIC
ELECTE
APR 1 0 1981

C

Project No. 6340

Prepared by

THE MITRE CORPORATION
Bedford, Massachusetts
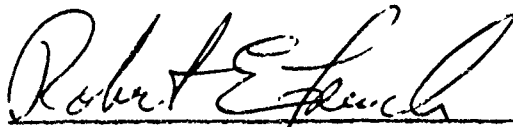Contract No. F19628-81-C-0001

DTIC FILE COPY

81 4 10 005

## REVIEW AND APPROVAL

This technical report has been reviewed and is approved for publication.

LAWRENCE H. METZ, Major, USAF
Electronic Engineer
Logistics Division

FOR THE COMMANDER

ROBERT E. FRENCH, Lt Col, USAF
Chief, Acquisition Division
Satellite Communications Terminal SPO
Deputy for Communications and Information Systems

| REPORT DOCUMENTATION PAGE | | READ INSTRUCTIONS BEFORE COMPLETING FORM |
|---|---|---|
| 1. REPORT NUMBER<br>ESD-TR-81-111, Vol. 1 | 2. GOVT ACCESSION NO.<br>AD-A097634 | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE *(and Subtitle)*<br>USER'S MANUAL FOR STRATEGIC<br>SATELLITE SYSTEM TERMINAL SEGMENT<br>LIFE CYCLE COST MODEL | | 5. TYPE OF REPORT & PERIOD COVERED |
| | | 6. PERFORMING ORG. REPORT NUMBER<br>MTR-8102, Vol. 1 |
| 7. AUTHOR(s)<br>Jane E. Cox<br>David B. Peters | | 8 CONTRACT OR GRANT NUMBER(s)<br>F19628-81-C-0001 |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>The MITRE Corporation<br>P.O. Box 208<br>Bedford, MA 01730 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS<br>Project No. 6340 |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>Deputy for Communications and Information Systems<br>Electronic Systems Division, AFSC<br>Hanscom AFB, MA 01731 | | 12. REPORT DATE<br>MARCH 1981 |
| | | 13. NUMBER OF PAGES<br>319 |
| 14. MONITORING AGENCY NAME & ADDRESS(If different from Controlling Office) | | 15 SECURITY CLASS. (of this report)<br>UNCLASSIFIED |
| | | 15a. DECLASSIFICATION DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, If different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

COMPUTERIZED MODELS
LIFE CYCLE COST
STRATEGIC SATELLITE SYSTEM

20. ABSTRACT *(Continue on reverse side If necessary and identify by block number)*

A computerized Life Cycle Cost (LCC) Model has been developed for the Strategic Satellite System (SSS) Terminal Segment Program. The model is tailored for this program in its structuring of terminal equipment and in the particular trade-off analyses which it supports. The Model emphasizes system support costs and design related cost drivers such as reliability and installation. A capability to study the cost trade-offs between fault isolation using built-in test equipment and using peculiar support equipment is included. The Model also considers three-level (over)

DD FORM 1473 EDITION OF 1 NOV 65 IS OBSOLETE

20. ABSTRACT

⌣ maintenance philosophies which include centralized intermediate maintenance facilities.

Volume I of this User' s Manual provides detailed instructions for entering data and running the LCC Model through step-by-step instructions and illustrative runs. All Air Force inputs to the Model equations are also provided. Volume II provides listings of the FORTRAN source code for the three programs comprising the Model.

This document is a part of the SSS Request for Proposal Package, and is specifically a supplement to the Statement of Work in that package. The Model is intended to be used in SSS Source Selection.

## ACKNOWLEDGMENT

# TABLE OF CONTENTS

# TABLE OF CONTENTS
## (continued)

## TABLE OF CONTENTS
(concluded)

## LIST OF FIGURES

## LIST OF FIGURES
### (concluded)

## LIST OF TABLES

## LIST OF TABLES
### (concluded)

# SECTION 1

## INTRODUCTION TO SSS LCC MODEL

### 1.1 Purpose of This Document

This is the User's Manual for the Strategic Satellite System (SSS)
Terminal Segment Life Cycle Cost (LCC) Model. SSS is to be a widely
deployed satellite communications system which is a follow-on to the
existing Air Force Satellite Communications (AFSATCOM) System. It
is expected that the SSS terminal segment may be composed of upwards
of 1000 hardware components, and the support costs may exceed the
procurement costs for the system. For this reason, an LCC Model has
been created to assist in analyzing these costs and to provide a
means of influencing the SSS terminal designs.

This Model has been tailored to the SSS terminal segment in its
structuring of terminal equipment and in the particular trade-off
analyses which it supports. The Model emphasizes system support
costs and design related cost drivers such as reliability and
installation. Other costs such as operation man hours and
government furnished equipment (GFE) are also included in the
calculations. Only the SSS terminal segment life cycle costs are
addressed -- the satellite portion of SSS is excluded. Therefore
any reference to SSS equipment is to be understood as referring only
to SSS terminal segment equipment.

This User's Manual is directed to the contractor's Design to
Cost/Life Cycle Cost (DTC/LCC) engineer or analyst, and also to
persons preparing input data for the Model, or making computer runs
with the Model. The rationale for each of the cost element
equations is discussed to assist the design engineer in interpreting
the outputs of the Model and using these results as an integral part
of the SSS design process. Detailed instructions for entering data
and running the LCC Model are provided through step-by-step
instructions and illustrative runs. All Air Force inputs to the
Model equations are also provided.

### 1.2 Applications of the Model

This document is a part of the Request for Proposal (RFP) package,
and is specifically a supplement to the Statement of Work (SOW) in
that package. It is intended that this LCC Model be used in SSS
Source Selection. This will give sufficient motivation to the
contractors to ensure their utilization of the Model. In this way,

11

the Air Force can convey its concern with LCC control and the contractors will in turn demonstrate to the Air Force that they are seriously involved in minimizing life cycle costs. Without full integration of an LCC control program within contractor design engineering efforts, many opportunities for possible LCC reduction, and avoidance of LCC increase, might go undetected. It is therefore important that this LCC Model be used by the contractor as a tool in performing cost trade-offs on SSS design alternatives, particularly in the areas where such trade-offs are required in the SOW.

The runs of the LCC Model submitted by the contractor as part of its response to the SSS RFP will be studied by the Air Force as an indication of the contractor's ability and willingness to use the Model as an integral part of its SSS design process. Furthermore, as the SSS program proceeds, specific examples of design studies or changes based on analyses using the LCC Model will be noted.

## 1.3 Structure of the Model

The core of the LCC Model is a set of equations used to determine values for cost elements and subelements from the input parameters. The eleven cost elements used are shown in Table 1-1.

The Model characterizes the SSS system in terms of prime mission equipment (PME) terminals installed on host platforms. Host platforms include airborne command posts, such as the E-4B and the EC-135, ground command posts, airborne force elements, such as the B-52, FB-111, and RC-135, and ground force elements, such as launch control centers and SAC wing command posts. Host platforms are deployed at operational sites or bases. PME installed on host platforms is broken down into Line Replaceable Units (LRUs) which in turn are broken down into Shop Repairable Units (SRUs). LRUs and SRUs are both given the generic name ITEMS. In addition to equipment installed on host platforms, there are initial and replacement spares for LRUs and SRUs. LRUs are typically black boxes, while SRUs are typically printed circuit board assemblies. The model also provides for support equipment (SE) (both common and peculiar) that is used in the maintenance and test of ITEMs. It distinguishes between Support Equipment needed for repair, and that needed only for bench checks. Maintenance is performed at bases and at depots. To reduce the number of input parameters, the size of files and the amount of data processing, both host Platforms and operating Bases have been aggregated into a small number of groupings. Only the average properties need to be specified for most of the parameters defining each group.

12

## Table 1-1

### SSS LCC Model Cost Elements

| Cost Element | Source |
|---|---|
| FSEDC = Full Scale Engineering Development | Contractor input |
| PRODC = Terminal procurement | Cost Element 1 |
| MIC = Integration of terminals into platforms | Cost Element 2 |
| OC = Operational labor cost and added fuel cost | Cost Element 3 |
| ISC = Investment Spares (pipeline and safety spares) | Cost Element 4 |
| RSC = Replacement Spares | Cost Element 5 |
| NMC = On-Equipment Maintenance | Cost Element 6 |
| OFMC = Off-Equipment Maintenance | Cost Element 7 |
| SEC = Support Equipment Procurement | Cost Element 8 |
| IIMC = ITEM Inventory Management | Cost Element 9 |
| STDC = Technical Orders | Cost Element 10 |
| MTRC = Maintenance Training | Cost Element 11 |

The Air Force establishes the identification and classification of host platforms and operational bases while the contractor structures the ITEMs and the support equipment. The overall functional characteristics of terminals are defined by Air Force requirements, but the determination of what ITEMS are needed in each type of terminal is a contractor function.

## 1.4 Key Assumptions

The overall ground rules and assumptions made in structuring the SSS LCC Model are discussed below.

o  Steady State  The model is a steady state model. This implies that all recurring costs are assumed to be constant from year to year. Average costs are computed based on peacetime usage and deployment of SSS equipment.

o  Equipment Structure  SSS equipment is structured as shown in Figure 1-1. Equipment includes terminals composed of ITEMs. SRUs are defined here to include modules. ITEMs may be Contractor Furnished Equipment or GFE. GFE is incorporated in the Model only if it must be modified for operation in the SSS system. The contractor is responsible for establishing what LRUs and SRUs are required to implement its particular SSS system design, and what their properties will be. In its input logistic parameters for modified GFE, the contractor is required to account for the difference between the cost of maintaining the modified GFE and the cost of maintaining the unmodified GFE.

o  Platform Structure  SSS terminals and integration equipment are installed on airborne and surface-based host Platforms, which are associated with sites (e.g. Bases), as shown in figure 1-1. For convenience, and to reduce the amount of data inputs and the volume of data processing, both host Platforms and operating Bases are treated statistically, that is, they are aggregated into a small number of groups, and average properties used for group characteristics.

o  System Lifetime  All equipment (including both airborne and surface based) are assumed to have the same Planned Inventory Utilization Period (PIUP) of 15 years.

o  Constant Dollars  The cost equations do not explicitly contain time as a variable. Costs are computed in constant Fiscal Year (FY) 1981 dollars, and are not discounted. The contractor must, therefore, enter all cost data to the Model in constant FY1981 dollars.

14

BASE OR OPERATING SITE  (e.g., LANGLEY, TINKER)

HOST PLATFORM  (e.g., E-4B, FB-111, SWCP)

TERMINAL

LINE REPLACEABLE UNIT (LRU)  (e.g., ELECTRONICS BOX)

SHOP REPAIRABLE UNIT (SRU)  (e.g., PRINTED CIRCUIT BOARD)
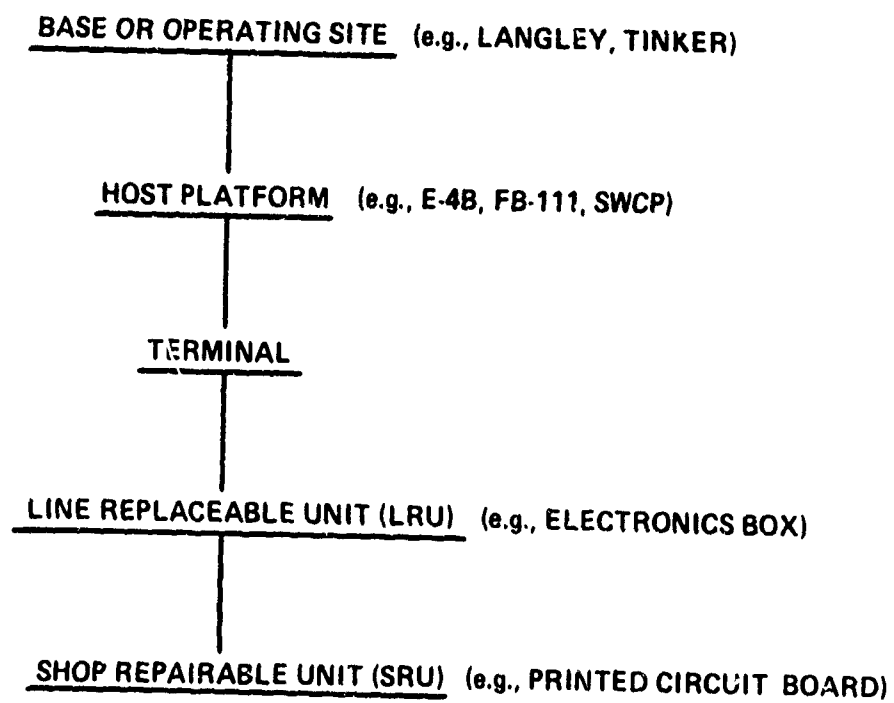
IA - 59,131

Figure 1-1.  Structure for SSS Terminal Equipment

15

o <u>FSED Cost</u>  The cost of the Full Scale Engineering Development (FSED) Program is not computed within the Model.  The user must derive this cost through an analytical effort of his own, and enter this cost as an input to the Model.  This cost is then passed through and included in the Model output tables.

o <u>Production Cost</u>  The production cost (variable PRODC) includes the hardware cost for all terminal equipment plus the recurring and non-recurring integration costs associated with each terminal type.  A learning curve is incorporated into the equation to reflect the decreasing production cost due to large procurement quantities.

o <u>Mod/Installation Cost</u>  The modification/installation (MOD/I) cost (variable MIC) includes the costs of installing SSS terminals into their associated host platforms.  A non-recurring cost to develop the required modifications and installations and a recurring cost to perform these mod/installations is included.

o <u>Operations Cost</u>  The operations cost (variable OC) includes the labor required to operate the SSS terminal and the added cost of fuel required due to the additional drag created by the addition of extremely high frequency (EHF) and/or super high frequency (SHF) radomes to the EC-135 and E-4B airborne command post aircraft.

<u>Support Philosophy Assumptions</u>:

o The SSS Maintenance philosophy is assumed to be the same as that for AFSATCOM, namely that there are three levels of repair, and that certain resources at the same base may be shared among the repair of different LRUs and SRUs.

o The three levels of repair are:

   - <u>Organizational</u>  Remove and replace LRUs.

   - <u>Intermediate</u>  Fault isolate to the SRU level, remove and replace faulty SRUs.

   - <u>Depot</u>  Repair SRUs.

o The four base types are:

- Independent bases with repair capability which are
  supported only by the main depot (and which in turn do not
  support any other bases).

- CIMFs - Bases with repair capability which provide
  maintenance support to satellite or secondary bases. CIMFs
  are supported only by the main depot. (CIMF = Centralized
  Intermediate Maintenance Facility).

- Satellite bases with no repair capability other than
  removing and replacing LRUs, which bases are dependent on a
  CIMF base for maintenance support.

- Repair depots or Technology Repair Centers (TRCs). It is
  assumed that there is only one depot for a given LRU or
  SRU.

o In addition to failures of LRUs, false pulls of LRUs are
  accounted for. Therefore all failures (and false pulls) which
  occur at a satellite base are first sent to the associated CIMF
  (even if the repair is eventually performed at the depot).
  Satellite bases also receive replacement spares from the CIMF.
  A satellite base does not possess the capability to identify
  false pulls. All false pulls are identified at the intermediate
  (e.g., CIMF) level.

o All failed and falsely pulled ITEMs are bench checked at the
  intermediate (e.g., CIMF) level (unless they are not removed
  from the next higher level indentured ITEM except at the depot
  level).

o Maintenance personnel at all bases and the depot are assumed to
  be non-dedicated to SSS, so that maintenance labor costs are
  accrued on an hours-per-repair basis.

o Average peacetime operating hours are used to determine Initial
  Spares and Support Equipment requirements.

o The Model considers corrective maintenance only, and assumes
  that there will be no preventive maintenance.

o The repair level decision for any specific ITEM does not depend
  on its base location (i.e., maintenance policy applies uniformly
  system-wide.

o No Initial Spares are supplied at the depot for discard-on-failure ITEMs. It is assumed that any spares at the depot will have been used up as replacement spares by the end of the life cycle of the system.

## 1.5 Excluded Cost Elements

The "Life Cycle Cost" computed by the Model excludes some cost elements. The following elements, in particular, are excluded:

o All advanced development cost and non-contractor FSED related cost.

o The cost of any acceptance testing of the equipment by or for the Air Force.

o The cost of operational fuel for aircraft. The added fuel consumption due to added radomes is included.

o System enhancement costs for correcting or enhancing the system after it is in operation. These are difficult to predict at this stage of the program, and so are not included.

o Base operating and support costs, personnel movement costs, and other costs that are not directly attributable to the design characteristics of the SSS system.

## 1.6 Features of the Model

In this section, the components of the SSS LCC Model are identified. The general structure of the Model and how it relates to the SSS program is discussed. The types of inputs and outputs which the Model uses and generates are presented. Finally, the interactive use of the LCC Model is discussed.

## 1.6.1 Major Components of the Model

The SSS LCC Model computer program consists of four main components. These consist of one basic component and three supplementary ones.

The LCC Program  The basic component implements a set of equations, detailed in Section 2, which compute the life cycle cost of the SSS system based on the values of the input parameters corresponding to a particular system design. The output of this first component gives the total LCC and also the LCC broken out into the eleven top-level cost elements shown in Table 1-1, and various subelements. The breakdown of Life Cycle Cost into various categories is intended

to help the user identify areas in which design and cost trade-offs should be made.

The Sensitivity Equations  The second component of the LCC computer program is a supplementary routine which provides a prestructured Sensitivity Analysis computation to be used as an additional aid in trade-off considerations.  (This capability is detailed in Section 3.)  More specifically, for certain selected contractor parameter inputs, this program component computes the average change (either positive or negative) in total LCC which is produced by a fractional increase in the value of the given parameter.  Sensitivity studies are of two types, those dealing with changes in global or system-wide parameters, and those dealing with changes on a per-ITEM basis.

The Preprocessor Program  The third component of the program is a preprocessor which is designed to run in concert with the SSS LCC Model.  The preprocessor's functions include creating an ITEM-in-platform matrix given an LRU-in-platform matrix and an SRU-in-LRU matrix, and scanning input files for various format errors.  Details of the preprocessor are given in Section 4.1.

The Repair Level Analysis Program  The fourth component of the LCC computer program is a supplementary routine which carries out a Repair Level Analysis (RLA).  The procedure and equations for RLA are described in Section 4.  This routine determines the maintenance costs associated with each possible repair level decision on each ITEM.  Possible repair level decisions are base repair, depot repair or discard.  The routine then determines the repair level choice for each ITEM that will minimize LCC.

1.6.2  Model Input Parameters

A very simplified system diagram for the Model, identifying major inputs and outputs, is shown in Figure 1-2.

The Model contains a large number of input parameters -- some furnished by the Air Force, and some developed by the contractor. These parameters are contained in fourteen input data files.  The data files are described in detail in Section 6.

In addition to the fourteen basic input files for the Model, as described above. there are inputs used with the supplementary features of the Model.  These inputs are Air Force sensitivity analysis inputs that are used to generate desired increments in selected input parameters.

19
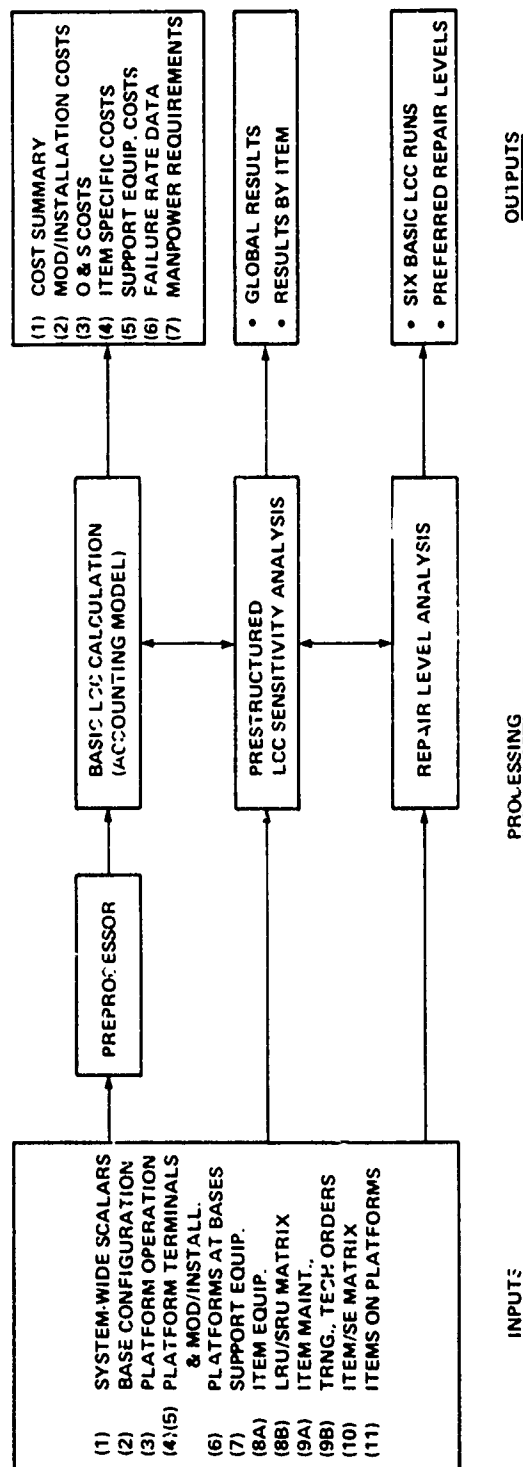
Figure 1-2. Simplified System Diagram of SSS LCC Model

IB-59,577

**INPUTS**

(1) SYSTEM-WIDE SCALARS
(2) BASE CONFIGURATION
(3) PLATFORM OPERATION
(4),(5) PLATFORM TERMINALS & MOD/INSTALL.
(6) PLATFORMS AT BASES
(7) SUPPORT EQUIP.
(8A) ITEM EQUIP.
(8B) LRU/SRU MATRIX
(9A) ITEM MAINT.
(9B) TRNG., TECH ORDERS
(10) ITEM/SE MATRIX
(11) ITEMS ON PLATFORMS

**PROCESSING**

PREPROCESSOR

BASIC LCC CALCULATION (ACCOUNTING MODEL)

PRESTRUCTURED LCC SENSITIVITY ANALYSIS

REPAIR LEVEL ANALYSIS

**OUTPUTS**

(1) COST SUMMARY
(2) MOD/INSTALLATION COSTS
(3) O & S COSTS
(4) ITEM SPECIFIC COSTS
(5) SUPPORT EQUIP. COSTS
(6) FAILURE RATE DATA
(7) MANPOWER REQUIREMENTS

• GLOBAL RESULTS
• RESULTS BY ITEM

• SIX BASIC LCC RUNS
• PREFERRED REPAIR LEVELS

All of the input parameters are described in detail in subsequent sections of this Manual.

## 1.6.3  Model Outputs

There are several types of printouts provided by the Model, as described briefly below.

The LCC program generates a set of input tables echoing the input data, and a set of output tables documenting the results of the Model's execution.  The results of the sensitivity analysis are combined into a single output table.  The preprocessor generates two tables, one echoing the input matrix and one displaying the created output matrix.  Finally, the Repair Level Analysis Program generates two echo input data tables and one output table showing the computed repair level decisions.

1.6.3.1  LCC Calculation Outputs contain the cost elements and subelements making up the total LCC of the contractor's SSS design, as well as quantities of spares, support equipment, and other significant supporting data.  Also shown are costs, failures and other ITEM data, and costs broken out by type of platform.  These results are displayed in seven output tables, with the titles listed below:

Output Table 1:  Summary by Cost Element

Output Table 2:  Platform Mod/Installation Cost

Output Table 3:  Operation and Logistic Support Cost Elements

Output Table 4:  ITEM-Specific Cost & Maintenance (three-part table)

Output Table 5:  Support Equipment Requirements and Costs

Output Table 6:  Platform/Terminal Failure Rate Data

Output Table 7:  Manpower Requirements (for maintenance and data management)

1.6.3.2  Sensitivity Analysis Outputs provide the results from a set of prestructured LCC sensitity analyses.  One set of outputs defines the approximate changes in total LCC due to prescribed increments in certain "global" or system-wide multiplying factors.  These factors effect program operational lifetime, all ITEM costs, all ITEM failure rates, all ITEM maintenance times and repair materials and

21

all false pull rates . A second set of outputs is devoted to unit costs, per ITEM-specific LCC changes due to increments in per ITEM unit costs, per ITEM failure rates, per ITEM repair materials, and per ITEM false pull rates. In addition, a very simple repair level calculation, in which each ITEM is considered independently of other ITEMS, is also presented. The result of each of these ITEM-specific investigations is printed in a format that ranks the first n ITEMS in accordance with the increment in total LCC.

1.6.3.3 <u>Preprocessor Outputs</u> are contained in one table which shows the ITEM deployment by platform matrix which the program created.

1.6.3.4 <u>Repair Level Analysis Outputs</u> are in two parts. First, LCC values for six basic runs with different limiting cases of repair approaches for all LRUs and all SRUs are shown, and second, preferred repair levels for each individual LRU and SRU are displayed. Repair level options for each item are (1) repair at base, (2) repair at depot, (3) discard on failure.

1.6.4 <u>Interactive Use of the Model</u>

The SSS LCC Model is designed for interactive use via a time-shared capability. This permits the analyst to make inputs to the Model at all steps of the calculations. The LCC Model may, however, easily be used in the batch mode as well.

A brief description of the organization of the full LCC Model, in its interactive mode, is as follows: First, the nominal values of standard input data files (which include Air Force and contractor data) are read into the model. Next, certain control parameters (e.g., instructions for output format) are input by the user from his terminal. At this point, the user may also override the nominal values of any selection of previous data inputs. Control is then transferred to the computer processor where the program calculates successively the life cycle cost of the modelled SSS program and the related values of the sensitivity analyses. The output of these computations is then directed to two separate devices. If the appropriate control parameter indicates that an off-line copy of output data is required, then the complete set of program output is produced on the off-line printer, including the LCC broken out into various categories and the sensitivity analysis values of all designated input factors. In addition, the user may request that a subset of the LCC output and the values of the sensitivity analysis calculations for a selected number of "most significant" input factors be displayed at his/her terminal.

The user is then asked at the terminal if he wishes another run. A "NO" response terminates the program. A "YES" response transfers the user back to the second step in the system operation where he may input new values for the control parameters and/or override the nominal values of a different selection of previous data inputs and then make a new run of the LCC Model. The user can make as many successive modifications of his data and reruns of the LCC Model in this interactive mode as he wishes. Alternatively, if the user wishes to perform a detailed analysis of the LCC output and sensitivity analysis factors before he reruns the model, he can terminate the program and use the off-line output as an aid in re-evaluating his SSS system design and maintenance concepts. (See Section 7 of this Manual for a full discussion of the LCC Model interactive capability.)

## 1.7 Document Overview

This document contains seven sections and four appendices.

Section 1 (Introduction) describes the detailed ground rules and assumptions underlying the Model and summarizes its structure, components and operating modes.

Section 2 (Cost Element Equations) describes the equations for all of the cost elements making up the basic LCC calculation, and identifies the parameters and variables involved.

Section 3 (LCC Sensitivity Analysis Capability) provides equations for a supplementary capability of the Model, namely prestructured sensitivity analyses on both a global (system-wide) basis and by equipment types.

Section 4 (Operating Characteristics) describes modes of operation, programming approach, equipment configuration required, performance characteristics and the nature of the Model data base. This section presents, therefore, an overview of the material contained in the last three sections, for the reader seeking such a synopsis.

Section 5 (Auxiliary Programs: The Preprocessor and Repair Level Analysis Programs) describes the two supplementary capabilities of the Model, namely a preprocessor to assist the user in constructing one of the large data files, and a methodology and the corresponding equations for investigating which repair level approaches, by ITEM, should lead to the lowest maintenance costs.

Section 6 (Input Parameters and Variables) identifies all inputs to
the Model, provides values for inputs furnished by the Air Force,
and gives instructions for the determination of Contractor inputs.

Section 7 (Operating Procedures) describes how inputs and outputs
are structured, how input files are prepared, how operations are
conducted in the interactive and the batch modes, and what output
tables are generated.

Three appendices are provided, namely: A. Glossary of Variables,
B. Illustrative Computer Run, and C. Glossary of Acronyms. There
is also an attachment containing a complete FORTRAN Program Listing.

It is recommended that a reader of this user's manual who wants an
overview of the nature and capabilities of the Model read sections 1
and 4. An LCC analyst and users of the Model should read sections 1
and 4 through 7, reserving sections 2 and 3 for use as reference,
and read appendix B.

# SECTION 2

## COST ELEMENT EQUATIONS

### 2.1 Introduction

This section presents the detailed equations for the cost elements identified in Section 1. Also identified are the motivations and specific assumptions underlying the structure of each of these equations.

To avoid redundancy, variables are defined only the first time that they appear in an equation. The glossary in Appendix A provides a reference if the reader wishes to recheck the definition of variables on subsequent occurrences.

The total system-wide life cycle cost (LCC) is computed as the sum of the following eleven cost elements:

| | | | |
|---|---|---|---|
| PRODC | - Production | OFMC | - Off-Equipment Maintenance |
| MIC | - Modification/Installation | SEC | - Support Equipment |
| OC | - Operations | IIMC | - ITEM Inventory Management |
| ISC | - Investment Spares | STDC | - System-Wide Technical Orders |
| RSC | - Replacement Spares | MTRC | - Maintenance Training |
| ONMC | - On-Equipment Maintenance | | |

### 2.2 Subscript Indexing Conventions

The indices of subscripted variables which appear in all equations in this User's Manual adhere to the following conventions. The values in parentheses indicate the allowable range of the subscript.

I - ITEM type  (1-999)

NP - platform grouping  (1-10)

NS - base type  (1-12)

L - support equipment type  (1-250)

M - mode of modification/installation on platforms  (1-4)

IA - equipment area on platforms for modification/installation  (1-4)

## 2.3  Auxiliary Calculations

The equations for certain internally computed quantities (i.e. not direct data inputs) which appear frequently within the cost element and sensitivity analysis equations are presented.  This format will serve both to highlight the importance of these internally computed variables and to facilitate the presentation of the cost element and sensitivity analysis equations in the following sections.

### 2.3.1  Failure Rates

First the average failure rates for each ITEM at each base are calculated, defined by:

FAIL(I,NS)  = the average number of failures (not including repairs in place or false pulls) of ITEM type I per month at each base of type NS (from all platforms NP deployed at the base), given by the equation:

$$FAIL(I,NS) = \sum_{NP} [NITEM(I,NP)*(1-RIP(I))*NPLT(NP,NS)*APFH(NP,LO(NS))$$

$$*TFAC(NP)*KFAC(LE(NP))/MTBMI(I,LE(NP))]*XFR$$

where

NITEM(I,NP)  = Average number of ITEMs of type I installed on each platform within grouping NP, including any multiple terminal platforms within the grouping.

26

RIP(I)     = fraction of maintenance incidents ITEM type I which are met by repair-in-place with piece parts.

NPLT(NP,NS)     = average number of platforms of type NP located at each base of type NS.

APFH(NP,LO(NS))     = average operating hours per month for platform type NP operating at base location LO(NS).

TFAC(NP)     = average fraction of operating time of platform type NP that SSS terminal equipment is activated.

KFAC(LE(NP))     = the reliability factor used to convert predicted failure rates to operational failure rates as a function of ⁻he environment LE(NP) of platform NP (See Section 5.2.1)

MTBMI(I,LE(NP))     = pr . ⁻cted mean operating hours between maintenance actions, over the life cycle, for an ITEM of type I operating in environment LE(NP), including maintenance actions involving repair-in-place with piece parts; e.g., replacing indicator lights. Should be calculated so as to represent the series, rather than system, failure rate of ITEM type I, including an adjustment for "duty cycle", as indicated in MIL HDBK 217B. (See Section 8.3.8)

XFR     = failure rate multiplier factor (may be used to globally adjust all ITEM failure rates for system trade-off studies).

LO(NS)     = location of base NS, defined as:
1, if base NS is within continental U.S.,
2, if base NS is a Pacific base,
3, if base NS is a European base

LE(NP)     = operating environment of platform NP, equals:
1, for Airborne-fighter platforms
2, for Airborne-cargo platforms
3, for Ground-fixed/transportable platforms
4, for Ground-mobile/manpack platforms

27

## 2.3.2 Pipeline Spares

Next, the ITEM pipelines spares at the bases and at the depot are computed, i.e., the average number of ITEMs of a given type I which are awaiting corrective maintenance action or replacement in supply at each location. These calculations are used to compute initial spares requirements, and are based on monthly failure rates.

NFB(I,NS) = expected number of failures of ITEM type I in base NS pipeline, given by the two cases:

(i) For a satellite base NS,

NFB(I,NS) = FAIL(I,NS)*LRU(I)*(1 + XFPR*FPR(I))*OSTC

where

OSTC = average order & shipping time from a satellite base to its associated CIMF (in months)

LRU(I) = LRU (line replaceable unit) indicator, equals 1 if ITEM type I is an LRU and equals 0 otherwise.

FPR(I) = false pull rate of ITEM type I; i.e., that multiple of actual failures which are removed but haven't failed.

FPR(I) should be calculated so as to satisfy the equation:

(# of removals) = (1 + FPR(I))(# of failures of ITEM I).

XFPR = false pull rate multiplier factor (may be used to globally adjust all ITEM false pull rates for system trade off studies)

(ii) For an Independent or CIMF base,

$$NFB(I,NS) = FAIL(I,NS)*(LRU(I) + RTS(NHI(I))) *[(FPR(I)*XFPR$$

$$+ RTS(I))*BRCT + (NRTS(1) + COND(I))*OST(LO(NS)))]$$

$$+ CIMF(NS)* \left\{ \sum_{B} FAIL(I,B)*NBC(B) \right\} *(LRU(I) + RTS(NHI(I)))$$

$$NHB(B)=NS$$

$$*[(RTS(I) + FPR(I)*XFPR)*CRCT + (NRTS(I) + COND(I))$$

$$*(OST(LO(NS)) + U(FPR(I)*XFPR)*CRCT)]$$

28

where

RTS(I) = fraction of (removed) failures of ITEM type I
which are repairable at the intermediate level
(RTS = repairable this station)

NRTS(I) = fraction of failures which must be repaired at
the depot level (NRTS = not repairable this station)

COND(I) = fraction of failures which are discarded, either due to
wearout or on the basis of an RLA decision.

Note: The RTS(I), NRTS(I) and COND(I) fractions refer only to
failures which are removed from the host platform and specifically
do not apply to failures repaired-in-place or to false pulls. In
addition, for each ITEM type I, these fractions must satisfy the
identity:

$$RTS(I) + NRTS(I) + COND(I) = 1.0$$

For the purposes of the automated repair level analysis capability,
explained in Section 7, the value of COND(I) actually input by the
user should represent only the fraction of failures discarded due to
wearout (assuming that, if repair is possible, it is performed).
The definition of COND(I) given in the Glossary of Variables
(Appendix A) reflects this. However, the user has the option to
input the discard-on-failure repair level decision for an ITEM via
the repair level code variable, RL(I), defined in Section 2.2.4 and
Appendix A.

OST(LO(NS)) = average order & shipping time in months from a base
NS to the depot (dependent on the location of the base
LO(NS))

BRCT = base repair cycle time, amount of time from removal
of failed (or falsely pulled) ITEM at the base until
repair at the (same) base and return of the ITEM to
base inventory (in months).

CRCT = amount of time from removal of a failed ITEM at a
satellite base until ITEM is shipped to and repaired
at the associated CIMF base and returned to CIMF
inventory (in months).

NHB(NS) = for satellite bases of type NS, equals the index of
the CIMF base on which it is dependent and equals 0 if
base NS is not a satellite base.

CIMF(NS) = CIMF base indicator, equals 1 if base NS is a CIMF base (i.e., if BTYPE(NS)=2) and equals 0 otherwise.

BTYPE(NS) = base type indicator; equals: 1, if base NS is an independent base; 2, if base NS is a CIMF; 3, if base NS is a satellite base.

NBC(NS) = for a satellite base NS, equals the number of bases of type NS which occur within the CIMF system which contains base NS and equals 0 if base NS is not a satellite base.

NHI(I) = for ITEM types I which are SRUs (shop repairable units), equals the index of the next higher level indentured ITEM in which ITEM I is contained (with the convention that NHI(I) = 0 if ITEM type I is an LRU).

Note:  The use of the term RTS(NHI(I)) above allows for the fact that an SRU can only be repaired at the intermediate level if its next higher indentured ITEM, NHI(I), was repaired at that level.  If ITEM type I is an LRU (so that NHI(I) = 0) then the Model sets "RTS(0) = 0" and LRU(I) = 1 so that the above equation simplifies to a form suitable for LRUs.  Thus, for both SRUs and LRUs, the expression "(LRU(I)+RTS(NHI(I)))" represents the fraction of the time that a failed ITEM of type I is _available_ for repair (i.e., removed from its next higher assembly) at the base level.  Hence, this expression is used as a "correction factor" thoughout the equations which appear in Sections 4 and 2.  In these equations the convention that RTS(0) = NRTS(0) = COND(0) = 0 is used to allow for the case when NHI(I) = 0.

Also above,

U = positive quantity indicator function, for any number X,

$$U(X) = \begin{cases} 1 & \text{if } X > 0 \\ 0 & \text{if } X \leq 0 \end{cases}$$

For the depot:

NFD(I) = expected number of failures of ITEM type I in the depot
pipeline, given by:

$$NFD(I) = \sum_{NS} FAIL(I,NS)*TNB(NS)$$

$$* \left\{ [LRU(I) + RTS(NHI(I))]*NRTS(I)*DRCT(LO(NS)) \right.$$

$$\left. + NRTS(NHI(I))*(1 - COND(I))*DAD \right\}$$

where

TNB(NS) = total number of bases within the entire SSS system
which are (treated as being) identical to base NS.

DRCT(LO(NS)) = amount of time in months from shipment of a failed
ITEM from base NS to the depot until it is received
and repaired at the depot and returned to depot
inventory (as a function of the location LO(NS) of
base NS).

DAD = average depot handling and repair time in months from
removal of a failed ITEM at the depot until it is
repaired and placed in depot inventory.

Note: NFD(I) = 0 if COND(I) = 1; i.e., no sparing provision is made
at the depot for discard-on-failure ITEMs (or "worn-out"
condemnations).

2.3.3 Maintenance Manhour Requirements

The next set of "Auxiliary Calculations" deal with ITEM corrective
maintenance manhour requirements at various locations and with
related support equipment utilization. Specifically,

ERHBI(I,NS) = expected intermediate level maintenance manhours per
month expended at a base of type NS in maintenance of
ITEM type I, computed by the conditions:

31

$$ERHBI(I,NS) = \begin{cases} 0, \text{ if base NS is a satellite base} \\ EBCBI(I,NS) + ERTBI(I,NS), \text{ if base NS is an} \\ \qquad \text{independent base or a CIMF} \end{cases}$$

where

$EBCBI(I,NS)$ = expected intermediate-level maintenance manhours per month expended at a base of type NS in bench checking of ITEM type I,

$ERTBI(I,NS)$ = expected intermediate-level maintenance manhours per month expended at a base of type NS in repair of ITEM Type I,

and these two variables are computed as follows:

$EBCBI(I,NS) = ERTBI(I,NS) = 0$ if base NS is a satellite base,

$$EBCBI(I,NS) = FAIL(I,NS)*(LRU(I) + RTS(NHI(I)))$$

$$*(1+XFPR*FPR(I))*BCMH(I)*BMF$$

$$+ CIMF(NS)* \left\{ \sum_{\substack{B \\ NHB(B)=NS}} FAIL(I,B)*NBC(B) \right\} *(LRU(I) + RTS(NHI(I)))$$

$$*[(RTS(I) + NRTS(I) + FPR(I)*XFPR$$

$$+ U(FPR(I)*XFPR)*COND(I))*BCMH(I)]*BMF, \text{ otherwise.}$$

and

$$ERTBI(I,NS) = FAIL(I,NS)*(LRU(I) + RTS(NHI(I)))*U(1-COND(I))$$

$$*RTS(I)*BMH(I) *BMF$$

$$+ CIMF(NS)*\left\{ \sum_{\substack{B \\ NHB(B)=NS}} FAIL(I,B)*NBC(B) \right\} *(LRU(I) + RTS(NHI(I)))$$

$$*U(1-COND(I))*RTS(I)*BMH(I) *BMF$$

where

BCMH(I) = average manhours to perform a base shop bench check, screening and fault verification of the removed ITEM prior to initiating repair action or condemning the ITEM.

BMH(I) = average manhours at a base to perform intermediate-level corrective maintenance of a failed ITEM of type I, including fault isolation, repair and verification.

BMF = base repair maintenance factor, to be applied to repair times to allow for time to get test equipment, parts, etc.

At the depot,

ERHD(I) = expected manhours per month expended at the depot in repair of I EM type I, calculated via the equation:

$$ERHD(I) = \sum_{NS} FAIL(I,NS) * TNB(NS) * [(LRU(I) + RTS(NHI(I))) * NRTS(I)$$

$$+ NRTS(NHI(I)) * (1-COND(I))] * DMH(I) * DMF$$

where

DMH(I) = average manhours to perform depot-level corrective maint.. _.._. on a failed ITEM of type I, including bench check-out, screening, fault verification and isolation, repair action and repair verification.

DMF = depot repair maintenance factor, to be applied to repair times to allow for time to get test equipment, spare parts, etc.

Any of three different types of support equipment (SE) may exist at a base in addition to common support equipment (CSE). They are peculiar support equipment (PSE), a maintenance bench set (MBS), and a universal card tester (UCT). At certain bases, designated by the user, an MBS or UCT will be installed to exercise the built-in-test equipment (BITE) of an ITEM. Other PSE may also be needed for the check-out and/or repair of an ITEM at these bases. If an ITEM at a base is not serviced by the MBS or UCT which exists at the base or neither an MBS nor a UCT is utilized at the base, then the ITEM will be checked-out and/or repaired by PSE and CSE only.

For support equipment utilization, then,

ERHAB(L,NS) = expected utilization of support equipment type L at a
base of type NS in hours per month, computed by:

$$ERHAB(L,NS) = \sum_I EBCBI(I,NS) \quad + \quad \sum_I ERTBI(I,NS)$$

$$SECODE(I,RMI(I,NS),L)>1 \qquad 0<SECODE(I,RMI(I,NS),L)<3$$

where

SECODE(I,IRM,L) = requirement indicator for support equipment type
L with respect to ITEM type I and ITEM repair mode
IRM, equals:

0, if SE type L not required for any maintenance
of ITEM type I,
1, If SE type L required for repair but not base
shop bench check of ITEM type I,
2, if SE type L required for both repair and base
shop bench check of ITEM type I,
3, if SE type L required for base shop bench check but
not repair of ITEM type I.

IRM = index referring to the various item repair modes
which an item may have equals
1, if ITEM repaired at the depot level,
2, If ITEM repaired at the base level by PSE only,
3, if ITEM repaired at the base level by an MBS plus
additional PSE if needed,
4, if ITEM repaired at the base level by a UCT plus
additional PSE if needed.

RMI(I,NS) = A value of IRM defining the particular item repair
mode which item type I will have at base NS.
RMI(I,NS) = BSP(NS)+1 only if the MBS or UCT existing
at a base is capable of servicing item type I.
Otherwise, RMI(I,NS) defaults to the value 2 if 2
exists as an IRM value for item I. If not, RMI(I,NS)
defaults to the value 1. Either default value
indicates that check-out and/or repair of item type I
will be performed by PSE only.

34

where

A(I,IRM,L) = matrix determining the quantity of support equipment
type L needed in repairing item I. Support equipment
quantities are input for a particular item I and
repair mode IRM only if the SE represented by the IRM
index is capable of servicing item I. (Contractor
input in Data File 10)

(Note that SE item quantities are input for IRM = 2 only if PSE at
the base differs from that used at the depot.)

BSP(NS) = base level support equipment philosophy equals
1, if PSE only is used,
2, if an MBS plus additional PSE is used,
3, if a UCT plus additional PSE is used.
(Input by contractor)

Also,

ERHAD(L) = expected utilization of support equipment type L at
the depot in hours per month, computed by:

$$ERHAD(L) = \sum_{I} ERHD(I)$$
$$0 < SECODE(I,1,L) < 3$$

The maximum number of units of each SE type required in any one
maintenance action performed at a particular location is given by:

ISET(L,NS) = maximum number of copies of support equipment type L
required for any maintenance action which will be
performed at a base of type NS, calculated by the
equation:

where

$$ISET(L,NS) = Max \left\{ \begin{array}{l} A(I,RMI(I,NS),L) \\ ERHBI(I,NS) > 0. \end{array} \right\} \text{ over all I such that}$$

Similarly,

ISETD(L) = maximum number of copies of support equipment type L
required for any maintenance action which will be
performed at the depot, calculated by:

$$ISETD(L) = Max\{A(I,1,L)\} \text{ over all I such that ERHD(I)>0.}$$

Finally, the number of copies of each support equipment type
required at each location is given by

NSEB(L,NS) = number of copies of support equipment type L required
at each base of type NS, computed by the formula:

$$NSEB(L,NS) = (ERHAB(L,NS)/BAA)*ISET(L,NS),$$

if L is common SE available on site (i.e., SETYPE(L)=1), and

$$NSEB(L,NS) = [ERHAB(L,NS)/BAA]^{+}*ISET(L,NS),$$

otherwise.

and

NSED(L) = number of copies of support equipment type L required
at the depot, computed by the formula:

$$NSED(L) = \begin{cases} (ERHAD(L)/DAA)*ISETD(L), & \text{if L is common SE available} \\ & \text{at depot (SETYPE(L)=1)} \\ + \\ [ERHAD(L)/DAA]^{+}*ISETD(L), & \text{otherwise} \end{cases}$$

where

BAA = total available active work time per maintenance man
in hours/month at a base repair shop

DAA = total available active work time per maintenance man
in hours per month at a depot repair shop

SETYPE(L) = support equipment acquisition indicator, equals
1, if SE type L is common and available on-site
(refer to Air Force-provided list of this SE),
2, if SE type L is common but requires procurement
for SSS use,
3, if SE type L is peculiar.

The operation [  +  ] represents rounding up to the next integer (when
the quantity in braces is not itself an integer).  Thus, common
support equipment which is available at base sites may be prorated
by utilization.  Other support equipment must be purchased in whole
units.


## 2.3.4  Calculation of Repair Level Fractions

The LCC Model is equipped with a short-cut mechanism for inputting
ITEM repair levels.  This mechanism is operated via the use of the
repair level code variable, RL(I).  RL(I) is a contractor input in
Data File (9A).  For each ITEM type I, RL(I) can be given one of
four possible values:  0,1,2, or 3.  The corresponding results of
each of these values are outlined in Table 2-1.  Basically, setting
RL(I) equal to zero has no effect, while giving RL(I) a non-zero
value will cause the input values of the repair level fractions,
RTS(I), NRTS(I), and COND(I), to be overridden (replaced with
internally calculated values).


Table 2-1

Results of Different Values of RL(I)


| RL(I) | Result |
| --- | --- |
| 0 | Initially input values of RTS(I), NRTS(I), and COND(I) are used in the LCC Model. |
| 1 | Input values of RTS(I), NRTS(I), and COND(I) are replaced with internally calculated values representing base repair of ITEM type I. |
| 2 | Input values of RTS(I), NRTS(I), and COND(I) are replaced with internally calculated values representing depot repair of ITEM type I. |
| 3 | Input values of RTS(I), NRTS(I), and COND(I) are replaced with internally calculated values representing discard-on-failure of ITEM type I. |

Given a non-zero value for RL(I), the LCC Program will calculate the corresponding values for RTS(I), NRTS(I) and COND(I) according to Table 2-2. Note that the entries of this table are determined by knowing that the value of COND(I) has to be at least WEAR(I), where

WEAR(I) = the fraction of (removed) failures of
ITEM type I which are condemned, due to
normal wear-out.

(Note that WEAR(I) gets its value from the initially input value of COND(I). Therefore, even if the user chooses to override the initially input repair level fractions via a non-zero value of RL(I), COND(I) must still be given a meaningful value. This value should represent the fraction of ITEM type I failures for which repair is infeasible due to wear-out (regardless of economic repair level decision).)

Also the value of NRTS(I) has to be at least RTS(I)*BIRD, where

BIRD = the fraction of base-repair-intended failures
which are actually repaired at the depot due
to insufficient base repair capability.

Finally, a largest possible fraction is assigned to RTS(I), NRTS(I), or COND(I) if ITEM type I is base-repaired, depot-repaired or discarded on failure respectively. Of course, the condition that RTS(I) + NRTS(I) + COND(I) = 1.0 is maintained.


Table 2-2

Calculation of Repair Level Fractions


| RL(I) | RTS(I) | NRTS(I) | COND(I) |
|-------|--------|---------|---------|
| 1 (base) | $\frac{1-WEAR(I)}{1+BIRD}$ | RTS(I)*BIRD | WEAR(I) |
| 2 (depot) | 0 | 1-WEAR(I) | WEAR(I) |
| 3 (discard) | 0 | 0 | 1 |

38

Note that if $RL(I) = 0$, then there will be no calculation of these fractions. Instead, the input values of RTS(I), NRTS(I), and COND(I) will be used provided their sum is exactly 1.0.

The Model also provides the means for the user to input a global maintenance strategy by changing the value of only one variable. This is the scalar R whose possible values are the integers from 0 to 6 inclusive. Setting R equal to 0 has no effect. Giving R one of its non-zero values causes the internal setting of the variables RL(I) as described in Table 2-3.

Table 2-3

Results of Non-Zero Values of R

|  | Resulting values of RL(I) if I is | |
| R | An LRU | An SRU |
|---|---|---|
| 1 | 1 | 1 |
| 2 | 1 | 2 |
| 3 | 1 | 3 |
| 4 | 2 | 2 |
| 5 | 2 | 3 |
| 6 | 3 | 3 |

The interpretation of Table 2-3 is that if R=1, both LRUs and SRUs are all designated for base repair; if R=2, all LRUs are base-repaired and all SRUs are depot-repaired; if R=3, LRUs are base-repaired and SRUs are discarded-on-failure; if R=4, both LRUs and SRUs are depot-repaired; if R=5, all LRUs are dpot-repaired and SRUs are discarded-on-failure; and finally, if R=6, all LRUs (and hence their contained SRUs) are discarded-on-failure.

The capability provided by R was built into the Model for the main purpose of generating the item cost input matrix TIAC(I,R) for the RLA Program described in Section 5. However, the user may choose to utilize the variable R for quickly inputting one of the six global maintenance strategies described above. In this event, he should be aware that a non-zero value of R will cause the computation and printing (on Output Table 4A described in Section 4.2.3) of TIAC(I,R) where

TIAC(I,R) = total repair-level-dependent cost attributed to
ITEM type I by global maintenance strategy R
(for non-zero values of R only).

This variable is computed by

TIAC(I,R) = ISCA(I) + RSCA(I) + ONMCA(I)+ OFMCA(I) + SECI(I)

+ IIMCA(I) + TDC(I) + MTRCI(I)

Where the variables summed on the right-hand side are ITEM-specific
parts of eight cost elements defined and computed in section 2.4.4
through 2.4.11.


2.3.5  Calculation of Procurement Quantities

This auxiliary calculation computes the total quantities of each
ITEM to be procured under the SSS terminal segment production
contracts.  This total includes three subtotals:  the PME ITEMs,
investment spares for each ITEM, and a specific number of years of
replacement spares for each ITEM.

The purpose of this auxiliary calculation is to allow for the
application of learning effects to the production contract
procurement costs.  The function LC(I) computes the effects of
learning based on the first unit cost for ITEM type I and the
procurement quantity of each ITEM, which is calcuated in this
routine.

The total production contract procurement quantity for each ITEM
type I will be

TOTPQ(I) = PMEQ(I) + TISQ(I) + NRUC*YRSQ(I)

where

PMEQ(I) = Total prime mission equipment procurement quantity for
LRU ITEMs of type I.

TISQ(I) = Total investment spares quantity for ITEM type I.

YRSQ(I) = Yearly replacement spares quantity for ITEM type I.

NRUC = Number of years worth of replacement spares to be
procured under the SSS terminal segment production
contract(s).

## 2.3.5.1 Prime Mission Equipment ITEM Quantities

The total PME quantities for each LRU ITEM is calculated as the product of the quantity of ITEMs in each terminal and the total number of terminals in the SSS.

Thus

$$PMEQ(I) = \sum_{NS} \sum_{NP} TNB(NS)*NPLT(NP,NS)*NITEM(I,NP)*LRU(I)$$

where

TNB(NS) = total number of bases in the SSS which are (treated as being) identical to base NS

NPLT(NP,NS) = average number of platforms of type NP deployed at each base within grouping NS.

Note that only LRUs are included in PMEQ(I), as only LRUs are deployed as PME.

## 2.3.5.2 Investment Spares Quantities

It is assumed that each base and the depot require an initial supply of Investment Spares to be used for immediate replacement of operational ITEMs upon failure. The stock of Investment spares is maintained by either placing repaired ITEMs back in stock or by purchasing replacement spares for ITEMs which are non-repairable and hence discarded.

The number of Investment spares allotted to each location is set equal to the number of pipeline spares for that location (represented by the auxiliary calculations NFB(I,NS) and NFD(I)), plus a safety stock. Here a standard Air Force stock control procedure* is used which has been shown to be numerically equivalent to the "expected number of backorders" criterion of the Air Force Logistic Support Cost Model**

---

*Stock Control at Bases, Chapter 11 of Air Force Manual AFM 67-1, Vol. II, Part One, 4 March 1974.

**Logistics Support Cost Model User's Handbook, Headquarters AFLC/AQML, August,1976.

Specifically, if NFB(I,NS) equals the pipeline spares of ITEM type I at a base of type NS, then the number of investment spares allotted to that base, denoted BS(I,NS), would be given by:

BS(I,NS) = F(NFB(I,NS))

where F is the function defined for any real number X by

$$F(X) = X + BF*\sqrt{X}$$

The coefficient BF in the definition of the function F determines the confidence level of safety stock. For example, if BF=1.65 then the function F will yield a stock of Investment spares which guarantee an expected back order of less than 0.1 unit per ITEM.

Similarly, if NFD(I) equals the pipeline spares of ITEM type I at the depot, then the number of investment spares of ITEM type I at the depot, denoted DS(I), is given by

DS(I) = F(NFD(I))

Thus the total investment spares quantities for an ITEM of type I is

$$TISQ(I) = \sum_{NS} TNB(NS)*BS(I,NS) + DS(I)$$

Notes:

1) The value for the function F is usually rounded off to the nearest integer number of spares, since it is most often used to compute the number of investment spares required at one particular location. However, the SSS LCC Model deals with groupings for similar bases which may not have exactly the same sparing requirements. Thus BS(I,NS) can be interpreted as the average number of initial spares of ITEM type I that are required at each base within grouping NS. For example, if there are 20 bases in a particular grouping NS, then BS(I,NS) = 1.5 could be interpreted as meaning that 10 of the bases require 2 spares of ITEM type I and the other 10 only require 1 spare for a total of 30 spares ( = TNB(NS)*BS(I,NS)) within base grouping NS.

Not rounding spares off to the nearest integer also has the advantage of avoiding the possibility of having small increases in failure rates produce large fluctuations in total spares requirements. For example, a small increase in the failure rate of ITEM type I might increase BS(I,NS) up from say 1.48 to 1.53. For a

grouping NS of 20 bases, this change represents an increase of only 1 spare over all 20 bases. However, if BS(I,NS) were rounded off to the nearest integer, a fluctuation of 1 spare per base or a total of 20 spares would occur. Given the fact that there is a range of uncertainty with regard to the ability of the LCC Model to accurately predict the numbers of investment spares which will actually be deployed, it is wise to minimize the impact of small fluctuations in failure rates (or in any other factor, for that matter). With this same point in mind and for consistency, the number of depot investment spares per ITEM is not rounded off to the nearest integer.

2) The pipeline spares quanties NFB(I,NS) and NFD(I), computed as auxiliary calculations in Section 2.2.2 are based on SSS being fully deployed.

### 2.3.5.3 Replacement Spares Quantities

Replacement spares include additional spares required to replace failed ITEMs which are discarded due to either normal wearout of to discard-on-failure repair level decisions (i.e., COND(I) fraction of failures).

The yearly replacement spares quantity due to an individual ITEM type I is given by

$$YRSQ(I) = 12*(\sum_{NS} FAIL(I,NS)*TNB(NS))*(1-COND(NHI(I)))$$

Note: If ITEM type I is an SRU contained in a higher indenture level ITEM (indexed NHI(I)) which is discarded at least for some fraction of its failures (indicated by COND(NHI(I)), then the replacement cost (or repair materials cost) of this SRU is covered or absorbed in the replacement spares cost of the higher indenture level ITEM. Thus, in the equation above, the replacement spares costs for such an SRU would only be incurred for that fraction of the time when its next higher level indentured ITEM is <u>not</u> discarded. This fraction is represented by the term

(1-COND(NHI(I))).

Note that if ITEM type I is an LRU, then by convention NHI(I)=0 and COND(0)=0, so that effectively the term (1-COND(NHI(I))) disappears.

## 2.3.6 Learning Curve Effects -- Function LC(I)

The function LC(I) is called to introduce learning effects in the SSS LCC Model equations. A learning curve is a relationship between production cost and production volume. It indicates that the cost to produce each additional unit is decreasing and that the amount of decrease is less with each successive unit. The result of LC(I) is a factor which is multiplied by the first unit cost UP(I) of ITEM type I to give the learned average unit cost.

The two inputs to the learning curve equation are a factor relating to the learning rate for ITEM type I and the total procurement quantity for ITEM type I. The learning rates are input by the contractor as LFAC(I). The procurement quantities for each ITEM include PME LRUs, investment spare ITEMs, a specific number of years of replacement spares for each ITEM, and a special sensitivity quantity XITEMQ(I) defined in Section 6.1.9.

The basic formula for a learning factor is as follows:

Define:

$$BI(I) = (\log LFAC(I))/\log 2$$

$$N(I) = TOTPQ(I) + XITEMQ(I)$$

Then

$$LC(I) = \frac{1}{N(I)} \sum_{X=1}^{N(I)} X^{BI(I)}$$

This formula, however, is inefficient for high values of N(I). An approximation formula has been derived by Cho and Schmidt. This formula is used by the LCC Model:

$$LC(I) = \frac{1}{N(I)} \left[ \frac{1}{BI(I)+1} *(N(I)^{BI(I)+1} -1) \right.$$

$$\left. + \frac{1}{2} *(N(I)^{BI(I)} +1) + \frac{BI(I)}{12} *(N(I)^{BI(I)-1} -1) \right]$$

44

## 2.4  Cost Element Equations

In this section the equations and an explanatory discussion for each
of the eleven cost elements is presented.  Free use will be made in
these equations of the auxiliary calculations presented in the
previous section.  Each cost element will be treated in a separate
sub-section below.

### 2.4.1  Production Cost Element  (PRODC)

The production cost of the SSS terminal segment will be taken as the
sum of unit terminal costs for all terminals deployed.  Unit
terminal costs are the sum of the learned costs of the LRUs in each
terminal, the recurring integration cost INTR(NP) associated with
each terminal of type NP, and a pro rata share of the non-recurring
cost INTNR(NP) associated with each terminal type.

The production cost for each platform is

$$TERMC(NP) = (INTNR(NP)/TOTT(NP)) + INTR(NP) + HDWRT(NP)$$

where

INTNR(NP) = the total non-recurring cost associated with the
integration of a terminal into platform type NP

TOTT(NP) = the total number of platforms associated with platform
type NP, calculated by

$$= \sum_{NS} TNB(NS) * NPLT(NP,NS) * NTRMP(NP)$$

INTR(NP) = the recurring integration cost associated with
platform type NP

HDWRT(NP) = Hardware (LRU) cost for platform type NP, calculated
by

$$= \sum_{I} HDWRIT(I,NP)$$

such that
$$LRU(I) = 1$$

where

HDWRIT(I,NP)= NITEM(I,NP)*LUP(I)*XUC

    LUP(I) = the learned unit price for ITEM type I, calculated by

$$LUP(I) = UP(I)*LC(I)$$

The total production cost PRODC is then calculated by

$$PRODC = \sum_{NP} TOIT(NP)*TERMC(NP)$$

This total cost can be split into a hardware component TERMH and an integration component TERMI, by

$$TERMH = \sum_{NP} TOTT(NP)*HDWRT(NP)$$

$$TERMI = \sum_{NP} INTNR(NP) + TOTT(NP)*INTR(NP)$$

## 2.4.2 Modification/Installation Cost Element (MIC)

This cost element is divided into 1) a non-recurrent component; that is, the cost of developing the required modifications and installations to be performed in installing terminals on each different platform type, and 2) a recurrent cost; that is, the unit cost of performing the developed MOD/I on each individual platform, including both production line MOD/Is and retrofits.

The non-recurring development cost for each platform grouping NP, denoted IMICA(NP), is given by the equation

IMICA(NP) = PDIV(NP)*NRMI(NP)

where

    PDIV(NP) = factor defining the total effective number of different types of platforms within platform grouping NP.

    NRMI(NP) = total non-recurring cost per platform type for MOD/I of SSS terminal equipment into platforms within grouping NP.

46

Note: An individual platform grouping NP contains platform types which are similar, but not exactly the same. Platform groupings were made on the basis of functional similarities (e.g., supersonic fighter aircraft) and the likelihood of identical SSS terminal equipment configurations. The contractor should make an estimate of the parameter NRMI(NP) for a single representative platform type within grouping NP, in accordance with the instructions in Section 5.4.3. The Air Force-provided platform diversity factor PDIV(NP) will then adjust these estimates to account for the additional MOD/I development costs due to the differences in platform types within grouping NP.

The average recurrent MOD/I cost for a platform within grouping NP, denoted RMICA(NP), is given by the equation

$$RMICA(NP) = \sum_M FR(M,NP) * \Big\{ MIFIX(M,NP)$$

$$+ \sum_{IA} [MIMH(IA,M,NP) * XMIL * MILR(M) + AKIT(IA,NP)] \Big\}$$

where

    FR(M,NP) = fraction of all platforms within grouping NP which undergo MOD/I in mode M.

    MIFIX(M,NP) = the fixed MOD/I cost for platform type NP in MOD/I mode M, meant to cover the cost of platform preparation for the MOD/I and the subsequent platform restoration.

MIMH(IA,M,NP) = the average number of man-hours required to perform the MOD/I to area IA on platform type NP in mode M.

    XMIL = MOD/I labor manhours multiplier factor (may be used to adjust all MOD/I manhour estimates by a uniform factor to measure LCC sensitivity or to perform system trade-off studies).

    MILR(M) = MOD/I labor rate in dollars per manhour for MOD/Is performed in mode M.

    AKIT(IA,NP) = unit cost for each "A-Kit" required for a MOD/I to area IA on platform type NP, to include all installation material cost not included in "terminal" costs.

47

Note: Antennas are considered part of PME (B-kits), not part of
A-kits. Thus antenna equipment costs should be averaged into unit
terminal costs used in the Production Cost Element and not included
in AKIT(IA,NP) costs.

M = mode in which platform MOD/I is performed, identified
by
1, if MOD/I performed during platform production,
2, if MOD/I performed in the field (by a depot team),
3, if MOD/I performed at the depot.

IA = index for various MOD/I areas on platforms. Values
are:
1, to indicate Antenna area,
2, to indicate Electronics Box area,
3, to indicate Control Head area,
4, to indicate Cabling area.

Note: the recurring, non-fixed MOD/I cost per platform is divided
into costs due to the four areas: Antenna, Electronics Box, Control
Head, and Cabling. Thus, again since any individual platform
grouping NP contains platforms of somewhat different types, the
contractor should make estimates of the manhours MIMH(IA,M,NP)
required for MOD/I in areas on the basis of a single representative
platform type within each grouping NP, in accordance with the
instructions provided in Section 6.4.4.

The total MOD/I Cost is then given by

$$MIC = \sum_{NP} \left\{ IMICA(NP) + \sum_{NS} TNB(NS) * NPLT(NP,NS) * RMICA(NP) \right\}$$

Thus the initial, non-recurring cost of developing the MOD/I is
incurred only once for each platform grouping NP, whereas the
recurring MOD/I cost is incurred for each individual platform within
grouping NP, located at all the bases where these platforms are
deployed.


## 2.4.3 Operations Cost Element (OC)

This cost element consists of the sum of Operational Labor Cost,
OLC, and Added Fuel Cost, AFC, so that

$$OC = OLC + AFC$$

Operational Labor Cost is meant to cover the cost of man-hours expended in routine activation of SSS terminals. This cost is <u>not</u> included in this version of the SSS LCC Model, because terminal synchronization is expected to be nearly instantaneous.

Added Fuel Cost will now be considered. For each airborne platform, the SSS added antenna elements increase the drag of the airframe. Hence to maintain the same average speed more fuel must be consumed per hour, or if the rate of fuel consumption is unchanged the mission will take longer. In the calculations, it is assumed that the fuel consumption rate is increased to provide an increment in average engine thrust equal to the average antenna drag.

It is further assumed that, for Platform NP, a direct proportionality between drag added to NP, and added fuel consumption required for NP. Specifically, set:

(Added fuel consumption for NP) = FUNCTION(NP)*(drag added to NP), where

$$FUNCTION(NP) = FGH(NP)/(K(NP)*THRS(NP)),$$

and FGH(NP) represents fuel consumption rate in the absence of extra drag, THRS(NP) represents average engine thrust utilized in the absence of extra drag, and K(NP) is a constant for each platform.

These considerations lead to the development of the following equation for Added Fuel Cost:

$$AFC = 12*PIUP*\sum_{NS}\sum_{NP} NPLT(NP,NS)*TNB(NS)*APFH(NP,LO(NS))$$

$$*FGH(NP)*CFG(LO(NS))*NAE(NP)*DRAG(NP)$$

$$/[K(NP)*THRS(NP)]$$

where

49

FGH(NP) = average fuel consumption in gallons per operating hour (without extra drag) for platform type NP

CFG(LO(NS)) = cost per gallon of fuel at operating location LO(NS) in dollars

NAE(NP) = number of added antenna elements required for SSS terminal installation on a platform of type NP

DRAG(NP) = average drag per new antenna element (in lbs.) for platform type NP

K(NP) = coefficient in thrust-fuel consumption equation for platform type NP

THRS(NP) = average thrust in pounds generated by platform type NP (without extra drag)

Note: Added Fuel costs clearly only apply to airborne platforms. Thus surface platforms will not be included when the above calculation is performed by the LCC Model.


## 2.4.4  Investment Spares Cost Element  (ISC)

The total cost of investment spares of ITEM type I over all locations, denoted ISCA(I), is given by

$$ISCA(I) = TISQ(I)*UP(I)*LC(I)*XUC$$

where

TISQ(I) = the total quantity of investment spares for an ITEM of type I

UP(I) = unit cost in dollars for ITEM type I

LC(I) = the learning factor for ITEM type I (see section 2.2.6)

The total investment Spares Cost is then

$$ISC = \sum_I ISCA(I)$$

### 2.4.5 Replacement Spares Cost Element (RSC)

This cost element covers the cost, over the SSS lifetime, of the purchase of additional spares required to replace failed ITEMs which are discarded due to either normal wear-out or to discard-on-failure repair level decisions (i.e., the COND(I) fraction of failures). Also included is the cost of repair materials consumed in ITEM repair actions (i.e., for the (1-COND(I)) fraction of failures).

The total replacement spares cost due to an ITEM type I is

$$RSCA(I) = [NRUC*LC(I) + (PIUP-NRUC)]*YRSQ(I)$$

$$[COND(I)+(1-COND(I))*RM(I)] *UP(I)*XUC$$

where

> RM(I) = repair materials factor for ITEM type I, equals the fraction of UP(I) that is consumed (in piece parts below the ITEM indenture level) in the repair of ITEM type I.

Notes: 1) One should set RM(I) = 0 if ITEM type I is always repaired by the removal and replacement of other lower level parts which are also designated as ITEMs in the model input data. (This is to avoid double counting.)

2) [The first] NRUC years of replacement spares are bought under the production contract and thus are bought at a learned unit cost.

The total cost of Replacement Spares is then given by

$$RSC = \sum_I RSCA(I)$$

### 2.4.6 On-Equipment Maintenance Cost Element (ONMC)

This cost element covers the system lifetime costs of all organizational level repair actions, including removal and replacement of failed (and falsely pulled) LRUs and all other corrective maintenance actions which are accomplished by repair-in-place without removal of equipment from the host platform.

The on-equipment maintenance cost due to ITEM type I is given by the equation

$$ONMCA(I) = 12*PIUP* \left\{ \sum_{NS} FAIL(I,NS)*TNB(NS) \right\}$$

$$* \left[ (1+FPR(I)*XFPR)*LRU(I)*RMH(I)*BLR \right.$$

$$+ \left. \frac{RIP(I)*IPCF(I)}{(1-RIP(I))} \right]*BMF$$

where

      IPCF(I) = average cost in dollars per failure of ITEM type I which is met by repair-in-place, including the costs of both manhours and replacement parts.

      BLR = base maintenance labor rate in dollars per hour.

      RMH(I) = average number of manhours required to remove and replace an ITEM of type I, including time spent in isolating a failure to the ITEM, removing the ITEM, and in verifying restoration of the system to operational status upon replacement of the failed (or falsely pulled) ITEM.

Notes:

1) The quantity FAIL(I,NS), computed as an auxiliary calculation in Section 2.2.1, represents the average number of <u>removed</u> failures of ITEM type I at a base of type NS per month. By referring to the formula for FAIL(I,NS), it can be seen that the quantity RIP(I)*FAIL(I,NS)/(1-RIP(I)) represents the number of <u>repaired-in-place</u> failures of ITEM type I. In the equation above this quantity is multiplied (in factored form) by the in-place cost per failure IPCF(I). (If RIP(I)=1 so that division by zero would occur in the term above, then the number of repaired-in placed failures of ITEM type I will be calculated directly by an appropriate formula within the LCC Model.)

2) Removal and replacement manhours RMH(I) apply only to LRUs and may be input as zero for SRUs.

Total On-Equipment Maintenance cost is then given by

$$ONMC = \sum_{I} ONMCA(I)$$

## 2.4.7 Off-Equipment Maintenance Cost Element (OFMC)

This cost element covers all intermediate and depot-level corrective maintenance labor costs and associated packing and shipping and maintenance management data costs over system lifetime.

First the off-equipment maintenance cost due to all ITEMs of type I, denoted OFMCA(I), is given by the formula

$$OFMCA(I) = 12*PIUP* \sum_{NS} FAIL(I,NS)*TNB(NS)*ACF(I,NS)$$

where

ACF(I,NS) = average off-equipment maintenance cost in dollars per failure of ITEM type J at base NS, computed by the equation:

ACF(I,NS) = (LRU(I)+RTS(NHI(I)))

$$*\{[(1+FPR(I)*XFPR)*BCMH(I)+RTS(I)*BMH(I)]*BMF*BLR$$

$$+ NRTS(I)*[DMH(I)*DMF*DLR+2*CPPD(LO(NS))*WT(I)]$$

$$+ COND(I)*CPPD(LO(NS))*WT(I)\}$$

$$+ NRTS(NHI(I))*(1-COND(I))*DMH(I)*DMF*DLR$$

$$+ SAT(NS)*LRU(I)*(1+FPR(I)*XFPR)*2*CPPC*WT(I)$$

$$+ \{(RIP(I)/(1-RIP(I)))*MRO + MRF + SR + TR\}*BLR$$

where

DLR = depot maintenance labor rate in dollars per manhour

CPPD(LO(NS)) = one-way packing and shipping cost per (net weight) pound from a base at location LO(NS) to the depot (including an adjustment to allow for the ratio of packaged weight to unpackaged weight).

WT(I) = net weight of ITEM type I in lbs.

53

CPPC = average one way packing and shipping cost per (net weight) pound from a satellite base to its associated CIMF (including an adjustment to allow for ratio of packaged weight to unpackaged weight).

SAT(NS) = satellite base indicator, equals 1 if base NS is a satellite base (i.e., BTYPE(NS)=3) and equals 0 otherwise

BTYPE(NS) = base type indicator, equals:
   1, for independent, non-CIMF bases;
   2, for CIMF bases;
   3, for satellite bases.

MRO = average manhours per failure to complete on-equipment maintenance records.

MRF = average manhours per failure to complete off-equipment maintenance records.

SR = average manhours per failure to complete supply transaction records.

TR = average manhours per failure to complete transportation transaction forms.

Thus total Off-Equipment Maintenance cost is given by

$$OFMC = \sum_I OFMCA(I)$$

The terms in the equation for ACF(I,NS) have the following interpretation: The first term (LRU(I)+RTS(NHI(I))) represents that fraction of failures of ITEM type I which are <u>available</u> for intermediate repair at the base level as a function of the ITEM's indenture level. For example, if ITEM type I is an LRU, then LRU(I)=1, NHI(I)=0, and RTS(0)=0, so that this term equals 1, i.e., all LRUs are available for intermediate level repair at the base level. On the other hand, if ITEM type I is an SRU, then LRU(I)=0 and NHI(I) is the index number of the next higher indenture level ITEM which contains ITEM type I. Thus, in this case, the term equals RTS(NHI(I)), i.e., an SRU is available (i.e., removed) for intermediate repair at the base level only when its next higher indenture ITEM is base repaired.

For those failures of ITEM type I which are available for repair at the base level, the next three lines in the equation indicate the

54

repair action implemented.  Specifically, all failures and false
pulls receive a base-level bench check, the RTS(I) fraction of
failures are base repaired, the NRTS(I) fraction are sent to the
depot for repair (and incur two-way packing and shipping costs) and
the COND(I) fraction are discarded (incurring only a one-way packing
and shipping cost for a replacement spare).

The fifth line in the equation for ACF(I,NS) accounts for those
ITEMs which are not removed from their next higher assembly until
they reach the depot (i.e., the NRTS(NHI(I)) fraction.  These ITEMs
are then repairable (at the depot) the fraction (1-COND(I)) of the
time.

The sixth line applies only to satellite bases (i.e., SAT(NS)=1) and
covers the cost of shipping all failed and falsely pulled LRUs to
the associated CIMF for repair action (and the cost of shipping
replacement spares or repaired ITEMs from the CIMF to the satellite
base).  Note that SRUs are not removed at satellite bases by
definition, so that they do not incur a separate shipping charge.

Finally, the last line accounts for the labor cost associated with
the completion of maintenance management data.


2.4.8  Support Equipment Cost Element  (TSEC)

The numbers of support equipment of each type L required at each
base of type NS and at the depot, denoted by NSEB(L,NS) and NSED(L),
respectively, were computed as auxiliary calculations in Section
2.3.3.  This calculation was based on estimated monthly hours of SE
utilization at each location and the number of available work hours
per month per maintenance man.  It is usually assumed in determining
SE requirements that one piece of SE cannot be utilized any more
hours per month than one maintenance man (see, for example, the Air
Force Logistic Support Cost Model, User's Handbook).

As noted in Section 2.2.3, common SE which is available at base
sites is charged in the LCC Model on a prorated basis, depending on
the fractional utilization of available hours.  Other SE must be
purchased in whole units, i.e., any utilization of this SE will
incur its full unit cost.  (See the Air Force-provided list of
common SE which is available at base sites.)

The life cycle cost of support equipment has been separated into two
categories, procurement cost (SEPC) and development cost (SEDC).
Every piece of support equipment has a unit cost and a development
cost which is input by the user.  The universal card tester also has

a per item development cost to account for the additional software needed to enable the UCT to perform check-out and/or repair on a specific item.

Total support equipment cost is computed by

$$TSEC = SEPC + SEDC$$

where

SEPC = support equipment procurement cost

SEDC = support equipment development cost

These two quantities are given by the equations below

$$SEPC = \sum_{L} [( \sum_{NS} NSEB(L,NS)*TNB(NS)) + NSED(L) ]$$
$$*CSE(L)*(1+PIUP*MSE(L))$$

$$SEDC = TUCTDC + \sum_{L} SEDV(L)$$

Where

CSE(L) = unit procurement cost of SE type L

MSE(L) = the yearly cost of maintaining a piece of SE of type L, expressed as a fraction of its unit cost CSE(L)

$$TUCTDC = \sum_{I} UCTDC(I)$$

UCTDC(I) = UCTDEV(I) * U(1-COND(I))

UCTDEV(I) = the software development cost for item I to be repaired by an appropriate UCT

SEDV(L) = U(ERHA(L)) * SEDEV(L)

ERHA(L) = expected utilization of SE type L

$$= \sum_{NS} ERHAB(L,NS) + ERHAD(L)$$

SEDEV(L) = the support equipment development cost of SE type L

56

For the Repair Level Analysis program, described in Section 7, it is necessary to prorate the cost of support equipment among individual ITEM types. For this reason, define the variable

SECI(I) = pro rata part of SEC attributed to ITEM type I,

which is calculated according to the formula

$$
SECI(I) = \sum_{L} \Bigg\{ (SECB(L) + PBDV(L))
$$
$$
* \left( \sum_{NS} \frac{ERHBI(I,NS)*TNB(NS)*A(I,RMI(I,NS),L)}{TERHB(L)} \right)
$$
$$
+ (SECD(L) + PDDV(L)) * \frac{ERHD(I)*A(I,1,L)}{TERHD(L)} \Bigg\}
$$
$$
+ UCTDC(I)
$$

where

$$
PBDV(L) = \frac{TERHB(L)*SEDV(L)}{TERHB(L) + TERHD(L)}
$$

$$
PDDV(L) = \frac{TERHD(L)*SEDV(L)}{TERHB(L) + TERHD(L)}
$$

$$
SECB(L) = [ \sum_{NS} NSEB(L,NS)*TNB(NS)] *CSE(L)*(1 + PIUP*MSE(L))
$$

$$
SECD(L) = NSED(L)*CSE(L)*(1 + PIUP*MSE(L))
$$

$$
TERHB(L) = \sum_{NS} \sum_{I} ERHBI(I,NS)*TNB(NS)*A(I,RMI(I,NS),L)
$$

$$
TERHD(L) = \sum_{I} ERHD(I)*A(I,1,L)
$$

## 2.4.9 ITEM Inventory Management Cost Element (IIMC)

This cost element accounts for the management (administrative) cost to introduce new assemblies and parts into the Air force inventory system, together with the recurring supply inventory management costs associated with such inventories.

The equation for Inventory Mangement costs incorporates the following basic assumptions:

1) All major ITEMs among the SSS terminal equipment will be new to the Air Force inventory system.

2) ITEMs incur an Inventory Management cost at the base level if and only if they are stocked at the given base.

3) Piece parts of an ITEM incur Inventory Mangement costs wherever the ITEM is repaired.

The number of bases which stock spares of ITEM type I, denoted BIS(I), is calculated by:

$$BIS(I) = \sum_{NS} W(BS(I,NS)) * TNB(NS)$$

where the function W is defined for any number X by

$$W(X) = \begin{cases} 0, & \text{if X is less than 0} \\ X, & \text{if X is between 0 and 1} \\ 1, & \text{if X is greater than 1} \end{cases}$$

Recall that the number of spares of ITEM type I at base NS, denoted BS(I,NS), is not rounded off to an integer, but instead represents the <u>average</u> number of spares of ITEM type I over all bases within grouping NS. Thus BS(I,NS)=.5 would mean half of the bases within group NS have 1 spare of ITEM type I and the other half have no spares of the ITEM. If BS(I,NS) is greater than 1, then it is assumed that all bases within group NS have at least one spare of ITEM type I and hence all incur Inventory Management costs.

The number of bases which perform Intermediate level repair of ITEM type I (and hence require an inventory of ITEM piece parts) is denoted by BCIS(I) and calculated by the equation

$$BCIS(I) = \sum_{NS} (1-SAT(NS)) * U(RTS(I) * NFB(I,NS)) * TNB(NS)$$

58

The conditions in the above equation for a base to require an inventory of piece parts of ITEM type I are thus: (i) Base NS must not be a satellite base, (ii) ITEM type I must be repairable, at least some of the time, at the intermediate level, i.e., RTS(I) > 0, and (iii) the pipeline of ITEM type I at base NS, denoted NFB(I,NS), must be positive, i.e., failures of ITEM type I must occur at base NS.

Thus the Inventory Management cost incurred by ITEM of type I is given by

$$IIMCA(I) = IUT(I)*(1+CPA(I))*U(1-COND(NHI(I)))*(IMC+PIUP*RMC)$$

$$+PIUP*(BIS(I)+BCIS(I)*CPA(I))*SA$$

where

IUT(I) = equals 1 if a spare of ITEM type I is ever required anywhere in the SSS, i.e., if it ever fails, and equals C otherwise. Computed by

$$IUT(I) = U(\sum_{NS} FAIL(I,NS))$$

IMC = initial depot-level inventory, management cost in dollars to introduce a new procurable part into the Air Force inventory system

RMC = recurring annual depot-level inventory management cost in dollars to maintain an ITEM or piece part in the Air Force inventory system

CPA(I) = corrected piece part count, i.e., equals PA(I) unless ITEM type I is designated as discard-on-failure (i.e., COND(I)=1) in which case CPA(I) is set equal to zero.

SA = recurring annual cost in dollars to maintain a line item or piece part in a base-level inventory system

Finally, the total ITEM Inventory Management cost is

$$IIMC = \sum_{I} IIMCA(I)$$

Note: PA(I) may be zero for some higher indenture level ITEMs to avoid double counting of SRUs which are listed as ITEMs. Thus if ITEM type I is an LRU which is repaired by removing and replacing SRUs (which are also listed as ITEMs), then PA(I) = 0. In other words, PA(I) should only count parts lower than the ITEM level. By the same token, new piece parts included in the PA(I) value of the SRU should not also be counted in the PA(I) value of the higher level LRU.

In addition, if some new piece parts are common components in several different ITEMs then their number should be averaged over the corresponding PA(I) values. For example, if 4 new piece parts are all components in each of 5 different ITEM types then the PA(I) value of each ITEM should be 0.8 so that the sum of the PA(I) equals 4. This action will avoid over-counting of piece parts.

2.4.10  Technical Orders Cost Element  (STDC)

The cost accounted for in this Element is that which can be attributed directly to the requirement for creating pages containing specific guidance to support maintenance of SSS terminal equipment. Various types of Technical Orders (TOs) are possible. TOs can be of a system level nature, not specific to any particular ITEM type. An example would be a theoretical description of the system's operation intended to assist a person performing maintenance. Secondly, there may be ITEM-specific TOs required for repair or bench check of particular equipment ITEMs. Also conceivable are TOs written to explain the operation of specific pieces of support equipment in the maintenance of ITEMs. The equation for this Cost Element is hence structured to accommodate these three types of tech orders.

The equation also accounts for three types of TO costs:  (1) acquisition cost of original negatives dependent only on the total number of distinct pages; (2) reproduction cost dependent on the total number of copies made; (3) upkeep cost dependent on the number of distinct pages and the system lifetime (PIUP).

The formula for computing TO cost necessitates the following additional Air Force inputs:

ACPP    = average acquisition cost per page for original negatives of TOs. This is an Air Force input in order to make it uniform among the submitting contractors. In this way the Contractor is more equitably held accountable for the size of the TO package his design generates.

RCPP     = TO reproduction cost per copy per page.

UCPP     = TO upkeep cost per distinct page.

The formula also necessitates the following additional contractor inputs:

DDATA    = number of distinct pages of system level TOs intended for depot maintenance only.

BDATA    = number of additional distinct pages of system level TOs written for base level maintenance.

DATAD(I) = number of additional distinct pages of TOs required for repair of ITEM type I and written for depot use only.

DATAB(I) = number of additional distinct pages of TOs required for base repair of ITEM type I.

DATAS(L) = number of additional distinct pages of TOs required for use of support equipment type L and not including any documentation which may be included in the unit cost of L.

Note that the five sets of pages counted by the five variables listed above are assumed to be mutually disjoint. For example, there should be no overlap between the pages counted by DATAD(I) and those counted by DATAB(I). However, it is expected that the user may wish to set one or more of the page count variables equal to 0. The wide variety of page count inputs is intended to provide the Model with the capability to accommodate a wide variety of TO configurations.

The cost of system-wide TOs, denoted by STDC, is then computed according to the following equations:

$$STDC = \left| DDATA + BDATA + \sum_I (DATAD(I) + DATAB(I)) \right.$$

$$+ \sum_L U(TNSE(L))*DATAS(L) \left| *(ACPP + RCPP + (PIUP-1)*UCPP) \right.$$

$$+ RCPP* \sum_{NS} TNB(NS)* \left| BDATA + (\sum_I DATAB(I)) + \sum_L U(NSEB(L,NS))*DATAS(L) \right|$$

where

$$TNSE(L) = \sum_{NS} NSEB(L,NS) + NSED(L)$$

and

$$U(X) = \begin{cases} 1 & \text{if } X > 0 \\ 0 & \text{if } X \leq 0 \end{cases}$$

Note that the formula for STDC is composed of two major terms. The first represents acquisition of original negatives, printing of one copy of each page for the depot, and upkeep cost for each year except the first. The second represents reproduction costs for all base copies necessitated by given repair levels.

For the Repair Level Analysis program, described in Section 7, it is necessary to prorate the cost of TOs among individual ITEM types. For this reason define the variable

   TDC(I) = the pro rata part of STDC attributed to ITEM type I,

which is calculated according to the formula

62

$$TDC(I) = \left\{ PPTM(I)*(DDATA + BDATA) + DATAD(I) + DATAB(I) \right.$$

$$+ \sum_L PPSE(I,L)*DATAS(L) \left. \right\} \; *(ACPP + RCPP + (PIUP-1)*UCPP)$$

$$+ RCPP* \sum_{NS} TNB(NS)* \left\{ PPTM(I)*BDATA + DATAB(I) \right.$$

$$+ \sum_L PPSE(I,L)*U(NSEB(L,NS))*DATAS(L) \left. \right\}$$

where

$$PPTM(I) \quad = (ONMCA(I) + OFMCA(I))/(ONMC + OFMC)$$

$$PPSE(I,L) = [\; U(A(I,1,L))*U(3 - SECODE(I,1,L))*ERHD(I)$$

$$+ \sum_{NS} \left\{ U(A(I,RMI(I,NS),L)) \right.$$

$$* [\; U(SECODE(I,RMI(I,NS),L) - 1)*TNB(NS)*EBCBI(I,NS)$$

$$+ U((3 - SECODE(I,RMI(I,NS),L))*SECODE(I,RMI(I,NS),L))$$

$$*TNB(NS)*ERTBI(I,NS) \; ] \left. \right\} \; ]$$

$$/ (ERHAD(L) + TERHAB(L))$$

$$TERHAB(L) = \sum_{NS} TNB(NS)*ERHAB(L,NS)$$

and, again,

$$U(X) = \begin{cases} 1 & \text{if } X > 0 \\ 0 & \text{otherwise.} \end{cases}$$

## 2.4.11 Maintenance Training Cost Element (MTRC)

The equation for this Cost Element is based on the following assumptions:

o Cost is incurred for training of maintenance personnel only. There is no operations training cost included.

o The cost estimated is that of <u>additional</u> training necessitated by SSS cerminal equipment, and the cost of basic avionics training is assumed sunk.

o Three types of tiaining are modeled:

- Type I is in-plant training by the production contractor;

- Type II is Air Force service training pertormed by Type I trainees;

- Recurring training is that necessitated by attrition among Air Force maintenance personnel.

o On-the-job (OJT) training, if employed, does not involve any cost.

o The number of persons requiring recurring training is determined by the number of avionics maintenance people expected to leave the Air Force each year and not by those who are merely transferred among bases.

o Depot personnel are trained for maintenance of any item not always discarded on failure.

o All base personnel are trained for maintenance of any item to be given intermediate maintenance at any base.

o The cost of training includes the entire pay and any additional allowance paid to personnel while they are being trained. This is because training time is time away from jobs which may have to be filled by replacement personnel. The cost to compensate for this should be represented in the AF parameters PAL1, PAL2D, and PAL2B defined below.

The formula to compute maintenance training cost necessitates the following additional AF inputs:

CPD2     = cost per class per day for type 2 training.

HPD2     = number of in-class hours per day for a type 2 training class.

PAL1     = average daily pay and allowance during training for a type 1 trainee.

PAL2B    = average daily pay and allowance during training for a type 2 base trainee.

PAL2D    = average daily pay and allowance during training for a type 2 depot trainee.

QTYP1    = number of trainees for type 1 training.

QTYP2B   = initial number of base trainees for type 2 training.

QTYP2D   = initial number of depot trainees for type 2 training.

SPC2     = maximum number of students per type 2 training class.

TORB     = turnover rate for base avionics maintenance personnel; the fraction of this work force leaving the AF (and replaced) per year.

TORD     = turnover rate for depot avionics maintenance personnel; the fraction of this work force leaving the AF (and replaced) per year.

TRAV1D   = average round trip travel expense for travel of type 1 and type 2 depot trainees to and from the relevant training facilities.

TRAVB    = average round trip travel expense for travel of type 2 base trainees to and from the type 2 training facility.

TYP2TF   = ratio of type 2 training time to type 1 training time when the same course material is covered in both.

The following additional Contractor inputs are also required:

CPD1     = cost per class per day for type 1 training.

HPD1     = number of in-class hours per day for a type 1 training class.

65

SPC1    = maximum number of students per type 1 training class.

TEFM    = cost in dollars of equipment, facilities, and manuals
          required for all training and not accounted for by any
          other element of the SSS LCC Model. (Facilities
          considered are for type 1 training only.)

TIME1(I) = number of additional hours of type 1 training
           required for repair of ITEM type I.

Prior to presentation of the Maintenance Training equation, a few
preliminary computations are performed to facilitate the reader's
understanding:

$$T1 = \sum_{I} TIME1(I)$$

$$T2DA = TYP2TF * \sum_{I} TIME1(I)*U(1-COND(I))$$

$$T2BA = TYP2TF * \sum_{I} TIME1(I)*U(\sum_{NS} ERTBI(I,NS))$$

The three variables, T1, T2DA, and T2BA may be interpreted as
follows. T1 represents the total number of type 1 training hours
per type 1 trainee necessitated by the contractor's design. T2DA
represents the total number of hours of type 2 training required for
a depot trainee. T2BA is the analogous total for a base trainee.
Computation of T2DA is based on the assumption that any ITEM which
will be discarded on failure will not increase the type 2 training
time. Similarly, for T2BA, only ITEMs which are expected to undergo
base repair will necessitate additional type 2 training.

Then, the cost of training, denoted by MTRC, is computed according
to the following equation:

$$\text{MTRC} = \lceil T1/HPD1 \rceil^{+} * \lceil QTYP1/SPC1 \rceil^{+} * CPD1$$

$$+ QTYP1 * (\lceil T1/HPD1 \rceil^{+} * PAL1 + TRAV1D*U(T1))$$

$$+ \lceil (T2DA*QTYP2D*(1 + (PIUP-1)*TORD)$$

$$+ T2BA*QTYP2B*(1 + (PIUP-1)*TORB))/(HPD2*SPC2) \rceil^{+} *CPD2$$

$$+ (1+(PIUP-1)*TORD)*QTYP2D*(\lceil T2DA/HPD2 \rceil^{+} *PAL2D + TRAV1D*U(T2DA))$$

$$+ (1+(PIUP-1)*TORB)*QTYP2B*(\lceil T2BA/HPD2 \rceil^{+} *PAL2B + TRAVB*U(T2BA))$$

$$+ TEFM$$

where

$[X]^{+}$ means the smallest integer greater than or equal to X, and

$$U(X) = \begin{cases} 1, & \text{if } X > 0 \\ 0, & \text{otherwise.} \end{cases}$$

Notice that the right hand side of the training equation consists of three main terms. The first accounts for type 1 training, the second for type 2 (initial and recurring), and the third is merely TEFM. In the type 1 term, the number of days of instruction and the number of classes are each computed separately, and their product is the number of class-days. In the type 2 term, to account for the possibility of depot and base personnel receiving some of their training concurrently, the total number of trainee-hours is computed and divided by trainee-hours per class-day before the rounding up process takes place.

As for support equipment and tech. orders, the cost of training must be prorated among ITEMs to accommodate the RLA program. To satisfy this need, define the variable

MTRCI(I) = the pro rata part of MTRC attributed to ITEM type I,

calculated by

MTRCI(I) =

$$ITPF1(I)*(\left|T1/HPD1\right|^+ *\left|QTYP1/SPC1\right|^+ * CPD1$$

$$+ QTYP1*(\left|T1/HPD1\right|^+ *PAL1 + TRAV1D*U(T1)))$$

$$+ ITPF2(I)* \left|(T2DA*QTYP2D*(1+(PIUP-1)*TORD)\right.$$

$$+ T2BA*QTYP2B*(1+(PIUP-1)*TORB))$$

$$*1/(HPD2*SPC2)\left|^+ *CPD2\right.$$

$$+ ITPF3(I)*(1+(PIUP-1)*TORD)*QTYP2D$$

$$*(\left|T2DA/HPD2\right|^+ *PAL2D + TRAV1D * U(T2DA))$$

$$+ ITPF4(I)*(1+(PIUP-1)*TORB)*QTYP2B$$

$$*(\left|T2BA/HPD2\right|^+ *PAL2B + TRAVB*U(T2BA))$$

$$+ ITPF5(I)*TEFM$$

where the ITPFx(I) variables (for x=1, ..., 5) are itemized training proration factors defined as follows:

$$ITPF1(I) = TIME1(I)/TI$$

68

$$ITPF2(I) = TYP2TF*TIME1(I)$$

$$*(QTYP2D*U(1-COND(I))+QTYP2B*U(\sum_{NS}ERTBI(I,NS)))$$

$$* \ 1/(QTYP2D*T2DA \ + \ QTYP2B*T2BA)$$

$$ITPF3(I) = TYP2TF*TIME1(I)*U(1-COND(I))/T2DA$$

$$ITPF4(I) = TYP2TF*TIME1(I)*U(\sum_{NS}ERTBI(I,NS))/T2BA$$

$$ITPF5(I) = TIME1(I)*\left\{ QTYP1 \ + \ TYP2TF*(QTYP2D*U(1-COND(I)) \right.$$

$$\left. + \ QTYP2B*U(\sum_{NS}ERTBI(I,NS))) \right\}$$

$$*1/(QTYP1*T1 \ + \ QTYP2D*T2DA \ + \ QTYP2B*T2BA)$$

# SECTION 3

## LCC SENSITIVITY ANALYSIS CAPABILITY

### 3.1 Introduction

In this section the methods used in the LCC Model to address the sensitivity of Life Cycle Cost to changes in various input data parameters is presented. This sensitivity analysis capability serves several purposes. First, it provides a measure of the fluctuation in LCC which may be experienced due to uncertainty in the estimates of various input parameters. For example, if failure rates can only be determined to within a 25% margin of error, then one of the LCC sensitivity analysis calculations will estimate the corresponding range of error in the LCC estimate.

Secondly, the sensitivity analysis calcuations help to identify the significant cost drivers among the various input parameters. For example, questions like "Do variations in ITEM unit costs produce greater changes in LCC than variations in ITEM failure rates?" and "For which particular ITEMs is LCC most sensitive for a 25% change in failure rate?" can be answered using the sensitivity analysis capability.

Thirdly, the LCC sensitivity analysis capability may be used as a tool to perform system trade-off analyses. In fact, the sensitivity analysis calculations should prove helpful in identifying where beneficial trade-offs might be made. For example, for a particular ITEM, if LCC is more sensitive to the failure rate of the ITEM than to its unit cost, then it may be cost-effective to redesign the ITEM to a more reliable, higher cost unit.

The primary component of the LCC sensitivity analysis capability is presented in Section 3.2 below, where, for selected data input parameters, a set of equations is presented which calculate the estimated changes in LCC which would be produced by a given fractional change to each particular parameter.

Section 3.3 includes a discussion of how the LCC Model user can perform a simplified RLA by utilizing the LCC sensitivity analysis calculations (described in Section 3.2) with respect to the repair level fractional allocations RTS(I), NRTS(I) and COND(I).

70

Section 3.4 presents a sensitivity analysis calculation which tries to identify those SRUs among the contractor's equipment design which, for cost-effectiveness, might be worth redesigning as LRUs.

Finally, Section 3.5 describes how the LCC Model user may also perform LCC sensitivity and trade-off analyses by utilizing the global multiplier factors XUC, XFR, XFPR, and XMIL (on unit costs, failure rates, false pull rates, and MOD/I labor hours, respectively). In particular, these global multiplier factors can be used as a supplement to and in conjunction with the detailed sensitivity analysis calculations presented in Section 3.2

## 3.2 LCC Sensitivity Analysis Using Incremented Data Parameters

Presented in this section are the LCC sensitivity equations which are used in the LCC Model to estimate the changes in LCC that would result from fractional changes in the values of each of certain selected input data parameters. We divide these parameters into global (system-wide) parameters and ITEM-specific parameters in Table 3-1 below:

Table 3-1

Sensitivity Analysis Data Parameters

Global Parameters

Unit Cost - XUC Multiplier
Failure Rate - XFR Multiplier
False Pull Rate - XFPR Multiplier
Repair Materials Cost - XRM Multiplier
Mod/Installation Labor Man-hours - XMIL Multiplier
Maintenance Repair Times - ͂INC Multiplier
Program Lifetime - FINC Multiplier

ITEM - Specific Parameters

Unit Cost - FINC Multiplier
Failure Rate - FINC Multiplier
False Pull Rate - FINC Multiplier
Repair Materials Cost - FINC Multiplier
Intermediate Repair Fraction - FINC Increment
Depot Repair Fraction - FINC Increment
Condemnation Rate - FINC Increment

71

For each of the data parameters listed above (and for each ITEM type I if the factor is ITEM-specific), the LCC Model computes the average change (either positive or negative) in Life Cycle Cost which is produced by a fractional increase in the value of the given factor.

The variable FINC is used to stand for the fractional increase in the factor under consideration. This increase is implemented in two different ways depending on the particular factor. For the factors XUC, XFR, XFPR, BMF/DMF, XRM, PIUP, XMIL, UP(I), FR(I), FPR(I), and RM(I), the equations compute the change in LCC which results from increasing the given factor by a multiple of FINC. For example, if FINC=.25 and the factor under consideration is UP(I), the change in LCC which would result from changing UP(I) to UP(I) + (.25)*UP(I)=(1.25)*UP(I) is computed. However, for the factors RTS(I), NRTS(I) and COND(I) (which are themselves fractions), FINC is used to stand for the absolute increase in the factor. Thus, if FINC=.25 and the factor under consideration is RTS(I), then the change in LCC which would result from changing RTS(I) to (RTS(I) + .25) is computed. (Actually the minimum of (RTS(I) + .25) and 1.0 is taken.)

In the equations below the notation TDXXX to stand for the change in LCC which is produced by a fractional increase of FINC in the factor XXX is used, where XXX may be any one of the factors listed in Table 3-1. Thus TDUP(I) stands for the change in LCC produced by a fractional change of FINC in the factor UP(I). We will, in addition, refer to TDXXX as the change in LCC with respect to the factor XXX.

Note that if XXX is one of the "global" parameters listed in Table 3-1, then TDXXX is a single value and will be printed in the Sensitivity Analysis Output Table of an LCC Model computer run. On the other hand, if XXX is one of the "ITEM-specific" parameters then there is a value of TDXXX for each different ITEM index I, e.g., if XXX is UP(I) then TDUP(I) will be calculated for each different index number I. In this case the LCC Model will print out the most significant TDUP(I) values first, i.e., the most significant TDUP(I) over all different I indices will be printed first, the second most significant TDUP(I) will be printed second, and so on. This "sorting" method thus effectively identifies those ITEMs for which a given ITEM-specific parameter is most cost-sensitive. In this context, since most LCC sensitivity calculations are "two-sided" (see Caution (2) below), the term "most-significant" for these calculations means largest in absolute value. By exception, for the terms RTS(I), NRTS(I), and COND(I), the analyst is most interested in those changes in repair levels which produce savings in LCC.

72

Thus for these three factors "most significant" means largest in negative value. In other words, TDRTS(I), TDNRTS(I), and TDCOND(I) will be sorted in order of greatest predicted savings in LCC. (A sample Sensitivity Analysis Output Table appears at the end of the Illustrative LCC Model Computer Run contained in Appendix B)

CAUTIONS: There are several important considerations which should be kept in mind when using the sensitivity analysis calculations. These are:

(1) In general, the sensitivity analysis calculations attempt to present average estimated changes in LCC, i.e., the continuous "trend" in LCC. Jump increases in costs, such as for peculiar support equipment are averaged out. Thus, for example, the sensitivity analysis calculations will prorate the cost of additional support equipment utilization (say, due to an increase in ITEM failure rates), regardless of whether or not the increased utilization necessitates the purchase of a new piece of support equipment.

For this reason, the increased LCC predicted by the sensitivity analysis calculation on, say, the XFR factor with a FINC value of .20, may not exactly equal the increase in the LCC value which is calculated by a re-run of the LCC Model in which the data input XFR has been increased by 20%. For example, the increase in failure rates may not have been quite significant enough to necessitate buying another $100,000 piece of peculiar support equipment, so no change in the support equipment (SE) cost would be visible in a re-run of the LCC Model. This gives the impression that SE costs, at that point, are very insensitive to changes in failure rates, whereas, in fact, the next slightest increase in failure rates will have a $100,000 impact on LCC. The sensitivity analysis calculation, on the other hand, may have included, say, 80% of the potential $100,000 added SE cost, indicating the "trend" of SE costs as a function of increased failure rates.

(2) The user should keep in mind that if a fractional increase in a particular factor produces an increase in Life Cycle Cost, then a fractional decrease in that factor should produce a comparable decrease in LCC. In this sense, one should view the LCC sensitivity calculations as being two-sided.

73

(3) The sensitivity analysis calculations exhibit the estimated change in LCC due to a fractional change in only one data parameter at a time. Since there may be some "interactive" effect on LCC of changing two different parameters, say UP(I) and FR(I), at the same time, the combined change in LCC may not equal the sum of the LCC changes predicted by the sensitivity analysis calculations for each data parameter separately. The combined change can best be measured by altering both data input parameters in a re-run of the LCC Model. As noted in Section 3.5, the global multiplier factors XUC, XFR, XFPR and XMIL can also be used in this manner to measure global interactive effects on LCC.

(4) In order to properly perform sensitivity analysis on the repair level fractions RTS(I), NRTS(I) and COND(I), all ITEM data that is required for any repair level decision must be provided as input to the model. For example, even if depot repair is not intended for ITEM type I, the user should still input a non-zero, realistic value for DMH(I), so that the LCC sensitivity calculation which corresponds to changing NRTS(I) from 0 to, say, .20 will be meaningful. Even in the extreme case where COND(I) = 1, the user must input realistic values for BCMH(I), BMH(I), DMH(I), RM(I), A(I,L), SECODE(I,L), DATAB(I), DATAD(I) and TIME1(I) in order for the LCC sensitivity calculations on RTS(I) and NRTS(I) to represent accurate cost changes.

### 3.2.1  Global Unit Cost - XUC Multiplier

The average increase in LCC produced by a fractional increase of FINC in all prime mission and timing net equipment unit costs (both for ITEMs and Terminals) is denoted by TDXUC and computed via the equation:

$$TDXUC = FINC*(TERMH + ISC + RSC)$$

where PRODC, ISC, and RSC are the total life cycle costs of the Production, Initial Spares, and Replacement Spares Cost Elements, respectively.

### 3.2.2  Global Failure Rate - XFR Multiplier

The expected change in LCC produced by a fractional increase of FINC in the failure rates of all ITEMs system wide is given by

74

$$TDXFR = \sum_I TDFR(I)$$

where TDFR(I) is the LCC sensitivity calculation with respect to the ITEM-specific failure rate FR(I). (See Section 3.2.9 for the equation which calculates TDFR(I).)

In words, LCC sensitivity with respect to the global failure rate factor XFR is just the sum of the changes in LCC produced by increasing the individual ITEM failure rates FR(I) by the same fractional amount FINC.

REMARK: Failure rates are directly proportional to operating hours. Thus, a fractional increase of FINC in operating hours will produce a fractional increase of FINC in the global failure rate, and hence an increase of TDXFR in LCC. Clearly then, sensitivity analysis on the global failure rate XFR also represents sensitivity analysis on global operating hours.

### 3.2.3  Global False Pull Rate - XFPR Multiplier

The estimated change in LCC produced by a fractional increase of FINC in all LRU false pull rates FPR(I) is given by:

$$TDXFPR = \sum_I TDFPR(I)$$

where TDFPR(I) is the LCC sensitivity calculated with respect to the ITEM-specific false pull rate FPR(I) (presented in Section 3.2.10).

We assume here that only LRUs have positive false pull rates. Thus, LCC sensitivity with respect to XFPR is given by the sum of the changes in LCC produced by increasing the individual false pull rates of each LRU by the fractional amount FINC.

### 3.2.4  Global Maintenance Repair Times

This section considers the change in LCC produced by increasing both the base maintenance factor BMF and the depot maintenance factor DMF by a fractional amount FINC. If the LCC Model user wishes to do sensitivity on only one of these two factors, he can change its value interactively in the appropriate NAMELIST while making consecutive runs of the model. (See Section 7.4 for a discussion of

75

interactive inputs.)  The resulting change in LCC is thus given by:

TDMF = FINC*ONMC

$$+ \; 12*PIUP*FINC*\sum_{I} \left[ \sum_{NS} \left( ERHBI(I,NS)*TNB(NS)*BLR \right) \right.$$

$$+ \; ERHD(I)*DLR \Big]$$

$$+ \; FINC*\sum_{L} \left[ \sum_{NS} \; [USE(L,NS)*ERHAB(L,NS)*ISET(L,NS)*TNB(NS)/BAA] \right.$$

$$+ \; USED(L)*ERHAD(L)*ISETD(L)/DAA \Big] *CSE(L)*(1+PIUP*MSE(L))$$

where

$$USE(L,NS) = \begin{cases} 0, \text{ if SE type L is not common/on-site and} \\ \qquad 0 < ERHAB(L,NS) < MUSE*BAA \\ \\ 1, \text{ otherwise} \end{cases}$$

and

$$USED(L) = \begin{cases} 0, \text{ if SE type L is not common/on-site and} \\ \qquad 0 < ERHAD(L) < MUSE*DAA \\ \\ 1, \text{ otherwise} \end{cases}$$

where

    MUSE = minimum fractional utilization threshold for considering
        additional SE costs; i.e., if a peculiar or
        common/requiring procurement SE unit is utilized less than
        the fraction MUSE of its available hours, then additional
        use of this SE unit will produce no predicted added cost in
        sensitivity analysis calculations.

Thus TDMF measures the increase in LCC that would occur if all
maintenance repair times were increased by a fractional amount FINC
(for example to measure the LCC impact of potentially underestimated
repair times).  The terms in the equation for TDMF above cover,
respectively, the increase costs for on-equipment maintenance,
intermediate repair manhours at the base level, depot repair
manhours, and added support equipment (SE) costs at the base and
depot level.

Note that if a peculiar SE unit or a common SE unit which requires
procurement is already deployed at a location and is being under-

utilized (i.e., used less than MUSE of its available time), then added utilization of this SE to meet increased repair times will produce no predicted added cost in the sensitivity calculation of TDMF. However, if this SE unit is being utilized a fair percentage of its available time, then a prorated portion of its unit cost will be incurred in the sensitivity calculation for additional usage. This indicates a "trend" in LCC in the sense that a continued increase in repair manhours will soon require the purchase of an additional unit of this SE Type. Common/on site SE costs are always pro-rated for fractional utilization. (See the calculations of NSEB(L,NS) and NSED(L) in Section 5.1.3.)

### 3.2.5 Global Repair Materials Cost - XRM Multiplier

A fractional increase of FINC in all ITEM repair materials cost factors RM(I) will produce an expected increase in LCC equal to:

$$TDXRM = \sum_I TDRM(I),$$

where TDRM(I) is the ITEM-specific increase in LCC due to a fractional increase of FINC in the value of RM(I) (calculated in Section 3.2.11.)

Note: As noted previously, XRM is not a direct data input to the LCC Model, hence it must not appear in Data File 1 and may not be input interactively in NAMELIST /GO2/.

### 3.2.6 System Operational Lifetime

In this section the impact on LCC of considering a longer program lifetime is considered. Of course, a shorter program lifetime would produce a comparable decrease in projected LCC.

First increase in PIUP is rounded to the nearest integer number of years by letting

$$CPIUP = |FINC*PIUP + .5|$$

where the bars represent truncation of the fractional part.

The change in LCC due to a change of CPIUP years in the value of PIUP is then given by:

77

$$TDPIUP = (CPIUP/PIUP)*(OC+ONMC+OFMC+SECR+IIMCR$$

$$+ (PIUP*\sum_I YRSQ(I)* [COND(I)+(1-COND(I))*RM(I)] *UP(I)*XUC)$$

$$+ \frac{PIUP}{PIUP-1}*(STDCR + RMTRC))$$

where OC, ONMC, and OFMC are, respectively, the total cost for the Operations, On-Equipment Maintenance, and Off-Equipment Maintenance Cost Elements.

$$(PIUP*\sum_I YRSQ(I)* [COND(I)+(1-COND(I)*RM(I)] *UP(I)*XUC)$$

represents the change in replenishment spares cost due to the change in PIUP. SECR represents the recurring maintenance cost of support equipment, given by the equation:

$$SECR = PIUP*[\sum_L (\sum_{NS} NSEB(L,NS)*TNB(NS)) + NSED(L)]*MSE(L)*CSE(L)$$

IIMCR represents the recurrent cost of ITEM Inventory Management, given by

$$IIMCR = PIUP*\sum_I [IUT(I)*(1+CPA(I))*U(1-COND(NHI(I)))*RMC$$

$$+ (BIS(I)+BCIS(I)*CPA(I))*SA]$$

STDCR represents the recurrent cost of technical orders, computed according to the formula:

$$STDCR = [ DDATA+BDATA+\sum_I (DATAD(I)+*DATAB(I))$$

$$+ \sum_L U(TNSE(L))*DATAS(L)]*(PIUP-1)*UCPP$$

RMTRC represents the recurrent cost of maintenance training, computed as

$$RMTRC = MTRC - IMTRC$$

where MTRC is the total cost of maintenance training, and IMTRC, the initial training cost, is given by

$$IMTRC = \{T1/HPD1\}^+ * \{QTYP1/SPC1\}^+ * CPD1$$

$$+ QTYP1*(\{T1/HPD1\}^+ * PAL1 + TRAV1D*U(T1))$$

$$+$$

$$\{(T2DA*QTYP2D + T2BA*QTYP2B)/(HPD2*SPC2)\}^+ * CPD2$$

$$+ QTYP2D*(\{T2DA/HPD2\}^+ * PAL2D + TRAV1D*U(T2DA))$$

$$+ QTYP2B*(\{T2BA/HPD2\}^+ * PAL2B + TRAVB*U(T2BA))$$

$$+ TEFM$$

### 3.2.7  Mod/Installation Labor Man-hours - XMIL Multiplier

Mod/Installation labor manhours are difficult to estimate with high accuracy. In this section the increase in LCC that would occur if all mod/I manhours were to increase by (or were underestimated by) a fractional amount FINC is measured. This resulting increase in LCC is denoted by TDXMIL and given by the equation:

$$TDXMIL = FINC * \sum_{NS} \sum_{NP} NPLT(NP,NS) * TNB(NS)$$

$$* \sum_{M} FR(M,NP) * MILR(M) * \sum_{IA} MIMH(IA,M,NP) * XMIL$$

### 3.2.8  ITEM Unit Cost

The estimated increase in LCC produced by a fractional increase of FINC in the unit cost of ITEM type I, UP(I), is calculated via the formula:

$$TDUP(I) = FINC * \sum_{NP} TOTT(NP) * NITEM(I,NP) * UP(I) * LC(I) * XUC$$

$$+ FINC * (ISCA(I) + RSCA(I))$$

where ISCA(I) and RSCA(I) are, respectively, the costs for Investment Spares and Replenishment Spares of ITEM type I, as calculated in Sections 5.2./ and 5.2.5, respectively.

The first term in the equation for TDUP(I) above is meant to cover the increased Production cost that can be inferred from an increased unit cost of ITEM type I.

Note:  Because of the use of learning effects in the SSS LCC Model, a calculation of the total change in ITEM procurement quantities must be made whenever changes in PMEQ(I), TISO(I), and/or YRSQ(I) are a result of the sensitivity analysis. This quantity change is represented by XITEMQ(I) in each sensitivity analysis considered. Such a calculation is required so that when LC(I) is called in the sensitivity equation, the resulting cost change will include the change due to the learning factor computed on the basis of the "new" procurement quantities.

### 3.2.9 ITEM Failure Rate

As noted previously, the ITEM failure rate factor FR(I) is not a direct data input to the LCC Model, but merely represents the average number of failures per million operating hours for ITEM type I. Thus, although FR(I) is not calculated directly within the LCC Model, it may be thought of as being given by the equation

$$FR(I) = 1000000/MTBMI(I),$$

where MTBMI(I) represents an "average mean time between maintenance incidents over the various MTBMI(I,LE(NP)) values for platforms NP in which ITEM type I is installed. This approach is taken because it is easier to interpret the meaning of (for example) a 20% increase in failure rate than a 20% increase in mean time between maintenance actions.

A change in ITEM failure rates affects both initial and replenishment spares requirements. This change is computed by:

$$XITEMQ(I) = (TISQN(I)-TISQ(I))+FINC*NRUC*YRSQ(I)$$

where TISQN(I) is the "new" investment spares quantity for ITEM I, computed as:

$$TISQN(I) = [\sum_{NS} TNB(NS)*F((1+FINC)*NFB(I,NS))] + F((1+FINC)*NFD(I))$$

The expected change in LCC produced by a fractional increase of FINC in the overall failure rate of ITEM type I, denoted TDFR(I), is then given by the equation:

$$TDFR(I) = (1+FINC) * [NRUC * LC(I) + (PIUP-NRUC)]$$

$$* YRSQ(I) * [COND(I) + (1-COND(I) * RM(I)] * UP(I) * XUC$$

$$- RSCA(I)$$

$$+ TISQN(I) * UP(I) * LC(I) * XUC$$

$$- ISCA(I)$$

$$+ FINC * (ONMCA(I) + OFMCA(I))$$

$$+ FINC * \sum_{L} \{ [ \sum_{NS} [USE(L,NS) * \frac{ERHBI(I,NS)}{BAA} * U(A(I,RMI(I,NS),L))$$

$$* ISET(L,NS) * TNB(NS)]$$

$$+ USED(L) * \frac{ERHD(I)}{DAA} * U(A(I,1,L)) * ISETD(L)] * CSE(L) * (1+PIUP * MSE(L)) \}$$

$$+ \sum_{NS} [\min\{F((1+FINC) * NFB(I,NS)), 1\} - \min\{F(NFB(I,NS)), 1\}]$$

$$* TNB(NS) * PIUP * SA$$

The terms in the equation above represent the increases in LCC produced in, respectively, Replenishment Spares, base and depot Intial Spares, On and Off-Equipment Maintenance, base Support Equipment, depot Support Equipment, and base-level Inventory Management.

### 3.2.10  ITEM False Pull Rate

The estimated change in LCC resulting from a fractional increase of
FINC in the false pull rate FPR(I) of ITEM type I is given by:

    (i)  If ITEM type I is not an LRU, i.e., LRU(I)=0, the
        TDFPR(I)=0.

        (Recall that it is assumed that only LRUs have positive
        false pull rates.)

    (ii)  If ITEM type I is an LRU, i.e., LRU(I)=1, then the
        estimated change in ITEM procurement quantities due to the
        effect of an increase of FINC in the false pull rate FPR(I)
        on the initial spares quantity TISQ(I) of ITEM I is given
        by:

$$\text{XITEMQ(I)}= \sum_{NS} \text{TNB(NS)}* \text{ [F(NFB(I,NS)+CHNFB(I,NS))-F(NFB(I,NS))]}$$

The resulting change in LCC due to a fractional increase in the
false pull rate FPR(I) of ITEM I and the accompanying change in the
learning curve factor LC(I) for item type I is given by:

$$\text{TDFPR(I)= (TISQ(I)+XITEMQ(I))*UP(I)*LC(I)*XUC - ISCA(I)}$$

$$+ \ 12*\text{PIUP}* \sum_{NS} \text{TNB(NS)*FAIL(I,NS)*FINC*FPR(I)*XFPR*RMH(I)*BMF*BLR}$$

$$+ \ 12*\text{PIUP}* \sum_{NS} \text{TNB(NS)*FAIL(I,NS)*FINC*FPR(I)*XFPR}$$

$$*\text{[BCMH(I)*BMF*BLR+SAT(NS)*2*CPPC*WT(I)]}$$

$$+ \sum_{NS} \text{[(1-SAT(NS))*\{FAIL(I,NS)+CIMF(NS)}* \sum_{\substack{B \\ NHB(B)=NS}} \text{FAIL(I,B)*NBC(B)\}}$$

$$*\text{FINC*FPR(I)*XFPR*BCMH(I)*BMF/BAA}$$

$$*\{ \sum_{L} \text{U(A(I,RMI(I,NS),L))*USE(L,NS)*1SET(L,NS)*CSE(L)}$$

$$*\text{(1+PIUP*MSE(L))\}]}$$

$$+ \sum_{NS} TNB(NS)*PIUP*SA* [\min\{F(CHNFB(I,NS)+NFB(I,NS)), 1 \}$$

$$- \min\{F(NFB(I,NS)), 1 \}]$$

$$+ \sum_{NP} TOTT(NP)* \quad NITEM(I,NP)*UP(I)*LC(I)*XUC - HDWRIT(I,NP)$$

$$+ [NRUC*LC(I)+(PIUP-NRUC)] *YRSQ(I)* [COND(I)+(1-COND(I)*RM(I)]$$

$$*UP(I)*XUC$$

$$- RSCA(I)$$

where the change in the base NS pipeline of ITEM type I which is due to the increased false pull rate is denoted by CHNFB(I,NS) and is determined as follows:

(i) If NS is a satellite base, i.e., BTYPE(NS)=3, then

$$CHNFB(I,NS)=FAIL(I,NS)*LRU(I)*FINC*FPR(I)*XFPR*OSTC$$

(ii) If NS is an independent or CIMF base, then

$$CHNFB(I,NS)=FAIL(I,NS)*LRU(I)*FINC*FPR(I)*XFPR*BRCT$$

$$+ CIMF(NS)* \sum_{\substack{B \\ NHB(B)=NS}} FAIL(I,B)*NBC(B)*LRU(I)*FINC*FPR(I)*XFPR*CRCT$$

The terms in the equation for TDFPR(I) above account for increases in LCC produced in, respectively, base Initial Spares, LRU removal and replacement manhours, bench checkout manhours and packing and shipping costs, Support Equipment, base Inventory Management, Production, and Replacement Spares.

### 3.2.11 ITEM Repair Materials Cost

The change in LCC produced by a fractional increase of FINC in the ITEM repair materials cost factor RM(I) is given by the equation:

$$TDRM(I)= [NRUC*LC(I) + (PIUP-NRUC)] *YRSQ(I)$$

$$*((1-COND(I))*FINC*RM(I))*UP*XUC$$

The equation above was derived from the repair materials cost portion of the Replacement Spares Cost Element equation given in Section 2.3.5.

### 3.2.12 CHLCC - Change in LCC for Repair Level Sensitivity

This section presents a basic equation which can be used to compute LCC sensitivity with respect to each of the ITEM repair level parameters RTS(I), NRTS(I), and COND(I). The fact that one basic equation is sufficient to compute LCC sensitivity with respect to these three different factors is due to the following circumstances. First, changes in any of these three parameters will impact exactly the same components of LCC. Secondly, for any particular ITEM type I, the three factors RTS(I),NRTS(I), and COND(I) cannot be increased or decreased independently of one another in any case. This is because the basic identity

$$RTS(I)+NRTS(I)+COND(I) = 1.0$$

must always be maintained for each value of I. For example, an increase of .25 in RTS(I) must be accompanied by an off-setting decrease of .25 in the sum of NRTS(I) and COND(I).

For these reasons, presented below are equations for the change in procurement quantities and in LCC produced by any possible combination of changes among the parameters RTS(I), NRTS(I), and COND(I). Thus, for a particular ITEM type I, if CR(I), CN(I), and CC(I) represent numerical changes to the parameters RTS(I), NRTS(I), and COND(I), respectively, then the resulting change in XITEMQ(I) due to the change in initial spares is estimated via the following equation:

$$XITEMQ(I) = \sum_{NS} TNB(NS)* [F(CNFB(I,NS)+NFB(I,NS))-F(NFB(I,NS))]$$

$$+ \quad F(CNFD(I)+NFD(I))-F(NFD(I))$$

The change in LCC, denoted CHLCC, due to changes in the parameters RTS(I), NRTS(I), COND(I), and LC(I) is estimated by the following equation (which is actually a <u>function</u> of CR(I), CN(I), CC(I), LC(I), and I):

$$CHLCC(CR(I),CN(I),CC(I),I)$$

$$= [\sum_{NS} TNB(NS)* F(CNFB(I,NS)+NFB(I,NS))]$$

$$+ F(CNFD(I)+NFD(I))] *UP(I)*LC(I)*XUC - ISCA(I)$$

$$+[NRUC*LC(I)+(PIUP-NRUC)] *YRSQ(I)$$

$$* [(COND(I)+CC(I)) + (1-(COND(I)+CC(I)))*RM(I)]$$

$$* UP(I)*XUC - RSCA(I)$$

$$+ 12*PIUP* \sum_{NS} FAIL(I,NS)*TNB(NS)*$$

$$\{ (LRU(I)+RTS(NHI(I)))* [CR(I)*BMH(I)*BMF*BLR$$

$$+ CN(I)*(DMH(I)*DMF*DLR + 2*CPPD(LO(NS))*WT(I))$$

$$+ CC(I)*CPPD(LO(NS))*WT(I)]$$

$$- NRTS(NHI(I))*CC(I)*DMH(I)*DMF*DLR \}$$

$$+\sum_{L}[\sum_{NS}[U(A(I,RMI(I,NS),L))*CSE(L)*(1+PIUP*MSE(L))*TNB(NS)*CHSE(L,NS)]$$

$$+ U(A(I,1,L))*CSE(L)*(1+PIUP*MSE(L))*CHSED(L)]$$

$$+ \sum_{NS} \Bigg\{ (1-SAT(NS))*TNB(NS)*PIUP*SA$$

$$* \ [\min\{F(CNFB(I,NS)+NFB(I,NS)),\ 1\ \}-\min\{F(NFB(I,NS)),\ 1\ \}$$

$$+ \ CPP(I,NS)*PA(I)] \Bigg\}$$

$$+ \sum_{NP} \Bigg\{ TOTT(NP)* \ NITEM(I,NP)*UP(I)*LC(I)*XUC \ - \ HDWRIT(I,NP) \Bigg\}$$

The terms in the above equation (i.e., each summation) accounts, respectively, for the changes in the cost of Investment Spares, Replenishment Spares, Maintenance, Support Equipment, ITEM Inventory Management and Production.

Also, in the above equation CNFB(I,NS) represents the resulting change in the base NS pipeline of ITEM type I, computed via the equation:

$$CNFB(I,NS) = (1-SAT(NS))*FAIL(I,NS)*(LRU(I)+RTS(NHI(I)))$$

$$*[CR(I)*BRCT+(CN(I)+CC(I))*OST(LO(NS))]$$

$$+ \ CIMF(NS)* \sum_{\substack{B \\ NHB(B)=NS}} \{FAIL(I,B)*NBC(B)\}*(LRU(I)+RTS(NHI(I)))$$

$$*[CR(I)*CRCT+(CN(I)+CC(I))*(OST(LO(NS))+U(FPR(I)*XFPR)*CRCT)]$$

Similarly, CNFD(I) represents the resulting change in the depot pipeline of ITEM type I, given by:

$$CNFD(I) = \sum_{NS} \ FAIL(I,NS)*TNB(NS)*\{(LRU(I)+RTS(NHI(I)))$$

$$*CN(I)*DRCT(LO(NS))-NRTS(NHI(I))*CC(I)*DAD\}$$

The terms CHSE(L,NS) and CHSED(L) in the equation for CHLCC represent resulting changes in support equipment requirements at the base and depot level, respectively. To calculate these changes in SE, the changes in repair manhours expended on ITEM type I at both the base and depot level must first be calculated. The change in repair manhours at each base of type NS is denoted by CRH(I,NS) and determined as follows:

87

(i)  If NS is a satellite base, CRH(I,NS)=0

(ii)  If NS is an independent or CIMF base, then

$$CRH(I,NS)=FAIL(I,NS)*(LRU(I)+RTS(NHI(I)))*CR(I)*BMH(I)*BMF$$

$$+ CIMF(NS)*\sum_{\substack{B\\NHB(B)=NS}} FAIL(I,B)*NBC(B)*(LRU(I)+RTS(NHI(I)))$$

$$*[(CR(I)+CN(I)+U(FPR(I)*XFPR)*CC(I))*BCMH(I)+CR(I)*BMH(I)]*BMF$$

The change in repair manhours expended on ITEM type I at the depot
is denoted by CRHD(I) and is given by the formula:

$$CRHD(I)=\sum_{NS} FAIL(I,NS)*TNB(NS)*[(LRU(I)+RTS(NHI(I)))*CN(I)$$

$$- NRTS(NHI(I))*CC(I)]*DMH(I)*DMF$$

The change in SE requirements at the base level is then determined
as follows:

(i)  If CRH(I,NS)=0  then CHSE(L,NS)=0 for all SE types L.

(ii)  If CRH(I,NS) > 0  then, for each SE type L,

$$CHSE(L,NS)=USE(L,NS)*[CRH(I,NS)/BAA]$$
$$*\max\{ISET(L,NS),A(I,RMI(I,NS),L)\}$$

(iii)  If CRH(I,NS) < 0  then, for each SE type L,

$$CHSE(L,NS)=[CRH(I,NS)/ERHAB(L,NS)]*NSEB(L,NS)$$

The change in SE requirements at the depot is determined is a
similar fashion, i.e.,:

(i)  If CRHD(I)=0  then CHSED(L)=0 for all SE types L.

(ii)  If CRHD(I) > 0 then

$$CHSED(L)=USED(L)*[CRHD(I)/DAA]*\max\{ISETD(L),A(I,1,L)\}$$

(iii)  If CRHD(I) < 0 then

$$CHSED(L)=[CRHD(I)/ERHAD(L)]*NSED(L)$$

Finally, the term CPP(I,NS) in the equation for CHLCC represents the change in the inventory of piece parts at the base level and is determined as follows:

(i)  If RTS(I)*NFB(I,NS) = 0 then

$$CPP(I,NS) = U(CR(I)*(CNFB(I,NS)+NFB(I,NS)))$$

(ii)  If RTS(I)*NFB(I,NS) > 0 then

$$CPP(I,NS) = \begin{cases} CR(I)/RTS(I), & \text{if } CR(I)<0 \\ 0, & \text{otherwise} \end{cases}$$

Thus CPP(I,NS) represents either possibly additional piece part inventory requirements (case (i)) or possibly reduced piece part inventory requirements (case (ii)).


### 3.2.13  ITEM Intermediate Repair Fraction

For sensitivity analysis on the parameter RTS(I) the change in LCC which results from an absolute (rather than fractional) increase in RTS(I) equal to an amount FINC is estimated.

However, there are two factors to consider in effecting this increase to the RTS(I) parameter.  First, the value of RTS(I) may never exceed unity.  Second, since the identity

(*)              RTS(I) + NRTS(I) + COND(I) = 1.0

must always be maintained, any increase to the RTS(I) parameter must be accompanied by an equal decrease to the sum of NRTS(I) and COND(I).

In addition, in order to properly perform sensitivity analysis on any of the repair level fractions RTS(I), NRTS(I) and COND(I), all ITEM data that is required for any repair level decision must be provided as input to the LCC Model.  For example, even if depot level repair is initially intended for an ITEM type I, the user should still input a non-zero, realistic estimate for base repair manhours BMH(I), so that the LCC sensitivity with respect to RTS(I) will represent a meaningful change in cost.

With these considerations in mind, define changes in the values of RTS(I), NRTS(I), and COND(I), (denoted by CR(I), CN(I) and CC(I), respectively) by the following equations and conditions:

<u>Case 1</u>:  If COND(I) = 1, then set

   CR(I) = min{FINC, 1 }

   CN(I) = 0 and CC(I) = - CR(I).

<u>Case 2</u>:  If COND(I) < 1 then set

   CR(I) = min{FINC, NRTS(I)}

   CN(I) = - CR(I) and CC(I) = 0.

The resulting change in LCC is then given by

$$\text{TDRTS(I)} = \begin{cases} 0, \text{ if CR(I)=0,} \\ \text{CHLCC(CR(I),CN(I),CC(I),I), if CR}(^{\tau})>0; \end{cases}$$

where CHLCC(CR(I),CN(I),CC(I),I) is computed as in Section 3.2.12.

Notes:  (1)  CR(I) + CN(I) + CC(I) = 0 for all cases since the equality (*) above must by maintained.

(2)  We assume that COND(I) = 1 in Case 1 above indicates a repair level decision, i.e., discard-on-failure, whereas a value of COND(I) < 1 indicates a wear-out rate of a normally repairable ITEM. Thus, for LCC sensitivity on RTS(I), we may reduce the value of COND(I) if and only if COND(I) = 1.  If COND(I) < 1 then any increase in the RTS(I) parameter must be absorbed by an equal decrease in the NRTS(I) parameter only.


### 3.2.14  <u>ITEM Depot Repair Fraction</u>

LCC sensitivity analysis on NRTS(I) is performed under the same assumptions as made for LCC sensitivity on RTS(I).  Thus, for a given value of FINC, define changes in the values of RTS(I), NRTS(I), and COND(I), (denoted by CR(I), CN(I) and CC(I), respectively) by the following criteria:

<u>Case 1</u>:  If COND(I)=1 then set

   CN(I) = min{FINC, 1},

   CR(I) = 0 and CC(I) = - CN(I).

Case 2: If COND(I) < 1 then set

$CN(I) = \min\{FINC, RTS(I)\}$,

$CR(I) = - CN(I)$ and $CC(I) = 0$.

The change in LCC produced by this <u>absolute</u> increase of CN(I) in the value of NRTS(I) is then given by

$$TDNRTS(I) = \begin{cases} 0, \text{ if } CN(I){=}0, \\ CHLCC(CR(I),CN(I),CC(I),I), \text{ if } CN(I) > 0. \end{cases}$$

where again CHLCC(CR(I),CN(I),CC(I),I) is calculated via the equation presented in Section 3.2.12.


## 3.2.15  ITEM Condemnation Rate

LCC sensitivity with respect to the COND(I) factor is performed under the same assumptions as were made for LCC sensitivity with respect to the RTS(I) and NRTS(I) factors.  Thus, for a given value of FINC, define the changes CR(I), CN(I), and CC(I) in the values of RTS(I), NRTS(I) and COND(I), respectively, in  accordance with the two cases below:

Case 1:  If COND(I)=1 then CC(I)=CR(I)=CN(I)=0.

Case 2:  If COND(I) < 1 then set

$CC(I)= \min\{FINC, 1{-}COND(I)\}$,

$$CR(I) = \frac{-RTS(I)}{(RTS(I)+NRTS(I))} *CC(I)$$

and

$$CN(I) = \frac{-NRTS(I)}{(RTS(I)+NRTS(I))} *CC(I)$$

Note, in this case, that the decreases in RTS(I) and NRTS(I) that are necessary to compensate for the increase in COND(I) are pro-rated.

The estimated change in LCC that is produced by an <u>absolute</u> increase of CC(I) in the value of COND(I) is then given by

91

$$TDCOND(I) = \begin{cases} 0, \text{ if } CC(I)=0 \\ \\ CHLCC(CR(I),CN(I),CC(I),I), \text{ if } CC(I)>0, \end{cases}$$

where again CHLCC(CR(I),CN(I),CC(I),I) is calculated as indicated in Section 3.2.12.

Notes: (1) The value of TDCOND(I) represents the estimated change in LCC that results from increasing the condemnation rate of ITEM type I by an amount CC(I) (in the extreme case of FINC=1, from making ITEM type I a discard-on-failure component). However, the estimate of the change in LCC that is produced by decreasing the condemnation rate of a discard-on-failure ITEM (i.e., COND(I)=1), and hence making it either base or depot-level repairable, is given by the value of either TDRTS(I) or TDNRTS(I), respectively.

(2) The value of TDCOND(I) includes a prorated projected savings in support equipment (SE) costs, i.e., if an ITEM is discarded-on-failure then its associated SE is utilized less often. However, a rerun of the LCC Model with COND(I)=1 for that ITEM may not produce the indicated savings in SE cost if other ITEM types utilize the same SE as ITEM type I. In fact, in most cases, to realize a savings in the SE cost of a particular SE type L, all ITEM types which utilize this SE type must be designated as discard-on-failure (COND=1). If TDCOND(I) is negative for all (or most) of these ITEM types, then making them all discard-on-failure will be a cost-effective repair-level decision.

## 3.3 Simplified Repair Level Analysis Capability

The sensitivity analysis calculations with respect to RTS(I), NRTS(I) and COND(I) provide the LCC Model with a simplified repair level analysis capability. For example, if ITEM type I is always repaired at the base level (i.e., RTS(I)=1), then the change in LCC produced by switching it to depot-level repair (NRTS(I)=1), is estimated by the value of TDNRTS(I), computed using a value of FINC=1. Thus, if the value of TDNRTS(I) is negative, then that may indicate that depot-level repair of ITEM type I is cheaper than base-level repair. (Although further detailed analysis would be warranted before making that decision.)

Similarly, the change in LCC produced by switching ITEM type I to discard-on-failure (COND(I)=1) is estimated by the value of TDCOND(I), also computed using a value of FINC=1. In general, the following table summarizes the estimated changes in LCC that would be produced by switching the current repair-level stategy for ITEM type I (represented by the input values of RTS(I), NRTS(I) and

92

COND(I)) to each of the following possibilities: (i) all repair at base-level, (ii) all repair at depot-level, and (iii) discard ITEM upon failure. (The reader should reread Caution (4) in Section 5.1 concerning the necessity to input data concerning all ITEM repair level decisions in order for the calculations of TDRTS(I),TDNRTS(I), and TDCOND(I) to represent meaningful changes in LCC.)

| Repair Level decision | * * | Resulting change in LCC | |
|---|---|---|---|
| Base-level repair | * * * | TDRTS(I) | |
| Depot-level repair | * * | TDNRTS(I) | all computed using FINC=1 |
| Discard-on-failure | * | TDCOND(I) | |

## 3.4 LCC Sensitivity to Identify Which SRUs should be LRUs

In this section the change in LCC which would occur if individual SRUs were made LRUs is estimated. For this purpose only ITEMs which are SRUs and whose next higher level indenture ITEM is an LRU will be examined, i.e., ITEM types I satisfying LRU(I)=0 and LRU(NHI(I))=1.

This sensitivity analysis is useful in identifying those SRUs which should be considered for re-designing as LRUs. For example, it may be cost effective to re-design an SRU with a high failure rate as an LRU. In this case, a smaller LRU would be shipped for repair and a smaller, less costly LRU would be spared to replace these failed items. This could result in a lowering of the total LCC.

In calculating the change in LCC the following assumptions are made:

If SRU type I is made an LRU, then

(1) The failure rate of the LRU type NHI(I) will be reduced by the failure rate of ITEM type I.
(2) The unit cost of LRU type NHI(I) will be reduced by the unit cost of ITEM type I.
(3) The false pull rate of ITEM type I will become the same as for LRU type NHI(I). (Recall only LRUs have non-zero false pull rates.)
(4) The repair level fractions RTS, NRTS, and COND will remain the same for both ITEM type I and LRU type NHI(I).

93

(5) Removal man-hours and cost of in-place repairs for ITEM type I (if changed to an LRU) will be the same as for LRU type NHI(I).

(6) The weight (for shipping) of LRU type NHI(I) will reduced by an amount equal to the weight of ITEM type I.

(7) The procurement quantities and therefore the learning curve factors change for both ITEM types I and NHI(I).

The above assumptions reflect the fact that if an SRU is to be re-designed as an LRU, then it will be physically removed from its next higher LRU assembly. The next higher LRU assembly will also require re-designing after which it presumably will weigh less, cost less, and fail less often as a result of having a portion of its original components removed (i.e., the SRU).

The change in LCC that is calculated below as being produced by changing SRU type I to an LRU is denoted by TDSRU(I). The value of TDSRU(I) must be negative of course, (indicating a savings in LCC) in order to indicate that it might be cost-effective to re-design SRU type I as an LRU. However, TDSRU(I) does not include an adjustment for the cost of the necessary re-design ng of both the SRU and its next higher LRU assembly into new LRU configurations. Thus, the LCC Model user will have to ascertain for himself whether a savings in LCC indicated by negative value of TDSRU(I) for a particular ITEM type I is large enough to off-set the implicit re-design engineering cost which would be incurred if the actual reconfiguration of the ITEM was undertaken.

Also, since the analyst is primarily interested in potential savings in LCC, the LCC Model will sort out the TDSRU(I) calculations in order of largest negative values. Thus, the model will identify that ITEM type I for which TDSRU(I) is most negative (indicating the largest potential savings in LCC) and will print that value first in the Sensitivity Analysis Output Table. The next most negative value will be printed second, and so on.

It should be noted that TDSRU(1) is an approximation to the change in LCC. If a particular SRU were re-designed as an LRU. This is due to the fact that SRU type I may be a component in several different LRU types, among which LRU type NHI(I) represents only its most common usage. The calculation of TDSRU(I) will assume that SRU type I has been charged to an LRU in all of its occurrences, but will only include changes in the higher LRU costs for LRU type NHI(I). Also, the data base of the LCC Model does not reveal whether there are multiple copies of a particular SRU within a given LRU.

Thus the TDSRU(I) calculation should be used as a "first-pass" screening device to indicate those SRUs which <u>potentially</u> might produce some cost savings if they were re-designed as LRUs. A more detailed analysis would then be warranted. For example as a next step, the data base of the LCC Model could be revised to incorporate all anticipated design, failure rate, unit cost, and maintenance changes to the SRU and all its higher level LRUs that would be expected if the SRU were re-designed as an LRU.

The equation for TDSRU(I) is:

(i) If ITEM type I is not an SRU whose next higher indenture level assembly is an LRU, then TDSRU(I)=0.

(ii) Otherwise, i.e., LRU(I)=0 and LRU(NHI(I))=1, then the change in ITEM procurement quantities for ITEM type I is computed by:

$$XITEMQ(I) = \sum_{NP} [TOTT(NP)*NITEM(I,NP)]$$

$$+ \sum_{NS} [TNB(NS)* \ F(DINFB(I,NS))]+F(DINFD(I)) \ -TISQ(I)$$

$$+ \ 12*NRUC*\sum_{NS} min\{FAIL(I,NS),FAIL(NHI(I),NS)\}$$

$$*TNB(NS)*(1-COND(NHI(I)))-NRUC*YRSQ(I)$$

The terms in the above equation (following each summation) account for the changes in procurement quantities for ITEM I produced in prime mission equipment, initial spares, and replacement spares quantities.

The change in ITEM procurement quantities for ITEM type NHI(I) is given by:

$$XITEM(NHI(I))=\sum_{NS} TNB(NS)* \ F(DNHNFB(I,NS))+F(DNHNFD(I)) \ - \ TISQ(NHI(I))$$

$$+12*NRUC*( \sum_{NS} max\{(FAIL(NHI(I),NS)-FAIL(I,NS),0\})$$

$$*TNB(NS)*(1-COND(NHI(I))-NRUC*YRSQ(NHI(I))$$

95

This parameter accounts for the changes in initial and replenishment spares procurement quantities, repectively.

The resulting change in LCC is given by:

$$TDSRU(I) = [\sum_{NS} TNB(NS)*F(DNHNFB(I,NS)) + F(DNHNFD(I))]$$

$$* (UP(NHI(I))-UP(I))*LC(NHI(I))*XUC - ISCA(NHI(I))$$

$$+ [\sum_{NS} TNB(NS)*F(DINFB(I,NS)) + F(DINFD(I)] *UP(I)*LC(I)*XUC$$

$$- ISCA(I)$$

$$+ [NRUC*LC(NHI(I))+(PIUP-NRUC)]$$

$$*12*[\sum_{NS} max\{FAIL(NHI(I),NS)-FAIL(I,NS),0\}$$
$$*TNB(NS)]* [COND(NHI(I))+(1-COND(NHI(I)))*RM(NHI(I))]$$

$$*(UP(NHI(I))-UP(I))*XUC$$

$$- RSCA(NHI(I))$$

$$+[NRUC*LC(I)+(PIUP-NRUC)] *12[\sum_{NS} min\{FAIL(I,NS), FAIL(NHI(I),NS)\}$$

$$*TNB(NS)]*(1-COND(NHI(I)))* [COND(I)+(1-COND(I))*RM(I)]$$

$$*UP(I)*LC(I)*XUC$$

$$- RSCA(I)$$

$$+ 12*PIUP*\sum_{NS} \{max\{FAIL(NHI(I)),NS)-FAIL(I,NS),0\}*TNB(NS)$$

$$*\{[(1+FPR(NHI(I))*XFPR)*BCMH(NHI(I)) + RTS(NHI(I))*BMH(NHI(I))]$$

$$*BMF*BLR$$

$$+ NRTS(NHI(I))$$

$$*[DMH(NHI(I))*DMF*DLR + 2*CPPD(LO(NS))*(WT(NHI(I))-WT(I))]$$

$$+ COND(NHI(I))*(CPPD(LO(NS))*(WT(NHI(I))-WT(I))$$

$$+ SAT(NS)*(1+FPR(NHI(I))*XFPR)*2*CPPC*(WT(NHI(I))-WT(I))\}\}$$

$$- OFMCA(NHI(I))$$

$$+12*PIUP*\sum_{NS} \{min\{FAIL(NHI(I),NS),FAIL(I,NS)\} \quad *TNB(NS)$$

$$*\{ [(1+FPR(NHI(I))*XFPR)*BCMH(I) + RTS(I)*BMH(I)] \quad *BMF*BLR$$

$$+ NRTS(I)*[DMH(I)*DMF*DLR + 2*CPPD(LO(NS))*WT(I)]$$

$$+ COND(I)*CPPD(LO(NS))*WT(I)$$

$$+ SAT(NS)*(1+FPR(NHI(I))*XFPR)*2*CPPC*WT(I)\}\}$$

$$- OFMCA(I)$$

$$-\sum_{L}\sum_{NS} U(A(NHI(I),RMI(NHI(I),NS),L))$$

$$*TNB(NS)*[ USE(L,NS)*RNHMH(I,NS)*(ISET(L,NS)/BAA)$$

$$+ USED(L)*min\{FAIL(I,NS), FAIL(NHI(I),NS)\}*NRTS(NHI(I))$$

$$*DMH(NHI(I))*DMF*ISETD(L)/DAA ] \quad *CSE(L)*(1+PIUP*MSE(L))$$

$$+ PIUP*SA* \sum_{NS} U(FAIL(I,NS))*SAT(NS)*TNB(NS)$$

The terms in the above equation (following each summation) account
for the changes in LCC produced in, respectively, Production,

Initial Spares, Replacement Spares (two summations), Off-Equipment
Maintenance (two summations), Packing and Shipping, Support
Equipment, and ITEM Inventory Management.

The revised base pipelines for ITEM type I and its higher LRU
assembly NHI(I) which are used in the above equation and denoted by
DINFB(I,NS) and DNHNFB(I,NS), respectively, are given by:

(i)  If NS is a Satellite base, then

$$DINFB(I,NS) = FAIL(I,NS)*(1+FPR(NHI(I)))*OSTC$$

and

$$DNHNFB(I,NS) = (FAIL(NHI(I),NS)-FAIL(I,NS))*(1+FPR(NHI(I)))*OSTC$$

(ii)  If NS is an Independent or CIMF base, then

$$DINFB(I,NS) = FAIL(I,NS)*[(FPR(NHI(I))*XFPR+RTS(I))*BRCT$$

$$+(NRTS(I)+COND(I))*OST(LO(NS))]$$

$$+ CIMF(NS)*\sum_{\substack{B \\ NHB(B)=NS}} FAIL(I,B)*NBC(B)*[(RTS(I)+FPR(NHI(I))*XFPR)*CRCT$$

$$+ (NRTS(I)+COND(I))*(OST(LO(NS))+U(FPR(NHI(I))*XFPR)*CRCT)]$$

and

$$DNHNFB(I,NS) = \max\{FAIL(NHI(I),NS)-FAIL(I,NS), 0\}$$

$$*[(FPR(NHI(I))*XFPR+RTS(NHI(I)))*BRCT$$

$$+(NRTS(NHI(I))+COND(NHI(I)))*OST(LO(NS))]$$

$$+ CIMF(NS)*\left(\sum_{\substack{B \\ NHB(B)=NS}} \max\{FAIL(NHI(I),B)-FAIL(I,B), 0\}*NBC(B)\right)$$

$$*[(RTS(NHI(I))+FPR(NHI(I))*XFPR)*CRCT+(NRTS(NHI(I))$$

$$+COND(NHI(I)))*(OST(LO(NS))+U(FPR(NHI(I))*XFPR)*CRCT)]$$

The revised depot pipelines for ITEM type I and its higher LRU assembly NHI(I) are denoted by DINFD(I) and DNHNFD(I), respectively, and calculated via the equations:

$$DINFD(I)=\sum_{NS} FAIL(I,NS)*TNB(NS)*NRTS(I)*DRCT(LO(NS))$$

and

$$DNHNFD(I)=\sum_{NS} \max\{FAIL(NH1(I),NS)-FAIL(I,NS),\ 0\}*TNB(NS)$$
$$*NRTS(NHI(I))*DRCT(LO(NS))$$

Finally, the variable RNHMH(I,NS), which is used in the equation for TDSRU(I) to represent the reduction in manhours expended in the intermediate level repair of the LRU assembly NHI(I) at base NS, is determined by:

$$RNHMH(I,NS)=\begin{cases} 0,\ if\ FAIL(NHI(I),NS)=0 \\ \\ \min\{FAIL(I,NS)/FAIL(NHI(I),NS),\ 1\}*ERHBI(NHI(I),NS), \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad otherwise \end{cases}$$

Note that this reduction in manhours is assumed to be due to the reduced failure rate of the LRU type NHI(I) which results from the removal of its component SRU type I.

## 3.5 LCC Sensitivity Analysis through Global Multipliers

The four global multiplier factors XUC, XFR, XFPR, and XMIL, which are direct input parameters from Data File 1 are provided in the LCC Model as additional LCC sensitivity analysis tools. These factors may be used either in conjuction with or independently of the LCC sensitivity calculations presented in Sections 3.2.1, 3.2.2, 3.2.3, and 3.2.7.

For example, suppose that the global unit cost sensitivity calculation TDXUC were to indicate that a $50M increase in LCC would result from a 25% increase (i.e., FINC=.25) in all ITEM and Terminal unit costs. To gain more insight as to exactly which cost elements would be effected, the LCC Model user need only input XUC=1.25 (immediately in NAMEL I T /G02/ if operating in Interactive Mode, see Section 8.4) and then rerun the model. The specific cost increases, in this case to the Production, Investment Spares, and Replenishment Spares Cost Elements, would then be visible in the resulting Output Tables of the model.

As another example, suppose one wished to perform a system-wide trade-off analysis on increased reliability versus increased unit cost. If it were determined that to produce a 40% reduction in system-wide failure rates would require an approximate 25% increase in the unit costs of all ITEMs and Terminals, then a rerun of the model using XFR=.60 and XUC=1.25 would exhibit the resulting changes in LCC. Note that this method would incorporate the implicit "interaction" resulting from changing failure rates and unit costs at the same time. The LCC sensitivity calculations for TDXFR and TDXUC, on the other hand, only represent the respective changes which would result from changing these factors <u>one</u> <u>at</u> <u>a</u> <u>time</u> and hence measure no interactive effect.

In addition, note that, for any one run of the LCC Model, all LCC sensitivity calculations must be made with the same fractional increase factor FINC. By using the global multiplier factors, however, one can measure the effect of, say, increasing global failure rates by 20%, decreasing all unit costs by 30%, increasing all ITEM false pull rates by 25% and increasing all modification/installation labor manhour estimates by 50%, by inputting XFR=1.2, XUC=.70, XFPR=1.25, and XMIL=1.5 and re-running the model. Thus the global multiplier factors provide a convenient method to incorporate any set of desired adjustments to the four system-wide categories: ITEM and Terminal unit costs, ITEM failure rates, ITEM false pull rates, and MOD/I labor hours.

It should also be noted that global LCC sensitivity analysis on corrective maintenance manhours may be accomplished by utilizing the maintenance factors BMF and DMF. The purpose of these two parameters in the LCC Model (as indicated by their definitions in Appendix A) is not specifically to serve as LCC sensitivity multiplier factors, but they may, in fact, easily serve this function. Thus, for example, to measure the LCC impact of a 25% increase in all base repair times one need only increase the current value of BMF by 25% and rerun the model.

Note, however, that for ITEM-specific LCC sensitivity analysis one must still rely on the calculations presented in Sections 3.2.8 through 3.2.15. In addition, the global multiplier factors do not average out any jump increases in cost, say for support equipment, and hence do not indicate the continuous "trend" in LCC. For this reason, the increase in LCC predicted by the LCC sensitivity calculation for TDXFR with FINC=.20 may not agree exactly with the increase obtained by rerunning the model using XFR=1.20. (For XUC and TDXUC, however, the values should agree exactly, since there are no jump increases to average out.)

100

# SECTION 4

## OPERATING CHARACTERISTICS OF THE MODEL

### 4.1 General Properties of the LCC Model

This section presents an overall view of the operation of the LCC
Model. This discussion will give the reader general information on
how the LCC Model is used, what the major components and features of
the Model are, and what type of computer facility is required for
running the Model. A concise description of the data input files
and output tables of the LCC Model is also presented.

While the material in this section gives, in condensed form, a
description of all of the main operating characteristics of the LCC
Model, it does not contain the technical details necessary for the
user to set up and run the LCC Model on his computer system, such as
file structure and Model execution. This information is provided in
Section 7.

### 4.1.1 Performance Characteristics

The SSS LCC Model has been designed to be readily adaptable to any
computer system of moderate capability and at least 5544K bytes of
core storage. In particular, the LCC Model is written completely in
ANSI FORTRAN, with two exceptions. One is its use of NAMELIST
statements and the other is the assumption that an index can be read
and used in a single READ statement.

Even though the LCC Model is designed to be run in an interactive
on-line computer mode, it may easily be utilized in batch mode.
Complete instructions for operating the LCC Model in batch mode are
given in Section 7.4.

The rate at which the LCC Model will accept inputs, process its
calculations, and produce its output tables will depend to a large
extent on the capability of the user's computer system. Processing
time will also be a function of the amount of data which is input to
the Model. However, as one indication of processing time, the LCC
Model run which produced the sample output in Appendix B consumed 12
CPU seconds of processing time on an IBM 370/3031 computer system
with VS2 operating system. The user should note, however, that the
amount of input data in this sample run, as listed in the sixteen
input tables in Appendix B, may be less than that required for an

actual contractor design. Specific limits for the amount of input data accepted by the LCC Model are given in Section 7.3.

## 4.1.2 Organization of the Model

The SSS LCC Model is a tool to estimate the total life cycle cost to the Air Force of alternative SSS terminal designs. The Model highlights cost elements which depend wholly or in part on the design of the system and those which depend on contractor provided data which affect system installation, operation and support. Thus, the output of the LCC Model will be useful to both the Air Force and contractors in estimating the life cycle cost of alternative system designs. The Model can be tailored to the specific deployment scheme, operations concept and maintenance concept of the system for a specified operating life.

The SSS LCC Model computer program package consists of the main program and two supportive programs. The main program has two components, the basic LCC calculations and the sensitivity analysis, and will be simply called the LCC program. The supportive programs will be referred to as the Repair Level Analysis (RLA) program and the Preprocessor.

The first component of the LCC program implements a model which computes the life cycle cost of the system based on the values of the input parameters corresponding to a particular system design (see Section 2 for a complete description of this model). The output of the first component gives the total LCC and also the LCC broken out into eleven top-level cost elements: Full Scale Engineering Development, Prime Mission Equipment, Operations, Modification/Installation, Spares, Support Equipment, On-Equipment Maintenance, Off-Equipment Maintenance, Training, Inventory Management, and Technical Orders. The output is further broken out into a number of cost sub-elements, and also by type of host platform, type of operational base, and type of equipment . This breakdown of life cycle cost into various categories is intended to help the user identify cost drivers and areas in which design and cost trade-offs should be considered.

The second component of the LCC program provides Sensitivity Analysis computations to be used as an additional aid in trade-off considerations. More specifically, for certain selected contractor inputs (e.g., UP(I), the first unit price of the Ith ITEM or FR(I), the failure rate of the Ith ITEM) this program component computes the average change (either positive or negative) in total LCC which is produced by a fractional increase in the value of the given parameter. These calculations should further aid the user in

identifying elements of his system design to which the LCC is
particularly sensitive, again indicating possible trade-offs in
design and/or installation, operation or support characteristics.
(See Section 3 for a full discussion of the sensitivity analysis
component.)

The first supportive program (RLA) of the LCC Model computer program
helps determine the repair level (base repair, depot repair, or
discard-on-failure) for each ITEM.  It is a separate program which
utilizes output from six runs of the first component (the basic LCC
program), each run using different repair strategy for the LRUs and
their SRUs.  The cost implications for each Item due to different
repair strategies are assessed and then evaluated in an analytical
procedure to select a repair level for each ITEM.  Model
specifications corresponding to each ITEM's recommended repair level
are provided in the output and can be implemented in a subsequent
run of the LCC Model.

The other supportive program, the preprocessor, assists the user in
constructing Data File 11A and in checking for format and
consistency errors in other input data files.

4.1.3  Operation of the Model

The contractor will generally operate the programmed SSS LCC Model
interactively, both as a design tool and as a means of providing
cost visibility.  Use of the LCC Model in a design study is
illustrated in Figure 4-1.

The LCC Model computer program package requires data inputs from
both the Air Force and the contractor (see Section 6, or the
Glossary in Appendix A for this breakdown).  The contractor data
inputs incorporate system design, including production costs, a
maintenance concept, and characteristics affecting the other top-
level cost elements.  Air Force data inputs include all factors over
which the contractor has no control (e.g., SSS deployment and
terminal operating hours) and also constraints which the
contractor's design must meet (e.g., the confidence factor for
safety stock of spare ITEMs).

Supplied with Air Force and contractor inputs, the main program of
the LCC Model (the LCC Program) calculates and prints out the total
LCC and its breakdown into various categories, and also outputs the
results of the sensitivity analysis.  When requested, the LCC
program can also provide the inputs to the RLA program for making
repair level decisions, which in turn can be used in a subsequent
run of the LCC program to produce the previously described outputs.

103
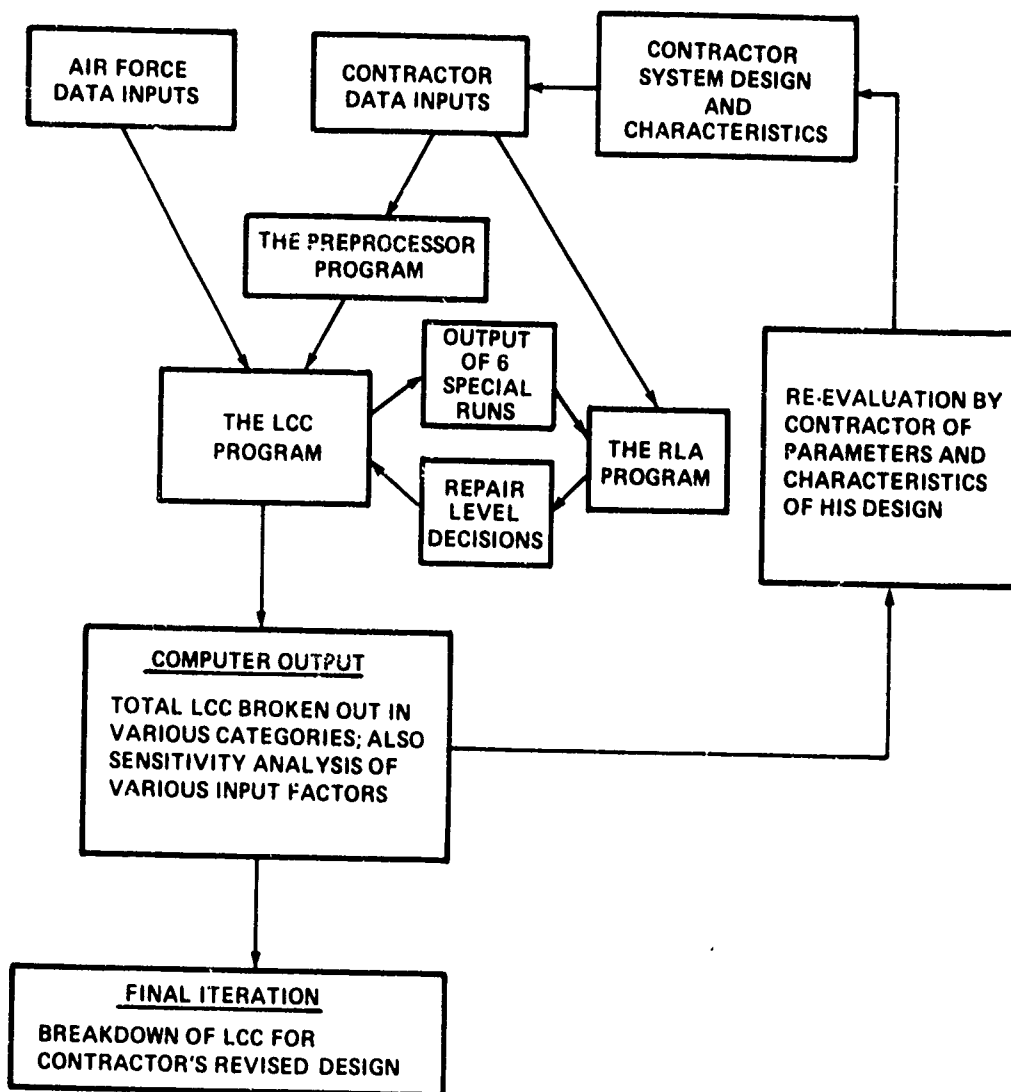
Figure 4-1.   Operation of the LCC Model for One Design Study

Using these outputs, the contractor can then reevaluate his system design, perform trade-offs in design and other parameters, and develop design and repair level modifications. Any new system design would then give rise to a change in contractor data inputs to be used in a subsequent LCC Model computer run. It is possible to iterate through this cycle as many times as necessary, evaluating many possible design variations to carry out the DTC/LCC tasks defined in the SSS SOW.

### 4.1.4  Configuration of the Model

The SSS LCC Model is designed for interactive use via a time-sharing capability. However, the LCC Model may easily be used in batch mode (see Section 7.6 for instructions). For interactive mode, the user will need to have the capability to run a FORTRAN program on-line with 13 input data sets and 3 output data sets. The user must have a computer terminal with a display of at least 80 columns which serves as one of the input data sets and as one of the output data sets. The user must also have an off-line printer with at least 133 column capability (including one column for carriage control) for printing out the second output data set, a FORTRAN compiler with NAMELIST capability and the capability to read and use indices in a single READ Statement (see section 4.1.1), and provision for approximately 5544K bytes of core storage (where 1K byte = 1024 bytes). With the exceptions noted above, the Model, and its interactive interface, are written in ANSI FORTRAN (version X3.9 - 1966). Finally, since the LCC Model is furnished in the form of FORTRAN statements on punched cards, the user will require a card-reader for use as an input device.

### 4.1.5  Operation of the LCC Program

Figure 4-2 presents an overview of the operation of the LCC program. First, the nominal values of thirteen standard input data files (which include Air Force and contractor data) are read into the Model. Next, certain instructions for output format are input by the user from his terminal in the format of responses to a sequence of computer-prompted questions. At this point, the user may also over-wri e the nominal values of any selection of previous data inputs. Control is then transferred to the computer processor where the program calculates successively the life cycle cost of the modelled system, and the related values of the sensitivity analysis. The output of these computations is then directed to two separate devices. If the appropriate control parameter indicates that an off-line copy of output data is required, then the complete (or partial) set of program output is produced on the off-line printer, including the LCC broken out into various categories and the
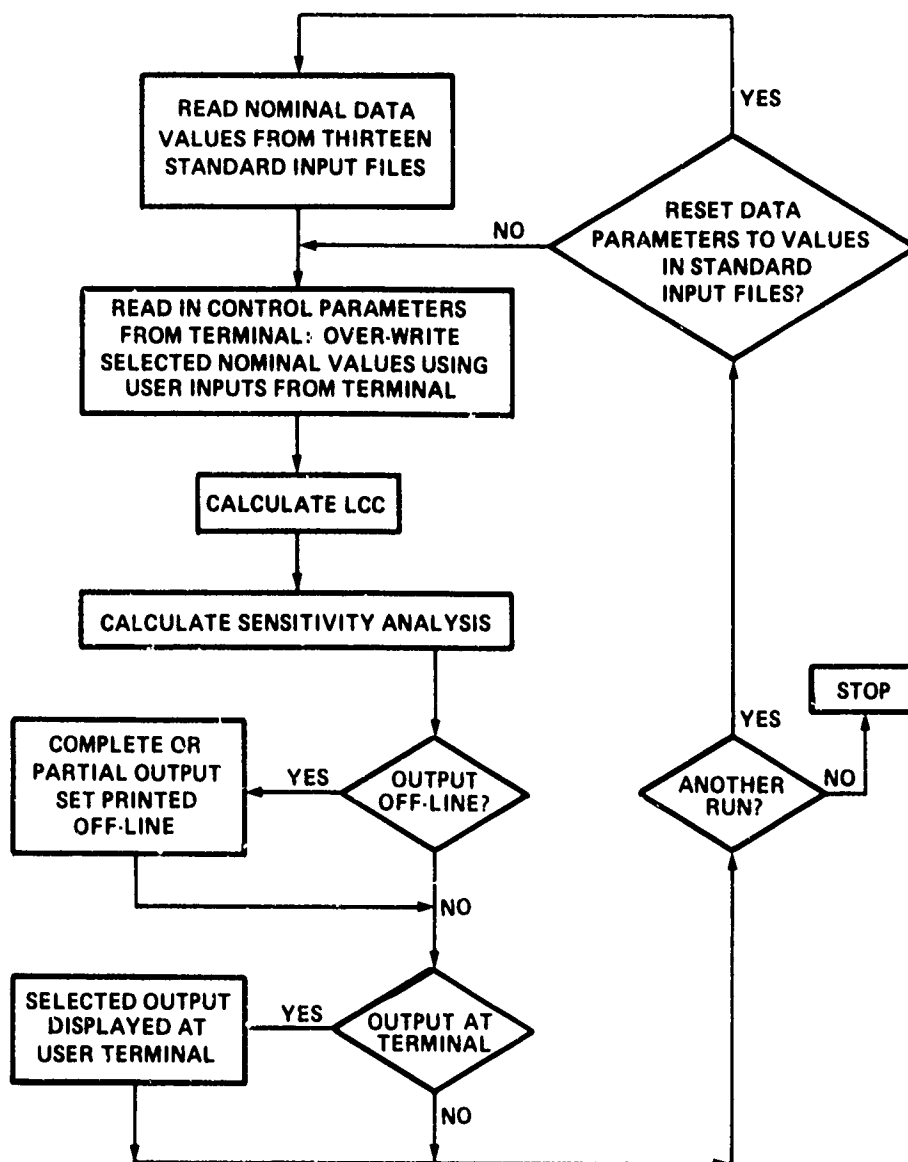
Figure 4-2.  Operation of the LCC Program

sensitivity analysis values of all designated input factors. In addition, if specified, the user's terminal may receive a subset consisting of two tables of the LCC output, and the values of the sensitivity analysis calculations for a selected number of "most sensitive" input factors.

The user is then asked at the terminal if he wishes another run. A "NO" response terminates the program. A "YES" response allows the user to initiate an interactive rerun of the LCC program. To prepare for this rerun, the user is first asked whether he wishes to reset the values of all data parameters back to those values found in the thirteen standard input files. A "YES" response to this question will cause the values in these Standard Files to be reread into the Model. Subsequent operation of the LCC program on the interactive rerun would then be exactly the same as described for the initial run. A "NO" response to this question directs that the values of data parameters used during the previous run (including any "over-written" values) be assumed as the "nominal" or initial values for use on the interactive rerun and then the user is transferred back to the second step in the system operation. At this point he may input new values for the control parameters and/or over-write the nominal values of a different selection of data inputs and then make a new run of the LCC Model. The user may make as many successive modifications of his data and reruns of the LCC program in this "interactive" mode as he wishes. Alternatively, if the user wishes to perform a detailed analysis of the LCC output, and/or sensitivity analysis factors before he reruns the Model, he may terminate the program and use the more detailed off-line output as an aid in reevaluating his system design and associated parameters.

### 4.1.6 Operation of the RLA Program

As noted above, the RLA is done by a separate program which utilizes the output of 6 special LCC Model runs. In order to facilitate the making of these runs, the user is provided with a special command file, which automatically makes the required runs by using the 13 input data files and setting the appropriate LRU and SRU repair levels in the batch mode. The outputs of these 6 runs are saved on a special output file, which together with an LRU/SRU organization file (see File 8B in Section 4.2.1 below) are input to the RLA program. The RLA program is then run to produce a full report of the RLA results. A means is also provided to automatically update the repair levels within the appropriate input data files for the LCC Model.

107

### 4.1.7  Operation of the Preprocessor

The preprocessor serves two purposes.  First, given an SRU-in-LRU matrix (LCC Model Data File 8B) and an LRU-in-Platform matrix (Data File 11B), an Item-in-Platform matrix is created and stored as Data File 11A, in the correct format.  Thus, the addition or removal of LRUs from a platform in design tradeoff studies can be quickly accomplished through the preprocessor, which automatically generates a new Data File 11A with the new set of LRUs and SRUs.

### 4.1.8  Error Messages

Many errors in the formatting and values of data inputs will be detected by the LCC Model which will in turn generate appropriate error messages.  For the proper interpretation of error messages, the user should refer to Sections 7.4 and 7.5.3.  As an additional aid in debugging input errors, the values of all data inputs, along with their associated variable names, will be printed out in the first component of the output of the LCC Model.

### 4.2  General Description of Inputs, Processing, Outputs

To aid in the discussion of this section, note that the SSS is made up of terminals installed on host platforms (airborne or surface-based) that are deployed at operational bases or sites.  Terminals are broken down into LRUs and those in turn into SRUs.  LRUs and SRUs are collectively called ITEMs.  On-equipment maintenance is conducted at all bases; off-equipment maintenance, at some or all bases, and at the depot.

### 4.2.1  Model Inputs

There are fourteen standard input data files maintained by the user which are read into working storage in the computer.  These data files are named:

    (1)    System-Wide Scalar Parameters
    (2)    Base Configuration Data
    (3)    Platform Operation Data
    (4)    Platform Terminal Data and Non-Recurring
           Mod/Installation Data
    (5)    Platform Recurring Mod/Installation Data
    (6)    Platform Deployment at Bases
    (7)    Support Equipment Data
    (8A)   ITEM Equipment Data
    (8B)   SRU/LRU Cross Reference Data

108

(9A)   ITEM Maintenance Data
(9B)   ITEM Technical Orders, Training, and UCT Development Data
(10)   ITEM/Support Equipment Cross Reference Data
(11A)  ITEM Configuration on Platforms
(11B)  LRU Configuration on Platfforms


All of the files, except the first, which is a NAMELIST file, are
organized primarily by one of the four major indices:  NS, which
identifies groupings of operational sites or bases;  NP, which
identifies groupings of host platforms; L, which identifies types or
groupings of support equipment, and I, which identifies types of
equipment ITEMs.  Three of the files are organized primarily by one
of these indices, and secondarily by a different index.

Each of these files will now be described briefly.  It should be
noted that more complete file descriptions are given in Section 6,
and detailed file formats are specified in Section 7.2.

Data File 1, System-Wide Scalar Parameters  This file contains Air
Force provided parameters that define installation, operation and
maintenance labor rates, labor factors, logistic pipeline times,
certain unit cost factors (such as fuel cost per gallon and packing
and shipping costs per pound), and miscellaneous factors including
the failure rate correction factors for the various operating
environments.  In addition, there are seven contractor provided
parameters included in Data File 1.  They are inputs pertaining to
technical orders and maintenance training.

Data File 2, Base Configuration Data  (Organized by Base Type NS)
The data in this file, all provided by the Air Force, defines the
characteristics of the operational bases (sites) at which airborne
or surface-based host platforms equipped with SSS terminals will be
deployed.  Bases at which airbrrne or ground-based terminals will be
operated are aggregated into groups according to operational theatre
and role in off-equipment maintenance.  Data File 2 indicates the
number of bases in each base group (index NS), whether these bases
perform their own off-equipment maintenance.  If so, it indicates
whether they do maintenance for equipment deployed at other bases as
well and the base support philosophy of the base (CSE and PSE only,
MBS, or UCT).

Data File 3, Platform Operation Data  (Organized by Platforr Type
NP)  This file contains data, furnished partly by the Air Force and
partly by the contractor, describing operational characteristics of

109

host platforms for SSS terminals. The Air Force furnishes platform-oriented data concerning the operation of terminals, while the contractor furnishes data for other terminal costs which may be incurred. This "other costs" variable is set to 0 for this version of the SSS LCC Model. In addition, Air Force parameters classify the operating environment provided by the host platform, and provide factors used in computing added fuel consumption due to antenna drag. Airborne and Ground platform types are aggregated into a small number of groups (identified by index NP), such as high performance aircraft, or fixed/transportable ground units.

Data File 4, Platform Terminal Data and Non-Recurring
Mod/Installation Data (Organized by Platform Type NP) This file contains a mixture of Air Force parameters, contractor parameters, and parameters established "jointly". The Air Force defines average number of PME terminals per platform in each platform grouping NP, certain parameters classifying mod/installation characteristics of platform groupings and a thrust/fuel consumption factor. The Contractor inputs the average number of added antenna elements per platform. The non-recurring mod/installation cost is established "jointly". The contractor estimates these costs using a detailed estimating procedure provided by the Air Force. (Non-recurring costs are those incurred once for each platform type, recurring, those incurred once for each individual installation.)

Data File 5, Platform Recurring Mod/Installation Data (Organized by Platform Type NP) Data elements are all established jointly. They define fixed modification cost, cost of group A-kits, and variable labor hours, classified (as appropriate) by mode of installation M and/or by installation functional area IA. Modes are: during platform manufacture, depot retrofit, and field retrofit by depot team. Installation areas are antennas, electronics boxes, control heads, and cabling/interconnections.

Data File 6 PLatform Deployment at Bases (Organized by Platform Type NP and Base Type NS) These Air Force inputs define the average number of SSS equipped platforms in each group NP that are deployed per base in each base grouping NS.

Data File 7, Support Equipment Data (Organized by SE Type L) The data in this file, all supplied by the contractor, defines the types of support equipment required to test and maintain the SSS. Required SE is identified by the contractor, and classified into groups of like SE items. Groups (identified by index L) are characterized in Data File 7 as common support equipment usually available on a support base, common support equipment that must be procured, and peculiar support equipment. Unit purchase prices of

110

SE, an annual maintenance cost factor, numbers of technical order pages for each SE type and the development cost of the support equipment are also established in Data File 7.

Data File 8A, ITEM Equipment Data (Organized by ITEM I) Data File 8A defines the equipment ITEMs identified by index I, which are made up of LRUs and their component SRUs, that the contractor determines are necessary to implement his system design, for all types of PME terminals. Data elements define the learning curve factor for each ITEM, classify each ITEM as an LRU or SRU, define how it fits into the logistic indenture level hierarchy, define its unit cost, its fraction of value replaced in repair, its weight, and its count of piece parts.

Data File 8B, LRU/SRU Cross Reference Data (Organized by LRU index IL and SRU index IS) This file is furnished by the contractor based on his system design. It indicates the different SRUs and their individual quantities contained in each LRU. This file is a required input for Repair Level Analysis and for the preprocessor, and is not used by the LCC Program or Sensitivity Analysis.

Data File 9A, ITEM Maintenance Data (Organized by ITEM I) Data File 9A contains contractor inputs that define for each ITEM I listed in Table 8A the following: mean time between maintenance incidents (MTBMIs) for each operating environment, fractions of maintenance actions that fall into each of five classes (false pull, repair in place, base repair, depot repair and condemnation), man-hours for the major types of maintenance actions (in-place repair, remove and replace, base bench check, base repair and depot repair), and repair level code.

Data File 9B, ITEM Technical Orders and Training Data (Organized by ITEM I) Data File 9B contains for each ITEM I the number of technical order pages required for depot and base maintenance and the number of hours required for type 1 training. Also included is the cost of UCT software development for each ITEM I. This file is, again, furnished by the contractor.

Data File 10, ITEM/Support Equipment Cross Reference Data
(Organized by ITEM I and SE group L)  This file, established by the
contractor on the basis of his concept of how maintenance actions
will be conducted, defines for each ITEM I, and for each repair mode
IRM of I, the types and numbers of pieces of SE of group L that will
be used in maintenance of the ITEM.  In particular, an ITEM I can
have any or all of 4 ITEM repair modes such as:

        1)  Depot Repair

        2)  Base Repair with CSE and PSE (if different from depot
            SE)

        3)  Base Repair with MBS

        4)  Base Repair with UCT

Data File 11A), ITEM Configuration on Platforms  (Organized by ITEM
I and Platform Group NP)  These data elements, all furnished by the
contractor, define how many units of each ITEM I are required to
make up the SE configurations per platform for platform in each
grouping NP.  This file can be entered by the contractor by hand or,
instead, Data File 11B can be entered by the contractor and the
preprocessor used to create Data File 11A.

Data File 11B).  LRU Configuration on Platforms  (Organized by LRU
ITEM I and Platform Group NP).  These data elements, all furnished
by the contractor, define how many of each LRU are required for
platform NP.  This file is only required as an input to the
preprocessor, which will create File 11A from Files 11B and 8B.

In addition to these sixteen data files, the user's terminal acts as
a seventeenth data input file.  Prior to each run of the LCC Model,
the user must enter several inputs from his terminal to control the
LCC Model output, and he may also use his NAMELIST capability to
overwrite from his terminal any data values previously input from
the standard Data Files 1 through 11A & B listed above.


4.2.2  Processing

The processing involved in each component of the LCC Model is
discussed briefly below.


112

## 4.2.2.1 Processing: The Basic Model Equations

Two types of processing are involved in the main program (the LCC Program) of the LCC Model: first, the Model equations, and second, the sensitivity analysis equations. The repair level analysis procedure and the preprocessor are supportive programs of the LCC Model. Each of these will be described briefly.

The Model equations are concerned with calculating the LCC elements and subelements. These eleven top-level cost elements, together with a number of subelements, are broken down into the three phases of the program; development, production, and support. A total for each cost element is also given. A description of the costs included in each program phase is given below:

a. DEVELOPMENT

   Full Scale Engineering Development
   Support Equipment Development Cost

b. PRODUCTION

   Prime Mission Equipment Hardware Cost
   Prime Mission Equipment Integration Cost
   Modification/Installation Cost
   Investment Spares
   Support Equipment Procurement Cost
   Technical Orders Cost

c. SUPPORT

   Operations Cost
   Replacement Spares Cost
   On-Equipment Cost
   Off-Equipment Cost
   Training Cost
   Technical Orders Cost

The total of the cost elements and subelements listed above is then the life cycle cost for purposes of the Model. (As explained in Section 1.5, however, the life cycle cost computed by the Model has some cost components missing.) In addition to the cost elements and subelements and total life cycle cost, various partial results, costs by various classifications, costs per terminal, and supplementary variables are computed. These are required for the Model output tables that are described in Section 4.2.5.

## 4.2.2.2  Processing:  The Sensitivity Analysis Equations

The most direct method of determining sensitivity of LCC to a
specific increment in a generic input parameter is to run the Model
twice, once with the original parameter value, and once with the
modified value.  Such an approach may require a large set of changes
to input data, if the generic parameter appears in many places - for
example, the unit cost UP(I) of each equipment ITEM I.  This
approach also consumes a lot of computer time.  Instead of using
this brute force approach, the LCC program  automatically computes,
in each run, the change in LCC for the input parameter changes of
interest.  This approach shortens the computation time and it may
also expose parameters and/or ITEMs to which LCC is particularly
sensitive, which may not have otherwise come to the user's
attention.  In particular, the LCC program will "sort out" those
ITEMs, for each ITEM-specific parameter, to which LCC is "most
sensitive" (see Section 3.1).

Two kinds of sensitivity analysis capabilities are provided.  The
first is called global analysis, since it deals only in system wide
changes.  The second kind is called ITEM-specific, since it deals
with the LCC impact of changes in ITEM-dependent parameters - i.e.,
parameter changes made separately to each individual ITEM.

The sensitivity analysis equations define LCC changes produced by
fractional increases in each of the parameters listed below.  There
is a separate sensitivity analysis equation in the LCC program for
each of these parameters where each equation represents an analytic
formulation of the exact components of LCC which are effected by a
change in the given parameter.

     <u>Global Factors</u>           Unit Costs
                                             Failure Rates
                                             False Pull Rates
                                             Maintenance Repair Times
                                             Repair Materials Costs
                                             Program Lifetime
                                             Mod/Installation Labor Hours

ITEM Specific Factors  Unit Cost
          Failure Rate
          False Pull Rate
          Repair Materials
          Intermediate Repair Fraction
          Depot Repair Fraction
          Condemnation Rate
          SRU/LRU Configuration

The results of applying the sensitivity analysis equations are used to determine:

o Change in LCC due to prescribed change in each global factor.
o Change in LCC due to prescribed change in each ITEM-specific factor for each ITEM. For each factor, ITEMs are then ordered by magnitude of LCC change.
o The effect on LCC of changing each SRU into an LRU.

### 4.2.2.3  Processing:  The Repair Level Analysis Procedure

The RLA is basically AFLC-AFSC 800-4 methodology implemented with a modification to especially account for LRU/SRU ITEM interaction. Specifically, the procedure explicitly recognizes that the repair level of an SRU depends on the repair level of its containing LRU and thus the repair level decision for each Item should not be made in isolation. When evaluating an LRU's repair level, the procedure takes the cost implication on its SRUs into consideration. And when a decision is made about an LRU's repair level, the procedure also identifies the best repair levels for its SRUs. If there are some SRUs each contained in more than one LRU, the procedure also makes adjustments to achieve a single repair level for each SRU. See Section 5 for a detailed description of this procedure.

### 4.2.2.4  Processing:  The Preprocessor

The preprocessor performs two functions. From an SRU-in-LRU matrix (Data File 8B) and an LRU-in-Platform matrix (Data File 11B), the preprocessor creates an ITEM-in-Platform matrix (Data File 11A). The preprocessor also checks Data Files 8A, 8B, 9A, 9B, 10, and 11A for input file errors. See Section 5 for a more detailed description of the preprocessor.

### 4.2.3 Model Outputs

The user's completion of his interactive responses to the sequence of computer-prompted questions initiates the processing of both the Model equations and the sensitivity analysis equations. The outputs of the LCC program are then printed in "hard-copy" on the off-line printer and/or on the user's terminal, in accordance with the user's previous interactive directions. The outputs are divided into three sections, which are: echo of input tables, cost elements and related outputs, and sensitivity analysis outputs. In addition, if the repair level analysis in the RLA Program is conducted, the results are contained in a separate output table. An illustrative, complete set of output tables from the LCC Model appears in Appendix B.

The first section of output on hard-copy contains an echoing of data inputs and their variable names from standard Data Files 1 through 12. This output allows the user to check that his data was input correctly to the LCC Model.

The second section of output on hard-copy contains the total LCC of the user's SSS system design, broken down into various categories and accompanied by other useful information such as installed ITEM equipment counts, counts of spares, and numbers of failures. Seven separate tables are provided, as follows:

> **Output Table 1:** Summary by Top-Level Cost Elements
>
> This table provides total system wide LCC for each of the eleven top-level elements, namely: FSE , PME, Operations, MOS/I, Spares (both Investment and Replacement), SE, On-Equipment Maintenance, Off-Equipment Maintenance, Training, Inventory Management, and TOs. Each cost is broken down into three phases of the program: Development, Production and Support.
>
> **Output Table 2:** Platform Modification/Installation Costs
>
> Table 2 is printed in two parts. The first part contains system-wide non-recurring MOD/I costs in total, and also broken down by engineering, prototype group A-kits, testing, proofing and data. The second part of the table contains recurring MOD/I costs for each platform grouping NP, and for all groupings combined, both in total, and also broken down to fixed platform preparation/restoration, Group A Kit equipment, and variable MOD/I labor. In addition the total recurring MOD/I cost for each grouping NP is separated into retrofit and production components, and A Kit plus MOD/I labor is broken down by

116

installation area (antenna, electronics box, control head, cabling).

## Output Table 3:   Operation and Logistic Support Cost Elements

This table provides total system-wide Operation and Logistics Support (O&LS) cost by cost subelement, namely:  operations labor, added fuel consumption, initial spares, replacement spares, on-equipment maintenance, off-equipment maintenance, common and peculiar support equipment, technical orders, maintenance training and ITEM inventory management.  For each of these cost subelements and the top level element, the table also provides a number of breakdowns.  These are:  first, initial cost and recurring cost; second, costs incurred at the following locations:  independent bases, CIMF bases, satellite (to a CIMF) bases, and the depot; and third, cost incurred at locations characterized as:  air bases and ground bases.  In addition there is a count of the number of bases that are independent, CIMF, and satellite, and the numbers that are airbases and ground bases.

## Output Table 4:   ITEM-Specific Maintenance Costs    and Characteristics

Table 4 has three parts (A, B, and C) and provides cost and other data for each ITEM I that the Contractor has defined. ITEMs include both LRUs and their component sub-units, SRUs. For each LRU and each SRU, Table(4A) provides an LRU identifier and breaks down total support cost for each ITEM into seven components:  initial spares, replacement spares, on-equipment maintenance, off-equipment maintenance, maintenance training, technical data, and inventory management.  There is also a column giving average corrective maintenance cost per failure for each of the LRUs and SRUs.  Table(4B) breaks down the system total number of each ITEM into three portions:  total number installed in the system, total initial spares at bases, and total initial spares at the depot.  It also gives the monthly and lifetime failures, the learned unit cost, and the total production contract procurement quantity for each ITEM I. Table(4C) provides the average corrective maintenance cost per failure for all the LRUs and for all the SRUs, and the total monthly and lifetime failures for all LRUs.

## Output Table 5:   Support Equipment Requirements and Costs

In this table output data are provided for each type or grouping (identified by the index L) of SE that the contractor has

defined. The table provides, for each SE grouping L, total number of SE units required system-wide, lifetime cost per unit, technical order cost, SE development cost, and aggregate system-wide lifetime cost. UCT software development cost is then included to get a total SE cost. It also breaks down total SE unit requirements of the five location categories: independent bases, CIMF bases; air bases, ground bases, and the depot.

## Output Table 6: Platform/Terminal Failure Rate Data

Table 6 exhibits the average per platform failure rate for each grouping NP, both in terms of failures per month and failures per million operating hours (i.e., the aggregate (series) failure rate of all SSS equipment installed on the given platforms). The per terminal failure rate is also shown for each platform grouping NP. The production cost per platform type is attached at the end of this table.

## Output Table 7: Manpower Requirements

This table breaks down the total manpower requirements per year per base into two function areas: maintenance and its management data. These figures are listed for each base type. Also shown in this table are the total manpower requirements per year per base type, the total for all bases, and the total for the depot. The total manpower requirements in training are also listed for the first year and each subsequent year.

The seven output tables described above are available at the hard-copy off-line printer. At the user's terminal, he may, if he chooses, obtain copies of Output Tables 1 and 3. Table 3, as displayed at the terminal, is somewhat abbreviated from the version described above.

The third section of output on hard-copy, the LCC Sensitivity Analysis Table, contains the results of the global and ITEM-specific sensitivity analysis calculations.

For the global calculations, the output consists of the change in total system-wide LCC for the assumed fractional change in each of the global factors listed above. This output consists of a single number for each global factor and these calculations always appear in the LCC Sensitivity Analysis Output Table.

For each ITEM-specific parameter for which LCC sensitivity analysis is provided, however, an LCC sensitivity value is computed for each different ITEM type. The number of values that get printed in the

LCC Sensitivity Analysis Table, if any, depends on the directions which the user inputs during his interactive sequence of responses (see Section 7.5 for details). As mentioned above, for each ITEM-specific parameter, the most significant calculation will be printed first.

Besides the three sections of the main program output as described above, there are additional output tables generated by the RLA and Preprocessor program. Obviously, these tables are available only if the corresponding processing is to be performed. The repair level analysis table first lists the resulting LCC for each of the six Model runs. After the RLA program is run the main results of the analysis are printed, namely the repair level (base, depot, or discard) recommended for each ITEM. The corresponding fractions of different maintenance actions for each ITEM are also provided for use in subsequent LCC program runs. The Preprocessor output table displays the ITEM configuration on platforms matrix which it generates.

# SECTION 5

## AUXILIARY PROGRAMS:
### THE PREPROCESSOR AND REPAIR LEVEL ANALYSIS PROGRAMS

## 5.1 Introduction

Two auxiliary programs are included in the SSS LCC Model. The first is a preprocessor which assists the user in creating Data File 11A. The second is an RLA program, which analyzes outputs from a set of six special runs of the LCC program and determines repair levels.

These two programs operate separately from the main LCC program. The usual sequence in which these auxiliary programs would be used would be as follows:

1) The user creates and enters data into Data Files 1 through 10 and Data File 11B. Data File 11A would be created but left empty.

2) The Preprocessor would be run to create Data File 11A, which is automatically written into the empty file.

3) The LCC Program would be run on the constructed data files. The values of any input parameters may be temporarily overridden through the use of the NAMELIST capability to perform trade-off analyses. In particular, changes to Data File 11A may be implemented directly or through changes to Data File 11B and another run of the Preprocessor.

4) Six special runs of the LCC Program are made with R=1 through R=6, creating inputs to the RLA Program.

5) The RLA Program is run, generating a set of repair level decisions. These decisions are written into a new copy of Data File 9A by the RLA Program.

6) The LCC Program is run with these repair level decisions.

## 5.2 Preprocessor Program

The Preprocessor performs two basic functions. The first is the creation of Data File 11A from Data Files 11B and 8B, and the second is the checking of six data files for format inconsistencies.

The rationale behind the development of the Preprocessor is that Data File 11A is a very large file, and because it contains both SRU and LRU ITEM configuration on platforms may be difficult to work with when studying design tradeoffs. For example, if the Model is to be run twice, once with a certain LRU in the system and once without that LRU, then the removal of that LRU from the system for the second run would entail not only setting the quantity of that LRU ITEM in each platform to zero, but also determining which SRU ITEMs are in that LRU and reducing the quantities of these SRUs in each platform by the appropriate amount. Using the Preprocessor, an LRU ITEM configuration on platforms is created (Data File 11B), and from this file and Data File 6B, which contains data on SRUs in each LRU, an ITEM in platform configuration is computed (Data File 11A). Thus in the example above, changing the data file for the second run would entail only setting the quantity of Preprocessor, which would automatically correct the SRU quantities.

Data Files 8A, 8B, 9A, 9B, 10, and 11A are scanned for input file format errors. In particular, the following error conditions are checked for:

- o Multiple records for an ITEM in any file
- o More records in a file than in the initial file (file 8A is the initial file)
- o Items not found in the initial file but found in other files
- o Fewer records in a file than in the initial file
- o Items appearing in the initial file but not found in other files
- o SRU ITEMs in LRU ITEM lists
- o LRU ITEMs in SRU ITEM lists
- o ITEM indices out of sequence in any file
- o ITEM indices out of range
- o More than the maximum allowable number of items in the initial file
- o More than the maximum number of SRUs in an LRU in the LRU/SRU cross reference file (file 8B)
- o End of file found before the end of the SRU list for an LRU in the LRU/SRU cross reference file
- o Missing end-of-file marker in a file

The last condition (a missing end-of-file marker) will be detected without a run time FORTRAN error only if there is at least one blank record after the last data record.

The Preprocessor will also be useful in making easier the task of initially entering Data File 11A, since only Data File 11B (a subset of 11A) need be entered. The error checking noted above will assist in the debugging of the data files without having to run the entire LCC Model.

## 5.3 Repair Level Analysis

Described in this section is an approach to help determine the repair level for each item in the SSS system. This approach has been implemented to be used in conjunction with the computerized SSS LCC Model. In repair level analysis, there are two interrelated stages of decisions: repair levels for LRUs and those for SRUs. For each stage there are three choices for each item: base repair, depot repair, and discard-on-failure. Since the stages are interrelated, i.e., the decisions made at one stage affect the decions to be made at the other, each item's repair level should not be determined in isolation. The approach described below is one that recognizes this interrelationship.

The approach for the repair level analysis is outlined in the flow chart (Figure 5-1) below. As shown, a scalar and a vector of input data are required initially:

> BIRD = fraction of base-repair-intended failures which are actually repaired at the depot due to insufficient repair capability at the bases.

> WEAR(I) = fraction of removed failures of ITEM type I which must be condemned due to normal wear-out.

These input parameters are used in the LCC Program to calculate RTS(I), NRTS(I), and COND(I) for each ITEM type I, which in turn are used in the LCC model equations. There are six different model runs to be made which are indexed by the value of R. Each R value defines a different repair strategy represented by the values of RTS(I), NRTS(I), and COND(I), as specified later. In each run R, all the other inputs remain the same and the total cost attributable to each ITEM type I is calculated and denoted as TIAC(I,R). Detailed calculation of the above is presented in Section 5.2.1.

```
┌─────────────────────────────────────┐
│     INPUT DATA TO LCC PROGRAM        │
│     INCLUDING BIRD AND WEAR(I)s      │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│          RUN LCC PROGRAM             │
│     FOR CASE R (R = 1, 2, ..., 6)    │
│        AND OUTPUT TIAC(I,R)s         │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐      ┌──────────────┐
│          RUN RLA PROGRAM             │      │    INPUT     │
│ TO OBTAIN THE RECOMMENDED REPAIR     │◄─────│  QPA(IL, IS)s│
│  LEVEL LCRL(I)s TO REPLACE RL(I)s    │      │              │
└─────────────────────────────────────┘      └──────────────┘
                  │
                  ▼
              ◇ USER ◇                YES     ┌──────────────┐
           ◇ ADJUSTMENT ◇ ──────────────────►│   CHANGE     │
              ◇      ◇                        │   RL(I)s     │
                  │ NO ◄──────────────────────│              │
                  ▼                           └──────────────┘
┌─────────────────────────────────────┐
│    RUN LCC PROGRAM WITH THE          │
│  DETERMINED REPAIR LEVEL RL(I)s      │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│          OUTPUT FINAL LCC            │
└─────────────────────────────────────┘
```
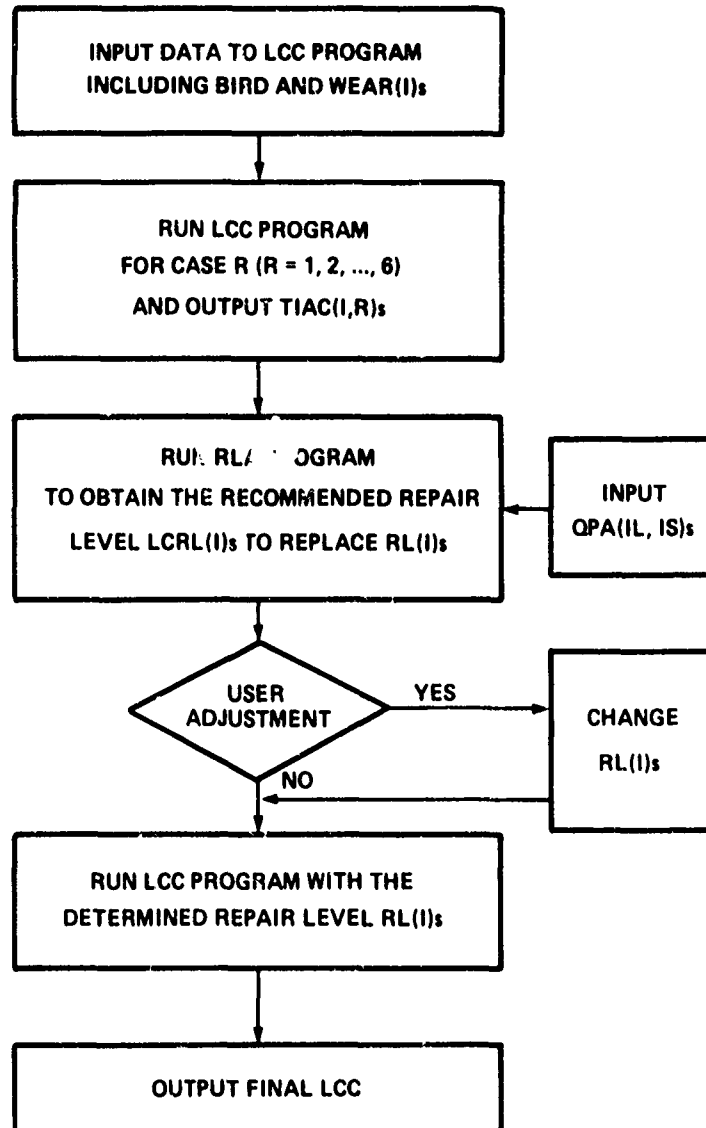
IA - 59,135

Figure 5-1.   Process of the Repair Level Analysis

123

The RLA program then uses the matrix TIAC(I,R) along with another
matrix QPA(IL,IS) to analytically determine the repair level for
each item, where

QPA(IL,IS) = number of units of SRU ITEM type IS contained in one
unit of LRU ITEM type IL.

As an output of the analysis, the repair level decision reached for
each ITEM type I is saved on a data file.  A subsequent LCC program
run to implement the repair level decisions (with possible user
adjustment) is thus ready to be conducted.  The specific procedure
of finding the recommended repair levels in the RLA Program is
presented in Section 5.2.2.

Note that when requested with proper inputs, the complete process of
computing TIAC(I,R)s will be performed automatically by the LCC
computer program.  With this calculated matrix TIAC(I,R) saved on a
data file and the additional input matrix QPA(IL,IS), the RLA
program is ready to proceed.  In addition, the results from the RLA
Program can be easily used through a simple input procedure.  See
Section 7 for details on how this is accomplished.


5.3.1  Calculation of ITEM Costs

To determine the repair level for each item, one has to first
determine the total cost which is affected by an item's repair
level.  There are three different repair levels for each LRU:  base
repair, depot repair, and discard-on-failure.  For each SRU, there
may also be a choice of repair levels, depending on the specific
repair level chosen for its LRU.  More explicitly, there are 6
different cases of repairing for each SRU and they can be grouped
into 3 sets according to its parent LRU's repair level, as follows:

## Table 5-1

### Different Cases of Repairing

| Set J | Case R | LRU | SRU |
|-------|--------|------|------|
| 1 | 1 | base repair | base repair |
|   | 2 | base repair | depot repair |
| 2 | 3 | base repair | discard |
|   | 4 | depot repair | depot repair |
| 3 | 5 | depot repair | discard |
|   | 6 | discard | discard |

Note that the set of first 3 cases has the parent LRU base-repaired, while the SRU can be base-repaired, depot-repaired, or discarded on failure. The set of next 2 cases requires depot repair for the LRU and allows either depot repair or discard-on-failure for its SRU. Base repair for the SRU is considered not practical when its LRU is sent for depot repair. The last case (or set) is that the parent LRU and thus the SRU will be discarded when failure occurs. For these different cases, there are different co. t implications for each item, SRU or LRU. To determine the total cost effect of each item's repair level, six LCC model runs are to be made, each corresponding to a case in Table 5-1. The model specifications of RTS(I), NRTS(I), and COND(I) for each ITEM type I in making these runs are listed in Table 5-2.

Note that the entries of this table are determined by knowing that the value of COND(I) has to be at least WEAR(I) and the value of NRTS(I) at least RTS(I)*BIRD, and then by assigning a largest possible fraction to RTS(I), NRTS(I), or COND(I), depending on whether ITEM type I is base-repaired, depot-repaired, or discarded on failure, as specified in Table 5-1. Of course, the condition that RTS(I) + NRTS(I) + COND(I) = 1.0 should always be observed.

Based on the results of each LCC model run R, one can sum up all the cost elements which are affected by the repair level of each ITEM type I as follows:

125

Table 5-2

Model Specifications of Repairing Cases

| Set J | Case R | LRU | | | SRU | | |
|---|---|---|---|---|---|---|---|
| | | RTS(IL) | NRTS(IL) | COND(IL) | RTS(IS) | NRTS(IS) | COND(IS) |
| 1 | 1 | $\frac{1-WEAR(IL)}{1+BIRD}$ | RTS(IL)*BIRD | WEAR(IL) | $\frac{1-WEAR(IS)}{1+BIRD}$ | RTS(IS)*BIRD | WEAR(IS) |
| | 2 | $\frac{1-WEAR(IL)}{1+BIRD}$ | RTS(IL)*BIRD | WEAR(IL) | 0 | 1-WEAR(IS) | WEAR(IS) |
| | 3 | $\frac{1-WEAR(IL)}{1+BIRD}$ | RTS(IL)*BIRD | WEAR(IL) | 0 | 0 | 1 |
| 2 | 4 | 0 | 1-WEAR(IL) | WEAR(IL) | 0 | 1-WEAR(IS) | WEAR(IS) |
| | 5 | 0 | 1-WEAR(IL) | WEAR(IL) | 0 | 0 | 1 |
| 3 | 6 | 0 | 0 | 1 | 0 | 0 | 1 |

126

$$TIAC(I,R) = ISCA(I) + RSCA(I) + ONMCA(I) + OFMCA(I)$$

$$+ TSECI(I) + IIMCA(I) + TDC(I) + MTRCI(I)$$

where ISCA(I) = investment spares cost of ITEM type I
(See Section 2.3.4)

    RSCA(I) = replacement spares cost of ITEM type I
(See Section 2.3.5)

    ONMCA(I) = on-equipment maintenance cost of ITEM type I
(See Section 2.3.6)

    OFMCA(I) = off-equipment maintenance cost of ITEM type I
(See Section 2.3.7)

    TSECI(I) = total support equipment cost allocated to ITEM type I
(See Section 2.3.8)

    IIMCA(I) = inventory management cost of ITEM type I
(See Section 2.3.9)

    TDC(I) = technical data cost allocated to ITEM type I
(See Section 2.3.10)

    MTRCI(I) = maintenance training cost allocated to ITEM type I
(See Section 2.3.11)

## 5.3.2  Procedure for Using the RLA Program

The procedure to analytically determine the repair level for each
item is described here.  There are four steps in the procedure and
the first three steps are based on dynamic programming concepts.  In
Step 1 a search of the least cost repair level for each SRU is done
for each possible repair level of the containing LRUs.  In Step 2 a
search of the least cost repair levels for the LRUs begins.  At this
point, the cost of each LRU's repair level will include the cost
attributable to that LRU at the repair level as well as the costs of
all its SRUs at their corresponding best repair levels.  The repair
level of an LRU determined this way will cost the least when the
complete process of repairing the LRU and all its SRUs is
considered.  The repair level decision made for the LRU in Step 2

127

implies the repair levels for its SRUs. These SRU repair levels are recorded in Step 3. If the repair level of an SRU installed in two or more LRUs is found to be inconsistent, Step 4 makes reasonable adjustments. A more complete but intuitive description of the procedure follows.

STEP 1:

Assuming each possible repair level for an LRU, one can determine the best repair levels for its SRUs. This is accomplished by comparing for each SRU ITEM type IS the cost of different repair levels allowed by the LRU's repair level, i.e., by comparing the calculated TIAC(IS,R) among all cases R in the set J corresponding to the LRU's repair level. The least TIAC(IS,R) will be called TSAC(IS,J) and the corresponding case R, LCRS(IS,J).

STEP 2:

Next, the repair levels of each LRU ITEM type IL are optimized. The cost corresponding to each LRU's repair level (denoted as TSAC(IL,J)) includes the input TIAC(IL,R), and the optimal costs of all the SRUs contained in LRU ITEM type IL are determined in Step 1. By comparing TSAC(IL,J) among different J values, one will obtain the best repair level for IL when the complete process of repairing the LRU and its SRUs is considered. The set number J which gives the least TSAC(IL,J) for IL is called LCRL(IL).

STEP 3:

Within this set, i.e., given the LRU repair level, one can easily determine the implied repair level for each of its SRUs by recalling LCRS(IS,J)s with J set to LCRL(IL). Note that LCRS(IS,J) gives the case number and will be translated into a code number LCRLS(IL,IS), which is directly comparable to the LCRL(IL).

STEP 4:

Finally, the value of LCRLS(IL,IS) for an SRU ITEM type IS may be different for different IL, i.e., inconsistent repair level for IS among different containing LRUs. In this case, one can make an adjustment by minimizing the cost over each SRU's repair level allowed by all containing LRUs and then revising the SRU's repair level to be the one that yields the least cost. This final repair level for IS is coded as LCRL(IS).

### 5.3.3 Analytical Basis for the Procedure

The exact analytical procedure is now given below.

#### STEP 1:

For each SRU ITEM type IS, let TSAC(IS,J) be the smallest of
TIAC(IS,R) among all cases R in set J (of given LRU repair level),
i.e.,

$$TSAC(IS,J) = \min_{R \text{ in set } J} \left\{ TIAC(IS,R) \right\}$$

Note that in set 1 the choice of least cost for each SRU ITEM type
IS is among TIAC(IS,1), TIAC(IS,2), and TIAC(IS,3). The choice for
each IS in set 2 is only between TIAC(IS,4) and TIAC(IS,5). In set
3, the least cost is simply TIAC(IS, ) for each IS.

Finally, let LCRS(IS,J) be the least cost repairing case in set J
for SRU ITEM type IS and set

$$LCRS(IS,J) = R1 \text{ for which } TIAC(IS,R1) = TSAC(IS,J)$$

#### STEP 2:

For each LRU repair level indicated by set J,    let TSAC(IL,J) be
the total cost attributable to LRU ITEM type IL as a whole:

$$TSAC(IL,J) = \sum_{\substack{IS \text{ in } IL \text{ and} \\ R1 = LCRS(IS,J)}} TIAC(IL,R1)/NDS(IL)$$

$$+ \sum_{IS \text{ in } IL} TSAC(IS,J) \cdot QPA(IL,IS)/NTL(IS)$$

or $= TIAC(IL,R1)$ if no SRUs in IL,
where R1 is the smallest R value in set J

where NTL(IS) = total number of SRU ITEM type IS in all the LRUs

$$= \sum_{IL} QPA(IL,IS)$$

Then for each LRU ITEM type IL, let TLAC(IL) be the least of TSAC(IL,J) among all sets J, i.e.,

$$TLAC(IL) = \underset{J}{Min} \left| TSAC(IL,J) \right|$$

Note that this is simply a choice of the least costly alternative for each IL among the LRU repair levels of base repair, depot repair, and discard-on-failure.

STEP 3:

Let LCRL(IL) be a least costly repair level indicator for LRU ITEM type IL and set

$$LCRL(IL) = J1 \text{ for which } TSAC(IL,J1) = TLAC(IL)$$

Clearly, LCRL(IL) registers the set number which indicates the least cost repair level for LRU type IL. Let the corresponding least cost repair level for each SRU ITEM type IS in IL, LCRLS(IL,IS), be

$$LCRLS(IL,IS) = \begin{cases} 1 \text{ if } LCRS(IS,J1) = 1 & \text{(or SRU base-repaired)} \\ 2 \text{ if } LCRS(IS,J1) = 2,4 & \text{(or SRU depot-repaired)} \\ 3 \text{ if } LCRS(IS,J1) = 3,5,6 & \text{(or SRU discarded on failure)} \end{cases}$$

where J1 = LCRL(IL)

130

Note LCRS(IS,J1) gives the case number which indicates the least
cost repair level for the SRU ITEM type IS in IL, and LCRLS(IL,IS)
is to register 1 if LCRS(IS,J1) indicates base-repair, 2 if depot-
repair, and 3 if discard-on-failure.  For example, if LCRL(IL) = 2,
then the LRU ITEM type IL under consideration should be depot-
repaired as indicated by set 2 in Table 5-I.  Furthermore, its SRU
ITEM type IS should be depot-repaired if LCRLS(IL,IS) = 2 or
discarded on failure if LCRLS(IL,IS) = 3.

STEP 4:

The least cost repair level for each item can thus be determined by
referring to LCRL(IL)s and LCRLS(IL,IS)s.  However, there is no
guarantee that a given SRU which goes into more than one LRU will be
treated at a same repair level.  For example, SRU ITEM type IS may
have LCRLS(IL1,IS) = 1 or base-repair in an LRU ITEM type IL1, while
having LCRLS(IL2,IS) = 2 or depot-repair in another LRU ITEM type
IL2.  In this case, an inconsistency exists and an adjustment to
reach a same repair level for the same SRU may be made with proper
judgment.  As evidenced in Step 1, the repair level for an SRU will
be consistent as long as its LRUs have a same repair level.  Thus,
the inconsistency in the repair level of an SRU can occur only when
its LRUs have different repair levels.  Further, since an LRU repair
level limits the repair alternatives of its SRU level, the lowest
(most decentralized) repair level that an SRU can have is the
highest (most centralized) repair level among its LRUs, i.e.,

$$\text{LCRL(IS)} > \max_{\text{IL containing IS}} \left\{ \text{LCRL(IL)} \right\}$$

where LCRL(IS) is the (adjusted) repair level for SRU ITEM type IS
in any LRU.  Now considering all the possible sets of different LRU
repair levels, one can only have the following:   1,2 , 1,3 , 2,3 ,
and  1,2,3 .  In all these cases except the first one, level 3 is
involved and, for these cases according to the above inequality,
LCRL(IS) must be 3 (discard-on-failure).  Consider the first case
where an SRU ITEM type IS has different LCRLS(IL,IS) for different
IL and LCRL(IL) = 1 for some IL's and LCRL(IL) = 2 for the others.
By the above inequality, LCRL(IS) can be 2 or 3 (depot repair or
discard-on-failure).  Judgment based on experience may be exercised
here to further determine the LCRL(IS) to be a specific number.  Or
to more objectively choose an adjusted repair level, one can compute
and compare the costs attributable to IS when LCRL(IS) is set to be
2 and when it is set to be 3.  That is, one can compute the
following with JD = 2 and then with JD = 3:

131

$$AIAC(IS,JD) = \sum_{IL \text{ containing } IS} TIAC(IS,R2 \ JD,LCRL(IL) \ )*QPA(IL,IS)/NTL(IS)$$

where R2 is the case number corresponding to JD in the set given by
LCRL(IL), as listed below:

| JD | LCRL(IL) | R2 |
|----|----------|----|
| 2  | 1        | 2  |
|    | 2        | 4  |
| 3  | 1        | 3  |
|    | 2        | 5  |

Comparing AIAC(IS,JD=2) and AIAC(IS,JD=3), one can determine the
adjusted repair level for IS by setting LCRL(IS) to be the JD value
which gives the smaller AIAC(IS,JD).

The SRU repair level adjustment is summarized below:  For each SRU
ITEM type IS, set

$$LCRL(IS) = \begin{cases} LCRLS(IL,IS), & \text{if IS is in IL only or} \\ & \text{if } LCRLS(IL,IS) \text{ is the same} \\ & \text{for each IL which contains IS;} \\ \\ 3, & \text{if } LCRLS(IL,IS) \text{ is different} \\ & \text{for different IL which contains IS} \\ & \text{and } LCRL(IL)=3 \text{ for some of the IL's;} \\ \\ 3, & \text{if it is none of the above} \\ & \text{and } AIAC(IS,3) \leq AIAC(IS,2); \\ \\ 2, & \text{if it is none of the above} \\ & \text{and } AIAC(IS,2) \leq AIAC(IS,3). \end{cases}$$

The vector LCRL(I) is the main result of the repair level analysis,
each entry representing the recommended repair level for ITEM type
I.  It is stored as RL(I) on an input data file to the LCC Program
and can be changed as user wishes.  When RL(I) is read in the LCC
Program, it is translated into RTS(I), NRTS(I), and COND(I)
according to table 5-3, below.

Table 5-3

Model Specifications of Repair Levels

| RL(I) | RTS(I) | NRTS(I) | COND(I) |
|-------|--------|---------|---------|
| 0 | (Data File values are used.) | | |
| 1 (base) | $\dfrac{1-WEAR(I)}{1+BIRD}$ | RTS(I)*BIRD | WEAR(I) |
| 2 (depot) | 0 | 1-WEAR(I) | WEAR(I) |
| 3 (discard) | 0 | 0 | 1 |

Note: The procedure described above explicitly recognizes the cost attributable to each SRU ITEM type IS being dependent on its LRU's repair level as indicated in the notation TIAC(IS,R). However, the procedure will be more accurate if one can assume the cost attributable to each LRU is independent of the repair levels of its SRUs. Specifically, this means that TIAC(IL,R) of an LRU ITEM type IL is the same for each R value in set J and thus in Step 2 the first summation term in the expression for TSAC(IL,J) becomes simply TIAC(IL,R) with any R value in set J. However, due to some inherent difficulty in perfectly allocating the cost of shared resources (e.g , support equipment) between items, the value of TIAC(IL,R) may vary somewhat for different R in set J. For this reason, when calculating TSAC(IL,J) the value of TIAC(IL,R) is weighted by the proportion of IL's SRU items which have a least cost repair level corresponding to case R in set J. More fundamentally, the procedure also assumes that for each ITEM type I the cost TIAC(I,R) is only dependent on R. If I is an LRU this implies, along with the earlier assumption, that the cost only depends on the value of J which contains R, i.e., it only depends on the LRU's own repair level. On the other hand, if I is an SRU the cost depends on its repair level, its LRU's repair level, and no others. Because of the same difficulty in allocating the cost of shared resources between items, TIAC(I,R) may vary somewhat due to different repair levels of the other items. The procedure should remain valid however, if TIAC(I,R)s are determined through careful cost allocation such that the variation can be kept small.

SECTION 6

INPUT PARAMETERS AND VARIABLES


6.1  Introduction

This section presents the description of the LCC Model input
parameters and variables.  In addition, numerical values are
provided for input parameters established by the Air Force, and
ground rules and instructions are given for the determination of
parameters to be furnished by the contractor.

The input data elements identified and defined in conjuction with
the description of the Model equations in Section 2, the Sensitivity
Analysis in Section 3, and the RLA and the Preprocessor in Section
5, are listed below in Section 6.2. This listing provides an overall
picture of the data elements and data files that are employed.
Detailed and precise definitions of the data items are given in
Appendix A, Glossary of Variables.  The precise representation of
each data element in the input files and output tables is
established in Section 7, Operating Procedures.  The Illustrative
Runs contained in Appendix B give examples of actual input and
output formats and typical data contents in an illustrative run of
the LCC Model.

6.2  Input Data Elements and General File Structures

The basic inputs to the Model equations and the preprocessor are
provided by fourteen input files.  Three of these files are in two
parts (A and B).  The files are:


     (1)   System-Wide Scalar Parameters (AF,CN)
     (2)   Base Configuration Data (AF)
     (3)   Platform Operation Data (AF,CN)
     (4)   Platform Terminal Data and Non-Recurring Mod/Installation
           Data (AF,CN)
     (5)   Platform Recurring MOD/I Data (AF,CN)
     (6)   Platform Deployment at Bases (AF)
     (7)   Support Equipment Data (CN)
    (8A)   ITEM Equipment Data (CN)
    (8B)   SRU/LRU Cross-Reference Data (CN)
    (9A)   ITEM Maintenance Data (CN)
    (9B)   ITEM Technical Order and Training Data (CN)
    (10)   ITEM/Support Equipment Cross Reference Data (CN)
   (11A)   ITEM Configurations on Platforms (CN)
   (11B)   LRU Configurations on Platforms (CN)


134

After each heading, the source of the input data is indicated:
AF = Air Force; CN = Contractor

In addition to the above inputs, there are special inputs used only
in the sensitivity analyses. These special inputs are entered
through the NAMELIST capability of the Model, and are discussed in
Section 7. The structure and purpose of each input data file is
further explained in Table 6-1. A consolidated list of the data
elements in each file is provided in Table 6-2.

As shown in Table 6-1, the fourteen input files have the following
roles:

o  Data File 1 - provides all scalar inputs which are independent
        of Base, Platform, Support Equipment, or ITEM type.
        Examples are labor rates and pipeline times.
o  Data File 2 - defines characteristics of Base groupings
o  Data Files 3, 4, 5 - define characteristics of Platform
        groupings, numbers of terminals per Platform, and all
        parameters associated with Platforms.
o  Data File 6 - defines deployment of Platform groupings at Bases
o  Data File 7 - establishes characteristics of Support Equipment
        groupings
o  Data Files 8A, 8B, 9A, 9B - define equipment ITEMs,
        their logistic interrelationships, their reliabilities
        and maintenance characteristics, and their impact on
        technical orders and training.
o  Data File 10 - relates Support Equipment to ITEMs.
o  Data File 11A - defines ITEM configurations by Platform types.
o  Data File 11B - defines LRU configurations by Platform types.

Either Data File 11A or 11B must be entered by the contractor.
Since Data File 11B is much smaller than 11A, the Preprocessor can
be used to generate Data File 11A from 11B and 8B.

Section 6.3 defines numerical values for those parameters in the
input files that are established by the Air Force. Section 6.4
provides instructions and data for contractors to use in developing
their input parameters.

135

Table 6-1
Structure and Content of Input Data Files

| FILE NO. | PRIMARY INDEX | SECONDARY INDEX | | DATA CONTENT |
|---|---|---|---|---|
| * | * | | * o | System - Wide Scalars: |
| (1)* | --- * | --- | * | Labor rates & factors, pipeline times, |
| * | * | | * | Various costs and logistic factors. |
| * | BASE * | | * o | Base Grouping, classification; |
| (2)* | Type NS * | --- | * o | No. of bases per group. |
| * | Platform * | | * o | Platform grouping, classification; |
| (3)* | Type NP * | --- | * | operating data |
| * | Platform * | | * o | Deployment of Terminals per Platform; |
| (4)* | Type NP * | --- | * | Terminal costs; Misc. Plat. parameters |
| * | * | | * o | Non-recur. Mod/Install. costs by |
| * | * | | * | platform |
| * | Platform * | | * o | Recurring Mod/Installation cost |
| (5)* | Type NP * | --- | * | factors by platform |
| * | Platform * | Base | * o | Deployment of platforms |
| (6)* | Type NP * | Type NS | * | per Base |
| * | SE .* | | * o | SE Grouping, classification, |
| (7)* | Type L * | --- | * | cost factors |
| * | Item * | | * o | Equip. Item definition, |
| (8A)* | Type I * | --- | * | classification, properties; Item costs |
| * LRU Item | * SRU Sequence | * o | | No. of SRUs in each LRU. |
| (8B)* | Type I * | No. K | * | and type |
| * | Item * | | * o | Item reliability and maintenace |
| (9A)* | Type I * | --- | * | characteristics |
| * | Item * | | * o | Item techical orders |
| (9B)* | Type I * | --- | * | and training time. |
| * | Item * | SE Sequence | * o | Item requirements |
| (10)* | Type I * | No. K | * | for SE |
| * | Item * | Platform | * o | Deployment of Items |
| (11A)* | Type I * | Type NP | * | per Platform |
| * LRU Item | * | Platform | * o | Deployment of LRU Items |
| (11B)* | Type I * | Type NP | * | per Platform |

136

## TABLE 6-2

### Consolidated List of Data Elements in Input Data Files

INDICES: NP - Platform type, NS - Base type, I - ITEM type, L - Support Equipment type, M - Mode of Installation, IA - Installation Functional Area, LE(NP) - Operational Environment, IL - LRU ITEM type, LO(NS) - Location of Base by Operational Theatre. Also, Index K is used as a sequence number.

DATA SOURCES   (AF)=Air Force, (CN)=Contractor

Data File 1:   System-Wide Scalar Parameters
(AF) Labor Factor:  BAA, DMF, DAA, DMF, HPD2, TORB, TORD
(AF) Labor Rates:  BLR, DLR, MILR(M), PAL1, PAL2B, PAL2D, PMLR, TNLR, TRAV1D, TRAVB
(AF) Logistic Pipeline Times:  BRCT, CRCT, DAD, DRCT(LO(NS)), OST(LO(NS)),OSTC
(AF) Unit Cost Times:  ACPP, CFG(LO(NS), CPD2, CPPC, CPPD(LO(NS)), IMC, RCPP, RMC, SA, UCPP
(AF) Miscellaneous Factors:  BF, BIRD, DSC, KFAC(LE(NP), MUSE, NRUC, PIUP, QTYP1, QTYP2B, QTYP2D, SPC2, SR, TR, TYP2TF, XFPR, XFR, XMIL, XUC
(CN) Contractor Inputs:  BDATA, CPD1, DDATA, FSEDC, HPD1, SPC1, TEFM

Data File 2:   Base Configuration Data - for Base Types NS
(AF) Designation:  BNOUN(NS)
(AF) Characteristics:  BPLAT(NS), BSP(NS), BTYPE(NS), LO(NS), NBC(NS), NHB(NS), TNB(NS)

Data File 3:   Platform Operation Data - for Platform Types NP
(AF) Designation and Environment:  PNOUN(NP); LE(NP)
(AF) Operating Hours and Number of Missions:  AMPM(NP,LO(NS)), APFH(NP,LO(NS)),TFAC(NP)
(CN) Operating Labor Times:  MMPD(NP,LO(NS)), MMPM(NP)
(AF) Thrust/Fuel Consumption:  FGH(NP), THRS(NP)

Table 6-2 (continued)

Data File 4:  Platform Terminal Data and Non-Recurring Mod/
                    Installation Data - for Platform Types NP.
(AF,CN) Terminal Data:  NTRMP(NP), INTNR(NP), INTR(NP)
(CN) Non-Recurring MOD/I Data:  NAE(NP), NRMI(NP)
(AF,CN) Other Parameters:  DRAG(NP), FR(M,NP), K(NP),
                                PDIV(NP)


Data File 5:  Platform Recurring Mod/Installation Data - for
Platform Types NP
(AF,CN) AKIT(IA,NP), MIFIX(M,NP), MIMH(IA,M,NP)
(CN) NAE(NP)


Data File 6:  Platform Deployment at Bases - for Platform Types NP,
and Base Types NS.
(AF) NPLT(NP,NS)


Data File 7:  Support Equipment Data - for S.E. Types L.
(CN) Designation:  SENOUN(L), SENUM(L)
(CN) Characteristics:  CSE(L), MSE(L), SETYPE(L)
(CN) TO Pages:  DATAS(L)
(CN) SE Development Cost. SEDEV(L)


Data File 8A:  ITEM Equipment Data - for ITEM Types I
(CN) ITEM Description & Class.:  INOUN(I), PTNUM(I); LFAC(I), GFE(I),
                                    INTEG(I), LRU(I), NHI(I)
(CN) Other ITEM Properties:  PA(I), RM(I), UP(I), WT(I)


Data File 8B:  LRU/SRU Cross-Reference Data - for LRU types IL and
the Kth SRU type contained in LRU IL.
(CN) NDS(IL); ISRU(IL,K), QPA(IL,K)

Table 6-2 (concluded)

Data File 9A:  ITEM Maintenance Data - for ITEM Types I
(CN) Reliability:  MTBMI(I,LE(NP))
(CN) Relative Frequency of Maintenance Actions: COND(I), FPR(I),
                              NRTS(I), RIP(I), RTS(I)
(CN) Man Hours and Cost of Maintenance Actions:  BCMH(I), BMH(I),
                              DMH(I), IPCF(I), RMH(I)
(CN) Repair Level Decision:  RL(I)


Data File 9B:  ITEM Technical Order and Training Data - for ITEM Type I
(CN) TO Pages:  DATAB(I), DATAD(I)
(CN) Hours Type 1 Training:  TIME1(I)
(CN) UCT Software Development Cost:  UCTDEV(I)


Data File 10:  ITEM/Support Equipment Cross Reference Data - for ITEM
Types I and the Kth SE type for I in repair mode RM
(CN) NJA(I); NRM(I) A(I,IRM,K), QSA(I,IRM,K)


Data File 11A:  ITEM Configuration on Platforms - for ITEM Types I,
and Platform Types NP.
(CN) NITEM(I,NP)*

Data File 11B:  LRU ITEM Configuration on Platforms - for LRU ITEM
Types IL, and Platform Types NP.
(CN) NITEM(IL,NP)*

---

* Note that either Data File 11A or Data File 11B is entered,
  depending on whether or not the Preprocessor is to be used.

## 6.3 Air Force Inputs

This section presents the data whose values are supplied by the Air Force.

### 6.3.1 Introduction

The input parameters furnished by the Air Force appear in the following six input files:

(1) System-Wide Scalar Parameters
(2) Base Configuration Data
(3) Platform Operation Data
(4) Platform Terminal Data and Non-Recurring MOD/I Data
(5) Platform Recurring Mod/Installation Data
(6) Platform Deployment at Bases

The set of Air Force input parameters that are given below defines a baseline deployment matrix (Platforms NP by Base NS) in Data File 6, and a baseline deployment and logistic configuration of Bases NS in Data File 2. These baseline values are utilized in the illustrative computer run in Appendix B. It must be emphasized that the sample deployment and operations data are highly aggregated and simplified, and do not represent any Air Force force structure or operating plans.

A table of Air Force parameter values is provided below for each of these input files. Air Force inputs to Sensitivity Analysis calculations are discussed in Section 7. As indicated in the Tables for Data Files 1, 3, 4, and 5 these files have contractor inputs in addition to Air Force inputs. See Section 6.4 for discussions of contractor inputs. Contractor comments on values used for all Air Force inputs would be welcomed.

### 6.3.2 Air Force Values for Data File 1 - System-Wide Scalar Parameters

Data values for Data File 1 are shown in Table 6-3. It should be noted that some of the "scalar" parameters are functions of one of the so-called "minor" indices, specifically: MOD/I labor rate MILR(M) depends upon mode of installation, M; pipeline times DRCT(LO(NS)) and OST(LO(NS)) and unit cost factors CFG(LO(NS)) and CPPD(LO(NS)) all depend upon base location, LO(NS); and failure rate adjustment factor KFAC(LE(NP)) depends upon platform environment, LE(NP).

140

# Table 6-3

## Values for Air Force Inputs to Data File 1, System-Wide Scalar Parameters

### GOVERNMENT-PROVIDED PARAMETERS

#### LABOR FACTORS

| | | | |
|---|---|---|---|
| BAA | – | Monthly Available Working Hours per Maintenance Man at Base Level | 140.00 |
| BMF | – | Base Maintenance Factor | 1.50 |
| DAA | – | Monthly Available Working Hours per Maintenance Man at Depot Level | 150.00 |
| DMF | – | Depot Maintenance Factor | 1.25 |
| HPD2 | – | Number of in-class hours per day for type 2 training | 8. |
| TORB | – | Turnover rate for base avionics maintenance personnel | 0.1 |
| TORD | – | Turnover rate for depot avionics maintenance personnel | 0.1 |

#### LABOR RATES

| | | | |
|---|---|---|---|
| BLR | – | Base Maintenance Labor Rate in $ Per Hour | 16.42 |
| DLR | – | Depot Maintenance Labor Rate in $ Per Hour | 33.90 |
| MILR(1) | – | Mod/Installation Labor Rate During Production in $ Per Hour | 26.43 |
| MILR(2) | – | Mod/Installation Labor Rate for Field Mods Using Depot Team in $ Per Hour | 39.00 |
| MILR(3) | – | Mod/Installation Labor Rate for Mods Performed at the Depot in $ Per Hour | 33.90 |
| PAL1 | – | Average daily pay and allowance for type 1 trainee | 80.00 |
| PAL2B | – | Same as PAL1 but for type 2 base trainee | 50.00 |
| PAL2D | – | Same as PAL1 but for type 2 depot trainee | 60.00 |
| TRAVID | – | Average round trip travel expense for type 1 and type 2 depot trainees | 200.00 |
| TRAVB | – | Same as TRAVID but for type 2 base trainees | 300.00 |
| TNLR | – | Terminal Activation Labor Rate in $ Per Hour | 0.00 |
| PMLR | – | PME Operator Labor Rate in $ Per Hour | 0.00 |

#### PIPELINE TIMES

| | | | |
|---|---|---|---|
| BRCT | – | Base Repair Cycle Time in Months | 0.200 |
| CRCT | – | Time for Failure at Satellite Base Until Repair at CIMF Base in Months | 0.460 |
| DAD | – | Time from Failure Removal at Depot Until Repair at Depot in Months | 0.132 |
| DRCT(1) | – | Time from Failure at CONUS Base Until Repair at Depot in Months | 1.700 |
| DRCT(2) | – | Time from Failure at Pacific Base Until Repair at Depot in Months | 1.900 |
| DRCT(3) | – | Time from Failure at Europe Base Until Repair at Depot in Months | 1.800 |
| OST(1) | – | Order and Shipping Time from CONUS Base to Depot in Months | 0.395 |

141

Table 6-3 (continued)

PIPELINE TIMES (continued)

| | | |
|---|---|---|
| OST(2) | – Order and Shipping Time from Pacific Base to Depot in Months | 0.559 |
| OST(3) | – Order and Shipping Time from Europe Base to Depot in Months | 0.525 |
| OSTC | – Order and Shipping Time from a Satellite Base to its CIMF Base in Months | 0.250 |

UNIT COST FACTORS

| | | |
|---|---|---|
| ACPP | – Average acquisition cost per page for tech. order negatives | 200.00 |
| CFG(1) | – Cost of Fuel in $ per Gallon at CONUS Bases | 0.55 |
| CFG(2) | – Cost of Fuel in $ per Gallon at Pacific Bases | 0.55 |
| CFG(3) | – Cost of Fuel in $ per Gallon at Europe Bases | 0.83 |
| CPD2 | – Cost per class per day for type 2 training | 400.00 |
| CPPC | – Cost of Packing and Shipping from a Satellite Base to its CIMF Base in $ per Net Weight Pound | 0.66 |
| CPPD(1) | – Cost of Packing and Shipping from CONUS Base to Depot in $ per Net Weight Pound | 0.66 |
| CPPD(2) | – Cost of Packing and Shipping from Pacific Base to Depot in $ per Net Weight Pound | 1.40 |
| CPPD(3) | – Cost of Packing and Shipping from Europe Base to Depot in $ per Net Weight Pound | 1.40 |
| IMC | – Initial Depot Inventory by Management Cost per New Part in $ | 51.00 |
| RCPP | – Tech. Order Reproduction Cost per Copy per Page | 0.01 |
| RMC | – Recurring Depot Inventory Management Cost per New Part in $ per Year | 127.14 |
| SA | – Base-Level Inventory Management Cost per New Part in $ per Year | 8.39 |
| UCPP | – Annual tech. order upkeep cost per page | 60.00 |

MISCELLANEOUS FACTORS

| | | |
|---|---|---|
| BF | – Coefficient in Sparing Function | 1.65 |
| BIRD | – Fraction of base-repair-intended failures that are actually repaired at the depot | 0.05 |
| MUSE | – Minimum Fractional Utilization for Sensitivity Calculations on Support Equipment Costs | 0.50 |
| NRUC | – Number of years of replacement spares to be procured under the Production Contract | 1.0 |
| PIUP | – Number of System Operating Years | 15. |
| QTYP1 | – Number of trainees for type 1 training | 20. |
| QTYP2B | – Initial number of base trainees for type 2 training | 200. |
| QTYP2D | – Initial number of depot trainees for type 2 training | 50. |
| SPC2 | – Maximum number of students per type 2 training class | 10. |
| TYF2T1 | – Ratio of type 2 training time for type 1 training time for same material | 1.5 |

# Table 6-3 (concluded)

MISCELLANEOUS FACTORS (concluded)

| | | | |
|---|---|---|---|
| XFPR | – | False Pull Rate Sensitivity Multiplier Factor | 1.00 |
| XFR | – | Failure Rate Sensitivity Multiplier Factor | 1.00 |
| XMIL | – | Mod/I Labor Hours Sensitivity Multiplier Factor | 1.00 |
| XUC | – | Unit Cost Sensitivity Multiplier Factor | 1.00 |
| KFAC(1) | – | Failure rate experience factor for airborne fighter environment | 2.60 |
| KFAC(2) | – | Failure rate experience factor for airborne cargo environment | 2.60 |
| KFAC(3) | – | Failure rate experience factor for ground fixed/transportable environment | 1.30 |
| KFAC(4) | – | Failure rate experience factor for ground mobile/manpack environment | 1.50 |
| MRF | – | Average manhours per failure to complete off-equipment maintenance records | 0.24 |
| MRO | – | Average manhours per failure to complete on-equipment maintenance records | 0.08 |
| SR | – | Average manhours per failure to complete supply transaction records | 0.24 |
| TR | – | Average manhours per failure to complete transportation transaction forms | 0.16 |

### 6.3.3  Air Force Values for Data File 2 - Base Configuration Data

Base configuration data are shown in Table 6-4.  Also shown in Table 6-4 is the logistics configuration for CIMFs, including the satellite bases (SAT) associated with each CIMF.  Bases are either located in the continental United States (CONUS) or in the Pacific or European theaters.  The bases or sites that are described in Data File 2 are of two types:  airbases, where aircraft are deployed, and ground bases.  Where a base supports both aircraft and ground terminals, the base is designated as an airbase.

### 6.3.4  Air Force Values for Data File 3 - Platform Operation Data

Data File 3 defines operating characteristics for each host platform grouping, which is identified by the index NP.  Of the ten parameters listed, three depend upon base location LO(NS) as well as upon platform type.  The parameters for Data File 3 are given in Table 6-5.

Data File 3 is constructed using seven platform groupings:

(1)  EC-135 Airborne Command Posts (ABNCPs)
(2)  E-4B Airborne Command Posts
(3)  RC-135 and EC-135 Airborne Force Elements (ABNFEs)
(4)  B-52 Airborne Force Elements
(5)  FB-111 Airborne Force Elements
(6)  Fixed Ground Command Posts (GNDCPs)
(7)  Ground Fixed/Transportable Force Elements (FEs)

### 6.3.5  Air Force Values for Data File 4 - Platform Terminal Data and Non-Recurring MOD/I Data

Air Force parameters in Data File 4 define for each platform type NP, first, the average number of prime mission equipment terminals to be installed; second, two parameters characterizing the MOD/I diversity and the fraction of installations to be made in each installation mode M; and third, two parameters relating drag/fuel consumption calculations (for airborne platforms only).  Parameter values are given in Table 6-6.

It should be noted that the quantity NTRMP(NP), in the second column of Data File 4, represents the number of terminals per platform group.  This value will be set to 1.0 in this version of the Model because the concept of terminals is not used.

144

## Table 6-4

### Values for Air Force Inputs to Data File 2, Base Configuration Data

| Base Index (NS) | Base Name (BNOUN) | Number of Bases (TNB) | Location (LO) | Base Type (BTYPE) | Next Higher Base (NHB) | Size of SAT Group (NBC) | Air or Ground Base (BPLAT) |
|---|---|---|---|---|---|---|---|
| 1 | Airborne SAT Europe | 1 | 3 | 3 | 3 | 1 | 1 |
| 2 | Ground SAT Europe | 2 | 3 | 3 | 3 | 2 | 2 |
| 3 | CIMF Europe | 1 | 3 | 2 | 0 | 0 | 1 |
| 4 | Ground SAT Pacific | 1 | 2 | 3 | 5 | 1 | 1 |
| 5 | CIMF Pacific | 1 | 2 | 2 | 0 | 0 | 1 |
| 6 | Airborne IND Pacific | 1 | 2 | 1 | 0 | 0 | 1 |
| 7 | Ground SAT CONUS | 11 | 1 | 3 | 8 | 11 | 2 |
| 8 | CIMF CONUS | 7 | 1 | 2 | 0 | 0 | 1 |
| 9 | Airborne IND CONUS | 14 | 1 | 1 | 0 | 0 | 1 |
| 10 | Ground IND CONUS | 8 | 1 | 1 | 0 | 0 | 2 |

---

*SAT = Satellite Base
IND = Independent Base
CIMF = Centralized Intermediate Maintenance Facility

**Any base which has both airborne and ground platforms is
arbitrarily designated as an air base. Also, because most CIMFs
service both air and ground satellite bases, all CIMFs are
arbitrarily designated as air bases.

Table 6-5

Values for Air Force Inputs to Data File 3,
Platform Operation Data

| Platform Index (NP) | Platform Name (PNOUN) | Environ- ment (LE) | Operating Hours In | | | Utilization Factor (TFAC) | Activation Time (MMPM) |
|---|---|---|---|---|---|---|---|
| | | | CONUS | PACIF (APFH) | EUROPE | | |
| 1 | EC-135 ABNCP | 2 | 72 | 72 | 72 | 1.20 | |
| 2 | E-4B ABNCP | 2 | 192 | 192 | 192 | 2.92 | (Contractor |
| 3 | EC-135 ABNFE | 2 | 34 | 34 | 34 | 1.20 | Inputs) |
| 4 | B-52 ABNFE | 2 | 31 | 31 | 31 | 1.20 | |
| 5 | FB-111 ABNFE | 1 | 22 | 22 | 22 | 1.20 | |
| 6 | FIXED GNDCP | 3 | 730 | 730 | 730 | 1.00 | |
| 7 | FIX/TRAN FE | 3 | 730 | 730 | 730 | 1.00 | |
| 8 | RC-135 ABNFE | 2 | 50 | 50 | 50 | 1.20 | |

| Platform Index (NP) | Missions Per Month | | | "Other" Operating Minutes | | | Thrust In Pounds (THRS) | Gallons Per Oper. Hour (FGH) |
|---|---|---|---|---|---|---|---|---|
| | CONUS | PACIF (AMPM) | EUROPE | CONUS | PACIF (MMPD) | EUROPE | | |
| 1 | 10.0 | 10.0 | 10.0 | | | | 11050 | 1420 |
| 2 | 25.0 | 25.0 | 25.0 | | | | 36500 | 3900 |
| 3 | 10.0 | 10.0 | 10.0 | (Contractor | | | 0 | 0 |
| 4 | 10.0 | 10.0 | 10.0 | Inputs) | | | 0 | 0 |
| 5 | 15.0 | 15.0 | 15.0 | | | | 0 | 0 |
| 6 | 1.0 | 1.0 | 1.0 | | | | 0 | 0 |
| 7 | 1.0 | 1.0 | 1.0 | | | | 0 | 0 |
| 8 | 10.0 | 10.0 | 10.0 | | | | 0 | 0 |

## Table 6-6

### Values for Air Force Inputs to Data File 4,
### Platform Terminal Data and Non-Recurring Mod/Installation Data

| Platform Index (NP) | No. PME Terminals (NTRMP) | Platform Diversion (PDIV) | FRACTION MODS IN | | | Thrust Fuel Consumption Factor (K) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| | | | PROD | FIELD (FR) | DEPOT | |
| 1 | 1.0 | 1.0 | 0.0 | 0.0 | 1.0 | 0.67 |
| 2 | 1.0 | 1.0 | 0.0 | 0.0 | 1.0 | 0.67 |
| 3 | 1.0 | 1.0 | 0.0 | 0.0 | 1.0 | 0.00 |
| 4 | 1.0 | 1.0 | 0.0 | 0.0 | 1.0 | 0.00 |
| 5 | 1.0 | 1.0 | 0.0 | 1.0 | 0.0 | 0.00 |
| 6 | 1.0 | 1.0 | 0.0 | 1.0 | 0.0 | 0.00 |
| 7 | 1.0 | 1.0 | 0.0 | 1.0 | 0.0 | 0.00 |
| 8 | 1.0 | 1.0 | 0.0 | 0.0 | 1.0 | 0.00 |

The MOD/I platform diversity factor PDIV(NP) is a measure of the number of different platforms included in a type grouping. For aircraft platforms this is the number of different aircraft types included in the grouping. Well-defined model differences are also differentiated. For surface platforms, the number of different kinds of units is stated.

### 6.3.6 Air Force Values for Data File 5 - Platform Recurring MOD/I Data

In Data File 5 Air Force parameters are provided for the fixed element of recurring MOD/I costs. These parameters are values of MIFIX (M,NP) for different installation/modes M and different platform groupings NP. MIFIX represents the cost of platform preparation for MOD/I, and the subsequent platform restoration necessary to return the platform to the operational inventory. Values of MIFIX are given in Table 6-7. Note that MIFIX is shown as non-zero only for airborne retrofits.

### 6.3.7 Air Force Values for Data File 6 - Platform Deployment at Bases

Data File 6 contains a platform population or deployment matrix NPLT(NP,NS), defining for each platform type NP, the average number of individual platforms per individual base in each base grouping, identified by the index NS. Table 6-8 gives the deployment.

## 6.4 Contractor Inputs

In this section, instructions for preparing and entering contractor inputs to the LCC Model are provided.

### 6.4.1 Introduction

The input parameters designated as contractor inputs shall be established in accordance with the ground rules and instructions given below.

## Table 6-7

### Values for Air Force Inputs to Data File 5, Platform Recurring Mod/Installation Data

| Platform Index (NP) | FIXED MOD/I COST (dollars) PROD | FIELD | DEPOT | A-KIT Equip. Cost (AKIT) | MOD/INSTALLATION LABOR HOURS (MIMH) |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 450,000 | | |
| 2 | 0 | 0 | 2,800,000 | | |
| 3 | 0 | 0 | 165,000 | CONTRACTOR | |
| 4 | 0 | 0 | 33,000 | INPUTS | |
| 5 | 0 | 115,000 | 0 | | |
| 6 | 0 | 85,000 | 0 | | |
| 7 | 0 | 30,000 | 0 | | |
| 8 | 0 | 0 | 165,000 | | |

Table 6-8

Values for Air Force Inputs to Data File 6,
Average Platform Deployment Quantities by Base Type (NPLT(NP,NS))

| Platform Index (NP) and Name (PNOUN) | Base Index (NS) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 EC-135 ABNCP | - | - | 4.0 | - | - | 3.0 | - | 1.86 | 0.357 | - |
| 2 E-4B ABNCP | - | - | - | - | - | - | - | 0.571 | - | - |
| 3 EC-135 ABNFE | - | - | - | - | - | - | - | - | 0.643 | - |
| 4 B-52 ABNFE | - | - | - | - | - | - | - | 9.14 | 14.86 | - |
| 5 FB-111 ABNFE | - | - | - | - | - | - | - | - | 4.79 | - |
| 6 GNDCP | - | - | 1.0 | - | 1.0 | - | 0.182 | 0.571 | - | 0.375 |
| 7 Other Ground FE* | · | 2.0 | - | 1.0 | - | - | 0.909 | 0.571 | - | - |
| 8 RC-135 ABNFE | 2.0 | - | - | - | 3.0 | - | - | 2.0 | - | 22.25 |

*"Other Ground FE" includes terminal for SAC Wing Command Posts,
Survivable Low Frequency Communications System, Launch Control
Centers, and Force Element Consolidated Ground Terminals.

Contractor inputs are required for twelve of the input files defined in Section 6.1. These files are:

(1)   System-Wide Scalar Parameters
(2)   Base Configuration
(3)   Platform Operation Data
(4)   Platform Terminal Data and Non-Recurring MOD/I Data
(5)   Platform Recurring MOD/I Data
(7)   Support Equipment Data
(8A)  ITEM Equipment Data
(8B)  LRU/SRU Cross-Reference Data
(9A)  ITEM Maintenance Data
(9B)  ITEM Technical Order and Training Data
(10)  ITEM/Support Equipment Cross Reference
(11A) ITEM Configurations on Platforms
(11B) LRU Configurations on Platforms


Note that either Data File 11A or 11B is entered, depending on whether the Preprocessor is used. The generation of data for each of these files is discussed in turn.

## 6.4.2   Contractor Inputs to Data File 1 - System-Wide Scalar Parameters

Contractor inputs to Data File 1 relate mostly to Training and Technical Orders. Instructions for establishing these parameters are as follows:

BDATA  - Number of additional (beyond those intended for depot use only) distinct pages of system level (not ITEM or support equipment specific) TOs written for base level maintenance.

CPD1   - Cost per class per day for type 1 training.

DDATA  - Number of distinct pages of system level (not ITEM or support equipment specific) TOs intended for depot maintenance only.

FSEDC  - The total cost of FSED for The SSS Terminal Segment Program. (This should be the estimated cost at completion for FSED submitted with the RFP. Subsequent LCC submissions should reflect cost at completion as reported on the most recent Cost Performance Reports.)

HPD1   - Number of inclass hours per day for a type 1 training class.

SPC1  - Maximum number of students per type 1 training class.

TEFM  - Cost in dollars of equipment, facilities, and manuals
        required for all training and not accounted for by any
        other Cost Element of the Model.  (Type 2 training
        facilities should not be included.)

## 6.4.3  Contractor Inputs to Data File 2 - Base Configuration Data

The only contractor input to Data File 2 is BSP(NS), which defines
the support equipment available at each base:

BSP(NS)  - The base level support philosophy at base NS, equals
           1, if PSE and CSE only are used
           2, if an MBS plus additional CSE is used
           3, if a UCT plus additional CSE is used.

## 6.4.4  Contractor Inputs to Data File 3 - Platform Operation Data

The two contractor inputs to Data File 3 are MMPM(NP) and
MMPD(NP,LO(NS)).

These variables are not used in this version of the SSS LCC Model,
but may be implemented at some future date.  Therefore, each of the
values of MMPM(NP) and MMPD(NP,LO(NS)) must be set to zero.

## 6.4.5  Contractor Inputs to Data File 4 - Platform Terminal Data and
##        Non-Recurring MOD/I Data

There are two types of contractor inputs tc Data File 4, namely:
platform terminal data and non-recurring MOD/I data.  There are also
Air Force inputs to Data File 4.

Contractor data inputs of Platform Terminal Data for each platform
type NP shall be generated in accordance with the following ground
rules:

INTNR(NP)  - Total non-recurring integration cost associated with
             the integration of terminals in platform type NP.

INTR(NP)  - Per terminal recurring integration cost associated
            with the integration of terminals in platform type NP.

NAE(NP)  - Number of new antenna/radome elements that must be
           installed on platform NP.

In calculating each the recurring and non-recurring production integration costs, INTR(NP) and INTNR(NP), the contractor shall include the cost elements listed in Table 6-9. Note that the integration costs are defined such that INTNR(NP) is the total non-recurring integration cost, and not averaged over the quantity of terminals, while INTR(NP) is the per terminal recurring integration cost. Also note that INTNR(NP) and INTR(NP) for the RC-135 platforms, which have two or more terminals, must include the costs for all terminals on the platform.

The quantity NAE(NP), number of added antenna elements, applies to airborne platforms only and is used in the Model equations only to estimate the added drag that SSS antennas will produce, and the resulting added fuel consumption that will be necessary. This applies only to the EC-135 and E-4B airborne command post platforms.

Table 6-10 provides the basic information that the contractor shall use in calculating DRAG(NP). (Parameters, other than NAE and DRAG, that appear in the equation for added cost of fuel are all furnished by the Air Force.)

Contractor data inputs associated with Non-Recurring MOD/I costs shall be generated as described below.

NRMI(NP) - Total cost of non-recurring MOD/I for the installation of SSS terminal equipment into platform type NP.

Five non-recurring MOD/I cost elements are associated with each platform grouping NP and included in NRMI(NP). These are costs for: Engineering, Prototype Group A-Kits for Test, Testing, Proofing, and Data. This parameter defines, for a given value of index NP, the average cost per platform type, for platforms within the grouping. These five elements are defined below:

1) Engineering: Engineering effort required to design, develop, integrate, test and qualify the installation of a terminal or set of terminals as specified for the platform.

2) Kits for Prototyping: Cost of one prototype group A-kit plus cost of man-hours to install kit. Cost of prototype installation is usually higher than normal installation.

3) Testing: Cost of testing divided into two subfunctions: ground testing and flight testing. Ground test includes cost of equipment and cost of personnel, figured as man-hours for ground support personnel and for engineering

153

Table 6-9

Cost Elements to be Included in Production Cost Element Calculations

CONTRACTOR PRODUCTION COSTS (NON-RECURRING)   (INTNR(NP))
>    Producibility Planning
>    Initial Production Facilities
>        Production Engineering
>        Tooling
>        Industrial Facilities
>        Manufacturing Support Equipment
>    System Integration
>    Quality Assurance Program
>    Qualification Testing Program
>    Production Sampling
>    Documentation
>    Technical Support
>    Contractor Production Management Costs
>        Planning
>        Administrative
>        Control
>    Other Non-Recurring Production Costs
>    Leaseholds
>    General and Administrative Costs (G&A) related to above elements
>    Fee or Profit on the above elements

CONTRACTOR PRODUCTION COSTS (RECURRING)   (INTR(NP))
>    Sustaining Engineering
>    Quality Control and Inspection
>    Packaging and Transportation
>    Other Recurring Production Costs
>    Hardware in a terminal that is not included in any LRU, e.g.
>        interconnections on ground terminals analogous to
>        airborne A-kits.
>    General and Administrative Costs (G&A) related to above elements
>    Fee or Profit on above elements

HARDWARE PRODUCTION COSTS
>    All terminal hardware costs should be included in the sum of
>        the costs of the LRUs in the terminal, which is computed in
>        the Production Cost Element.

154

Table 6-10

Data for Calculation of Antenna Drag

DRAG(NP) = the average drag due to added radome, for NP=1,2.

This drag will be estimated as a percentage of the thrust generated by the platform. This percentage is of the form F(H,L), where:

H = Height of radome in inches
L = Length of radome in inches

and

F(H,L) = -0.09 + 0.002*L + 0.003H + 0.0006*H**2

where    H**2 = H*H.

This estimated drag is based on tests performed at Tinker AFB on the effects of radomes on aircraft performance. The equation above applies to both the EC-135 and E-4B aircraft and to radomes being located at any of the possible locations atop the aircraft.

Due to the negative leading coefficient, very small values of L and H could yield F(H,L,NP) < 0. In this case use F(H,L,NP) = 0, so that

DRAG(NP) = THRS(NP)*max $\left| F(H,L,NP) , 0 \right|$/100
For example, suppose that a radome of height 20 inches and length 100 inches is designed for teh E-4B aircraft.   Then

F(20,100) = 0.41

indicating a 0.41% drag.   Thus

DRAG(NP=2) = THRS(NP=2)*0.41/100

= 36500*0.41/100

= 150 lb., approximately.

Round all values of DRAG(NP) to the significance of H and L.

155

times cost per man-hour. Flight test includes cost of aircraft operation engineers man-hours plus the cost of flight and support personnel man-hours.

4) **Proofing:** Cost of one production group A-kit plus cost of engineering man-hours to install and approve or revise the installation design and procedures.

5) **Data:** This is the cost for updating manuals, printing of manuals, preparing and printing of TCTO. This may be calculated as number of pages times cost per pages.

### 6.4.6 Contractor Inputs to Data File 5 - Platform Recurring MOD/I Data

Contractor inputs to Data File 5 define the recurring acquisition cost of A-Kits in dollars, and the number of recurring labor hours to modify platforms and install SSS terminals. The cost of A-Kits, AKIT(IA,NP), is classified by installation area IA and by platform type NP. The MOD/I labor hours MIMH(IA,M,NP) depends upon mode of installation M as well as upon installation area and platform type. Both airborne and ground-based platforms are involved. Note that AKIT(IA,NP) and MIMH(IA,M.NP) both refer to the complete complement of equipment installed on a platform, which may include only one terminal, or may include two or more terminals. The definitions of the variables and indicies follow.

AKIT(IA,NP) = The items, parts or components to be permanently or semi-permanently installed in a configuration item to support, secure, interconnect or accomodate the prime mission equipment included in a modification (A-kits). Note that for purposes of this analysis this cost is broken up into separate costs for each major subsystem or installation area IA included in the installation.

The cost of A-kits is to be estimated separately for each of the four installation subsystems. The first three subsystems primarily involve mounting brackets, however the wiring subsystem includes the cost of the cabling to be installed. B-kit costs are estimated elsewhere as PME; cabling, however, is not included in PME.

MIMH(IA,M,NP) = The man-hours, by installation area and mode of installation, associated with the actual work content of the MOD/I itself. These man-hours are directly affected by the installation design and comprise the performance of the tasks that would be identified in

TCTO procedures. These tasks are grouped into seven work categories defined below:

o <u>Equipment Removal (Temporary)</u> - In order to gain access to the affected areas and systems of the platform, it may be necessary to temporarily remove items such as panels, doors, floor boards, seats, tubing, wire barriers, clamps, brackets and electronic equipment that are obstructing the modification work area of the platform. Also included is the removal of these items for relocation on the platform.

o <u>Equipment Removal (Permanent)</u> - This task includes permanent removal of electronics, mechanical equipment, brackets, cabling, clamps, fittings, controls and other items that are part of a system that is being replaced or modified for retrofit of a new cne. These items will be discarded or recycled.

o <u>Structure Modification</u> - Any alterations to the basic mechanical framework and housing of the platform such as the airframe, bulkheads, stringers and skins in the case of an aircraft. Work in this category includes layout and cutting/drilling of holes and openings; reinforcement with doublers; enlargement of holes; cut-outs; creation of new recesses; removal of identification, instructions, nameplates; filling of openings, holes, cavities; bending, cutting, welding, riveting new structural members to frameworks; smoothing, refinishing, resealing, repainting, etc.

o <u>Facilities/System Modifications</u> - This group is concerned with changes to heating, lighting, cooling, power, oxygen, pneumatic, hydraulic and other facilities made necessary to accommodate the SSS system. It includes cutting, drilling, bending, clamping and rerouting cables, tubing, ducts and pipes. Also, the relocation and mounting of motors, fans, compressors, pumps and other facilities equipment.

o <u>Equipment Installation</u> - The assembly and mounting of the SSS system and supporting equipment in the platform. Installation includes fixing the B-kit prime mission equipment in position for mission operation and installing its interconnecting A-kit brackets, clips, etc.

o <u>Original Equipment Reinstallations</u> - The replacement of items such as panels, doors, floorboards, seats, tubing, electronic equipment, and wire harnesses that were

temporarily removed to gain access to the modification work area or for relocation on the platform.

o <u>System Operational Check-out</u> - This task includes a functional check on both the new system and any system that was disturbed during the installation.

SSS installation areas, identified by index IA, are defined below:

IA = 1: <u>Antenna Subsystem</u> - Consists of both new and/or modified antenna elements and any electronic boxes directly associated with them. Installation consists of mounting the new elements and any electronic boxes, connecting all electrical connections and performing any required inspection tasks.

IA = 2: <u>Electronics Subsystem</u> - Consists of the major electronic boxes comprising the installed system. Installation consists of mounting all new boxes, removal and replacement of any modified boxes and completing electrical connections. A complete system check out upon completion of the installation is also included as a task.

IA = 3: <u>Control Subsystem</u> - Consists of the separate radio/system control boxes. Installation consists of removal and replacement of existing control panels or integration of a new panel.

IA = 4: <u>Cable/Wiring Subsystem</u> - Consists of all inter-connecting cabling between and among the other main subsystems. Installation of the other subsystems implies merely making connections to cabling installed separately as a part of this subsystem.

SSS Installation modes, identified by index M, are defined below:

M = 1: Installation during manufacture of the host platform.

M = 2: Retrofit installation in the field by a depot team.

M = 3: Retrofit installation in the depot.

During the production phase, the contractors shall deal only with the second and third installation mode. (Data in Table 6-6 define installation modes by platform.)

## 6.4.7 Contractor Inputs to Data File 7 - Support Equipment Data

Data File 7 defines types, and unit costs for CSE and PSE that the contractor determines will be needed for SSS. Quantities of SE required for test and repair of each ITEM are defined later in Data File 10. Total numbers of units of SE that will be needed for all SSS equipment worldwide are calculated by the appropriate equations in the LCC Model.

The contractor shall determine what items of CSE and of PSE will be necessary for test and repair of operational SSS equipment. These include three types of equipment: common equipment usually available at a base or depot, common equipment that will probably have to be procured, and peculiar equipment. Once the SE items have been defined, they shall be classified into sets of items with similar usage patterns. The item sets are identified by the index L. Any classification that allows convenient definition of the ITEM/SE Cross Reference Table (see Data File 10, below) is acceptable.

In considering what types of SE are needed for the SSS system, the contractor shall take into account the following special requirement. Means are required to check out the functioning of the adaptive antenna array on either a daily, or a start-of-mission basis. Equipment suitable for performing this checkout function shall be included in the list of peculiar support equipment. (Note: Although the adaptive array checkout unit differs from other SE in its manner of use, the LCC Model equations should nevertheless provide a reasonable approximation to the total number of units required.)

For each SE item set identified by a value of the Index L, contractor shall define an appropriate name SENOUN(L) and part number SENUM(L) and the following parameters:

SETYPE(L) - Type indicator for SE type L, equals
1, if this piece of SE is common and available on site;
2, if this piece of SE is common but must be procured for SSS use;
3, if this piece of SE is peculiar.

CSE(L) - estimated acquisition cost (1981 dollars) for one set of SE type L. This should include a pro rata portion of development cost if SE type L is PSE. It should also include a pro rata portion of the cost of any new programming required if it is programmable SE.

159

MSE(L) - ratio of the annual cost (1981 dollars) of
maintaining the SE of type L to CSE(L).

DATAS(L) - Number of addtional distinct pages of TOs required
for use of SE type L and not including any
documentation which may be included in the unit cost
of SE type L.

SEDEV(L) - Development cost in dollars for SE type L.


6.4.8  Contractor Inputs to Data File 8A - ITEM Equipment Data

Data File 8A defines the logistic configuration for all ITEMS I in
the SSS.  It also defines ITEM unit cost, unit weight and other
parameters.

An ITEM may be completely contractor furnished, or may be a unit of
GFE which has been modified for incorporation into the SSS.  The
contractor is responsible for determining what different LRUs are
necessary to realize the SSS system on all platforms at all bases,
and how these LRUs should be broken down into SRUs.  All such LRUs
and SRUs are combined into a single ITEM list, identified by an
index I.

Figure 6-1 shows the logistic hierarachy which Data File 8A
represents.  Data elements used in Data File 8A to represent this
structure are given below:

INOUN(1) - Name assigned to ITEM I

PTNUM(I) - Part number assigned to ITEM I

LRU(I) - Index denoting LRUs and SRUs, equals 1 if ITEM I is
an LRU, 0 if it is a SRU.

NHI(I) - The index for the next higher ITEM above ITEM I in
the logistic hierarchy.  NHI(I) = 0 if ITEM I is an
LRU).  If an SRU is a component of more than one type
of LRU, the index of the most numerous LRU shall be
used.

GFE(I) - Index denoting GFE items, equals 1 if ITEM I is
unmodified GFE, 2 if ITEM I is modified GFE, 3 if ITEM
is not GFE.

BASE OR OPERATING SITE   (e.g., LANGLEY, TINKER)

HOST PLATFORM  (e.g., E-4B, FB-111, SWCP)

TERMINAL

LINE REPLACEABLE UNIT (LRU)   (e.g., ELECTRONICS BOX)

SHOP REPAIRABLE UNIT (SRU)   (e.g., PRINTED CIRCUIT BOARD)
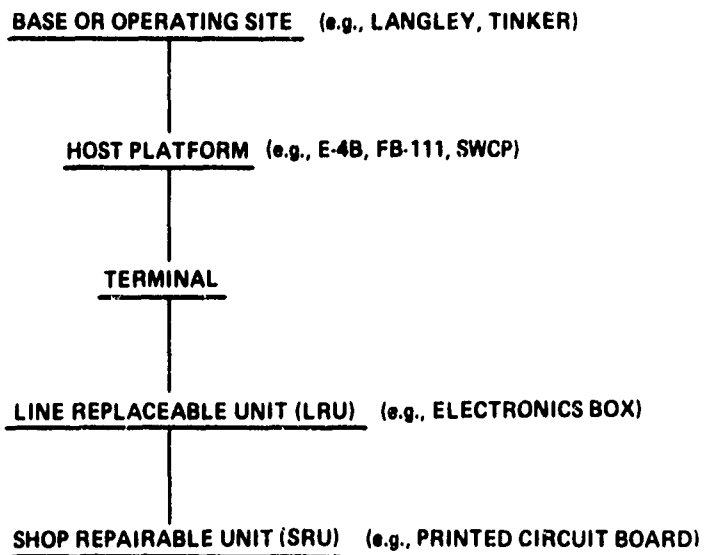
NOTES:   DATA FILE 6 DEFINES PLATFORMS AT BASES
         DATA FILE 4 DEFINES TERMINALS PER PLATFORMS
         DATA FILE 11 DEFINES ITEMS PER PLATFORM
         LRUs AND SRUs ARE COLLECTIVELY CALLED ITEMS.

IA - 59,132

Figure 6-1. Logistic Structure for SSS Terminal Equipment

<u>INTEG(I)</u> - This variable is not used in this version of the SSS LCC Model. Therefore, INTEG(I) should be set to zero for all I.

In addition to these parameters defining the logistic structure within SSS, there are four parameters defining ITEM characteristics.

These are:

<u>LFAC(I)</u> - Learning curve rate for Item type I. (e.g., LFAC(I) = 0.95 implies a 95% learning curve for ITEM type I). All learning assumptions must be justified by the contractor.

<u>UP(I)</u> - Unit Production cost (1981 dollars) of ITEM I. This s established by the contractor using the same ground rules as those defined for th er terminal production cost values contained in Data File 4. It should be noted that the sum of the costs of the separate SRU ITEMS making up an LRU should equal the cost of the LRU, except for additional assembly and testing required at the higher assembly level. Similarly, LRU costs should add up to terminal costs, except for additional terminal level assembly and testing.

<u>WT(I)</u> - This is the net weight of ITEM I.

<u>PA(I)</u> - This is the estimated number of new piece parts introduced into the Air Force inventory by the introduction of ITEM I into the SSS (note remarks in Section 2.4.9 on preventing multiple counting.)

<u>RM(I)</u> - This is the repair materials factor, which equals the fraction of UP(I) that is consumed (in piece parts below the item indenture level) in the repair of ITEM of type I. (note remark (1) in Section 2.4.6.)

GFE is handled in a special manner. An unmodified piece of GFE incorporated into a SSS terminal need not be considered in calculating any of the LCC elements. Hence, such GFE is not entered into the ITEM list in Data File 8A. If a piece of GFE must be <u>modified</u> for incorporation into the SSS, the <u>cost of modification</u> <u>only</u> is considered to be a part of production cost. Hence <u>modified</u> <u>GFE</u> is entered into the ITEM list. The maintenance parameters for the SSS shall be established to account for the difference in

162

support cost between the incorporation of modified GFE, and the free-standing unmodified GFE.

### 6.4.9 Contractor Inputs to Data File 8B - LRU/SRU Cross Reference Data

The data in Data File 8B are not utilized in the main LCC run, they are utilized only in the Preprocessor and RLA programs. Data File 8B defines, in "pointer matrix" form, what SRUs make up each LRU. In order to show this relationship, the file utilizes an LRU index IL. It also utilizes a sequential index K to identify the several SRUs contained in each LRU. The following variables are involved:

NDS(IL) - This is the number of distinct SRUs that are contained in LRU type IL.

ISRU(IL,K) - This is the index I of the Kth type of SRU contained in an LRU of type IL.

QPA(IL,K) - This is the number of SRUs of type ISRU(IL,K) that are contained in one LRU of type IL.

### 6.4.10 Contractor Inputs to File 9A - ITEM Maintenance Data

The data for Data File 9A, ITEM Maintenance Data, is completely furnished by the contractor. It involves three sets of data elements for each ITEM, namely: mean time between maintenance incidents (MTBMI) for each of four operating environments, five different parameters defining relative frequencies of different types of maintenance actions, five parameters defining man-hours (or in one case cost) for different maintenance actions, and a repair level code.

163

MTBMI(I,LE(NP)) - This is the mean time between maintenance
incidents (MTBMI) for each ITEM I in each applicable
operating environment. Values shall be computed in
accordance with the procedures of MIL-HANDBOOK-217C,
and the environmental conditions specified in the next
paragraph. In computing MTBMI. The contractor shall
utilize a completely serial system reliability block
diagram. All items of equipment in a SSS terminal
shall be assumed to operate continuously during the
period when the terminal is turned on, except the
transmitter, which shall be assumed to have a 15% duty
cycle, for all platforms except fixed/transportable.
For fixed/ transportables, the tramsmitter duty cycle
shall be assumed to be 50%.

The environmental conditions that shall be assumed for operation of
SSS equipment are shown in Table 6-11.


TABLE 6-11

Operational Environment


FB-111 Airborne Platform:        Airborne-Fighter   (LE=1)

All Other Airborne Platforms:    Airborne-Cargo   (LE=2)

All Ground Platforms:            Ground, fixed/transportable   (LE=3)




It should be noted that the Model computes failure rates per ITEM
per month (see equation on page 2-2) using the expression:

$$\left[ \text{APFH}(NP,LO(NS)) * \text{TFAC}(NP)/\text{MTBMI}(I,LE(NP)) \right] * \text{KFAC}(LE(NP))$$

The first two factors determine total terminal operating hours per
month. The expression in brackets gives the "intrinsic" failure
rate per month. The factor KFAC(LE(NP)) is then used to convert the
intrinsic failure rate to the "operational" failure rate that may be

164

expected in field operation. The nature of the KFAC correction was described above in Section 6.3.1. Note that KFAC is used to adjust failure rates for differences between the two airborne environments and between the two ground environments, as well as to account for mishandling, breakage, and other hazards of the actual operational environment.

Contractor inputs concerning relative frequencies of maintenance actions for each ITEM I are:

FPR(I) - False pull rate for ITEM type I, i.e., the ratio of removals that are false pulls to those that are verified failures.

RIP(I) - The fraction of maintenace actions that are accomplished by repair-in-place with piece parts.

RTS(I) - The fraction of removed failures assigned to repair at base shop

NRTS(I) - The fraction of removed failures assigned to repair at depot.

COND(I) - The fraction of (removed) failures which are condemned, due to normal wear-out. (The LCC Model will automatically adjust the COND(I) fraction if ITEM type I is occasionally discarded because its next higher assembly has worn-out or is a discard-on-failure assembly.)

The "maintenance actions" associated with the MTBMI are repair-in-place actions plus removals that test out as failures. Such removed failures are then allocated to further maintenance actions in accordance with RTS, NRTS and COND. The contractor shall determine the relative frequency parameters in accordance with a documented logistic approach that is in conformity with Air Force guidance.

Note that: 1) maintenance actions performed on SRUs must be consistent with those on the LRUs in which they reside, and 2) the value of RIP(IL) must be in the range 0<RIP(IL)<1 for all LRU ITEMs of type IL. The logistics values computed by the Model are incorrect for ITEMs which are maintained entirely by repair-in-place (RIP(IL)=1).

Contractor inputs concerning man-hours or cost for various maintenance actions for each ITEM I are:

<u>RMH(I)</u> - The average manhours to remove and replace (applicable only to an LRU, not an SRU).

<u>BCMH(I)</u> - The average manhours to perform base shop bench check.

<u>BMH(I)</u> - The average manhours to perform base-level corrective maintenance.

<u>DMH(I)</u> - The average manhours to perform depot level repair, including bench check.

<u>IPCF(I)</u> - The average cost per failure of repair-in-place actions, including cost of replacement parts and labor.

Contractor calculations of these parameters shall be in accordance with the applicable provisions of MIL-Handbook-472.

Finally, Data File 9A contains a repair level code, defined below:

<u>RL(I)</u> - Repair level code for ITEM type I;

  = 0 if initially input RTS (I), NRTS(I), and COND(I) values are to be used;
  = 1 if RTS(I), NRTS(I), and COND(I) are to be internally calculated to represent base repair of ITEM I;
  = 2 if RTS(I), NRTS(I), and COND(I) are to be internally calculated to represent depot repair of ITEM I;
  = 3 if RTS(I), NRTS(I), and COND(I) are to be internally calculated to represent discard-on-failure of ITEM I.

The variable RL(I) provides a short-cut method for the input of maintenance strategy. Its non-zero values cause the overriding of the previously input RTS(I), NRTS(I), and COND(I) values.

### 6.4.11 Contractor Inputs to Data File 9B - ITEM Technical Order and Training Data

This file contains contractor inputs defining Technical Order and Training characteristics and UCT software development costs of individual ITEMs I. Four parameters are involved, and are defined below:

DATAB(I) - Number of additional distinct pages of technical
orders required for base repair of ITEM type I.

DATAD(I) - Number of additional distinct pages of technical
orders required for repair of ITEM type I and written
for depot use only.

TIME1(I) - The number of additional hours of type 1 training
added for ITEM type I.

UCTDEV(I) - Software development cost for an Item type I to be
served by the UCT.

The UCT software development cost may be a function of the level of
service (i.e. check-out or check-out and repair) that the UCT
performs on an ITEM of type I. That is, software for check-out
alone can be expected to be less costly than that for check-out and
repair. Therefore the contractor must be sure to enter the correct
UCTDEV(I) when studying different repair options.

### 6.4.12 Contractor Inputs to Data File 10 - ITEM/SE Cross Reference Data

This file, containing only contractor furnished data, defines what
types (Index L) and numbers of units of SE must be utilized in the
test and repair of an ITEM I in repair mode IRM. IRM takes on four
values, 1 - depot repair, 2 - base level repair by CSE and PSE only,
3 - base level repair by an MBS and additional PSE, 4- base level
repair by a UCT and additional SE. Data File 10 deals with the
types or sets of SE defined by Data File 7, and the types of ITEMS
defined by Data Files 8A and 9A.

Basically, Data File 10 is used to input the matrix variables
$A(I,IRM,L)$ and $SECODE(I,IRM,L)$ which are used in the LCC Model
equations presented in Sections 2 and 3. $A(I,IRM,L)$ represents the
number of copies of SE type L required in each repair or bench-check
of an ITEM of type I for every applicable repair mode IRM.
$SECODE(I,IRM,L)$ indicates the type of maintenance (repair, bench-
check, or both) of ITEMS of type I for which SE type L is required.
However, these two matrices are combined into one which must be
input in "pointer form" in Data File 10.

Four variables are involved as described below:

NRM(I) - number of different repair modes which can be used in the check-out and/or check-out and repair of ITEM type I.

NJA(I,IRM) - number of different SE types (i.e., different values of L) required in the repair of ITEM I in repair mode IRM.

A(I,IRM,K) - Index number of Kth support equipment type required for maintenance of ITEM type I.

QSA(I,IRM,K) - For support equipment type A(I,K), this is a 3 digit whole number. The hundreds digit of QSA(I,K) is the value of SECODE(I,A(I,IRM,K)). The units digit of QSA(I,K) is the number of pieces of SE of type A(I,IRM,K) required for performance of one maintenance action on one ITEM of type I in repair mode IRM.

The specific instructions given in Section 7.3.10 should be carefully followed so as to avoid confusion when inputting this file.


### 6.4.13   Contractor Inputs to Data File 11A - ITEM Configuration on Platforms

Data File 11A contains only contractor inputs.  It defines for each Platform type NP, the average number, NITEM(I,NP), of each ITEM type I that is to be installed.  It should be noted that in the case of the RC-135 platforms, which contains two or more terminals, the ITEMs for both terminals must be included.  This is due to the fact that the concept of terminals is not incorporated into this version of the SSS LCC Model.

It should be noted that the Model equations determine the total number of installed ITEMS of type I, world-wide, by the following calculation:

$$\sum_{NP}\sum_{NS} NITEM(I,NP)*NPLT(NP,NS)*TNB(NS)$$

The contractor should note that both all LRUs and all SRUs are contained in Data File 11A.  Values of NITEM(I,NP) must be consistent with the logistic hierarchy defined by the ITEM Equipment Data in Data File 8A.  Thus if a particular platform type contains only 3 LRUs of a certain type, each composed of one each of the same set of 4 different SRUs, NITEM will contain both the three LRU population and all four of the SRU populations.  The logistic equations in the LCC Model are constructed so that there is never any "double-counting" in computing failures, spares, and other logistic variables.

As an aid to constructing this data file, a Preprocessor has been designed and included in this LCC Model package.  Section 5 contains a discussion of the operation of the preprocessor.  Basically, a smaller file of LRU ITEMs in Platforms is entered, and the Preprocessor uses this file and Data File 8B to generate Data File 11A.  This smaller LRU ITEMs in Platforms file is Data File 11B, and is described in the following section.

169

### 6.4.14 Contractor Inputs to Data File 11B - LRU Configuration on Platforms

Data File 11B contains only contractor inputs, and defines for each Platform type NP the average number NITEM(IL,NP) of each LRU ITEM type IL to be installed. This Data File is not a direct input to the LCC Model. It is an input to the Preprocessor, which will use Data Files 11B and 8B to create Data File 11A. Since Data File 11B is much smaller than Data File 11A, this is seen as an aid to the users of the LCC Model.

The Preprocessor is designed to assist the contractor in creating Data File 11A. Once an LRU-in-Platform matrix is created (in Data File 11B), the "rest of the file", namely the SRUs, are "added on" and placed in a new file as input to the LCC Model (Data File 11A). During design trade-offs, then, if a number of LRUs are added or removed from certain platforms, this can be noted in the LRU-in-Platform matrix and the Preprocessor will automatically incorporate these changes and the changes in SRUs included in each terminal. See Section 5.2 for details of the operation and functions of the preprocessor.

# SECTION 7

## OPERATING PROCEDURES

### 7.1 Introduction

This section provides all the technical details necessary for the user to implement the SSS LCC Model on his computer system. Section 7.2 identifies all input and output device channel numbers which are referred to in the FORTRAN code of the LCC Model (both the LCC Program and the RLA Program). Section 7.3 describes the exact formatting and field column allocation that is required in each of the fourteen data input files. Section 7.4 identifies the error messages which the LCC Program will generate in response to errors detected in either the formatting or the values of data in the input files. Section 7.5 describes the operation of the Preprocessor Program. Section 7.6 describes the operation of the LCC Program in interactive mode, including instructions on the appropriate user responses at the terminal to the sequence of computer-prompted questions which are generated by the LCC Program. Section 7.7 illustrates the steps required to convert the LCC Program to batch mode operation. Section 7.8 shows the detailed procedures for running the RLA Program in conjunction with the LCC Program. Finally, Section 7.9 gives a detailed description of the information printed by the LCC Model which includes fourteen Input Tables (basically echoing the data in the fourteen input files), seven Output Tables (presenting the estimated LCC, broken down into various cost categories), and an LCC Sensitivity Analysis Table.

There are fourteen Data Files, thirteen of which must be entered by the user, namely Data Files 1, 2, 3, 4, 5, 6, 7, 8A, 8B, 9A, 9B, 10, 11A, and 11B, which are described in detail in section 7.3. However, the user need only input either 11A or 11B: only Data File 11A is used by the ICC Model, and the Preprocessor can be used to generate Data File 11A from 11B.

171

## 7.2 Input/Output Device Channel Numbers

Table 7-1 lists the channel numbers which the user should assign to
the various input/output files that are required by the LCC Program.
These numbers correspond to the device designation numbers used
internally by the computer program.

TABLE 7-1

LCC Input/Output Device Channel Numbers

| INPUT/OUTPUT CHANNEL NUMBER | FILE |
|---|---|
| 5 | User Interactive Inputs from Terminal |
| 6 | LCC Program Outputs to Terminal |
| 7 | LCC Program Outputs to Off-line Printer |
| 11 | System-Wide Scalars (Data File 1) |
| 12 | Base Configuration Data (Data File 2) |
| 13 | Platform Operation Data (Data File 3) |
| 14 | Platform Term Data & Non-Recur. MOD/I Data (Data File 4) |
| 15 | Platform Recur. MOD/I Data (Data File 5) |
| 16 | Platform Deployment at Bases (Data File 6) |
| 17 | Support Equipment Data (Data File 7) |
| 18 | ITEM Equipment Data (Data File 8A) |
| 19 | ITEM Maintenance Data (Data File 9A) |
| 22 | ITEM Technical Orders Training and UCT Development Data (Data File 9B) |
| 20 | ITEM/SE Cross Reference Data (Data File 10) |
| 21 | ITEM Configuration on Platforms (Data File 11A) |
| 25 | LRU Configuration on Platforms (Data File 11B) |
| 23 | Repair Level Analysis Save File (Data File 13) |

Note: All input/output files require a record length of 80 bytes
(i.e., each line on the file must be 80 bytes long), except unit 7,
the off-line printer, which requires a record size of at least 133
bytes.

172

Table 7-2 lists the channel numbers which the user should assign to the various input/output files that are required by the RLA Program. These numbers correspond to the device designation numbers used internally by the computer program. Note that Data File 13 is assigned to have an output channel number (23) in the LCC Program and an input channel number (10) in the RLA Program. Table 7-3 lists the same data for the Preprocessor.

Table 7-2

RLA Input/Output Device Channel Numbers

| Input/Output Channel Number | File |
|---|---|
| 7 | RLA Program Outputs to Off-line Printer |
| 11 | LRU/SRU Cross Reference Data (Data File 8B) |
| 12 | Repair Level Analysis Save File (Data File 13) |
| 13 | ITEM Maintenance Data (original Data File 9A) |
| 14 | Copy of Data File 9A with updated RL(I) values (new Data File 9A) |

Table 7-3

Preprocessor Input/Output Device Channel Numbers

| Input/Output Channel Number | File |
|---|---|
| 6 | Preprocessor Outputs to Terminal |
| 18 | ITEM Equipment Data (Data File 8A) |
| 19 | ITEM Maintenance Data (Data File 9A) |
| 22 | ITEM Technical Orders and Training Data (Data File 9B) |
| 20 | ITEM/SE Cross Reference Data (Data File 10) |
| 21 | ITEM-in-Platform Data (Data File 11A) |
| 25 | LRU-in-Platform Data (Data File 11B) |
| 26 | LRU/SRU Cross Reference Data (Data File 8B) |

173

## 7.3 Preparation of Data Input Files

The fourteen data input files (listed in Table 6-2) contain all the information necessary to describe the design, operation, deployment, and maintenance strategies of the user's SSS concept. This information is a combination of Air Force and contractor provided data. Since the purpose of this section is only to describe how this information is to be prepared on data input files, the source, interpretation, or LCC Model utilization of any of the data input parameters is not discussed here. The reader should refer to Section 8 for a breakdown of the various data input parameters into Air Force-provided and contractor-provided. Detailed ground rules and guidelines are also presented in Section 8 for the determination of contractor-provided data inputs. In addition, definitions of all data input parameters appear in the Glossary in Appendix A.

Data Files 1 through 11B may be input from any device (e.g., punched cards, magnetic tape, disk) that the user chooses as long as the correct channel designations are used. For ease of presentation below, it is assumed that this data is being input on punched cards, but the discussion will be sufficient to indicate the correct formatting of data on any input device.

In addition, Data File 1 (on channel 11) must be input via the user's NAMELIST capability (where the data inputs can be listed in any order). Data Files 2 through 11B do not utilize the NAMELIST capability, but are instead read in record by record, where each record adheres to a fixed format and order of data elements, according to the reference type (i.e., ITEM, SE, base or platform) of the record.

Most of the information required for the preparation of Data Files 2 through 11B can be determined from the respective figures presented below. These data files are read into the LCC Model record by record. For the discussion below, it is assumed that each record corresponds to a separate punched card and a byte of input data is identified with a column on the punched card. However, important information on the number and sequence of records in each file is presented in the text.

Each of these fourteen data files is specifically discussed in the repective subsections which follow.

174

### 7.3.1 System-Wide Scalar Parameters - Data File 1

Data File 1 contains mostly system-wide scalar parameters and is input via a NAMELIST, entitled "MISC". The data parameters which must be input in this file are listed in Table 7-4 below, and their definitions appear in the Glossary in Appendix A.

Figure 7-1 below, gives a generalized example of a listing of Data File 1. To determine the exact formatting of NAMELIST/MISC/ that is appropriate for the computer system on which the LCC Model is being run, the user should consult his installation's FORTRAN manual.

```
(NAMELIST /MISC/ HEADER) BAA=144.0, BMF=1.5, DAA=144.0,
...,MILR(1)=30.00, MILR(2)=30.00, MILR(3)=30.00,
...,OSTC=0.250., (End-of-NAMELIST Designator)
```

Figure 7-1. Generalized Example of Data File 1.

In the above example, the NAMELIST header and end-of-NAMELIST formats must be determined by the user from his installation's FORTRAN manual. There may also be differences in the formatting of the data inputs which are internal to NAMELIST /MISC/. For example, in Figure 7-1, it may be permissable to replace "MILR(1)=30.00, MILR(2)=30.00, MILR(3)=30.00" by the equivalent formulation "MILR(1)=3*30.00", depending on the user's NAMELIST capability. As noted, it is up to the user to determine the details of his required NAMELIST formatting.

Table 7-4

System-Wide Scalar Parameters

| LABOR FACTORS | LABOR RATES | PIPELINE TIMES |
|---|---|---|
| BAA | BLR | BRCT |
| BMF | DLR | CRCT |
| DAA | MILR(1) | DAD |
| DMF | MILR(2) | DRCT(1) |
| HPD2 | MILR(3) | DRCT(2) |
| TORB | PAL1 | DRCT(3) |
| TORD | PAL2B | OST(1) |
| | PAL2D | OST(2) |
| | PMLR | OST(3) |
| | TNLR | OSTC |
| | TRAV1D | |
| | TRAVB | |

| UNIT COST FACTORS | MISCELLANEOUS | CONTRACTOR-PROVIDED PARAMETERS |
|---|---|---|
| ACPP | BF | BDATA |
| CFC(1) | BIRD | CPD1 |
| CFG(2) | DSC | DDATA |
| CFG(3) | KFAC(1) | FSEDC |
| CPL2 | KFAC(2) | HPD1 |
| CPPC | KFAC(3) | SPC1 |
| CPPD(1) | KFAC(4) | TEFM |
| CPPD(2) | MRF | |
| CPPD(3) | MRO | |
| IMC | MUSE | |
| RCPP | NRUC | |
| RMC | PIUP | |
| SA | QTYP1 | |
| UCPP | QTYP2B | |
| | QTYP2D | |
| | R | |
| | SPC2 | |
| | SR | |
| | TR | |
| | TYP2TF | |
| | XFPR | |
| | XFR | |
| | XMIL | |
| | XUC | |

## 7.3.2  Base Configuration Data - Data File 2

Data File 2 contains information describing the bases at which SSS
equipment will be deployed.  Each record (punched card) in Data
File 2 should contain all data pertaining to a particular base type
NS.  The data input parameters which should be listed on each record
of this file, together with their designated formats and column
allocations are indicated in Figure 7-2.  In particular, the index
number of the particular base grouping (i.e., the value of NS)
should appear in columns 2-3.  The index numbers which appear on
successive records in Data File 2 must be consecutive positive
integers, starting with 1.  The current maximum number of base types
allowed is 16.

The input data to this file is entirely Air Force provided, hence
there should be no need to make additions or deletions of records
from the file.  Thus "gaps" in successive base index numbers should
never occur and, in fact, are not allowed.

Note that the first column of each record serves as an end-of-file
designator.  This column must be left blank if the record contains
data inputs for a particular base type NS.  The record for the last
base type should be followed by a record with an asterisk "*" in the
first column and with all other columns left blank (so that it
should appear as the second row in Figure 7-2).  The "*" in the
first column of this otherwise blank record then designates the end
of the Base Configuration Data File.

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA -"*" enter only on last card | FI |
| 2-3 | BASE INDEX NUMBER - NS | NUMERIC - INTEGER (I2) | RJ |
| 4-19 | BASE NAME | ALPHA - (16A1) | FR |
| 20-22 | TNB(NS) | NUMERIC - REAL (F3.0) | ID or ED |
| 23-24 | LO(NS) | | |
| 25-26 | BTYPE(NS) | NUMERIC - INTEGER (I2) | RJ |
| 27-28 | NHB(NS) | | |
| 29-31 | NBC(NS) | | |
| 32-33 | BPLAT(NS) | NUMERIC - REAL (F3.0) | ID or ED |
| 34-35 | BSP(NS) | NUMERIC - INTEGER (I2) | RJ |
| 35-80 | BLANK | | |

LEGEND

FI = Fixed Form
FR = Free Form
RJ = Right Justified
ID = Implicit Decimal - Comply with Format [△]
ED = Explicit Decimal - Supply Decimal

Figure 7-2. Base Configuration - Data File 2

178

### 7.3.3 Platform Operation Data - Data File 3

Data File 3 contains information about the operating characteristics of the various platform types (actually, platform groupings) into which SSS equipment will be installed. Each record (punched card) in Data File 3 should contain all data pertaining to a particular platform type NP. The data input parameters which should be listed on each record of this file, together with their designated formats and column allocations are indicated in Figure 7-3. In particular, the index number of the particular platform grouping (i.e., the value of NP) should appear in columns 2-4. The index numbers which appear on successive records in Data File 3 must also be consecutive positive integers starting with 1. The current maximum number of platform types allowed is 10.

The index numbers and platform types (as well as most of the other inputs) that are to be listed in Data File 3 are Air Force-provided data inputs. Thus, again, no need will arise for "gaps" in successive index numbers.

One should note the use of implicit decimal formatting in Data File 3 (as well as other data files). The location of "implicit" decimals is indicated in Figure 7-3 (and following figures) by the "triangles" printed between adjacent columns. For example, if the value of the data input TFAC(NS) is indicated by listing "100" in columns 31-33, as shown in Figure 7-3, then the value assigned by the LCC Model when the file is read in will be TFAC(NS)=1.00. Thus there is no need to "use up" a column by including an explicit decimal. However, if the implicit decimal formatting in a particular field is not appropriate for a particular data input, the use of an explicit decimal will over-ride the implicit decimal location indicated in Figure 7-3.

Again the first column serves as an end-of-file designator in Data File 3. Thus an asterisk "*" in the first column denotes the end-of-file in the same manner as described for Data File 2 in Section 7.3.2.

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA -"*" enter only on last card | FI |
| 2-4 | PLATFORM INDEX NUMBER - NP | NUMERIC - INTEGER (I3) | RJ |
| 5-16 | PLATFORM NAME | ALPHA - (12A1) | FR |
| 17-18 | LE(NP) | NUMERIC - INTEGER (I2) | RJ |
| 19-22 | APPH(NP,1) | NUMERIC - REAL (F4.0) | ID or ED |
| 23-26 | APPH(NP,2) | | |
| 27-30 | APPH(NP,3) | | |
| 31-33 | TFAC(NP) | NUMERIC - REAL (F3.2) | ID or ED |
| 34-37 | BLANK | | |
| 38-40 | HHPH(NP) | NUMERIC - REAL (F3.1) | ID or ED |
| 41-44 | AMPH(NP,1) | NUMERIC - REAL (F4.1) | |
| 45-48 | AMPH(NP,2) | | |
| 49-52 | AMPH(NP,3) | | |
| 53-57 | MMPD(NP,1) | NUMERIC - REAL (F5.1) | ID or ED |
| 58-62 | MMPD(NP,2) | | |
| 63-67 | MMPD(NP,3) | | |
| 68-74 | THRS(NP) | NUMERIC - REAL (F7.0) | |
| 75-79 | FGH(NP) | NUMERIC - REAL (F5.0) | |
| 80 | BLANK | | |

LEGEND

FI = Fixed Form

FR = Free Form

RJ = Right Justified

ID = Implicit Decimal - Comply with Format [A]

ED = Explicit Decimal - Supply Decimal

Figure 7-3. Platform Operation - Data File 3

180

### 7.3.4  Platform Terminal & Non-Recurring MOD/I Data - Data File 4

Data File 4 contains a combination of platform terminal installation and cost data and non-recurring MOD/I data.  Each record (punched card) in Data file 4 should contain data pertaining to a particular platform type NP.  The data input parameters which should be listed on each record of this file, together with their designated formats and column allocations are indicated in Figure 7-4.

The platform index number NP must appear in columns 2-4 as indicated and must represent exactly the same platform types that they stood for in Data File 3.  In addition, each platform type which is represented by a record in Data File 3 must also be represented by a record in Data File 4, and vice-versa.  Thus, the records in Data Files 3 and 4 must match up index number by index number, representing identical platform types (or "groupings") in exactly the same sequence.  Clearly, both files must also contain the same number of records (up to a maximum of 10).

Note that implicit decimal formatting is used in Data File 4 also and has the same interpretation as was explained for Data File 3 in Section 7.3.3.  Two implicit decimals are specified in Figure 7-4 for the data parameter NAE(NP).  This format is to allow better accuracy if the average number of new antenna elements for the (not necessarily identical) platforms within grouping NP is not an integer.

Again the first column in Data File 4 serves as an end-of-file designator.  Thus an asterisk "*" in the first column denotes the end-of-file in the same manner as was described for Data File 2 in Section 7.3.2.

Figure 7-4. Platform Terminal and Non-Recurring MOD/I – Data File 4

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA –"*" enter only on last card | |
| 2-4 | PLATFORM INDEX NUMBER - NP | NUMERIC - INTEGER (I3) | FI |
| 5-8 | NTRMP(NP) | NUMERIC - REAL (F4.2) | RJ |
| 9-17 | INTNR(NP) | NUMERIC - REAL (F9.0) | |
| 18-25 | INTR(NP) | NUMERIC - REAL (F8.0) | |
| 26-34 | NRMI(NP) | NUMERIC - REAL (F9.0) | |
| 35-38 | PDIV(NP) | NUMERIC - REAL (F4.2) | ID or ED |
| 39-41 | FR(1,NP) | NUMERIC - REAL (F3.2) | |
| 42-44 | FR(2,NP) | NUMERIC - REAL (F3.2) | |
| 45-47 | FR(3,NP) | | |
| 48-50 | DRAG(NP) | NUMERIC - REAL (F3.0) | |
| 51-54 | K(NP) | NUMERIC - REAL (F4.2) | |
| 55-58 | NAE(NP) | NUMERIC - REAL (F4.2) | |
| 59-80 | BLANK | | |

182

### 7.3.5  Platform Recurring MOD/I Data - Data File 5

All of the parameters in Data File 5 relate to recurring MOD/I costs.  Each record (punched card) in Data File 5 should contain data pertaining to a particular platform type NP.  The data input parameters which should be listed on each record of this file, together with their designated formats and column allocations are indicated in Figure 7-5.

The platform index number NP must appear in columns 2-4 as indicated and must represent exactly the same platform types that they stood for in Data Files 3 and 4.  In addition, each platform type which is represented by a record in Data File 3 and 4 must also be represented by a record in Data File 5, and vice-versa.  Thus, the records in Data Files 3,4, and 5 must match up index number by index number, representing identical platform types in exactly the same sequence.  Thus all three files must contain the same number of records (up to a maximum of 10).

Again the first column in Data File 5 serves as an end-of-file designator.  Thus an asterisk "*" in the first column denotes the end-of-file in the same manner as was described for Data File 2 in Section 7.3.2.

Figure 7-5. Platform Recurring MOD/I – Data File 5

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA -"*" enter only on last card | FI |
| 2-4 | PLATFORM INDEX NUMBER - NP | NUMERIC - INTEGER (I3) | RJ |
| 5-9 | MIFIX(1,NP) | | |
| 10-14 | MIFIX(2,NP) | | |
| 15-19 | MIFIX(3,NP) | | |
| 20-24 | AKIT(1,NP) | NUMERIC - REAL (F5.0) | ID or ED |
| 25-29 | AKIT(2,NP) | | |
| 30-34 | AKIT(3,NP) | | |
| 35-39 | AKIT(4,NP) | | |
| 40-42 | MIMH(1,1,NP) | | |
| 43-45 | MIMH(2,1,NP) | | |
| 46-48 | MIMH(3,1,NP) | | |
| 49-51 | MIMH(4,1,NP) | | |
| 52-54 | MIMH(1,2,NP) | | |
| 55-57 | MIMH(2,2,NP) | NUMERIC - REAL (F3.0) | ID or ED |
| 58-60 | MIMH(3,2,NP) | | |
| 61-63 | MIMH(4,2,NP) | | |
| 64-66 | MIMH(1,3,NP) | | |
| 67-69 | MIMH(2,3,NP) | | |
| 70-72 | MIMH(3,3,NP) | | |
| 73-75 | MIMH(4,3,NP) | | |
| 76-80 | BLANK | | |

LEGEND

FI = Fixed Form

FR = Free Form

RJ = Right Justified

ID = Implicit Decimal -
Comply with Format [▲]

ED = Explicit Decimal -
Supply Decimal

### 7.3.6  Platform Deployment at Bases - Data File 6

Data File 6 contains all of the values of the matrix variable
NPLT(NP,NS), the number of platforms of type NP located at each base
of type NS. Each record in Data File 6 gives the base deployment
information pertaining to a particular platform type NP. The
designated format and column allocations for this data is indicated
in Figure 7-6. Note, in particular, that two implicit decimals are
allowed in each NPLT(NP,NS) field to allow better accuracy in the
case that the average number of platforms of type NP located at a
typical base within grouping NS is not an integer. (An explanation
of the correct interpretation of implicit decimal formatting is
given in Section 7.3.3.)

The platform index number NP which appears in columns 2-4 again must
match up record for record with the respective index numbers used in
Data Files 3, 4, and 5, in the manner described in the previous
section.

Again, the first column in Data File 6 serves as an end-of-file
designator. Thus an asterisk "*" in the first column denotes the
end-of-file in the same manner as was described for Data File 2 in
Section 7.3.2.

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA -"*" enter only on last card | FI |
| 2-4 | PLATFORM INDEX NUMBER - NP | NUMERIC - INTEGER (I3) | RJ |
| 5-8 | NPLT(NP,1) | | |
| 9-12 | NPLT(NP,2) | | |
| 13-16 | NPLT(NP,3) | | |
| 17-20 | NPLT(NP,4) | | |
| 21-24 | NPLT(NP,5) | | |
| 25-28 | NPLT(NP,6) | NUMERIC - REAL (F4.2) | ID or ED |
| 29-32 | NPLT(NP,7) | | |
| 33-36 | NPLT(NP,8) | | |
| 37-40 | NPLT(NP,9) | | |
| 41-44 | NPLT(NP,10) | | |
| 45-48 | NPLT(NP,11) | | |
| 49-52 | NPLT(NP,12) | | |
| 53-56 | NPLT(NP,13) | | |
| 57-60 | NPLT(NP,14) | | |
| 61-64 | NPLT(NP,15) | | |
| 65-68 | NPLT(NP,16) | | |
| 69-80 | BLANK | | |

LEGEND

FI = Fixed Form

FR = Free Form

RJ = Right Justified

ID = Implicit Decimal - Comply with Format [▲]

ED = Explicit Decimal - Supply Decimal

Figure 7-6. Platform Deployment at Bases - Data File 6

186

### 7.3.7 Support Equipment Data - Data File 7

Data File 7 lists all SE that is required for intermediate and depot level corrective maintenance actions on ITEMs within the contractor's SSS system design. SE which may be required for organizational maintenance actions only (e.g., removing and replacing failed LRUs on-board a platform) need not be included. However, as mentioned in Section 6, any "tester" required for validating the functioning of adaptive array antennas should be included here.

The maximum SE index number allowed is 250. Thus a maximum of 250 different SE types may be represented in Data File 7 (in which case the index numbers would have to be consecutive integers starting with 1). (See comment on maximum index values in Section 7.3.8A.)

This file contains information concerning SE procurement cost, development cost, maintenance and type (i.e., common/on-site, procurable common, or peculiar). SE designated common/on-site must appear on the Air Force-provided list. The designated format and column allocations for this data are indicated in Figure 7-7. Each record (punched card) in Data File 7 should contain all data pertaining to a particular SE type L.

In particular, the SE index number (i.e., value of L) should appear in columns 2-4. In contrast to the previous data files, the SE index numbers appearing on successive records in Data File 7 need not be consecutive, and the first index number need not be 1. Rather, successive SE index numbers should only be positive integers, listed in increasing order. Thus "gaps" are allowed in successive SE index numbers. This feature allows the LCC Model user flexibility in making changes to and/or deletions from his SE list. Since the inputs to Data File 7 are all contractor-provided, it might be anticipated that changes to this data will be made fairly frequently, as the contractor gains more information regarding his maintenance requirements or possibly wants to trade-off alternate SE configurations.

Again, the first column in Data File 7 serves as an end-of-file designator. Thus an asterisk "*" in the first column denotes the end-of-file in the same manner as was described for Data File 2 in Section 7.3.2.

187

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA -"*" enter only on last card | FI |
| 2-4 | SUPPORT EQUIPMENT INDEX NUMBER - L | NUMERIC - INTEGER (I3) | RJ |
| 5-24 | SUPPORT EQUIPMENT NAME | ALPHA - (20A1) | FR |
| 25-36 | SUPPORT EQUIPMENT PART NUMBER | ALPHA - (12A1) | FR |
| 37-43 | CSE(L) | NUMERIC - REAL (F7.0) | ID or ED |
| 44-47 | MSE(L) | NUMERIC - REAL (F4.3) | ID or ED |
| 48-49 | SETYPE(L) | NUMERIC - INTEGER (I2) | RJ |
| 50-52 | DATAS(L) | NUMERIC - INTEGER (I3) | RJ |
| 53-60 | SEDEV(L) | NUMERIC - REAL (F8.0) | ID or ED |
| 61-80 | BLANK | | |

LEGEND

FI = Fixed Form

FR = Free Form

RJ = Right Justified

ID = Implicit Decimal -
Comply with Format (A)

ED = Explicit Decimal -
Supply Decimal

Figure 7-7. Support Equipment Data – Data File 7

188

## 7.3.8 ITEM Equipment Data - Data File 8A

Data File 8A contains information concerning the ITEM equipment characteristics. Each record (punched card) in the file should contain all data pertaining to a particular ITEM type I. The data input parameters which should be listed on each record of this file, together with their designated formats and column allocations are indicated in Figure 7-8A.

The maximum ITEM index number currently allowed is 999. Thus a maximum of 999 different ITEM types may be represented in Data File 8A (in which case the index numbers would have to be consecutive integers starting with 1). The maximum ITEM index number was somewhat arbitrarily determined, as was the maximum SE index number. Of course, these maximum values directly impact the core storage requirements of the LCC Model. If the contractor is presented with any difficulty produced by these maximum index values being either too large or too small, he should contact the Contracting Officer regarding making dimension changes to the LCC Model.

In particular, the ITEM index number (i.e., value of I) should appear in columns 2-4. As is the case for the SE index numbers in the previous data file, the ITEM index numbers appearing on successive records in Data File 8A need not be consecutive and the first index number need not be 1. Successive ITEM index numbers should only be positive integers, listed in increasing order. Thus, "gaps" are allowed in successive ITEM index numbers. Again this feature allows the LCC Model user flexibility in making changes to and/or deletions from his ITEM list. Since the contractor may wish to experiment with different possible design configurations, it may be that Data File 8A will undergo fairly frequent revisons.

An error check is made on Data File 8A to ensure that the LRU(I) and NHI(I) values given for each ITEM type I are consistent. Recall that if ITEM type I is an LRU, so that LRU(I)=1, then NHI(I) must be zero. Conversely, if ITEM type I is not an LRU, then LRU(I)=0 and NHI(I) must equal a positive integer (i.e., the ITEM index number of its next higher LRU assembly). See Section 7.4 for a discussion of error checks and messages.

"Implicit" decimal formatting is used in Data File 8A and the reader is referred to Section 7.3.3 for an explanation of the feature.

Again, the first column in Data File 8A serves as an end-of-file designator. Thus an asterisk "*" in the first column denotes the end-of-file in the same manner as was described for Data File 2 in Section 7.3.2.

189

**Figure 7-8A. ITEM Equipment – Data File 8A**

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA - "*" enter only on last card | FI |
| 2-4 | ITEM INDEX NUMBER - I | NUMERIC - INTEGER (I3) | RJ |
| 5-28 | ITEM NAME | ALPHA - (24A1) | FR |
| 29-40 | ITEM PART NUMBER | ALPHA - (12A1) | FR |
| 41-43 | LFAC(I) | NUMERIC - REAL (F3.2) | ID or ED |
| 44-45 | LRU(I) | NUMERIC - INTEGER (I2) | RJ |
| 46-48 | NHI(I) | NUMERIC - INTEGER (I | |
| 49-50 | GFE(I) | NUMERIC - INTEGER (I2) | |
| 51-52 | INTEG(I) | NUMERIC - INTEGER (I2) | |
| 53-58 | UP(I) | NUMERIC - REAL (F6.0) | ID or ED |
| 54-52 | RM(I) | NUMERIC - REAL (F4.3) | |
| 63-67 | WT(I) | NUMERIC - REAL (F5.2) | |
| 68-71 | FA(I) | NUMERIC - REAL (F4.2) | |
| 72-80 | BLANK | | |

LEGEND

FI = Fixed Form
FR = Free Form
RJ = Right Justified
ID = Implicit Decimal - Comply with Format [▲]
ED = Explicit Decimal - Supply Decimal

## 7.3.9 LRU/SRU Cross Reference Data - Data File 8B

Data File 8B indicates for each LRU ITEM how many units that each SRU ITEM type goes into it according to the contractor's design. This information is required for conducting the repair level analysis (see Section 4), where the matrix variable QPA(IL,IS) is the quantity of SRU ITEM type IS per assembly of LRU ITEM type IL. The actual input of this information, however, is through a matix in pointer form as described below.

Each record (punched card) in File 8B contains all the information for a particular LRU ITEM type IL regarding the make-up of its SRUs. The LRU ITEM index IL is given in columns 2-4. The number of distinct SRUs which it contains is denoted by the variable NDS(IL) which is given in columns 5-6 (and whose value may not exceed 30). The index numbers of these distinct SRU ITEMS are represented in Data File 8B by the variables ISRU(IL,K) where K runs from 1 to NDS(IL).

The index number ISRU(IL,K) should represent exactly the same SRU ITEM type that it stood for in Data File 8A. The quantity of SRU ITEM type with index ISRU(IL,K) in each LRU ITEM type IL is represented by the variable QPA(IL,K). Note that this is a different interpretation of the matrix QPA than was used in the Repair Level Analysis Capability of the LCC Model. For example, in Figure 7-8B, QPA(1,2) = 3 means that 3 units of SRU ITEM type ISRU(1,2) = 24 (not type K=2) are contained in an LRU ITEM type 1. Thus, K does not stand for an SRU ITEM index number, but rather only refers to the order of the SRU ITEM type in the record corresponding to LRU ITEM type IL.

The parameters ISRU(IL,K) and QPA(IL,K) must be input in pairs, according to the format and column allocatior s indicated in Figure 7-8B. The LRU ITEM index numbers that appear in columns 2-4 in Data File 8B must represent exactly the same LRU ITEM types that they stood for in Data File 8A. Note that there should be exactly one record in Data File 8B for each LRU ITEM type (if an LRU ITEM type has no SRUs, it should have NDS(IL)=0) and that the records should be sequenced by LRU ITEM index numbers in increasing order (gaps allowed).

Again, the first column in Data File 8B serves as an end-of-file designator. Thus, an asterisk "*" in the first column denotes the end-of-file in the same manner as was described in Section 7.3.2.

191

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA - "*" enter only on last card | FI |
| 2-4 | LRU ITEM INDEX NUMBER - IL | NUMERIC - INTEGER (I3) | RJ |
| 5-6 | NDS (IL) | NUMERIC - INTEGER (I2) | |
| 7-9 | ISRU(IL,1) | | |
| 10-11 | QPA(IL,1) | | |
| 12-14 | ISRU(IL,2) | | |
| 15-16 | QPA(IL,2) | NUMERIC - INTEGER (I3) | RJ |
| 17-19 | ISRU(IL,3) | NUMERIC - INTEGER (I2) | RJ |
| 20-21 | QPA(IL,3) | | |
| 22-24 | ISRU(IL,4) | | |
| 25-26 | QPA(IL,4) | | |
| 27-29 | ISRU(IL,5) | | |
| 30-31 | QPA(IL,5) | | |
| 32-34 | ISRU(IL,6) | | |
| 35-36 | QPA(IL,6) | | |
| . . . | . . . | | |
| 72-74 | ISRU(IL,14) | | |
| 75-76 | QPA(IL,14) | | |

LEGEND

FI = Fixed Form
FR = Free Form
RJ = Right Justified
IP = Implicit Decimal - Comply with Format [a]
ED = Explicit Decimal - Supply Decimal

Figure 7-8B. LRU/SRU Cross Reference Data - Data File 8B

### 7.3.10 ITEM Maintenance Data - Data File 9A

Data File 9A contains all the information concerning the reliability and corrective maintenance characteristics of each ITEM type. Each record (punched card) in the file should contain all data pertaining to a particular ITEM type I. The data input parameters which should be listed on each record of this file, together with their designated formats and column allocations are indicated in Figure 7-9A.

The same ITEM indexing conventions that were described for Data File 8A also apply to Data File 9A. In addition, the ITEM index numbers appearing in columns 2-4 in Data File 9A must represent exactly the same ITEM types that they stood for in Data File 8A. Moreover, each ITEM type which is represented by a record in Data File 8A must also be represented by a record in Data File 9A, and vice-versa. Thus, the records in Data Files 8A and 9A must match up index number by index number, representing identical ITEM types in exactly the same sequence. In fact, an error message will be printed and processing will be terminated if the index numbers in these two files do not match (see Section 7.4 for a discussion of error messages). Both files must also contain the same number of records (with a maximum ITEM index value of 999).

A second error check will be performed to ensure that a non-zero value for MTBMI(I,LE(NP)) is input in Data File 9A whenever an ITEM of type I is installed on a platform with operating environment LE(NP) (i.e., NITEM(I,NP) > 0), where LE(NP) = 1, 2, 3, or 4, according to its definition given in the Glossary. If an ITEM is never used in a given environment, however, the corresponding MTBMI(I,LE(NP)) value may be entered as zero, since it will never be used in any LCC Model calculations.

Finally, if RL(I)=0 a third error check will be performed to ensure that the RTS(I), NRTS(I) and COND(I) parameters which appear on each record in Data File 9A add up to exactly one. As mentioned, a list and discussion of all error messages generated by the LCC Model is given in Section 7.4.

Note if RL(I)=1,2, or 3, then the program will calculate RTS(I), NRTS(I), and COND(I) using BIRD and WEAR(I) according to the repair level code (as shown in Table 7-3, Section 7.3). Recall that WEAR(I) is the fraction of removed failures of ITEM type I which must be condemned due to normal wear-out and is automatically set equal to the original COND(I) provided by the contractor in Data File 9A. RL(I) can be nominally set to 3 if the contractor believes the ITEM of type I should be discarded even if WEAR(I) < 1, but RL(I) must be set to 3 if WEAR(I) = 1.

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA - "*" enter only on last card | |
| 2-4 | ITEM INDEX NUMBER - I | NUMERIC - INTEGER (I3) | FI |
| 5-12 | MTBMI(I,1) | NUMERIC - REAL (F8.0) | RJ |
| 13-20 | MTBMI(I,2) | | |
| 21-28 | MTBMI(I,3) | | |
| 29-36 | MTBMI(I,4) | | |
| 37-40 | FPR(I) | NUMERIC - REAL (F4.3) | |
| 41-43 | RIP(I) | NUMERIC - REAL (F3.2) | |
| 44-48 | IPCF(I) | NUMERIC - REAL (F5.2) | ID or ED |
| 49-52 | KTS(I) | | |
| 53-56 | NRTS(I) | NUMERIC - REAL (F4.3) | |
| 57-60 | COND(I) | | |
| 61-64 | RMH(I) | | |
| 65-68 | BCMH(I) | NUMERIC - REAL (F4.2) | |
| 69-72 | BMH(I) | | |
| 73-76 | DMH(I) | | |
| 77 | RL(I) | NUMERIC - INTEGER (I1) | RJ |
| 78-80 | BLANK | | |

LEGEND

FI = Fixed Form
FR = Free Form
RJ = Right Justified
ID = Implicit Decimal - Comply with Format [a]
ED = Explicit Decimal - Supply Decimal

Figure 7-9A. ITEM Maintenance - Data File 9A

The first column in Data File 9A again serves as an end-of-file designator. Thus an asterisk "*" in the first column denotes the end-of-file in the same manner as was described in Section 7.3.2.

The user should recall from the discussion in Section 3 that the LCC sensitivity analysis calculations with respect to RTS(I), NRTS(I), and COND(I) assume that the maintenance data given for all repair level decisions in Data File 9A represents realistic estimates. Thus, for example, even if an ITEM type I is intended for discard-on-failure, realistic estimates for BCMH(I), BMH(I), and DMH(I) should be entered in the data file for LCC sensitivity analysis purposes.

### 7.3.11  ITEM Technical Order, Training, and SE Software Development Data- Data File 9B

Data File 9B contains all the information regarding the technical order page and type 1 training time requirements as well as SE software development cost for each ITEM type. Each record (punched card) in the file should contain all data pertaining to a particular ITEM type I. The data input parameters which should be listed on each record of this file, together with their designated formats and column allocations are indicated in Figure 7-9B.

Exactly the same ITEM indexing conventions that were described for Data File 9A apply to Data File 9B. One can simply refer to Section 7.3.10 for a detailed description.

The first column in Data File 9B again serves as an end-of-file designator. Thus, an asterisk "*" in the first column denotes the end-of-file in the same manner as was described in Section 7.3.2.

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA -"*" enter only on last card | F: |
| 2-4 | ITEM INDEX NUMBER - I | | |
| 5-7 | DATAD(I) | NUMERIC - INTEGER (I3) | RJ |
| 8-10 | DATAB(I) | | RJ |
| 11-13 | TIME1(I) | | |
| 14-19 | UCTDEV(I) | NUMERIC - REAL (F7.0) | ID or FD |
| 20-80 | BLANK | | |

LEGEND

FI = Fixed Form
FR = Free Form
RJ = Right Justified
ID = Implicit Decimal
     Comply with Format [△]
ED = Explicit Decimal -
     Supply Decimal

Figure 7-9B. ITEM Technical Order, Training, and
SE Software Development Data-Data File 9B

## 7.3.12 ITEM/SE Cross Reference Data - Data File 10

Data File 10 indicates which pieces of SE, and how many, are required for intermediate and depot-level corrective maintenance on each ITEM type I. Careful attention should be paid to the instructions for filling out this data file for the following reason: While the matrix variables SECODE(I,IRM,L) and A(I,IRM,L) appearing in Sections 5 and 6 are treated as separate variables, they are actually only separate digits of one variable, QSA(I,IRM,L). Furthermore, the matrix QSA(I,IRM,L) must be input in Data File 10 in pointer form.

The matrix QSA(I,IRM,L) is input in "pointer form" in Data File 10 using the following conventions: Each record (punched card) in the file contains all SE requirements for a particular ITEM type I with a particular mode IRM, where the index I is given in columns 2-4 and the index IRM is given in columns 7-8. The number of different repair modes (i.e., different values of IRM) with which ITEM I can be repaired is represented by NRM(I) given in columns 5-6 (and may not exceed 4). The number of different SE types (i.e., different values of L) utilized in the maintenance of ITEM type I in repair mode IRM is represented by the variable NJA(I,IRM), whose value should be given in columns 9-11 (and may not exceed 30). The index numbers of these different SE types are then represented in Data File 10 by the values of the parameters A(I,IRM,K) where the K runs from 1 to NJA(I,IRM).

Note that an entry must be input in Data File 10 for each ITEM only for repair modes (i.e., values of IRM) with which that ITEM can be serviced. (An entry may contain one or more records in the file, depending on the number of pieces of support equipment listed.)

IRM takes on four values. Each ITEM I should have an entry in the file corresponding to IRM=1 containing all SE requirements for depot level repair. All ITEMs whose base-level CSE and PSE requirements differ from depot SE requirements must have an entry in the file corresponding to IRM=2, listing all SE needed to repair an ITEM in the absence of any type of MBS or UCT. Repair modes 3 and 4 can be used to represent repair with any type of MBS or UCT. Any ITEM which is serviced by the equipment represented by IRM=3, IRM=4, or both, must have an entry listing of SE which would be needed at the base level for that value of IRM.

For example, suppose either an MBS or a UCT will be available for base level repair. This will be indicated by the user by setting BSP(NS)=2 or BSP(NS)=3 in Data File 2 for some NS. These two pieces of equipment can be represented by repair modes IRM=3 and IRM=4

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA -"*" enter only on last card | |
| 2-4 | ITEM INDEX NUMBER - I | NUMERIC - INTEGER (I3) | FI |
| 5-6 | NRM(I) | NUMERIC - INTEGER (I2) | RJ |
| 7-8 | IRM | NUMERIC - INTEGER (I2) | |
| 9-11 | NJA(I) | NUMERIC - INTEGER (I3) | |
| 12-15 | A(I,IRM,1) | | |
| 16-18 | QSA(I,IRM,1) | | |
| 19-22 | A(I,IRM,2) | | |
| 23-25 | QSA(I,IRM,2) | | |
| 26-29 | A(I,IRM,3) | | |
| 30-32 | QSA(I,IRM,3) | | |
| 33-36 | A(I,IRM,4) | | |
| 37-39 | QSA(I,IRM,4) | | |
| 40-43 | A(I,IRM,5) | NUMERIC - INTEGER (I4) | RJ |
| 44-46 | QSA(I,IRM,5) | NUMERIC - REAL (F3.0) | ID or ED |
| 47-50 | A(I,IRM,6) | | |
| 51-53 | QSA(I,IRM,6) | | |
| 54-57 | A(I,IRM,7) | | |
| 58-60 | QSA(I,IRM,7) | | |
| 61-64 | A(I,IRM,8) | | |
| 65-67 | QSA(I,IRM,8) | | |
| 68-71 | A(I,IRM,9) | | |
| 72-74 | QSA(I,IRM,9) | | |
| 75-80 | BLANK | | |

LEGEND

LJ = Left Justified
RJ = Right Justified
FR = Free Form
FI = Fixed Form
ID = Implicit Decimal - Comply with Format (▲)
ED = Explicit Decimal - Supply Decimal

Figure 7-10. ITEM/SE Cross Reference - Data File 10

respectively (MBS=3, UCT=4). Let ITEM I be an ITEM whose depot
level SE requirements are the same as base level support equipment
used in the absence of an MBS or a UCT. Hence there is a list of SE
coresponding to IRM=1 and not IRM=2. Suppose also that ITEM I is
capable of being serviced by the UCT, however, the MBS cannot
perform any check-out or repair activities on ITEM I. There will,
therefore, be a list of SE corresponding to IRM=4 but not IRM=3 for
ITEM I. (Note: when ITEM I is capable of being serviced by ITEM
repair modes 3 or 4, be sure to include the UCT or MBS in the
appropriate list of SE for that ITEM.)

The index number A(I,IRM,K) should represent the same SE type that
it stood for in Data File 7. (note that this is a different
interpretation of the matrix A than was used in the LCC Model
Equations.) Thus, A(I,IRM,1) is the index number of the first SE
type required in the repair of ITEM type I with repair mode IRM,
A(I,IRM,2) is the index number of the second SE type required, and
so on.

The type of maintenance action on ITEM type I with repair mode IRM
for which SE type A(I,IRM,K) is required (denoted in Section 4 by
SECODE) and the quantity (i.e., number of copies) of this SE type
required for each such maintenance action (denoted in Section 4 by
A) are given by the hundreds and units digits of the parameter
QSA(I,IRM,K). Thus in the example in Figure 7-10, QSA(1,1,3)=101
means that 1 copy of SE type A(1,1,3)=4 is required for repair but
not base bench check of ITEM type 1. (Note, in particular, that the
data given by QSA(I,IRM,K) does not correspond to SE type K, i.e., K
does not stand for an SE index number, but rather refers only to the
order of the SE type in the record corresponding to ITEM type I in
repair mode IRM.)

The parameters A(I,IRM,K) and QSA(I,IRM,K) must be input in pairs,
according to the format and column allocations indicated in Figure
7-7. The ITEM index numbers that appear in columns 2-4 in Data File
10 must represent exactly the same ITEM types that they stood for in
Data Files 8A and 9A & B. Moreover, each ITEM type which is
represented by a record in Data Files 8A and 9A & B must also be
represented by a record in Data File 10, and vice-versa. (If an
ITEM type I in repair mode IRM requires no support equipment for its
repair then the user should set NJA(I,IRM)=0.) Thus, the records in
Data Files 8A, 9A & B, and 10 must match up index number by index
number, representing identical ITEM types in exactly the same
sequence. In fact, an error mesage will be generated and processing
will be terminated if the ITEM index numbers in these files do not
so match. (See Section 7.4 for a discussion of error messages.)

In particular then, any addition or deletion of ITEMs made to any one of the Data Files 8A, 9A & B, 10 (or 11) must be made to the other four files also.

The first column in Data File 10 serves as an end-of-file designator. Thus, an asterisk "*" in the first column denotes the end-of-file in the same manner as was described in Section 7.3.2.

The echo printing of this Data File will be four tables (Tables 10A through 10D). Each table will show support equipment type and quantity by ITEM for a particular repair mode. Table 10A corresponds to IRM=1, Table 10B to IRM=2, Table 10C to IRM=3, and Table 10D to IRM=4.

### 7.3.13  ITEM Configuration on Platforms - Data File 11A

Data File 1'A consists of all of the values of the matrix variable
NITEM(I,NP), the average number of ITEMs of type I that are to be
installed on each platform within grouping NP.  Each record (punched
card) in Data File 11A contains all values which correspond to a
particular ITEM type I, where the index I must appear in columns 2-
4.  Since there is a maximum of 12 different platform groupings NP
currently allowed in the LCC Model, each record in the file then
contains the values NITEM(I,1) through NITEM(I,12), i.e., the
respective numbers of ITEMs of type I which are to be installed on
each platform within the 12 groupings NP.

Data File 11A is a very large file.  In an effort to make the
construction of this file easier for the user, a Preprocessor has
been included with the SSS LCC Model.  This preprocessor will
generate Data File 11A given Data File 8B (SRUs-in-LRUs) and Data
File 11B, LRUs-in-Platforms.  Thus the user may enter Data File 11B
and call on the preprocessor to generate 11A.  (See Section 7.5)

Note in Figure 7-11 that the format for entering each NITEM(I,NP)
value specifies two implicit decimal places.  This format is
utilized because of the fact that, while platforms included within a
particular platform grouping NP are of a similar type and function,
they are not all exactly the same.  There may even be a difference
in the number of SSS terminals that are installed on different
platforms within a particular grouping NP.  Thus NITEM(I,NP) should
be determined as a true average number of ITEMs of type I that are
installed on each platform within grouping NP and its value may very
well not be an integer.  (See Section 7.3.3 for a discussion of
implicit decimal formatting.)

The ITEM index numbers that appear in columns 2-4 in Data File
11A & B must represent exactly the same ITEM types that they stood
for in Data Files 8A, 9A & B, and 7.  In fact, all the conventions
regarding ITEM index numbers that were described for those files
apply equally well here.  Thus, the records in Data Files 8A, 9A &
B, 10 and 11 must match up index number by index number,
representing identical ITEM types in exactly the same sequence.
Again, an error message will be generated and processing will be
terminated if these ITEM index numbers do not so match.

As mentioned in the previous section, any addition or deletion of
ITEMs to any one of the Data Files 8A, 9A & B, 10 or 11A & B must
thus be made to the other files also.  However, for trade-off
studies, say performed in an interactive computer session, one can
effectively delete an ITEM type I from his system design by setting

201

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA -"*" enter only on last card | FI |
| 2-4 | ITEM INDEX NUMBER - I | NUMERIC - INTEGER (I3) | RJ |
| 5-8 | NITEM(I,1) | | |
| 9-12 | NITEM(I,2) | | |
| 13-16 | NITEM(I,3) | | |
| 17-20 | NITEM(I,4) | | |
| 21-24 | NITEM(I,5) | | |
| 25-28 | NITEM(I,6) | NUMERIC - REAL (F4.2) | ID or ED |
| 29-32 | NITEM(I,7) | | |
| 33-36 | NITEM(I,8) | | |
| 37-40 | NITEM(I,9) | | |
| 41-44 | NITEM(I,10) | | |
| 45-80 | BLANK | | |

LEGEND

FI = Fixed Form
FR = Free Form
RJ = Right Justified
ID = Implicit Decimal -
    Comply with Format (▲)
ED = Explicit Decimal -
    Supply Decimal

Figure 7-11A.  ITEM Configurations on Platforms —
Data File 11A

NITEM(I,NP) = 0 for all values of NP (without changing any other ITEM data in the other files).

Again, the first column in Data File 11A serves as an end-of-file designator. Thus an asterisk "*" in the first column denotes the end-of-file in the same manner as was described in Section 7.3.2.


### 7.3.14  LRU Configuration on Platforms - Data File 11B

Data File 11B consists of the values of NITEM(IL,NP) for all LRU ITEMs IL. This Data File is only required if the user is generating Data File 11A through the use of the preprocessor. Each record in Data File 11B contains all values of NITEM(IL,NP) which correspond to a particular LRU ITEM type IL, where the index IL must appear in columns 2-4. See section 7.3.13 for details on the format of Data File 11B, recalling that only LRU ITEMS appear in the file.

Again, the first column in Data File 11B serves as an end-of-file designator. Thus an asterisk "*" in the first column denotes the end-of-file in the same manner as was described in Section 7.3.2.

| COLUMN(S) | DESCRIPTION | FORMAT | JUSTIFICATION |
|---|---|---|---|
| 1 | END-OF-FILE-INDICATOR | ALPHA - "*" enter only on last card | FT |
| 2-4 | LRU ITEM INDEX NUMBER - IL | NUMERIC - INTEGER (I3) | RJ |
| 5-8 | NITEM(IL,1) | | |
| 9-12 | NITEM(IL,2) | | |
| 13-16 | NITEM(IL,3) | | |
| 17-20 | NITEM(IL,4) | | |
| 21-24 | NITEM(IL,5) | | |
| 25-28 | NITEM(IL,6) | NUMERIC - REAL (F4.2) | |
| 29-32 | NITEM(IL,7) | | |
| 33-36 | NITEM(IL,8) | | |
| 37-40 | NITLV(IL,9) | | ID or ED |
| 41-44 | NITEM(IL,10) | | |
| 45-80 | BLANK | | |

LEGEND:
FT = Fixed Form
FR = Free Form
RJ = Right Justified
ID = Implicit Decimal - (a) Comply with Format
ED = Explicit Decimal - Supply Decimal

**Figure 7-11B.   LRU Configurations on Platforms - Data File 11B.**

204

## 7.4 LCC Program Data Input Error Messages

There are two different categories of error checks which are made by the LCC program. The error checks in the first category are related to the index numbers used on the records in Data Files 2 through 11A. These error checks and associated error messages will be described first in this section. The error checks in the second category are all related to the values of the data inputs to the LCC Model. These error checks will be described in the second part of this section.

Error messages generated by the Preprocessor are discussed in Section 7.5. No error messages are generated by the RLA program, and in particular, no error checking is done of Data File 8B. Therefore extreme caution must be observed when contructing this data file.

Any error messages resulting from error checks made on the index numbers of input records will be printed at the user's terminal during his interactive input sequence at the point immediately preceding the NAMELIST routines (described in detail in Section 7.6 below). If off-line output is requested by the user, then these error messages will also appear on the off-line printer.

Any error messages resulting from error checks made on the values of data inputs will be printed at the user's terminal after the interactive NAMELIST routines have been completed. The error checks on data input values are made after these NAMELISTs have been completed by the user to ensure that they incorporate any new values of data inputs which may have resulted from "overwriting" in NAMELISTS /GO1/ and /GO2/. Again, if off-line output has been requested by the user, then these error messages will also appear on the off-line printer. The LCC Model will not be processed if any index number errors occur on data records. However, the user will still be allowed to complete the interactive NAMELISTs in this case so that he can receive the printout of any error messages concerning the values of data inputs. Thus, the user is immediately alerted to additional errors in the values of his data inputs. In addition, the first thirteen output tables of the LCC Model, which provide an echo print of the thirteen input data files, will always be printed off-line, as an aid in debugging data input errors.

If any data input error messages occur, then, after the interactive NAMELISTs have been entered and any data input value error messages have been printed, the message "PROGRAM STOPS DUE TO (NERRXX) ERRORS ON INPUT", where NERRXX equals the number of errors which have occurred.

There are ten types of specific error messages resulting from error checks on index numbers of input records. Any error message concerning the index number of records in Data Files 2 through 11B will identify the device channel number or name of the input data file in which the error occurs. (See Section 7.2 for these channel numbers.) These error messages are described below.

(1)  UNIT (XX) ERROR: END OF FILE CARD NOT FOUND AFTER MAXIMUM NUMBER OF CARDS WERE READ IN:

This error message refers to the data file with channel number (XX) and indicates either that there are too many records (punched cards) listed in the file or that the end-of-file card (i.e., a record with an asterisk "*" in the first column and all other columns blank) does not appear after the maximum number of records have been read in.

The maximum numbers of records allowed in each of the Data Files 2 through 11B are defined as follows: Data File 2 contains records which are indexed by Base type NS. Base-specific input parameters have an array dimension maximum of 8, hence at most 8 records may appear in this file. Data Files 3, 4, 5 and 6 contain records which are indexed by Platform type NP. Since all Platform-specific input parameters have an array dimension maximum of 6, at most 6 records may appear in these files. Data File 7 contains records which are indexed by Support Equipment type L. Since all SE-specific input parameters have an array dimension maximum of 30, at most 30 records may appear in this file.

The Data Files 8A, 9A & B, 10, and 11A all contain records which are indexed by ITEM type I. Currently, all ITEM-specific input parameters have an array dimension maximum of 999. Data File 8A then may have at most (and up to) 999 records. However, the number of records contained in Data File 8A then sets the maximum number of records that may be entered in Data Files 9A & B, 10, and 11A & B. Thus, for example, if Data File 8A contains only 60 records, then none of the Data Files 9A & B, 10, or 11A & B may contain more than 60 records. Data File 11B is indexed by LRU ITEM type IL, and the maximum number of LRUs allowed (from among the 999 ITEMs) is 120. There is no limit on the number of SRUs, so long as the total number of ITEMs does not exceed 999.

As mentioned in Sections 7.3.8A through 8.2.11, the ITEM index numbers used on successive records within Data Files 8A, 9A & B, 10, and 11A must, in fact, match up record by record, representing exactly the same ITEM types in exactly the same sequence. Since Data File 8A is read in first, it thus sets the ITEM indexing

standard against which Data Files 9A & B, 10, and 11A are tested. The following set of error messages all relate to this ITEM index number testing on Data Files 9A & B, 10, and 11A.

(2)  ITEM MAINT. FILE CONTAINS FEWER ITEMS THAN ITEM EQUIP. FILE

(3)  ITEM X-REF. FILE CONTAINS FEWER ITEMS THAN ITEM EQUIP. FILE

(4)  ITEM CONFG. FILE CONTAINS FEWER ITEMS THAN ITEM EQUIP. FILE

Error messages (2), (3) and (4) are self-explanatory and indicate, respectively, that Data File 9A & B, 10, or 11A contains fewer (ITEM-indexed) records than Data File 8A.

(5)  INDEXING IN ITEM MAINTENANCE DOESN'T MATCH ITEM EQUIPMENT

(6)  INDEXING IN ITEM X-REFERNC. DOESN'T MATCH ITEM EQUIPMENT

(7)  INDEXING IN ITEM CONFGURATN. DOESN'T MATCH ITEM EQUIPMENT

Error messages (5), (6), and (7) indicate that the ITEM index numbers used on successive records in, respectively, Data File 9A & B, 10, or 11A do not match up, record by record, with the ITEM index numbers used on successive records in Data File 8A.

The error messages resulting from error checks on the values of data input parameters are now discussed. These are listed below:

(8)  INPUT ERROR:  RTS + NRTS + COND <> 1 FOR ITEM TYPE (XX).

The ITEM specific parameters RTS(I), NRTS(I) and COND(I), which represent fractional repair level allocations and are entered in Data File 9A, must sum to unity for each ITEM type I with RL(I)=0. If this condition does not hold for a given ITEM type I = XX, then error message (8) will be printed.

(9)  INPUT ERROR:  INDENTURE LEVEL INDICATORS (LRU & NHI) NOT
     CONSISTENT FOR ITEM TYPE (XX)

If an ITEM type I is an LRU, i.e., LRU(I) = 1, then the next higher assembly indicator, NHI(I), must be set to zero. Conversely, if ITEM type I is an SRU, i.e., LRU(I) = 0, then NHI(I) must equal the non-zero ITEM index number of its next higher assembly. If either of these conditions fail to hold for a given ITEM type I = XX, then error message (9) will be printed. (Note: LRU(I) and NHI(I) are both contained in Data File 8A.)

(10)  INPUT ERROR:  MTBMI CANNOT BE ZERO FOR ITEM TYPE (XX) IN
      OPERATING ENVIRONMENT (YY).

As discussed in Section 7.3.9A, if an ITEM of type I is installed on
a platform of type NP, i.e., NITEM(I,NP) > 0, then the mean time
between maintenance incidence for that ITEM type operating in the
environment of platform type NP, denoted MTBMI(I,LE(NP)), cannot be
given a zero value in Data File 9A.  If this condition is violated
for an ITEM type I = XX operating in environment LE(NP) = YY, then
error message (10) will be printed, i.e., in this case MTBMI(XX,YY)
will not be allowed to be zero.  Note that there is sufficient space
allowed in Data File 9A to indicate very low failure rates (i.e.,
high MTBMIs), if they can be justified.

## 7.5 Operation of the Preprocessor

The SSS LCC Model Preprocessor performs two basic functions. First,
an ITEM in Platform matrix (Data File 11A) is created from a
(smaller) LRU ITEM in Platform matrix (Data File 11B), and second,
the by-item data files (Data Files 8A, 8B, 9A, 9B, 10, and 11A are
scanned for input file format errors.

### 7.5.1 Input/Output Device Channel Numbers

The Preprocessor is designed to operate alongside the SSS LCC Model
as a stand-alone program. It may be run interactively or in batch
mode. The channel numbers correspond to the same Data Files as the
LCC Model, as shown in Table 7-3. Note that

- o The LRU-in-platform matrix (Data File 11B) is channel 25 and
  must not be confused with the ITEM-in-platform matrix (Data File
  11A), which is an output of the preprocessor.

- o Data File 8B (channel 26) is not used in the LCC Model (it is
  used in the RLA program), and must be created before the
  preprocessor can be run.

- o An empty file must be created in channel 21 before the
  preprocessor can write Data File 11A into that channel.

### 7.5.2 Preparation of Data Input Files

All data files must be prepared as specified in Section 7.3.

### 7.5.3 Preprocessor Output

The output of the preprocessor is to the terminal (unit 6), and
consists of the following messages:

- o An message indicating that execution has begun
- o The number of LRUs and SRUs read from the initial file
- o Error messages (if any)
- o A message indicating the completion of execution and giving
     the total number of errors detected
- o A messaged stating whether the output file (file 11A) was
     written

The output file will be written only if no errors are detected in
files 8A, 8B, and 11B, and will be formatted exactly as specified in
Section 7.3.11 of the SSS LCC Model User's Manual. In addition,

209

off-line printouts of Data Files 11A and 11B are generated. Note that these printouts are not formatted exactly as the file created is formatted. The Data File created (11A) contains NITEM(I,NP) without decimal points in a field of width four, while the off-line printout displays NITEM(I,NP) with a decimal point in a field of width seven, for ease of reading.

Table 7-5 summarizes the error messages generated by the preprocessor and notes the probable causes and solutions associated with each error.

### 7.5.4 Sample Runs

Three sample runs are shown in figures 7-12 through 7-14. The first demonstrates normal execution of the preprocessor with correctly formatted input files. The second demonstrates some of the error messages generated by incorrectly formatted input files. The corresponding data files which are identified as containing errors are also partially listed (the first four columns are shown) to illustrate the errors). The third run demonstrates an abnormal termination of the preprocessor run due to a missing end-of-file card. Note that the FORTRAN error message is quite clear as to the source of the error.

## Table 7-5

### Summary of Preprocessor Error Messages

**Error 1**

**Message:**

ITEM NUMBER i HAS TWO CARDS IN UNIT u

**Probable Cause:**  Two cards with the same index number in columns 2-4 appear in unit u

**Programmer Response:**  Remove one of the two conflicting cards.

**Error 2**

**Message:**

A NEW ITEM INDEXED i APPEARS IN UNIT u

**Probable Cause:**  A card in unit u contains an index in columns 2-4 that did not appear in columns 2-4 on any card in the initial file

**Programmer Response:**  Remove or correct the conflicting card.

**Error 3**

**Message:**

AN SRU (ITEM i) APPEARS IN THE LRU LIST IN UNIT u

**Probable Cause:**  ITEM i is marked as an SRU in the initial file (by LRU(i)=0 ) but appears in a by-LRU file.

**Programmer Response:**  If ITEM i is an LRU, correct the initial file, if not, remove it from unit u.

211

## Table 7-5

### Summary of Preprocessor Error Messages
(continued)

**Error 4**

    <u>Message</u>:

        ITEM i IS MISSING FROM UNIT u

    <u>Probable Cause</u>:  A record with index i in columns 2-4 appears in the initial file, but no such record was found in unit u.

    <u>Programmer Response</u>:  If the record in the initial file does not belong there, then remove it.  Otherwise create a record in unit u with index i in colums 2-4.

**Error 5**

    <u>Message</u>:

        ITEM i IS OUT OF SEQUENCE IN UNIT u

    <u>Probable Cause</u>:  The index numbers in columns 2-4 of unit u are not in ascending numerical order.

    <u>Programmer Response</u>:  Resequence the records.

**Error 6**

    <u>Message</u>:

        INVALID SRU INDEX IN LIST FOR LRU ITEM i IN UNIT u

    <u>Probable Cause</u>:  The index for an ITEM in the SRU list for LRU ITEM i is out of the allowed range.  (See Section 7.3.8A for the allowable index range.)

    <u>Programmer Response</u>:  Correct the index if it was entered incorrectly, if it was entered correctly then the ITEM must be re-indexed within the allowable range.

Table 7-5

Summary of Preprocessor Error Messages
(continued)


Error 7

Message:

AN LRU (ITEM i) APPEARS IN THE SRU LIST IN UNIT u

Probable Cause: Index i appears in the SRU list for some LRU in
unit u, but is marked as an LRU in the initial file.

Programmer Response: If ITEM i is marked incorrectly in the
initial file, then correct it. Otherwise remove the LRU
from the SRU list.


Error 8

Message:

INVALID ITEM INDEX (i) APPEARS IN UNIT u

Probable Cause: An index in columns 2-4 of unit u is not in the
allowable index range. (See Section 7.3.8A for the
allowable ITEM index range.)

Programmer Response: If the index was entered incorrectly, then
re-enter it. If the index was correctly entered, then the
ITEM must be re-indexed within the allowable range.


Error 9

Message:

END OF FILE MARKER (*) MISSING FROM UNIT u

Probable Cause: The end of file designator was not found in
column 1 of the last record of the file.

Programmer Response: Place an asterisk (*) in column 1 of an
otherwise blank record at the end of the file.


213

Table 7-5

Summary of Preprocessor Error Messages
(continued)

**Error 10**

Message:

    FILE FORMAT ERROR IN UNIT u: NRM VALUE FOR ITEM i IS
        INCONSISTENT.  THE REMAINDER OF THIS FILE IS NOT READ.

Probable Cause:  The value of NRM on the record for ITEM i does
    not correspond to the number of IRM records found.

Programmer Response:  If NRM is greater than 1, then the records
    for these IRM values (that is, all but the first IRM value
    listed) must be blank in columns 1-6 (see Figure 7-10).
    For each ITEM, the program must find NRM-1 records which
    are blank in columns 1-6.

**Error 11**

Message:

    ITEM DESCRIPTION FILE CONTAINS MORE THAN MAXIMUM ALLOWABLE
        NUMBER OF ITEMS

Probable Cause:  The initial file (Data File 8A) contains more
    than 500 items.

Programmer Response:  Delete some items from the list, if
    possible, otherwise contact the Air Force Contracting
    Office concerning an extension of the maximum allowable
    number of items.

Table 7-5

Summary of Preprocessor Error Messages
(continued)

## Error 12

### Message:

UNIT u CONTAINS MORE ITEMS THAN INITIAL FILE

Probable Cause: If the file in unit u is by item, then there
are more items in this file than were in the initial file.
If the file in unit u is by LRU item, then there are more
LRU items in this file than there were items labelled as
LRUs in the initial file.

Programmer Response: This error will be generated with Error 2,
which will identify the "extra" items. If there are
extraneous items in the file in unit u, then remove them.
Otherwise, include the flagged items in the initial file.

## Error 13

### Message:

UNIT u CONTAINS FEWER ITEMS THAN INITIAL FILE

Probable Cause: If the file in unit u is by item, then fewer
items appear in this file than appeared in the initial
file. If the file in unit u is by LRU item, then fewer LRU
items appear in this file than there are items labelled as
LRUs in the initial file.

Programmer Response: This error will be generated with Error 4,
which will identify the "missing" items. If there are
missing items in the file in unit u, then enter them.
Otherwise, delete the flagged items from the initial file.

## Table 7-5

### Summary of Preprocessor Error Messages
### (concluded)

**Error 14**

**Message:**

IRM VALUE OUT OF RANGE FOR ITEM i IN UNIT u

**Probable Cause:** An IRM value not in the range of 1 through 4 was found.

**Programmer Response:** Correct the IRM value.


**Error 15**

**Message:**

LRU i CONTAINS TOO MANY SRUS IN UNIT u

**Probable Cause:** The SRU/LRU cross reference list for LRU ITEM i contains more than the allowable maximum number of SRUs.

**Programmer Response:** Delete some SRUs from the list, if possible, otherwise contact the Air Force Contracting Office concerning an extension of the maximum allowable number of items.


**Error 16**

**Message:**

END OF FILE FOUND BEFORE END OF SRU LIST FOR LRU i IN UNIT u

**Probable Cause:** While attempting to read in the SRU list for LRU i, an end of file condition occurred. The value of NDS (the number of distinct SRUs) did not match the actual number of ISRU/QPA pairings somewhere in Data File 8B.

**Programmer Response:** Correct the values of NDS in Data File 8B.

Preprocessor Output:

```
SSS LCC PREPROCESSOR -- EXECUTION BEGINS

  3 LRUS AND    3 SRUS READ FROM INITIAL FILE.

PROCESSING COMPLETED.    0 ERRORS DETECTED.

OUTPUT FILE (ITEMS IN PLATFORMS) WRITTEN TO UNIT 21.
```

Figure 7-12

Normal Preprocessor Execution -- No Errors Detected

<u>Preprocessor Output</u>:

SSS LCC PREPROCESSOR -- EXECUTION BEGINS

  3 LRUS AND   3 SRUS READ FROM INITJAL FILE.

UNIT 20 CONTAINS FEWER ITEMS THAN INITIAL FILE

     (ITEM   3 IS MISSING FROM UNIT 12)

ITEM   3 IS OUT OF SEQUENCE IN UNIT 22

UNIT 22 CONTAINS MORE ITEMS THAT INITIAL FILE

A NEW ITEM NUMBERED  16 APPEARS IN UNIT 22

A NEW ITEM NUMBERED  17 APPEARS IN UNIT 22

END OF FILE MARKER (*) MISSING FROM UNIT 22

PROCESSING COMPLETED.   7 ERRORS DETECTED.

OUTPUT FILE (ITEMS IN PLATFORMS) WRITTEN TO UNIT 21.


<u>Partial Listing of Data Files</u>

| Channel 12: | Channel 22: |
|---|---|
| Column | Column |
| 1---5 | 1---5 |
| 1 | 1 |
| 2 | 2 |
| 10 | 10 |
| 13 | 3 |
| 14 | 13 |
| * | 14 |
| (end of file) | 16 |
| | 17 |
| | (blank record) |
| | (end of file) |


Figure 7-13

Normal Preprocessor Execution -- Errors Detected

Preprocessor Output

SSS LCC PREPROCESSOR -- EXECUTION BEGINS

  3 LRUS AND    3 SRUS READ FROM INITIAL FILE.

UNIT 20 CONTAINS FEWER ITEMS THAN INITIAL FILE

    (ITEM    3 IS MISSING FROM UNIT 12)

IHO900I EXECUTION TERMINATING DUE TO ERROR COUNT FOR ERROR NUMBER 217
IHO217I FIOCS - END OF DATA SET ON UNIT   22


Partial Listing of Data File

    Channel 22:

        Column
        1---5
           1
           2
           3
          10
          13
          14
    (end of file)




Figure 7-14

Abnormal Termination of Preprocessor Execution

## 7.6 Operation of the LCC Program in Interactive Mode

The SSS LCC Model has been primarily designed for operation in interactive mode. No special procedures are required of the user to operate the LCC Model in interactive mode. There are, however, a few extra steps which are necessary to convert the Model to batch mode and these steps are discussed in Section 7.7.

After the user has prepared Data Files 1 through 11A and has initiated a run of the LCC Model, he must respond through his terminal to several computer-prompted questions and he must also complete three separate NAMELIST data input routines. This section gives the specific details necessary for the user to perform his terminal inputs properly. The discussion will be related to the sample interactive sequence in Figure 7-15, given at the end of this section. For illustrative purposes, the computer-prompted questions and directives appear in capital letters and the user responses and inputs appear in small letters.

After a run of the LCC Model has been initiated by the user, the computer first asks the user whether he wants MAXIMUM or MINIMUM PROMPTING, i.e., a maximum or minimum amount of instruction by the computer to the user. These prompting instructions relate to the current values of input and control variables and the purposes of the three separate NAMELIST routines. The example in Figure 7-15 below shows the maximum prompting instructions in brackets. Under minimum prompting, these instructions would not appear.

One feature of the prompting questions is that if the user requests maximum prompting on his initial run (or any subsequent rerun) of the LCC Model, then he will be asked on his next interactive rerun whether he wants maximum or minimum prompting again. However, if a user requests minimum prompting on one run, then the Model will automatically assume that he wishes minimum prompting on the next (and all subsequent) interactive reruns of the Model. To change from minimum prompting to maximum prompting, the user must exit from the LCC Model and then reinstate the Model as he did for his initial run.

The next two computer prompted questions in the example allow the user to designate whether he wants the output of the LCC Model to go to his terminal and/or to the off-line printer. As indicated in Figure 7-15, the user may direct either FULL, PARTIAL, OR NONE of the output to the off-line printer. FULL output consists of thirteen Input Tables which echo the thirteen input Data Files, seven LCC Output Tables, and an LCC Sensitivity Analysis Table. PARTIAL output consists of only the first three LCC Output Tables.

Output directed to the user's terminal, if requested, consists of Output Tables 1, a slightly condensed version of Output Table 3, and an LCC Sensitivity Analysis Table. These output tables are discussed fully in Section 7.7 and a full set of illustrative output tables is also presented in Appendix B.

If the user directs that the output of the LCC Model should go to the off-line printer, then the next computer instruction printed is "SUBMIT A TITLE FOR THIS RUN:". The user may then designate his current run with a title consisting of at most 28 characters. This title will appear on the header to the off-line output when the current run is processed. The differing titles of successive interactive reruns of the LCC Model will help the user sort out the output from the off-line printer. If output is not to be printed off-line, then a title will not be requested by the LCC Model.

The user then proceeds to the three NAMELIST routines. Before he enters these routines, the computer prints out the instruction, "SET EXITXX=1 IN ANY NAMELIST IF YOU WANT TO EXIT." This instruction means that the user can exit from his current run of the LCC Model during the execution of any of three NAMELIST routines by typing EXITXX=1 as a data input to that NAMELIST. When the NAMELIST is then entered, the processing of the LCC Model is bypassed and the computer-prompted question, "ANOTHER RUN (Y OR N)?" is immediately returned. This option allows the user the flexibility to terminate his current run and either re-initialize his next run or exit from the LCC Model altogether. This option would be useful, for example, if the user were to decide, during one of the NAMELIST routines, that he wanted to change his output designations in the preceding computer-prompted questions.

Next in Figure 7-15, a computer-prompted explanation of NAMELIST /G01/ is printed. As indicated in this explanation, NAMELIST /G01/ contains all data input variables from Data Files 1 through 12 that begin with the letters A through M. Before the first execution of NAMELIST /G01/, these variables are set equal to the values entered in the data input files. To use these values, the user need only submit an empty NAMELIST /G01/. However, he may override (i.e., overwrite) the values assigned by the input files to any of the NAMELIST /G01/ variables (and only these variables) by making the proper assignment in this NAMELIST.

Next the user must enter NAMELIST /G02/. As indicated in Figure 7-15, NAMELIST /G02/ performs exactly the same function as NAMELIST /G01/, except that NAMELIST /G02/ contains all data input variables from Data Files 1 through 12 that begin with the letters N through Z.

221

As an example, if the user wishes to make changes to the following data input parameters: BMH(4) = 1.5, RTS(5) = 0., COND(5) = 1., XFR = 1.25, then, as indicated in Figure 7-15, he should enter BMH(4) = 1.5, COND(5) = 1. in NAMELIST /GO1/ and RTS(5) = 0., XFR = 1.25 in NAMELIST /GO2/. All other data input parameters will retain the values that they were given in the Data Files. More extensive and sophisticated entries can, of course, be made in NAMELISTs /GO1/ and /GO2/, in accordance with the user's NAMELIST capability. Again, it is emphasized that the NAMELIST format used in the example in Figure 7-15 may not correspond to the format necessary at the user's computer installation. The user must determine his required NAMELIST format from his installation's FORTRAN manual.

After the user enters NAMELISTs /GO1/ and /GO2/, the computer then prints out the prompting for NAMELIST /SENS/. This NAMELIST controls the output of the LCC Sensitivity Analysis calculations. As indicated in the computer prompting, the Model will always output at the user's terminal the LCC sensitivity calculations with respect to the global parameters (listed in Table 3-1 in Section 3.2). For the ITEM-specific parameters for which LCC sensitivity analysis is provided, the user must input values for the control variables of the form LDXXX in NAMELIST /SENS/ to indicate the number of (most significant) sensitivity calculations that should be printed at his terminal for each of the ITEM-specific factors XXX(I). Thus, in the first run of Figure 7-15, the NAMELIST /SENS/ inputs direct that the 6 most significant calculations for each of the factors FR(I), UP(I), and SRU(I) be printed. Because the user did not submit a non-zero value for any other sensitivity control variable LDXXX, LCC sensitivity calculations for the other ITEM-specific factors will not appear at the user's terminal. Note that no index I is used with the LDXXX variables. Thus, set LDFR=6 and not LDFR(I)=6. Note that the factor SRU(I), discussed in Section 6.3, is included with the other ITEM-specific factors which are listed in Table 6-I.

The amount of LCC Sensitivity Analysis printed off-line is determined by the values of the control variables LDXXX and the control variable LDERV. The variable LDERV is also included in NAMELIST /SENS/ where it may be set equal to the minimum number of LCC sensitivity calculations that the user wishes to be printed in "hard-copy" off-line for each of the eight ITEM-specific factors. The actual number of sensitivity calculations for a particular ITEM-specific factor that will be printed off-line would then be equal to the maximum of LDERV and the value of LDXXX for that factor. For example, if LDERV=12 and LDUP=6, then the 12 most significant UP(I) calculations would be printed out off-line and the 6 most

significant UP(I) calculations would be printed out at the user's terminal.

The user should take care that none of the values of the control variables LDERV and LDXXX exceed the number of different ITEM types within his system design. An error will occur in the processing of the LCC Model if this condition is violated.

In addition, since the LCC sensitivity calculations for any one of these eight ITEM-specific factors is printed out in a format of 6 per line at the user terminal, the values of LDXXX specified by the user might as well be multiples of 6 to maximize the output per terminal line; and, since these calculations are printed out in a format of 12 per line on the off-line printer, the specified value of LDERV might as well be a multiple of 12.

If LDERV is not assigned a value in NAMELIST /SENS/, then it "defaults" to a value of 12. Thus, the effect of the input to NAMELIST /SENS/ in the first run in Figure 7-15 below is to direct that the 12 most significant calculations for each ITEM-specific factor be printed out off-line.

For a discussion of how "most significant" LCC sensitivity calculations are defined, the reader should refer to Section 6.1 (immediately before the CAUTIONS) and (for SRU(I)) to Section 6.3.

The user may also input a value for the variable FINC in NAMELIST /SENS/. As described fully in Section 6, the value of FINC represents the fractional increase in each factor undergoing sensitivity analysis that is used to determine the change in LCC. If FINC is not assigned a value in NAMELIST /SENS/, then it "defaults" to a value of 0.25 (as in the first run below).

As soon as NAMELIST /SENS/ is entered, the Model computes the LCC, including Sensitivity Analysis calculations. Then before the output of any data (and assuming no errors have occurred in processing the LCC Model), the computer prints out the message "LCC COMPLETED" and the instruction "IF YOU WISH TO EXIT, HIT -E-, THEN HIT -RETURN-; OTHERWISE ADJUST TERMINAL TO NEW PAGE AND HIT -RETURN-". The first part of this instruction tells the user how to exit from his current LCC Model run without having to wait for the output of the run to be printed. Typing "E" and then "RETURN" has the same effect at this point as entering "EXITXX=1" in any of the NAMELISTs above. Thus, if the "E-RETURN" option is exercised, then no output will be printed, either at the user's terminal or on hard-copy on the off-line printer. Otherwise, to receive the LCC output display, the user may at this point adjust his terminal to a new page (before

performing a carriage return) to enhance the readability of the output tables.

LCC Output Tables 1 and 3 will then be printed at the user's terminal. Since each of these tables takes up two (80 column) pages at a display terminal, the user may have to "clear" his terminal three successive times to view the two complete tables. The two output tables will "break" at convenient points. Since Output Tables 1 and 3 (as well as all other output tables) will be explained in detail in the Section 7.7, it has been left out of Figure 7-15. After these LCC output tables are printed and before the LCC Sensitivity Analysis calculations are displayed, the instruction "IF YOU WISH TO EXIT, HIT -E-, THEN HIT -RETURN-; OTHERWISE, ADJUST TERMINAL TO NEW PAGE AND HIT -RETURN-" is again printed out at the terminal. This instruction has the same effect at this point as was described for its first occurrence. A carriage return response to this instruction will cause a table of LCC Sensitivity Analysis calculations to be printed at the terminal. Again, since this output will also be explained in Section 7.7, it has been left out of Figure 7-15.

There are two possible variations that can occur in the two displays of the last instruction mentioned above. First, if output is not requested at the terminal, then this instruction will appear only once (immediately after "LCC COMPLETED"). Secondly, under "MINIMUM" prompting, only the last half of this instruction will be printed (as indicated by the brackets in Figure 7-15).

After the printout of the LCC Sensitivity Analysis Table has been completed, the computer-prompted question, "ANOTHER RUN (Y or N)-?", is printed at the user's terminal. An "N" response allows the user to exit from the LCC Model computer program. A "Y" response allows the user to rerun the LCC Model beginning with his interactive terminal inputs. Figure 7-15 below also illustrates a typical interactive rerun.

On any interactive rerun of the LCC Model, all overwritten values of NAMELIST /GO1/ and /GO2/ variables are retained from previous runs. In particular, this fact holds true even if a previous run was terminated by executing the "EXITXX=1" option in any NAMELIST. In this case, all inputs to any of the three NAMELISTs, either preceding or following the EXITXX=1 input, are retained for the next run.

After a "Y" response to the "ANOTHER RUN?" question, the computer prompts the question, "AT THIS POINT VARIABLE VALUES ARE AS THEY WERE AFTER THE LAST NAMELIST WERE SUBMITTED. DO YOU WISH TO RESET

NAMELISTS /GO1/ AND /GO2/ VARIABLES TO THE VALUES FOUND IN THE INPUT
FILES (Y OR N)-?". A "Y" response to this question directs that all
NAMELIST /GO1/ and /GO2/ variables be set back equal to their
initial values found in Data Files 1 through 12. A "N" response to
the question directs that the values assigned to these variables
through "overwriting" in all NAMELIST /GO1/ and /GO2/ statements
entered in previous runs during the current interactive session (and
since the last "reset") be retained as current values. Thus, a "N"
response designates that all NAMELIST /GO1/ and /GO2/ variables
start off the next run with the values used during the last run.

The remaining interactive computer-prompted questions and user
responses have the same structure as in the initial run. The user
is asked the three questions, "MINIMUM OR MAXIMUM PROMPTING?",
"OUTPUT AT TERMINAL?" and "FULL, PARTIAL, OR NO OUTPUT ON OFF-LINE
PRINTER?". His responses have the same implications as described
for the initial run. He may next enter a new title for his second
run. As indicated by the brackets in Figure 7-15, the "SET
EXITXX=1" instruc.ion is then printed on interactive reruns only
under "MAX" promting. However, on the initial run, the "SET
EXITXX=1" instruction is printed under either "MAX" or "MIN"
prompting.

Next, the user again encounters the three NAMELIST routines. Note
in the second run of the LCC Model in Figure 7-15 that the maximum
prompting portions of the computer instructions to these NAMELISTs
have changed (from those in the first run) to indicate the current
status of the respective NAMELIST variables. The user may at this
point overwrite any selection of the NAMELIST /GO1/ and /GO2/
variables that he chooses, keeping in mind the current values of
these variables in light of his response to the "RESET?" question.

The values of the NAMELIST /SENS/ variables are always retained from
the previous run (even if it was terminated by using "EXITXX=1" in
NAMELIST/SENS). Since these variables are not affected by the
user's response to the "RESET" question, the only way to change
their values from the previous run is to reassign them via NAMELIST
/SENS/. Thus, in the second run in Figure 7-15, the value of FINC
is changed to 0.20 and the value of LDFR is changed to 0. Thus, no
sensitivity analysis calculations with respect to the factor FR(I)
will appear on the second run, but because of the input to the
previous NAMELIST /SENS/, sensitivity calculations with respect to
UP(I) and SRU(I) will still appear.

After NAMELIST /SENS/ is again entered, the processing of the second run of the LCC Model takes place. The subsequent computer prompted directives and possible user responses are exactly the same as described for the initial run. The user may continue in this fashion, altering his data inputs and output formats through the three NAMELISTs, and making as many runs as he wishes, until he responds "N" to the question "ANOTHER RUN".

STRATEGIC SATELLITE SYSTEM LCC MODEL

MINIMUM OR MAXIMUM PROMPTING (MIN OR MAX)-?

max

OUTPUT AT TERMINAL (Y OR N)-?

y

OFF-LINE OUTPUT: FULL, PARTIAL, OR NONE (F, P, OR N)-?

f

SUBMIT A TITLE FOR THIS RUN:

first run

SET EXITXX=1 IN ANY NAMELIST IF YOU WANT TO EXIT.

(NAMELIST /GO1/ CONTAINS ALL VARIABLES FOUND IN THE INPUT FILES
THAT BEGIN WITH THE LETTERS A TO M.
AT THIS POINT, NAMELIST /GO1/ VARIABLES CONTAIN VALUES AS IN
THE INPUT FILES.
TO USE THESE VALUES, SUBMIT AN EMPTY NAMELIST /GO1/.
TO OVERIDE ANY OF THESE VALUES, SUBMIT A NON-EMPTY NAMELIST /GO1/.)
SUBMIT NAMELIST /GO1/ IN NAMELIST FORMAT:

$go1 bmh(4)=1.5, cond(5)=1. $end

(NAMELIST /GO2/ CONTAINS ALL VARIABLES FOUND IN THE INPUT FILES
THAT BEGIN WITH THE LETTERS N TO Z.
AT THIS POINT, NAMELIST /GO2/ VARIABLES CONTAIN VALUES AS IN
THE INPUT FILES
TO USE THESE VALUES, SUBMIT AN EMPTY NAMELIST /GO2/.
TO OVERIDE ANY OF THESE VALUES, SUBMIT A NON-EMPTY NAMELIST /GO2/.)
SUBMIT NAMELIST /GO2/ IN NAMELIST FORMAT:

$go2 rts(5)=0., xfr=1.25 $end

Figure 7-15

Sample User Terminal Interactive Session

227

(NAMELIST /SENS/ CONTAINS VARIABLES THAT CONTROL THE
DISPLAY OF THE SENSITIVITY ANALYSIS.
AT THIS POINT, THE TERMINAL DISPLAYS SENSITIVITY WITH
RESPECT TO ONLY GLOBAL SENSITIVITY VARIABLES.
FOR THE SAME TERMINAL DISPLAY, SUBMIT AN EMPTY NAMELIST /SENS/.)
SUBMIT NAMELIST /SENS/ IN NAMELIST FORMAT:

$sens ldfr=6, ldup=6, ldsru=6 $end

LCC COMPLETED.

IF YOU WISH TO EXIT, HIT -E-, THEN HIT -RETURN-; OTHERWISE,
ADJUST TERMINAL TO NEW PAGE AND HIT -RETURN-.

        (LCC OUTPUT TABLES 1 AND 3)

IF YOU WISH TO EXIT, HIT -E-, THEN HIT -RETURN-; OTHERWISE,
ADJUST TERMINAL TO NEW PAGE AND HIT -RETURN-.

        (SENSITIVITY ANALYSIS TABLE)

ANOTHER RUN (Y OR N)-?

y

AT THIS POINT, VARIABLE VALUES ARE AS THEY WERE AFTER LAST
NAMELISTS WERE SUBMITED.  DO YOU WISH TO RESET NAMELIST /GO1/ AND
/GO2/ VARIABLES TO THE VALUES FOUND IN THE INPUT FILES (Y OR N)-?

n

MINIMUM OR MAXIMUM PROMPTING (MIN OR MAX)-?

max


Figure 7-15

Sample User Terminal Interactive Session
(Continued)

OUTPUT AT TERMINAL (Y OR N)-?

y

OFF-LINE OUTPUT:  FULL, PARTIAL, OR NONE (F,P, )R N)-?

p

SUBMIT A TITLE FOR THIS RUN:

second run

SET EXITXX=1 IN ANY NAMELIST IF YOU WANT TO EXIT

(NAMELIST /GO1/ CONTAINS ALL VARIABLES FOUND IN THE INPUT FILES
THAT BEGIN WITH THE LETTERS A TO M.
AT THIS POINT, NAMELIST /GO1/ VARIABLES ARE AS THEY WERE AFTER
THE LAST NAMELIST /GO1/ WAS SUBMITTED.
TO USE THESE VALUES, SUBMIT AN EMPTY NAMELIST /GO1/.
TO OVERIDE ANY OF THESE VALUES, SUBMIT A NON-EMPTY NAMELIST /GO1/.)
SUBMIT NAMELIST /GO1/ IN NAMELIST FORMAT:

$go1  $end

(NAMELIST /GO2/ CONTAINS ALL VARIABLES FOUND IN THE INPUT FILES
THAT BEGIN WITH THE LETTER N TO Z.
AT THIS POINT NAMELIST /GO2/ VARIABLES ARE AS THEY WERE AFTER
THE LAST NAMELIST /GO2/ WAS SUBMITTED.
TO USE THESE VALUES, SUBMIT AN EMPTY NAMELIST /GO2/.
TO OVERIDE ANY OF THESE VALUES, SUBMIT A NON-EMPTY NAMELIST /GO2/.)
SUBMIT NAMELIST /GO2/ IN NAMELIST FORMAT:

Figure 7-15

Sample User Terminal Interactive Session
(Continued)

229

$go2    $end

(NAMELIST /SENS/ CONTAINS VARIABLES THAT CONTROL THE
DISPLAY OF THE SENSITIVITY ANALYSIS.
AT THIS POINT, THE TERMINAL SENSITIVITY DISPLAY IS
AS IT WAS ON THE PREVIOUS RUN.
FOR THE SAME TERMINAL DISPLAY, SUBMIT AN EMPTY NAMELIST /SENS/.
FOR A DIFFERENT TERMINAL DISPLAY, SUBMIT A NON-EMPTY NAMELIST /SENS/.)
SUBMIT NAMELIST /SENS/ IN NAMELIST FORMAT:

$sens finc=.20, ldfr=0 $end

LCC COMPLETED.

IF YOU WISH TO EXIT, HIT -E-, THEN HIT -RETURN-:  OTHERWISE,
ADJUST TERMINAL TO NEW PAGE AND HIT -RETURN-.

          (LCC OUTPUT TABLES 1 AND 3)

IF YOU WISH TO EXIT, HIT -E-, THEN HIT -RETURN-:  OTHERWISE,
ADJUST TERMINAL TO NEW PAGE AND HIT -RETURN-.

          (SENSITIVITY ANALYSIS TABLE)

ANOTHER RUN (Y OR N)-?

n

Figure 7-15

Sample User Terminal Interactive Session
(Concluded)

## 7.7   Operation of the LCC Program in Batch Mode

The SSS LCC Model may be easily converted from its normal interactive mode of operation to a batch mode by merely storing the appropriate interactive user responses in an internal data file and properly adjusting the assignment of device channel numbers.  All other aspects of running the LCC Model would remain the same in batch mode as they are in interactive mode.  This procedure is explained in greater detail below.  (To avoid redundancy, it is assumed that the reader is familiar with the previous contents of Section 7 of this User's Manual, especially Section 7.6).

To convert to batch mode, the user should create two internal data files.  The first of these files should contain the responses which, in interactive mode, would have been input by the user at the terminal.  Channel number 5 should be assigned to this file.  The second of these files should just be a dummy file to absorb normal computer-prompted messages which, in interactive mode, are displayed at the user's terminal.  The user should assign channel number 6 to this dummy file.

The responses which the user puts in the channel 5 file must be consistent with the description found in Section 7.6 and the illustration found in Figure 7-15.  Each user response should be listed on a separate and consecutive line in the data file.  For example, the interactive interface between user and computer that is illustrated in Figure 7-15 of Section 7.6 would be equivalently simulated in batch mode by creating the two data files described above.  A listing of the first of these data files would then be given by Figure 7-16 below.

Thus the lines in Figure 7-16 contain, in sequence, the user responses to the computer-prompted requests listed in Figure 7-15. The reader should compare the corresponding user inputs between Figure 7-15 and Figure 7-16.  In particular, he should note that the first blank line in Figure 7-16 serves as a carriage return response to the computer directive, "IF YOU WISH TO EXIT, HIT -E-, THEN HIT -RETURN-; OTHERWISE, ADJUST TERMINAL TO NEW PAGE AND HIT -RETURN-"., which immediately follows the "LCC COMPLETED" message.  The next blank line in Figure 7-16 serves as a carriage return response to the same directive when it is again prompted after the printing of the LCC Output Tables in Figure 7-15.

231

```
max
y
f
first run
$go1 bmh(4)=1.5, cond(5)=1. $end
$go2 rts(5)=0., xfr=1.25 $end
$sens ldfr=6, ldup=6, ldsru=6 $end
(blank line)
(blank line)
y
n
max
y
p
second run
$go1 $end
$go2 $end
$sens finc=.20, ldfr=0 $end
(blank line)
(blank line)
n
```

Figure 7-16

Data File for Batch Mode Version of Figure 7-15.


Of course, the user responses in Figure 7-15 are not very
appropriate for batch mode.  In particular, since the output which
would go to the user's terminal under interactive mode is just
dumped into a "dummy" file in batch mode, this portion of the LCC
output should be kept to a minimum.  Hence, in batch mode, minimum
prompting should be requested and the user response to the question
"OUTPUT AT TERMINAL (Y or N)-?" should be "N".  In addition, the
value of each control variable of the form LDXXX should be left at
its default value of 0 by merely leaving these variables out of
NAMELIST /SENS/.

Thus a more appropriate set of user responses to be listed in the
first additional internal data file under batch mode is illustrated
by Figure 7-17 below.

```
min
n
f
first run
$go1 $end
$go2 $end
$sens 1derv=24 $end
(blank line)
y
n
n
p
second run
$go1 $end
$go2 xuc=1.25, xfr=.70 $end
$sens finc=.20 $end
(blank line)
n
```

Figure 7-17

Typical Data File for Batch Mode

Note in Figure 7-17 that minimum prompting is requested on the first run, hence, as described in Section 7.5, this prompting question will not be asked on the second run and therefore no "max" or "min" response is required for the second run. Also note, since the response to the question "OUTPUT AT TERMINAL-?" is "n", that only one blank line is required in the first (and second) run of Figure 7-17 because no carriage return between the output of the LCC Tables and the Sensitivity Analysis Table is required if no output is directed to the "terminal" (i.e., the dummy file in batch mode). Again, the reader should compare the user responses in Figure 7-17 to the computer prompted sequence of requests which are discussed in Section 7.5.

In batch mode the user may still make as many successive reruns of the LCC Model as he wishes, provided that the responses which he lists in the data file are consistent with the computer prompted requests that are generated. An inconsistent response would terminate the processing of the LCC Model and cause an error message to be displayed on the off-line printer.

## 7.8  Operation of the RLA Program

The purpose of using the RLA Program is to reach a good decision on
the repair level for each ITEM.  In terms of the input data to the
LCC Program, one is to determine the RL(I) value for each ITEM type
I.  To do this, the following data files must be set up as inputs to
the RLA Program:

o Data File 9A - This is to provide the initial RL(I) values set
   by the user.  These values are not used directly in the RLA
   procedure, but rather they will be checked with the RLA-derived
   on LCRL(I) values to indicate any differences.  Also, the
   COND(I)s on Data File 9A will be checked to see any COND(I)=1.,
   for which LCRL(I) will be automatically set to 3 (dscard-on-
   failure) in the RLA procedure.

o Data File 8B - This is to provide the LRU/SRU Cross-Reference
   Data QPA(IL,IS)s.

o Data File 13 - This is a save file with TIAC(I,R)s provided by 6
   special LCC Program runs, which are set up in a consecutive
   batch mode.  The data file for conducting these 6 runs is listed
   in Figure 7-18.  The total ITEM support cost TIAC(I,R) for
   global repair strategies R=1 through R=6 are calculated
   respectively in these six LCC runs and saved in Data File 13 as
   an input to the RLA Program.

With these inputs, the RLA Program is executed to produce the
recommended repair level LCRL(I) for each ITEM type I (the detailed
instruction for this part of operation will be furnished later).
The LCRL(I) value is then used by the Program to replace RL(I) on a
copy of Data File 9A (the original Data File 9A will be left
intact).  The new Data File 9A with the updated RL(I)s can then be
used for the final LCC Program run, and any further change on the
RL(I)s can still be made through the NAMELIST capability of the LCC
Program.  The LCRL(I)s will also be printed by the RLA Program with
an indicator to flag any difference between LCRL(I) and the original
RL(I) value.

234

```
min                             n
n                               n
f                               f
first run: R=1                  fourth run: R=4
 $go1 $end                       $go1 $end
 $go2 R=1 $end                   $go2 R=4 $end
 $sens $end                      $sens $end
(blank line)                    (blank line)
(blank line)                    (blank line)
y                               y
n                               n
n                               n
f                               f
 second run: R=2                 fifth run: R=5
 $go1 $end                       $go1 $end
 $go2 R=2 $end                   $go2 R=5 $end
 $sens $end                      $sens $end
(blank line)                    (blank line)
(blank line)                    (blank line)
y                               y
n                               n
n                               n
f                               f
third run: R=3                  sixth run: R=6
 $go1 $end                       $go1 $end
 $go2 R=3 $end                   $go2 R=6 $end
 $sens $end                      $sens $end
(blank line)                    (blank line)
(blank line)                    (blank line)
y                               n
```

Figure 7-18

Data File for Six LCC Runs for RLA Input

235

## 7.9  Description of Model Output Tables

A general description of the LCC Model output was given in Section
6.2.3.  Output of the LCC Model can be directed by the user to
either "hard-copy" on the off-line printer or to the user's terminal
(or both), as described in Section 7.5.  An example of the full off-
line output of the LCC Model is given in Appendix B.  This section
gives a table by table explanation of the significance of this
output.  Since the output displayed at the user's terminal is just a
subset of the off-line output (as described in Section 7.5) our
description of the output in Appendix B will also cover the output
displayed at the terminal.

Note:  Since arbitrary data was used to generate the output in
Appendix B, the user should in no way construe that the values
displayed are meant to be representative of prospective SSS designs.

As illustrated in Appendix B, each listing of output on the off-line
printer is preceded by the heading, "SSS LCC MODEL", and the title
of the current run (i.e., the title submitted at the terminal by the
user).

The first component of off-line output of the LCC Model is an
echoing of the thirteen input data files.  As shown in Appendix B,
the inputs to these files are listed in fifteen successive tables,
where in each table the variable name, a brief definition, and the
assigned value of each data parameter is printed out.  As mentioned
previously, this listing of the values of data parameters allows the
user to check that his data was input correctly to the LCC Model.
Note that the Input Table number in which each parameter is printed
in Appendix B is the same as the Data File number in which it is
entered into the LCC Model.

The order in which data input parameters are printed out in Input
Tables 2 through 11A in Appendix B is the same as the order in which
these parameters appear in the corresponding Data Files.  (This fact
is borne out by comparing Input Tables 2 through 11A in Appendix B
with Figures 7-2 through 7-17 in Section 7.3.

Even though bogus data and names were used to generate the
illustrative run which appears in Appendix B, there is a "code"
built into the ITEM part numbers which appear in Input Table 8A
which may help the reader interpret the significance of some of the
data inputs.  It is not necessary that the contractor utilize this
built-in code.  Specifically, ITEM part numbers which begin with the
letters AL, SL, AS, SS, and ASS indicate, respectively, that the
ITEM is an Airborne LRU, Surface LRU, Airborne SRU, Surface SRU, and

236

common Airborne-Surface SRU. Here "Airborne" and "Surface" mean that the ITEM is generally installed only on platforms which operate in that environment.

After the fifteen tables of input data, the next section of output to the off-line printer contains the total LCC of the user's SSS design, broken down into various categories in seven separate tables. As shown in Appendix B, Output Table 1 of this section contains a breakdown of the total LCC in terms of its eleven Top-Level Cost Elements, i.e., Full Scale Engineering Development, Prime Mission Equipment (Hardware and Integration), Operations, Modification/Installation, Spares (Investment and Replacement), Support Equipment, On-Equipment Maintenance, Off-Equipment Maintenance, Training, Inventory Management, and Technical Orders. Each cost element is broken down into three program phases: Development, Production, and Support. The last column of Output Table 1 gives a total cost for each cost element and the last row of the table shows a total for each of the three program phases. A total Life Cycle Cost is given in the lower right hand corner of Output Table 1.

Output Table 2 presents a detailed breakdown of the Modification Installation Cost Element. It exhibits the recurring MOD/I costs broken down into costs incurred by each individual platform grouping. This portion of the table is self-explanatory and is easily interpreted by referring to the equation for platform NP recurring MOD/I cost, RMICA(NP), which is presented in Section 2.3.3. In particular, the "Retrofit Mod/I Total" is the sum over "Field" and "Depot" modifications (i.e., modes M=2 and M=3). The "Production Mod/I Total" is the sum for "Production" modifications (i.e., mode M=1).

Output Table 3 presents a breakdown of the Top-Level Initial Sepport and Recurrent Operations & Support Cost Elements which appeared in Output Table 1. As shown in Appendix B, the Initial Spares cost element is considered as an "Initial" or acquisition cost, while the cost elements, Added Fuel, Operations Labor, Replacement Spares, On-Equipment Maintenance, and Off-Equipment Maintenance are considered as "Recurring" costs. In addition, the costs of purchasing required SE is considered an Initial cost, while the cost of maintaining SE (at the fraction MSE(L) of unit cost per year) is considered a Recurring cost. The partitioning of the SE Cost Element into Initial and Recurring costs can be determined by examining its equation in Section 2.3.9. Also, the cost of entering new items in the Air Force depot-level inventory management system (at a cost of IMC dollars per item) is considered an Initial cost, whereas the cost of maintaining items in the inventory at the base and depot

levels (at costs of SA and RMC dollars per item per year, respectively) is considered a Recurring cost. This separation of cost into Initial and Recurring portions can be determined from the ITEM Inventory Management Cost Element equation which is presented in Section 2.3.7. Similarly, the acquisition of technical orders and type 1 training will incur Initial costs, while the upkeep of technical orders and other training activities will incur Recurring costs. Again, these breakdowns of costs can be determined from the equations for Maintenance Training and Technical Orders in Sections 2.3.11 and 2.3.12.

All of the cost elements listed in Output Table 3 have their costs calculated within the computerized LCC Model for each individual base type NS and the depot. Thus, each of these cost elements may be easily divided into costs incurred at the various locations indicated in the table. The base indicators BTYPE(NS) and BPLAT(NS) which appear in Input Table 2 are utilized to perform this allocation of costs. These two indicators are also used to determine the numbers of different bases which appear at the bottom of Output Table 3.

Output Table 4 (in three parts: a, b, and c) in Appendix B illustrated the breakdown of costs and other corrective maintenance characteristics which can be attributed to individual ITEM types. In particular, the first part of the table (4a) presents the value of the ITEM specific costs ISCA(I), RSCA(I), ONMCA(I), OFMCA(I), MTRCI(I), TDC(I), and IIMCA(I) whose equations appear in Sections 2.3.5, 2.3.6, 2.3.7, 2.3.8, 2.3.10, 2.3.11 and 2.3.12 respectively. Note that the bottom totals for these columns give the total cost of the Initial Spares, Replacement Spares, On-Equipment Maintenance, Off-Equipment Maintenance, Maintenance Training, Technical Data, and ITEM Inventory Management Cost Elements, respectively. These cost elements also appear in Output Table 3.

The costs in Output Table 4A are presented in _thousands_ of dollars. In addition, the cost elements for Production, Mod/Installation, Operations Labor, Added Fuel, and SE do not appear in Output Table 4A, because these costs are not directly attributable to individual ITEM types.

The column designated "Corrective Maintenance Cost per Failure" holds the average cost of Replacement Spares, On-Equipment and Off-Equipment Maintenance per ITEM failure, i.e., the sum of RSCA(I), ONMCA(I) and OFMCA(I) divided by the number of lifetime failures of ITEM type I which is given in the last column of the second part (4B) of the table. Note that the costs of Initial Spares, Maintenance Training, Technical Data, and ITEM Inventory Management

are not included in this figure because the costs in these categories are not incurred in association with individual ITEM failures.

The second part of the Table 4 (4B) lists for each ITEM the total number installed in the system, total initial spares at bases, and total initial spares at the depot. Their sum is then listed in the fourth column. The monthly and lifetime failures for each ITEM are presented in the next two columns. The learned unit cost is given in the next column followed by the production contract procurement quantity (i.e., the total number of initial and replacement spares which will be bought under the production contract).

The last part of the Table 4 (4C) gives the average corrective maintenance costs per LRU failure and per SRU failure as well as the estimated total number of LRU failures system-wide.

Output Table 5 presents costs (in thousands of dollars) and requirements for each individual SE type L. The SE costs included are the unit lifetime cost, technical orders cost, and SE development cost. Recall that, within the LCC Model, common SE which is available on-site may be acquired and costed on a fractional, pro-rated basis, depending on its utilization for SSS. Thus, the Model may charge, say, .25 of such a SE unit to a particular base location or the depot. All SE requirements in the table, however, (except for the depot) are rounded to the nearest integer.

Common SE which requires procurement for SSS use (i.e., common SE which is not on the Air Force provided list) and PSE must be required within the LCC Model in unit quantities. Thus the full unit cost of this SE will be incurred if this SE is required for even low utilization.

Also given in Output Table 5 is the Total UCT Software Development Cost. This cost is added to Total System Lifetime Cost to get the total Support Equipment Cost.

Output Table 6 exhibits the average total (series) failure rate per platform of each type NP in terms of both failures per month and per million operating hours. Per terminal failure rates by platform type are also shown and are obtained by dividing the per platform failure rates by the number of terminals per platform (i.e., by NTRMP(NP))

The per platform failure rates represent the sum of the (series) failure rates of all SSS ITEMs which are installed on that platform

239

type (i.e., NITEM(I,NP)). The total number of platforms within each grouping NP for the SSS is also displayed in Output Table 6. By multiplying these numbers by the per platform failure rates, one can obtain the system-wide failure rates of complete platform groupings.

Output Table 7 lists for each base type the maintenance manpower requirements per year per base. These requirements are broken down into two areas: manpower for maintenance itself and that for its management data (both in manhours). The sum of the two is listed (in manyears) in the fourth column of the table. And the last two columns of the table show the total manpower requirements per year per base type, first in manhours and then in manyears. At the end of each of these two columns, it shows the total for all the base types, the total for the depot, and then their sum or the grand total.

Also shown in the lower portion of Output Table 7 are the total manpower requirements for maintenance training. They are listed in manyears for the first year and then for each subsequent year.

The last section of the main output contains the results of the LCC Sensitivity Analysis calculations. As fully described in Section 6, the Sensitivity Analysis calculations yield the average change (either positive or negative) in the total LCC which is produced by a fractional change in the value of each of the factors XUC, XFR, XFPR, BMF/DMF, XRM, PIUP, XMIL, UP(I), FR(I), FPR(I), RM(I), RTS(I), NRTS(I), COND(I), and SRU(I). (LCC sensitivity with respect to SRU(I) actually measures the cost impact of changing ITEM type I from an SRU to an LRU and hence is not associated with a fractional change, see Section 3.3). For a full appreciation of the significance and the limitations of the LCC Sensitivity Analysis calculations, the user should read Section 6 thoroughly. In particular, the user should read through the "Cautions" listed in Section 3.2.

The LCC Sensitivity Analysis Table first gives the changes in LCC produced by a percentage change (equal to FINC) in each of the global scalar factors XUC through XMIL above. For the remaining eight factors, which are all subscripted by ITEM type, a specific number of the "most significant" calculations are displayed for each factor. The specific number of calculations displayed for each factor is determined by the values of the control variables LDERV and LDXXX, as described in Section 7.5. Here the "most significant" calculations follow the definitions given in Sections 3.2 and 3.3.

Thus, under the heading for each of the eight subscripted factors in the LCC Sensitivity Analysis Table, the calculations pertaining to

240

individual ITEM types are presented in a column by column fashion in order of decreasing significance (i.e., most significant appear first). In a given column, representing a particular ITEM type, the three values displayed represent, respectively, the index number of the ITEM type, the actual (i.e., not fractional) change in the value of the factor that is used to determine the change in LCC, and the resulting change in LCC produced by the given change in the factor.

Note, in particular, that the change in the value of FR(I), the failure rate of ITEM type I, is expressed in terms of failures per million operating hours. Also, the change in the SRU(I) factor is given as 1 if the calculation represents the estimated cost difference produced by changing ITEM type I from an SRU to an LRU. The change in SRU(I) is given as 0 if ITEM type I cannot be changed from an SRU to an LRU (e.g., if it is already an LRU). In addition the change in the value of RM(I), the repair materials factor, is expressed in terms of the change in the cost of repair materials per repair of ITEM type I (i.e., the change in RM(I)*UP(I)), rather than just the change in the factor RM(I) itself.

Also note that, for RTS(I), NRTS(I), COND(I), and SRU(I), only negative changes in LCC will appear in the table, indicating a savings in LCC. This is because, for these four factors, "most significant" is defined as largest negative LCC sensitivity analysis calculations. Thus, to facilitate the sorting of most significant sensitivity calculations, positive changes in LCC for these four factors will be zeroed out. For the other four ITEM-specific factors UP(I), FR(I), FPR(I), and RM(I), "most significant" LCC sensitivity analysis calculations are interpreted as meaning those which are largest in absolute value, because these calculations are basically two-sided (again, see "Cautions" in Section 3.2).

Finally, the output printed at the user's terminal by the LCC Model consists only of Output Table 1 (in the exact same format as it appears in Appendix B), Output Table 3 (where the INDEP, CIMF, SATEL BASE, and BASE TOTAL columns have been deleted) and the Sensitivity Analysis Table. In addition, at the terminal there may be fewer calculations displayed for each of the eight ITEM-specific factors mentioned above, depending again on the values of the control variables LDERV and LDXXX, as described in Section 7.5. None of the echoed Input tables or other Output tables will be displayed at the user's terminal.

# APPENDIX A

## GLOSSARY OF VARIABLES

A(I,IRM,L)           = Number of pieces of support equipment of type L
                       required in the maintenance of ITEM type I when
                       repair mode IRM exists.  (Note:  The matrix A
                       should be input in "pointer" form in Data File
                       10.  See instructions in Section 7.3.10)
                       (Contractor input in Data File 10)


ACF(I,NS)            = Average off-equipment maintenance cost in
                       dollars per failure of ITEM type I at base NS
                       (Internally calculated in Section 2.4.7)


ACPP                = Average acquisition cost per page for original
                       negatives of technical orders.  (Air Force input
                       in Data File 1)


AFC                 = Total cost in dollars for the added Fuel Cost
                       component of the Operations Cost Element
                       (Internally calculated in Section 2.4.3)


AKIT(IA,NP)         = Unit cost for each "A-Kit" required for a
                       modification/installation to area IA on platform
                       type NP, to include all installation material
                       costs not included in "Terminal" costs
                       (Contractor input in Data File 5)


AMPM(NP,LO(NS))     = Average prime mission equipment missions per
                       month for platform type NP at a base at location
                       LO(NS).  (Air Force input in Data File 3)


APFH(NP,LO(NS))     = Average operating hours permonth for platform
                       type NP deployed at base location LO(NS) (Air
                       Force input in Data File 3)

242

| | |
|---|---|
| B | = (secondary) index used to indicate base groupings, primary index for bases is NS |
| BAA | = Total available active work time per maintenance man in hours/month at a base repair shop (Air Force input in Data File 1) |
| BCIS(I) | = The number of bases which perform intermediate level repair of ITEM type I (and hence require an inventory of ITEM piece parts) (Internally calculated in Section 2.4.9) |
| BCMH(I) | = Average manhours to perform a base shop bench check, screening and fault verification of the removed ITEM prior to initiating repair action or condemning the ITEM. (Contractor input in Data File 9A) |
| BDATA | = Number of additional (beyond these intended for depot use only) distinct pages of system level (not ITEM or support equipment specific) technical orders written for base level maintenance (Contractor input in Data File 1) |
| BF | = Coefficient in the function F which is used to compute ITEM initial spares requirements (Air Force input in Data File 1) |
| BIRD | = Fraction of base-repair-intended failures which are actually repaired at the depot due to insufficient base repair capability. (Air force input in data File 1) |
| BIS(I) | = The number of bases which stock spares of ITEM type 1 (and hence are charged inventory management costs) (Internally calculated in Section 2.4.9) |
| BLR | = Base Maintenance labor rate in dollars per hour. (Air Force input in Data File 1) |

BMF                 = Base repair maintenance factor, to be applied to repair times to allow for time to get test equipment, parts, etc.  (Air Force input in File 1)

BMH(I)              = Average manhours to perform base-level corrective maintenance of a failed ITEM of type I, including fault isolation, repair and verification.  (Contractor input in Data File 9A)

BPLAT(NS)           = Indictor of PME platform types supported by base NS, equals
                      1,if base NS supports mainly airborne platforms,
                      2, if base NS supports mainly ground platforms,
                      (Air Force input in Data File 2)

BRCT                = Base repair cycle time, time from removal of a failed ITEM  at a base until ITEM is repaired (at the same base) and returned to base inventory.
                      (Air Force input in Data File 1)

BS(I,NS)            = Average number of Initial spares of ITEM type I that are required at each base within base grouping.  (Internally calculated in Section 2.4.4)

BSP(NS)             = Base level support equipment philosophy, equals
                      1, if PSE only is used
                      2,3, if an MBS and/or a UCT plus
                          additional PSE are used
                      (Contractor input in Data File 2)

BTYPE(NS)           = Base types indicator; equals:
                      1, if base NS is an Indepedent base
                      2, if base NS is a CIMF
                      3, if base NS is a Satellite base
                      (Air Force input in Data File 2)

CFG(LO(NS))        = Cost in dollars per gallon of fuel at opearating
                     location LO(NS)  (Air Force input in Data File 1)


CIMF(NS)           = CIMF base indicator equals 1 if base NS is a
                     CIMF (Centralized Intermediate-level Maintenance
                     Facility) and equals 0 otherwise. (Internally
                     calculatad in Section 2.3.2)


COND(I)            = Fraction of (removed) failures of ITEM type I
                     which are condemned, due to normal wear-out. (The
                     LCC Model will automatically adjust the COND(I)
                     fraction if ITEM type I is occasionally discarded
                     because its next higher assembly has worn-out or
                     is a discard-on-failure assembly) (Contractor
                     input in Data File 9A)


CPA(I)             = Corrected piece part count for ITEM type I;
                     equals PA(I) unless ITEM type I is designated as
                     a discard-on-failure ITEM (i.e., COND(I)=1) in
                     which case CPA(I) is set equal to zero
                     (Internally calculated in Section 5.2.9)


CPD1               = Cost per class per day for type 1 training.
                     (Contractor input in Data File 1)


CPD2               = Cost per class per day for type 2 training.
                     (Air force input in Data Filc 1)


CPPC               = Average one way packing & shipping cost in
                     dollars per (net weight) pound from a satellite
                     base to its associated CIMF (including an
                     adjustment to allow for ratio of packaged weight
                     to unpackaged weight) (Air Force input in Data
                     File 1)


CPPD(LO(NS))       = One-way packing & shipping cost in dollars per
                     (net weight) pound from a base at location LO(NS)
                     to the depot (including an adjustment to allow
                     for the ratio of packaged weight to unpackaged
                     weight ) (Air Force input in Data File 1)


245

CRCT        = CIMF repair cycle time, time from removal of a failed ITEM at a satellite base until it is shipped to and repaired at the associated CIMF and placed in CIMF inventory. (Air Force input in Data File 1)

CSE(L)        = Unit cost of SE type L in dollars. Should include a pro rata portion of development cost if L is peculiar SE. Should include a pro rata portion of the cost of any new programming required if L is programmable SE. (Contractor input in Data File 7)

DAA        = Total available active work time per maintenance man in hours/month at a depot repair shop (Air Force input in Data File 1)

DAD        = Average depot handling and repair time in months from removal of a failed ITEM at the depot until it is repaired and placed in depot inventory. (Air Force input in Data File 1)

DATAB(I)        = Number of additional distinct pages of technical orders required for base check-out and repair of ITEM type I. (Contractor input in Data File 9B)

DATAD(I)        = Number of additional distinct pages of technical orders required for check-out and repair of ITEM type I and written for depot use only. (Contractor input in Data File 9B)

DATAS(L)        = Number of additional distinct pages of technical orders required for use of support equipment type L and not including any documentation which may be included in the unit cost of L. (Contractor input in Data File 7)

DDATA        = Number of distinct pages of system level (not ITEM or support equipment specific) technical orders intended for depot maintenance only. (Contractor input in Data File 1)

DLR        = Depot maintenance labor rate in dollars per hour. (Air Force input in Data File 1)

DMF        = Depot repair maintenance factor, to be applied to repair times to allow for time to get test equipment, spare parts, etc. (Air Force input in Data File 1)

DMH(I)        = Average manhours to perform depot-level corrective maintenance on a failed ITEM of type I, including bench check-out, screening, fault verification and isolation, repair action and repair verification. (Contractor input in Data File 9A)

DRAG(NP)        = Average drag per added antenna element (in lbs.) for platform type NP (Contractor input in Data File 4)

DRCT(LO(NS))        = Depot repair cycle time in months from shipment of a failed ITEM from base NS to the depot until it is received & repaired at the depot and placed in depot inventory (as a function of the location LO(NS) of base NS). (Air Force input in Data File 1)

DS(I)        = Number of initial spares of ITEM type I that are required at the depot. (Internally calculated in Section 2.4.4)

EBCBI(I,NS)  = Expected intemediate-level mainenance manhours per month expended at a base of type NS in bench-checking of ITEM type I. (Internally calculated in Section 2.3.3)

ERHA(L)  = Expected utilization of support equipment type L. (Internally calculated in Section 2.4.8)3

ERHAB(L,NS)  = Expected utilization of support equipment type L at a base of type NS in hours per month. (Internally calculated in Section 2.3.3)

ERHAD(L)  = Expected utilization of support equipment type L at the depot in hours per month. (Internally calculated in Section 2.3.3)

ERHBI(I,NS)  = Expected intermediate-level maintenance manhours per month expended at a base of type NS in maintenance of ITEM type I. (Internally calculated in Section 2.3.3)

ERHD(I)  = Expected manhours per month expended at the depot in the repair of ITEM type I. (Internally calculated in Section 2.3.3)

ERTBI(I,NS)  = Expected intermediate-level maintenance manhours per month expended at a base of type NS in repair of ITEM type I. (Internally calculated in Section 2.3.3)

F  = Function used to compute the number of Initial Spares (including safety stock) required to support each ITEM, specifically, for any number X, F(X) is defined as

$$F(X) = X + BF* \sqrt{X}$$

where the coeficient BF determines the confidence level for safety spares (e.g., BF=1.65 yields a 95 percent confidence level) (See Section 2.4.4)

248

FAIL(I,NS)        = Average number of failures (not including
                    repairs in place or false pulls) of ITEM type I
                    per month at each base of type NS.  (Internally
                    calculated in Section 2.3.1)


FGH(NP)           = Average fuel consumption in gallons per
                    operating hour (without extra drag) for platforms
                    in group NP.  (Air Force input in Data File 3)


FINC              = Fractional increase applied to those data input
                    parameters for which LCC Sensitivity Analysis is
                    provided.  (Interactive data input in NAMELIST
                    /SENS/) (default value =.25)


FPR(I)            = False pull rate for ITEM for type I; i.e., that
                    multiple of actual failures which are removed but
                    haven't failed.  FPR(I) should be calculated so
                    as to satisfy the equation:

                    (# of removals) = (1 + FPR(I)) (# of failures ).

                    e.g., if, out of every 125 removals of ITEM type
                    I, there are, on the average, only 100 actual
                    failures, then FPR(I)=.25.  (We assume that only
                    LRUs have non-zero false pull rates.)
                    (Contractor input in Data File 9A)


FR(M,NP)          = The fraction of all platforms of type NP which
                    undergo modification/installation in mode M (Air
                    Force input in Data File 4)


FSEDC             = The total cost of Full Scale Engineering
                    Development for the SSS Terminal Segment Program.
                    (Contractor input in Data File 1)


GFE(I)            = Air Force furnished equipment indicator, equals:
                    1, if ITEM type I is un-modified GFE
                    2, if ITEM type I is modified GFE
                    3, if ITEM type I is new equipment
                    (Contractor input in Data File 8A)


249

HDWRT(NP)         = Hardware cost per terminal type NP.  (Internally
                    calculated in Section 2.4.1)

HDWRIT(I,NP)      = Hardware cost per LRU type I on platform type
                    NP.  (Internally calculated in Section 2.4.1)

HPD1              = Number of inclass hours per day for a type 1
                    training class.  (Contractor input in Data File
                    1)

HPD2              = Number of inclass hours per day for a type 2
                    training class.  (Air Force input in Data File 1)

I                 = Index used to indicate ITEM type

IA                = Index used for various modification/installation
                    areas on platforms.  Values are:
                    1, to indicate Antenna area
                    2, to indicate Electronics Box area
                    3, to indicate Control H area
                    4, to indicate Cabling area

IIMC              = Total cost in dollars for the ITEM Inventory
                    Management Cost Element  (Internally calculated
                    in Section 2.4.9)

IIMCA(I)          = Total lifetime ITEM Inventory Management Costs
                    in dollars for ITEMs of type I (and their piece
                    parts)  (Internally calculated in Section 2.4.9)

IIMCR             = Total recurring cost if item inventory
                    management.  (Internally calculated in Section
                    3.2.6)

IL                = Index used in place of I to distinguish LRU's
                    for purposes of repair level analysis.

IMC = Initial inventory management cost in dollars to introduce a new procurable part into the Air Force inventory system. (Air Force input in Data File 1)

IMICA(NP) = Total non-recurring modification/installation development cost in dollars for platforms within grouping NP (Internally calculated in Section 5.2.2)

IMTRC = Total recurring initial training cost. (Internally calculated in Section 3.2.6)

INTEG(I) = Integration ITEM indicator, equal 1 if ITEM type I is an "Integration Item", i.e., not an integral component of a "Terminal", and equals 0 otherwise. (Contractor input in Data File 8A)

INTR(NP) = Per terminal recurring integration cost for terminal type NP. (Contractor input in Data File 4)

INTNR(NP) = Total non-recurring integration cost for terminal type NP. (Contractor input in Data File 4)

IPCF(I) = Average cost per failure of ITEM type I whichis met by repair-in-place, including the costs of both manhours and replacement parts. (Contractor input in Data File 9A)

IRM = Index defining the ITEM repair modes, equals
1, if ITEM is repaired at the depot.
2, if ITEM is repaired at the base level by PSE if needed only;
3,4, if ITEM is repaired at the base level by an MBS and/or a UCT plus additional PSE if needed.

IS = Index used in place of I to distinguish SRU's for purposes of repair level analysis.

ISC
= Total cost in dollars for the Initial Spares Cost Element. (Internally calculated in Section 2.4.4)

ISCA(I)
= Total cost in dollars for the Initial spares of ITEM type I that are required at all locations, i.e., at all bases plus the depot (Internally calculated in Section 2.4.4)

ISET(L,NS)
= Maximum number of copies of support equipment type L required for any maintenance action which will be performed at a base of type NS. (Internally calculated in Section 2.3.3)

ISETD(L)
= Maximum number of copies of support equipment type L required for any maintenance action which will be performed at the depot. (Internally calculated in Section 2.3.3)

ITEM
= Any component within the SSS system which is either an LRU or SRU, Piece Parts excluded.

IUT(I)
= ITEM utilization indicator; equals 1 if a spare of ITEM type I is ever required anywhere in the SSS system (so that depot level inventory management costs are incurred) and equals 0 otherwise (Internally calculated in Section 2.4.9)

K(NP)
= Coefficient in thrust-fuel consumption equation for platform type NP (Air Force input in Data File 4)

KFAC(LE(NP))
= The reliability factor used to convert predicted failure rates to operational failure rates as a function of the environment LE(NP) of the host platform NP. (See Section 8.2) (Air Force input in Data File 1)

L = Index used to indicate support equipment type (or grouping)

LC(I = A factor which is multiplied by the first unit cost of an ITEM type I to give the learned average unit cost.

LDERV = Sensitivity Analysis control parameter. Equals the minimum number of LCC Sensitivity Analysis calculations that are to be printed out off-line for each of the eight ITEM-specific parameters for which LCC Sensitivity Analysis is provided. (interactive data input in NAMELiST /SENS/) (default value=12) (See Section 7.5)

LDXXX = Stands for any of the control variables LDUP, LDFR, LDFPR, LDRM, LDRTS, LDNRTS, LDCOND, LDSRU. If XXX(I) is any one of the eight ITEM-specific factors UP(I), FR(I), FPR(I),..., SRU(I), then the value of LDXXX specifies the number of LCC Sensitivity Analysis calculations for that factor which are to be displayed at the user's terminal. (Interactive input in NAMELIST /SENS/) Default value=0) (See Section 7.5)

LE(NP) = Operating environment of platform type NP, identified by
1, Airborne-Fighter
2, Airborne-Cargo
3, Ground-Fixed/Transportable
4, Ground-mobile/manpacks
(Air Force input in Data File 3)

LFAC(I) = Learning curve rate for ITEM type I (e.g., LFAC(I) = .95 implies a 95% learning curve). (Contractor input in Data File 8A)

LO(NS) = Location of base NS, designated by:
1, for CONUS bases
2, for PACIFIC bases
3, for European bases
(Air Force input in Data File 2)

| LRU | = Acronym for "line replaceable unit', i.e., an assembly which can be removed and replaced to accomplish organizational level repair. |
|---|---|
| LRU(I) | = LRU indicator, equal 1 if ITEM type I is an LRU and equals 0 otherwise  (Contractor input in Data File 8A) |
| LUP(I) | = The average learned unit cost for ITEM type I. (Internally calculated in section 2.4.1) |
| M | = Index for mode in which platform Modification and SEEK TALK Installation is performed, identified by: 1, if MOD/I performed during platform production 2, if MOD/I performed in the field (by a depot team) 3, if MOD/I performed at the depot |
| MIC | = Total cost in dollars for the Modification/Installation Cost Element (Internally calculated in Section 5.2.2) |
| MIFIX(M,NP) | = The fixed modification/installation cost in dollars for platform type NF in mod/installation mode M, meant to cover the cost of platform preparation for the mod/installation and the subsequent restoration.  (Contractor input in Data File 5) |
| MILR(M) | = Modification/installation labor rate in dollars per manhour for mode M mod/installations  (Air Force input in Data File 1) |
| MIMH(IA,M,NP) | = Average manhours to perform a mod/installation to area IA on platform type NP in mode M (Contractor input in Data File 5) |

MMPD(NP,LO(NS))      = Timing net minutes of operator labor per day for platform type NP deployed at a base at location LO(NS)  (Contractor input in Data File 3)

MMPM(NP)      = Prime mission equipment minutes of operator labor per mission for platform type NP to cover initial activation of PME terminals  (Contractor input in Data File 3)

MRF      = Average manhours per failure to complete off-equipment maintenance records.  (Air Force input in Data File 1)

MRO      = Average manhours per failure to complete on-equipment maintenance records.  (Air Force input in Data File 1)

MSE(L)      = The yearly cost of maintaining a piece of Support Equipment (SE) of type L, expressed as a fraction of its unit cost CSE(L)  (Contractor input in Data File 7)

MTBMI(I,LE(NP))      = Predicted mean operating time in hours between maintenance actions over the life cycle, for an ITEM of type I operating in environment LE(NP), including maintenance actions involving repair-in-place.  The calculation of MTBMI(I,LE(NP)) should be made on the basis or the series (i.e., not system ) failure rate of ITEM type I and should include an adjustment for "duty-cycle", as indicated in MIL HDBK 217B (See Section 6.3.6) (Contractor input in Data File 9A)

MTRC      = Total cost in dollars for the Maintenance Training Cost Element.  (Internally calculated in Section 2.4.11)

MTRCI(I)      = Pro rata part of Maintenance Training Cost attributed to ITEM type I.  (Internally calculated in Section 2.4.11)

MUSE = Minimum fractional utilization theshold for
considering additional support equipment (SE)
costs in Sensitivity Analysis Calculations, i.e.,
if a peculiar or common/requiring procurement SE
unit is utilized less than the fraction MUSE of
its available hours, then additional use of this
SE unit will produce no predicted added cost in
Sensitivity Analysis Calculations  (Air Force
input in Data File 1)

NAE(NP) = Number of added antenna elements required for
SSS installation on platform type NP (Contractor
input in Data File 5)

NBC(NS) = For satellite bases, equals the number of bases
of type NS which occur within the CIMF system
which contains base NS (and equals zero if NS is
an independent base or a CIMF)  (Air Force input
in Data File 2)

NDS(IL) = Number of distinct SRU's contained in one LRU of
type IL.  (Used to input the matrix QPA(IL,IS) in
"pointer form" in Data File 8B) (see instructions
in Section 10.)

NFB(I,NS) = Average number of ITEMs of type I in the base
type NS pipeline, i.e., the average number of
ITEMs of type I which are awaiting maintenance
action or replacement in supply at base NS.
(Internally Calculated in Section 2.3.2)

NFD(I) = Average number of ITEMs of type I in the depot
pipeline, i.e., the average number of ITEMs of
type I which are awaiting maintenance action or
replacement in supply at the depot.  (Internally
Calculated in Section 2.3.2)

NHB(NS) = For satellite bases of type NS, equals the index
of the CIMF base on which it is dependent.
Equals 0 if base NS is not a satellite base.
(Air Force input in Data File 2)

256

NHI(I)                  = Equals 0 if ITEM of which ITEM type I is an LRU
                        and, for SRUs, equals the index number of the
                        next higher level indentured ITEM type I is a
                        component (if an SRU is contained in several
                        larger assemblies, choose the index number of the
                        most common occurrence).  (Contractor input in
                        Data File 8A)


NITEM(I,NP)             = Average number of ITEMs of type I installed on
                        each platform within grouping NP, including ITEMs
                        within all Full-up, Partial, and Modem-only
                        terminal configurations on platforms and counting
                        any multiple terminal platforms within the
                        grouping. (Contractor input in Data File 11)


NJA(I,IRM(I))           = The number of different support equipment types
                        (i.e., different values of L) required in the
                        repair of ITEM type I in repair mode IRM(I) (used
                        to input the matrix A(I,IRM(I),L) in "pointer
                        form" in Data File 10) (See instructions in
                        Section 10.2.10)

NRM(I)                  = The number of different repair modes which can
                        be used in the check-out and/or repair of ITEM
                        type I.   (Contractor input in Data File 10)

NRMI(NP)                = Total non-recurring mod/installation costs for
                        the installation of SSS terminal equipment into
                        platforms of type NP.  This should include costs
                        of:  non-recurring engineering to design,
                        develop, integrate, test, and qualify the
                        required installation;  non-recurring testing
                        (including ground testing and flight testing)
                        necessitated by the mod/installation;  proofing
                        activities necessitated by the mod/installation
                        including one production group A-kit and the
                        engineering manpower required to install,
                        approve, and/or revise the design of the
                        mod/installation;  non-recurring data required
                        for the mod/installation.  (Contractor input in
                        Data File 4)

NP                      = Index used to indicate platform groupings


257

NPLT(NP,NS)    = Average number of platforms of type NP deployed at each base of type NS   (Air Force input in Data File 6)

NRTS(I)    = Fraction of (removed) failures of ITEM type I which must be repaired at the depot level.   (The LCC model will automatically adjust the NRTS(I) fraction to include those intermediate-level repairs of ITEM type I which must be performed at the depot due to circumstance, e.g., if ITEM type I is an SRU and its higher LRU is depot repaired for some proportion of its failures   (Contractor input in Data File 9A)

NRUC    = Number of years worth of replacement spares to be p ⸱⸱red under the SSS production contract(s).   (Air ⸱⸱ ce input in Data File 1)

NS    = Index used to indicate base groupings

NSEB(L,NS)    = Number of copies of support equipment type L required at each base of type NS (fractional utilization of common SE is allowed)   (Internally Calculated in Section 2.3.3)

NSED(L)    = Number of copies of support equipment type L required at the depot   (Internally Calculated in Section 2.3.3)

OC    = Total cost in dollars for the Operations Cost Element (Internally calculated in Section 2.4.3)

OFMC    = Total cost in dollars for the Off-Equipment Maintenance Cost Element (Internally calculated in Section 2.4.7)

OFMCA(I)    = Total Off-Equipment Maintenance Cost in dollars due to repairs of ITEMs of type I   (Internally calculated in Section 2.4.7)

OLC = Total cost in dollars for the Operational Labor Cost component of the Operations Cost Element (Internally calculated in Section 2.4.3)

ONMC = Total cost in dollars for the On-Equipment Maintenance Cost Element (Internally calculated in Section 2.4.6)

ONMCA(I) = Total Lifetime cost in dollars for all On-Equipment Maintenance actions on ITEMs of type I (Internally calculated in Section 2.4.6)

OST(LO(NS)) = Average order & shipping time from a base NS to the depot (as a function of the location of the base LO(NS)), i.e., the time (in months) from when a replacement ITEM is ordered from the depot until it is received and placed in base serviceable stock (Air Force input in Data File 1)

OSTC = Average order & shipping time in minths from a satellite to its associated CIMF (Air Force input in Data File 1)

PA(I) = Number of subassemblies or piece parts within ITEM type I which would be added to the Government inventory system if ITEM type I were repaired in the system (Contractor input in Data File 8A)

PAL1 = Average daily pay and allowance during training for a type 1 trainee. (Air Force input in Data File 1)

PAL2B = Average daily pay and allowance during training for a type 2 base trainee. (Air Force input in Data File 1)

| PAL2D | = Average daily pay and allowance during training for a type 2 depot trainee. (Air Force input in Data File 1) |

PBDV(L) = Portion of support equipment development cost contributed by support equipment type L at the base level. (Internally calculated in Section 2.4.8)

PDIV(NP) = Factor defining total effective number of types of platforms in platform grouping NP. (Air Force input in Data File 4)

PDDV(L) = Portion of support equipment development cost contributed by support equipment type L at the depot level. (Internally calculated in Section 2.4.8)

PIUP = Operational lifetime in yars of the SEEK TALK system (Air Force input in Data File 1)

PME = Acronym for "prime mission equipment".

PMEQ(I) = Total prime mission equipment procurement quantity for LRU ITEMs of type I. (Internally calculated in Section 2.3.5.1)

PMLR = Prime mission equipment operator labor rate in dollars per hour (Air Force input in Data File 1)

PPSE(I,L) = Portion of the manhours of use of support equipment of type L attributed to ITEM type I. (Internally calculated in Section 2.4.10)

PPTM(I) = Portion of ONMC and OFMC attributed to ITEM type I. (Internally calculated in Section 2.4.10)

PRODC = Total cost in dollars for the Production Cost element (Internally calculated in Section 2.4.1)

QPA(IL,IS)    = Number of units of SRU type IS contained in one
              unit of LRU type IL.  (Note:  The matrix
              QPA(IL,IS) should be input in "pointer form" in
              Data File 8B.  See instructions in Section 10.2.)
              (Contractor input in Data File 8B)


QSA(I,K)      = A three digit code whose unts digit equals the
              number of copies of the Kth support equipment
              type that is required for a maintenance action on
              ITEM type I, and whose hundreds digit indicates
              the nature of the maintenance action for which
              this SE is required.  The K stands for the <u>order</u>
              that the SE type is listed in Data File 10 and
              <u>not</u> the SE index number.  (Used to input matrices
              $\overline{A(I,L)}$ and SECODE(I,L) in "pointer form" in Data
              File 10)  (See instructions in Section 7.3.10)

QTYP1         = Number of trainees for type 1 training.  (Air
              Force input in Data File 1)


QTYP2B        = Initial number of base trainees for type 2
              training.  (Air Force input in Data File 1)


QTYP2D        = Initial numbers of depot trainees for type 2
              training.   Air Force input in Data File 1)


R             = Global repair strategy indicator primarily used
              to generate the input file necessary for the
              Repair Level Analysis program.  The value of R
              automatically sets ITEM repair levels according
              to the following scheme:

261

| R | All LRUs | All SRUs |
|---|----------|----------|
| 0 | as input by user | as input by user |
| 1 | base repair | base repair |
| 2 | base repair | depot repair |
| 3 | base repair | discard on failure |
| 4 | depot repair | depot repair |
| 5 | depot repair | discard on failure |
| 6 | discard on failure | discard on failure |

(Contractor input in Data File 1)

RCPP = Technical order reproduction cost per copy per page. (Air Force input in Data File 1)

RIP(I) = Fraction of maintenance actions on ITEM type I which are met by repair-in-place with piece parts. (Contractor input in Data File 9A)

RL(I) = Repair level code for ITEM type I;
= 0 if initially input RTS (I), NRTS(I), and COND(I) values are to be used;
= 1 If RTS(I), NRTS(I), and COND(I) are to be internally calculated to represent base repair of ITEM I;
= 2 if RTS(I), NRTS(I), and COND(I) are to be internally calculated to represent depot repair of ITEM I;
= 3 if RTS(I), NRTS(I), and COND(I) are to be internally calculated to represent discard-on-failure of ITEM I.
(Contractor input in Data File 9A)

RM(I) = Repair materials factor for ITEM type I, equals the fraction of UP(I) that is consumed ( in piece parts below the ITEM indenture level) in the repair of ITEM type I (Contractor input in Data File 8A)

262

RMC = Recurring annual inventory management cost in dollars to maintain an ITEM or piece part in the depot-level Air Force inventory system (Air Force input in Data File 1)

RMH(I) = Average number of manhours required to remove and replace a failed ITEM of type I from its host platform. (Applies only to LRUs). Should include time spent in isolating a failure to the ITEM, removing the ITEM, installing a replacement ITEM, and in verifying restoration of the system to operational status. (Contractor input in Data File 9A)

RMI(I,NS) = Repair mode of ITEM type I at base NS. The values of RM (I,NS) are the elements of IRM. (Internally calculated in Section 2.3.3)

RMICA(NP) = Average recurring modification/installation cost in dollars per platform within grouping NP (Internally calculated in Section 2.4.2)

RMTRC = Total recurring costs of maintenance training. (Internally calculated in Section 3.2.6)

RSC = Total cost in dollars of the Replacement Spares Cost Element (Internally calculated in Section 5.2.5)

RSCA(I) = Total lifetime cost due to ITEMs of type I for Replacement Spares (including repair materials costs) (Internally calculated in Section 5.2.5)

RTS(I)                      = Fraction of removed failures (i.e., failures not
                              repaired-in-place) of ITEM type I which can be
                              repaired at the intermediate level, assuming that
                              the ITEM has been removed from its next higher
                              assembly at the intermediate level.  (The LCC
                              model will automatically correct the RTS(I)
                              fraction to account for that proportion of
                              failures under which the ITEM is not available
                              for repair at the intermediate level, e.g., if
                              the ITEM is an SRU and its higher LRU is depot-
                              repaired or condemned-on-failure.)  (Contractor
                              input in Data File 9A)

SA                          = Recurring annual cost in dollars to maintain a
                              line item or piece part in a base-level inventory
                              system  (Air Force input in Data File 1)

SAT(NS)                     = Satellite base indicator, equals 1 if base NS is
                              a satellite base and equals 0 otherwise.
                              (Internally Calculated in Section 2.4.7)

SECB(L)                     = Support equipment procurement cost incurred at
                              the base level.  (Internally calculated in
                              Section 2.4.8)

SECI(I)                     = Pro rata part of support equipment cost
                              attributed to ITEM type I.  (Internally
                              calculated in Section 2.4.8)

SECD(L)                     = Support equipment procurment cost incurred at
                              the depot level.  (Internally calculated in
                              Section 2.4.8)

SECODE(I,IRM,L)    = Requirement indicator for support equipment type
                     L with respect to ITEM type I when repair mode
                     IRM exists;

                     = 0   if SE type L not required for
                           any maintenance of ITEM type I;
                     = 1   If SE type L required for repair
                           but not base shop bench check
                           of ITEM type I;
                     = 2   if SE type L required for both
                           repair and base shop bench check
                           of ITEM type I;
                     = 3   if SE type L required for base
                           shop bench check but not repair
                           of ITEM type I.
                     (Note:   The matrix SECODE(I,L) should be input in
                     "pointer form" in Data File 10.   See instructions
                     in Section 10.2.)   (Contractor input in Data File
                     10)

SECR               = Total recurring maintenance cost of support
                     equipment.   (Internally calculated in Section
                     2.4.8)

SEDC               = Total support equipment development cost.
                     (Internally calculated in Section 2.4.8)

SEDEV(L)           = Development cost in dollars for support
                     equipment of type L.   (Contractor input in Data
                     File)

SEDV(L)            = Actual development cost for support equipment
                     type L.   This is a function of whether the piece
                     of support equipment is used.   (Internally
                     calculated in Section 2.4.8)

SEPC               = Total support equipment procurement cost.
                     (Internally calculated in Section 2.4.8)

SETYPE(L) = Equals 1 if support equipment type L is common and available on-site (refer to Air Force-provided list of this SE), equals 2 if support equipment type L is common but requires procurement for SEEK TALK use, and equals 3 if SE type L is peculiar (Contractor input in Data File 7)

SPC1 = Maximum number of students per type 1 training class. (Contractor input in Data File 1)

SPC2 = Maximum number of students per type 2 training class. (Air Force input in Data File 1)

SR = Average manhours per failure to complete supply transaction records. (Air Force input in Data File 1)

SRU = Acronym for "shop replaceable (or repairable) unit, i.e., a component which is usually only removable (from an LRU or another SRU) and repairable in a shop (at either base or depot level), e.g., LRU repair may consist of removing and replacing an internal SRU. The SRU itself may then also be repairable.

STDC = Total cost in dollars of the Technical Orders Cost Element. (internally calculated in Section 5.2.10)

STDCR = Total recurring cost of technical orders. (Internally calculated in Section 3.2.6)

T1 = Total number of type 1 training hours per type 1 trainee. (Internally calculated in Section 2.4.11)

266

| | |
|---|---|
| T2BA | = Total number of hours of type 2 training required for a base trainee. (Internally calculated in Section 2.4.11) |
| T2DA | = Total number of hours of type 2 training required for a depot trainee. (Internally calculated in Section 2.4.11) |
| TDC(I) | = The pro rata part of Technical Orders Cost attributed to ITEM type I (Internally calculated in Section 5.2.10) |
| TDXXX | = Stands for any of the LCC Sensitivity Analysis variables TDXUC, TDXFR, TDXFPR, TDMF, TDXRM, TDPIUP, TDXMIL, TDUP(I), TDFR(I), TDFPR(I), TDRM(I), TDRTS(I), TDNRTS(I), TDCOND(I), TDSRU(I). In general terms, TDXXX represents the estimated change in LCC that would occur if the parameter XXX were to increase by a fractional amount FINC, where XXX can be any of the factors XUC, XFR, ..., NRTS(I), COND(I). In addition, TDSRU(I) represents the change in LCC that would result from changing ITEM type I from an SRU to an LRU. (Internally calculated in Section 6) |
| TEFM | = Cost in dollars of equipment, facilities, and manuals required for all training and not accounted for by any other Cost Element of the Model. (Type 2 training facilities should not be included.) (Contractor input in Data File 1) |
| TERHAB(L) | = Total number of manhours which support equipment type L is used at the base level. (Internally calculated in Section 2.4.10) |
| TERHB(L) | = Total number of manhours which check-out and/or repair support equipment type L is used at the base level. (Internally calculated in Section 2.4.8) |

TERHD(L)            = Total number of check-out and/or repair manhours
                      which support equipment type L is used at the
                      depot level. (Internally calculated in Section
                      2.4.8)

TERMC(NP)           = Total production cost for a terminal of type NP,
                      including hardware costs, recurring integration
                      costs, and a portion of the non-recurring
                      integration costs. (Internally calculated in
                      Section 2.4.1)

TERMH               = Total hardware costs for production of all
                      terminals. (Internally calcuated in Section
                      2.4.1)

TERMI               = Total integration costs for production of all
                      terminals. (Internally calculated in Section
                      2.4.1)

TFAC(NP)            = Average fraction of operating time that SEEK
                      TALK equipment on platform type NP is activated
                      (Air Force input in Data File 3)

THRS(NP)            = Average thrust in lbs. generated by platform
                      type NP (airborne platforms only). (Air Force
                      input in Data File 3)

TIME1(I)            = The number of additional hours of type 1
                      training added for ITEM type I (Contractor input
                      in Data File 9B)

TISQ(I)             = Total investment spares quantity for ITEM type I
                      (Internally calculated in Section 5.1.5.2)

TNB(NS)             = Total number of bases within the SEEK TALK
                      system which are (treated as being) identical to
                      base NS  (Air Force input in Data File 2)

TNSE(L)          = Total number of pieces of support equipment of
                 type L procured. (Internally calculated in
                 Section 2.4.10)

TORB             = Turnover rate for base avionics maintenance
                 personnel; the fraction of this work force
                 leaving the Air Force (and replaced) per year.
                 (Air Force input in Data File 1)

TORD             = Turnover rate for depot avionics maintenance
                 personnel; the fraction of this work force
                 leaving the Air Force (and replaced) per year.
                 (Air Force input in Data File 1)

TOTPQ(I)         = Total production contract procurement quantity
                 for each ITEM type I. (Internally calculated in
                 Section 2.3.5)

TR               = Average manhours per failure to complete
                 transportation transaction forms. (Air Force
                 input in Data File 1)

TRAV1D           = Average individual roundtrip travel expense for
                 travel of type 1 and type 2 depot trainees to and
                 from the relevant training facilities. (Air
                 Force input in Data File 1)

TRAVB            = Average individual roundtrip travel expense for
                 travel of type 2 base trainees to and from the
                 type 2 training facility. (Air Force input in
                 Data File 1)

TSEC             = Total cost for the support equipment cost
                 element. (Internally calculated in Section
                 2.4.8)

TUCTDC           = Total UCT development cost. (Internally
                 calculated in Section 5.2.8)

269

TYP2TF      = Ratio of type 2 training time to type 1 training time when the same course material is covered in both. (Air Force input in Data File 1)

U      = Unit step function used to indicate positive quantities, i.e., for any number X, $U(X) = 1$ for $X > 0$, and $U(X) = 0$ otherwise

UCPP      = Annual technical order upkeep cost per distinct page of original technical orders. (Air Force input in Data File 1)

UCTDC(I)      = UCT software development cost for ITEM type I, incurred to enable the UCT to repair ITEM type I. (Internally calculated in Section 2.4.8)

UCTDEV(I)      = Software development costfor an ITEM type I to be checked out and/or repaired, by a UCT (Contractor input in Data File 9B)

UP(I)      = Unit cost in dollars for ITEM type I (Contractor input in Data File 8A)

USE(L,NS)      = Support equipment indicator used for LCC sensitivity analysis calculations. Equals 0 if SE type L is purchased for base NS (as a whole unit) and is underutilized (so that additional use generates no extra cost) and equals 1 otherwise. (Internally calculated in Section 3.2.4)

USED(L)      = Support equipment indicator used for LCC sensitivity in the same manner as USE(L,NS), except refers to SE type L purchased for the depot (Internally calculated in Section 6.1.4)

W(X)      = Function which is defined for any number X by

$$W(X) = \begin{cases} 0, & \text{if } X < 0 \\ X, & \text{if } 0 \le X \le 1 \\ 1, & \text{if } X > 1 \end{cases}$$

270

WEAR(I)                     = The fraction of (removed) failures of ITEM type
                              I which are condemned to to normal wear-out.
                              (Internally calculated in Section 2.3.4)


WT(I)                       = Net weight of ITEM type I in pounds (Contractor
                              input in Data File 8A)


XFPR                        = False pull rate multiplier factor. May be used
                              to globally adjust all ITEM false pull rates in
                              LCC sensitivity analyses or sytem trade-off
                              studies (Must be set equal to 1, in Data File 1,
                              in all Air Force submissions)


XFR                         = Failure rate multiplier factor. May be used to
                              globally adjust all ITEM failure rates in LCC
                              sensitivity analyses or system trade-off studies
                              (Must be set equal to 1, in Data File 1, in all
                              Air Force submissions)


XITEMQ(I)                   = Total change in procurement quantity of ITEM
                              type I, used in sensativity equations.
                              (Internally calculated in Section 3.2.9)


XMIL                        = Mod/installation labor manhours multiplier
                              factor. May be used to uniformly adjust all
                              mod/installation labor manhour estimates for LCC
                              sensitivity analysis or system trade-off studies
                              (Must be set equal to 1, in Data File 1, in all
                              Air Force submissions)


XUC                         = Unit cost multiplier cost multiplier factor.
                              May be used to globally adjust all ITEM and
                              Terminal unit costs in LCC sensitivity analyses
                              or system trade-off studies  (must be set equal
                              to 1, in Data File 1, in all Air Force
                              submissions)


YRSQ(I)                     = Yearly replacement spares quantitiy for ITEM
                              type I.  (Internally calculated in Section
                              2.3.5.3)

# APPENDIX B

## ILLUSTRATIVE COMPUTER RUNS

This appendix contains printouts from illustrative computer runs of the SSS LCC Model. The contractor can use these runs as a test that he has correctly implemented the Model on his computer system.

The first printouts exhibit a run of the SSS LCC Model Preprocessor, including two input tables and one output table.

Next are two runs of the LCC Program. From Run 1, eleven input tables (which give the values of all input parameters), six output tables (which represent the calculated LCC in various breakouts), and a Sensitivity Analysis table are shown. In this run, the repair level of each ITEM is set in input Data File 9A to either the value 1 (for base repair of ITEM I), 2 (for depot repair of ITEM I), or 3 (for discard-on-failure of ITEM I). The Model then internally computes the fraction of failures repaired at the base, repaired at the depot, or discarded. These values are shown in input Data File 9A.

One input Data File and two output tables from Run 2 are shown. In this run, the repair levels are set to zero for all ITEMs so that the fractions of failures repaired at the base, repaired at the depot, or discarded, which the Model uses are the values input by the contractor.

Finally, a run of the RLA Program is shown, including two input Data Files and one output tables.

The input files shown contain the values to be used for all Air Force data inputs. The data shown for Model inputs designated as contractor furnished or jointly determined are illustrative only and are not intended to represent realistic parameter values.

SSS LCC MODEL

PREPROCESSOR

2 INPUT TABLES

1 OUTPUT TABLES

```
*********************************************
*                                           *
*   SSS LIFE CYCLE COST MODEL               *
*           PREPROCESSOR                    *
*                                           *
*********************************************
```

PREPROCESSOR INPUT FILE:  DATA FILE EP -- LRU/SRU CROSS REFERENCE DATA

| LRU INDEX (IL) | #SRU TYPES IN LRU (NDS) | SRU INDEX NO. (ISRU) | SRU QUAN-TITY (QPR) | SRU INDEX NO. (ISRU) | SRU QUAN-TITY (QPR) | SRU INDEX NO. (ISRU) | SRU QUAN-TITY (QPA) | SRU INDEX NO. (ISRU) | SRU QUAN-TITY (QPA) | SRU INDEX NO. (ISRU) | SRU QUAN-TITY (QPA) | SRU INDEX NO. (ISRU) | SRU QUAN-TITY (QPA) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 10 | | 11 | | 0 | | 0 | | 0 | | 0 | |
| 2 | 4 | 0 | | | | 8 | | 0 | | 0 | | 0 | |
| 3 | 2 | 12 | | 17 | | 0 | | 0 | | 0 | | 0 | |
| 4 | 4 | 16 | | 0 | | 18 | | 15 | | 0 | | 0 | |
| 5 | 6 | 0 | | 0 | | 20 | | 0 | | 0 | | 0 | |
| 6 | 2 | 22 | | 0 | | 0 | | 21 | | 0 | | 0 | |
| 7 | 3 | 23 | | 0 | | 20 | | 0 | | 0 | | 0 | |

PREPROCESSOR INPUT FILE: DATA FILE 11x -- LRU ITEM CONFIGURATION ON PLATFORMS

AVERAGE NUMBER OF LRU ITEMS INSTALLED ON PLATFORM TYPE

| ITEM INDEX (I) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 1.00 | 2.00 | 0.0 | 0.0 | 1.00 | 1.00 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 | 1.00 | 0.0 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 2.00 | 2.00 | 0.0 | 0.0 | 2.00 | 0.0 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 1.00 | 1.00 | 1.00 | 2.00 | 0.0 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 0.0 | 0.0 | 0.0 | 2.00 | 0.0 | 0.0 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

AVERAGE NUMBER OF ITEMS INSTALLED ON PLATFORM TYPE

| ITEM INDEX (II) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 1.00 | 2.00 | 0.0 | 0.0 | 1.00 | 1.00 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 | 1.00 | 2.00 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 2.00 | 2.00 | 0.0 | 0.0 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 1.00 | 0.0 | 1.00 | 2.00 | 0.0 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 1.00 | 0.0 | 0.0 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 0.0 | 0.0 | 0.0 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 0.0 | 1.00 | 2.00 | 0.0 | 0.0 | 1.00 | 1.00 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 0.0 | 1.00 | 2.00 | 0.0 | 0.0 | 1.00 | 1.00 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 | 1.00 | 0.0 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 | 2.00 | 0.0 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 14 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 | 1.00 | 0.0 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | 2.00 | 2.00 | 0.0 | 0.0 | 2.00 | 0.0 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16 | 2.00 | 2.00 | 0.0 | 0.0 | 3.00 | 0.0 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 2.00 | 2.00 | 1.00 | 0.0 | 1.00 | 2.00 | 0.0 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 18 | 0.0 | 0.0 | 1.00 | 0.0 | 1.00 | 2.00 | 0.0 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19 | 0.0 | 0.0 | 1.00 | 0.0 | 0.0 | 0.0 | 4.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 20 | 0.0 | 0.0 | 0.0 | 2.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 0.0 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |

SSS LCC MODEL

ILLUSTRATIVE RUN 1

11 INPUT TABLES

6 OUTPUT TABLES

```
STRATEGIC SATELLITE SYSTEM LCC MODEL

FIG: ILLUSTRATIVE RUN
```

SYSTEM OPERATING LIFE 15.00 YEARS

REPAIR LEVEL CASE NO   0

SENSITIVITY MULTIPLIER FACTORS

AUC     .000
AFR    1.000
AFFR   1.000
ANAL   1.000
RLAC   0.350

INPUT TABLE 1: SYSTEM-WIDE SCALAR PARAMETERS

GOVERNMENT-PROVIDED PARAMETERS

LABOR FACTORS

| | | |
|---|---|---|
| BAA - | MONTHLY AVAILABLE WORKING HOURS PER MAINTENANCE | 140.00 |
| | MAN AT BASE LEVEL | 1.50 |
| BMF - | BASE MAINTENANCE FACTOR | |
| DAA - | MONTHLY AVAILABLE WORKING HOURS PER MAINTENANCE | 150.00 |
| | MAN AT DEPOT LEVEL | 1.25 |
| DEF - | DEPOT MAINTENANCE FACTOR | |
| NPU2 - | NUMBER OF HOURS SPENT BY A TYPE 2 | b |
| | TRAINEE IN CLASS PER DAY | |
| RAO - | AVERAGE MANHOURS PER FAILURE TO COMPLETE | 0.66 |
| | ON-EQUIPMENT MAINTENANCE RECORDS | |
| RNF - | AVERAGE MANHOURS PER FAILURE TO COMPLETE | 0.44 |
| | OFF-EQUIPMENT MAINTENANCE RECORDS | |
| SR - | AVERAGE MANHOURS PER FAILURE TO COMPLETE | 0.24 |
| | SUPPLY TRANSACTION RECORDS | |
| TORB - | TURNOVER RATE FOR BASE MAINT. PERSONNEL | 0.10 |
| TORD - | TURNOVER RATE FOR DEPOT MAINT. PERSONNEL | 0.10 |
| TR - | AVERAGE MANHOURS PER FAILURE TO COMPLETE | 0.16 |
| | TRANSPORTATION TRANSACTION FORMS | |

LABOR RATES

| | | |
|---|---|---|
| BLR - | BASE MAINTENANCE LABOR RATE IN $ PER HOUR | 16.42 |
| DLR - | DEPOT MAINTENANCE LABOR RATE IN $ PER HOUR | 33.50 |
| MILR(1) - | MOD/INSTALLATION LABOR RATE DURING PRODUCTION IN $ PER HOUR | 26.43 |
| MILR(2) - | MOD/INSTALLATION LABOR RATE FOR FIELD MODS USING DEPOT YEAR IN $ PER HOUR | 39.00 |
| MILR(3) - | MOD/INSTALLATION LABOR RATE FOR MODS PERFORMED AT THE DEPOT IN $ PER HOUR | 33.50 |
| PAL1 - | AVERAGE DAILY PAY & ALLOWANCE FOR A TYPE 1 TRAINEE | 80.00 |
| PAL2B - | AVERAGE DAILY PAY & ALLOWANCE FOR A TYPE 2 TRAINEE | 50.00 |
| PPL2E - | AVERAGE DAILY PAY & ALLOWANCE FOR A TYPE 2 DEPOT TRAINEE | 60.00 |
| PRLR - | PRIME MISSION EQUIP OPER LABOR RATE IN $ PER HOUR | 16.42 |
| TRAV1C - | AVERAGE TRAVEL EXPENSE FOR TYPE 1 AND TYPE 2 DEPOT TRAINEES | 200.00 |
| THAVB - | AVERAGE TRAVEL EXPENSE FOR TYPE 2 BASE TRAINEES | 200.00 |
| TRLR - | TIMING KIT OPERATOR LABOR RATE IN $ PER HOUR | 16.42 |

INPUT TABLE 1: SYSTEM-WIDE SCALAR PARAMETERS
(CONTINUED)

## PIPELINE TIMES

| | | |
|---|---|---|
| BRCT | - BASE REPAIR CYCLE TIME IN MONTHS | 0.200 |
| CBCT | - TIME FOR FAILURE AT SATELLITE BASE UNTIL REPAIR AT CONUS BASE IN MONTHS | 0.960 |
| DAE | - TIME FACE FAILURE REMOVAL AT DEPOT UNTIL REPAIR AT DEPOT IN MONTHS | 0.132 |
| DBCT(1) | - TIME FROM FAILURE AT CONUS BASE UNTIL REPAIR AT DEPOT IN MONTHS | 1.700 |
| DBCT(2) | - TIME FROM FAILURE AT PACIFIC BASE UNTIL REPAIR AT DEPOT IN MONTHS | 1.900 |
| DBCT(3) | - TIME FROM FAILURE AT EUROPE BASE UNTIL REPAIR AT DEPOT IN MONTHS | 1.800 |
| OST(1) | - ORDER AND SHIPPING TIME FROM CONUS BASE TO DEPOT IN MONTHS | 0.355 |
| OST(2) | - ORDER AND SHIPPING TIME FROM PACIFIC BASE TO DEPOT IN MONTHS | 0.559 |
| OST(3) | - ORDER AND SHIPPING TIME FROM EUROPE BASE TO DEPOT IN MONTHS | 0.525 |
| OSTC | - ORDER AND SHIPPING TIME FROM A SATELLITE BASE TO ITS CONUS BASE IN MONTHS | 0.250 |

## UNIT COST FACTORS

| | | |
|---|---|---|
| ACPP | - ACQUISITION COST PER PAGE FOR ORIGINAL NEGATIVES OF TECH. DATA | 200.000 |
| CFG(1) | - COST OF FUEL IN $ PER GALLON AT CONUS BASES | 0.550 |
| CFG(2) | - COST OF FUEL IN $ PER GALLON AT PACIFIC BASES | 0.550 |
| CFG(3) | - COST OF FUEL IN $ PER GALLON AT EUROPE BASES | 0.830 |
| CPD4 | - COST PER CLASS PER DAY FOR TYPE 2 TRAINING | 400.000 |
| CPPC | - COST OF PACKING AND SHIPPING FROM A SATELLITE BASE TO ITS CONUS BASE IN $ PER NET WEIGHT POUND | 0.640 |
| CPPD(1) | - COST OF PACKING AND SHIPPING FROM CONUS BASE TO DEPOT IN $ PER NET WEIGHT PCUBE | 0.660 |
| CPPD(2) | - COST OF PACKING AND SHIPPING FROM PACIFIC BASE TO DEPOT IN $ PER NET WEIGHT PCUBE | 1.400 |
| CPPD(3) | - COST OF PACKING AND SHIPPING FROM EUROPE BASE TO DEPOT IN $ PER NET WEIGHT PCUBE | 1.900 |
| RCPP | - REPRODUCTION COST PER COPY PER PAGE OF TECH. DATA | 0.010 |
| IRC | - INITIAL DEPOT INVENTORY MANAGEMENT COST PER NEW PART IN $ | 5.000 |
| RRC | - RECURRING DEPOT INVENTORY MANAGEMENT COST PER NEW PART IN $ PER YEAR | 127.180 |
| SA | - BASE-LEVEL INVENTORY MANAGEMENT COST PER NEW PART IN $ PER YEAR | 4.390 |
| UCPP | - UPDATE COST PER YEAR PER DISTINCT PAGE OF TECH. DATA | 60.000 |

INPUT TABLE 1: SYSTEM-WIDE SCALAR PARAMETERS
(CONTINUED)

MISCELLANEOUS FACTORS

| | | |
|---|---|---|
| EF | - COEFFICIENT IN SPARING FUNCTION | 1.65 |
| BIRL | - FRACTION OF BASE-REPAIR-INTEREST FAILURES | 0.05 |
| KFAC(1) | - FAILURE RATE EXPERIENCE FACTOR FOR AIRBORNE-FIGHTER ENVIRONMENT | 2.00 |
| KFAC(2) | - FAILURE RATE EXPERIENCE FACTOR FOR AIRBORNE-CARGO ENVIRONMENT | 2.60 |
| KFAC(3) | - FAILURE RATE EXPERIENCE FACTOR FOR GROUND-FIXED/TRANSPORTABLE ENVIRONMENT | 1.30 |
| KFAC(4) | - FAILURE RATE EXPERIENCE FACTOR FOR GROUND-MOBILE ENVIRONMENT | 1.50 |
| PLSE | - MINIMUM FRACTIONAL UTILIZATION FOR SENSITIVITY CALCULATIONS ON SUPPORT EQUIPMENT COSTS | 0.50 |
| SSUC | - NUMBER OF YEARS OF REPLACEMENT SPARES TO BE PROVIDED UNDER THE SSS PRODUCTION CONTRACT(S) | 1.00 |
| | SYSTEM OPERATING YEARS | 15.00 |
| PTUF | - NUMBER OF TYPE 1 TRAINEES | 20 |
| NTYF1 | - NUMBER OF TYPE 2 BASE TRAINEES | 200 |
| NTYF2B | - NUMBER OF TYPE 2 DEPOT TRAINEES | 50 |
| NTYF2C | | |
| A | - REPAIR LEVEL CASE MTA NUMBER | 0 |
| SPC2 | - MAXIMUM NUMBER OF TYPE 2 TRAINEES PER CLASS | 10 |
| TYP21F | - RATIO OF TYPE 2 TRAINING TIME TO TYPE 1 TRAINING TIME | 1 |
| | TRAINING TIME | 1.50 |
| RFFM | - FALSE PULL RATE SENSITIVITY MULTIPLIER FACTOR | 1.00 |
| LFM | - FAILURE RATE SENSITIVITY MULTIPLIER FACTOR | 1.00 |
| XMLL | - MOD/I LABOR HOURS SENSITIVITY MULTIPLIER FACTOR | 1.00 |
| LUC | - UNIT COST SENSITIVITY MULTIPLIER FACTOR | 1.00 |

IRIS TABLE 1: SYSTEM-WIDE SCALAR PARAMETERS
(CONTINUED)

CONTRACTOR - DETERMINED VARIABLES

NDATA - NUMBER OF TECH. DATA PAGES FOR EACH MAINT. AND/
        LOT ITEM OR SE SPECIFIC                                    50

CPLI  - COST PER CLASS PER DAY FOR TYPE 1 TRAINING              1000.00
DDATA - NUMBER OF TECH. DATA PAGES FOR EACH MAINT.
        AND NOT ITEM OR SE SPECIFIC                                50

FSLLC - TOTAL COST OF FULL SCALE ENGINEERING
        DEVELOPMENT PROGRAM                                  20000000.0

MPLI  - NUMBER OF CLASS HOURS PER DAY FOR A TYPE 1              6

SPCI  - TRAINING CLASS
        MAXIMUM NUMBER OF TYPE 1 TRAINEES PER CLASS            10
TIIF  - COST OF TRAINING EQUIPMENT, FACILITIES AND
        MANUALS                                             16000000.00

INPUT TABLE 22: BASE CONFIGURATION DATA

| BASE INDEX (BS) | BASE NAME (BBCOR) | NO. OF BASES (TBB) | LOC. OF BASE (LU) | BASE TYPE (BTYPL) | NEXT HIGHER BASE (BHF) | AC. UNIT CIPT (MEC) | BASE PLAT- FORMS (BPLAT) | BASE SUPPORT PHILOSOPHY (BSP) |
|---|---|---|---|---|---|---|---|---|
| 1 | AIB SAT EUROF | 1. | 1 | 1 | 1 | 1.0 | 1 | 0 |
| 2 | GBL SAT EUROF | 2.0 | 1 | 1 | 1 | 2.0 | 1 | 0 |
| 3 | CIRI SAT EUROF | 1. | 1 | 2 | 5 | 0.0 | 1 | 2 |
| 4 | GBL SAT PACIF | 1. | 1 | 1 | 3 | 1.0 | 1 | 0 |
| 5 | CIPI SAT PACIF | 1. | 1 | 1 | 3 | 0.0 | 1 | 1 |
| 6 | AIB INDEB PACIF | 1. | 1 | 1 | 5 | 0.6 | 1 | 0 |
| 7 | GBL SAT COBUS | 11. | 1 | 1 | 8 | 1.6 | 2 | 2 |
| 8 | CIRI COBUS | 7. | 1 | 1 | 0 | 0.0 | 1 | 1 |
| 9 | AIB INDEF COBUS | 14. | 1 | 1 | 0 | 0.0 | 1 | 1 |
| 10 | GBL INDEF COBUS | 6. | 1 | 1 | 0 | 0.0 | 2 | 1 |

INPUT TABLE 5: PLATFORM OPERATION DATA

| PLAT-FORM INDEX (NP) | PLATFORM NOMENCLATURE (PNOMN) | AA-VRION REMI (LE) | OPERATING HOURS *CONUS FACIF EUFOPE (AFPR) | INOUTILI-ZATION FACTOR (TFAC) | ACTI-VATION TIME (RRPR) | FISSIONS *CONUS FACIF EUROPE (AFFR) | N FORTH *CONUS FACIF EUROPE (AFFR) | OTHER HOURS *CONUS FACIF EUROPE (FRPD) | *THRUST IB (IRHS) | GALLONS PER OPER HR (FGH) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EC135 ABACF | 4 | 72. 72. 72. | 1.20 | 0.0 | 1.0 1.0 1.0 | 1.0 2.0 1.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 11050. 1976. |
| 2 | E4B ABBCF | 1 | 192. 192. 192. | 1.72 | 0.0 | 2.5 2.5 2.5 | 2.5 2.0 2.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 38560. 3900. |
| 3 | EC-/EC135 FL | 2 | 50. 50. 50. | 1.20 | 0.0 | 1.0 1.0 1.0 | 1.0 1.0 1.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0. 0. |
| 4 | E52 ABBFL | 2 | 31. 31. 31. | 1.20 | 0.0 | 1.0 1.0 1.0 | 1.0 1.0 1.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0. 0. |
| 5 | FB111 ABBBL | 1 | 736. 736. 736. | 1.00 | 0.0 | 1.5 1.5 1.5 | 1.5 1.5 1.5 | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0. 0. |
| 6 | F1K1 GBDCF | 3 | 730. 730. 730. | 1.00 | 0.0 | 0.1 0.1 0.1 | 0.1 0.1 0.1 | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0. 0. |
| 7 | F1K/IRAB FL | 3 | 50. 50. 50. | 1.20 | 0.0 | 1.0 1.0 1.0 | 1.0 1.0 1.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0. 0. |

286

INPUT TABLE 6:  PLATFORM TERMINAL DATA & NON-RECURRING RGD/INSTALLATION DATA

IN THOUSANDS OF DOLLARS

| PLAT-FORM INDEX (NP) | NO. PRE TER-MINALS (NTRMP) | NON-RECUR. INTEG (INTRR) | RECUR. INTEG (INTR) | NON-RECUR. ROD/I COST (NRRI) | PLAT-FORM DIVER-SITY (PDIV) | *FRACTION RODS IN* | | | NO. A.DED A/TEM GAS (NAE) | LBS. DRAG PER ANTEN (DRAG) | THRUST-FUEL CNSMPT FACTOR (K) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | PROD | FIELD | DEPOT* (FR) | | | |
| 1 | 1.00 | 10000.000 | 20.000 | 500.000 | 1.00 | 0.0 | 0.0 | 1.00 | 1.00 | 1.0 | 0.67 |
| 2 | 1.00 | 10000.000 | 20.000 | 500.000 | 1.00 | 0.0 | 0.0 | 1.00 | 1.00 | 1.0 | 0.67 |
| 3 | 1.00 | 10000.000 | 20.000 | 500.000 | 1.00 | 0.0 | 0.0 | 1.00 | 0.0 | 0.0 | 0.0 |
| 4 | 1.00 | 10000.000 | 20.000 | 500.000 | 1.00 | 0.0 | 0.0 | 1.00 | 0.0 | 0.0 | 0.0 |
| 5 | 1.00 | 10000.000 | 20.000 | 500.000 | 1.00 | 0.0 | 1.CC | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 1.00 | 10000.000 | 20.000 | 500.000 | 1.00 | 0.0 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 1.00 | 10000.000 | 20.000 | 500.000 | 1.00 | 0.0 | 1.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 1.00 | 10000.000 | 20.060 | 500.000 | 1.00 | 0.0 | 0.0 | 1.00 | 0.0 | 0.0 | 0.0 |

INPUT TABLE 5: PLATFORM RECURRING PCO/INSTALLATION DATA

INPUT TABLE 6: PLATFORM DEPLOYMENT AT BASES - DELTS(BP,DS)

AVERAGE NUMBER OF PLATFORMS OF GIVEN TYPE AT EACH BASE WITHIN CYCLES BELOW

| PLAT-FORM INDEX (BP) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.00 | 0.00 | 0.0 | 3.00 | 0.0 | 1.86 | 0.36 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.57 | 0.64 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 18.66 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 1.00 | 0.0 | 1.00 | 0.0 | 0.78 | 0.0 | 4.79 | 0.36 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 2.00 | 0.0 | 1.00 | 0.0 | 0.0 | 0.91 | 0.57 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 2.00 | 0.0 | 0.0 | 0.0 | 3.00 | 0.0 | 0.0 | 2.00 | 0.0 | 22.25 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

289

INPUT TABLE 7: SUPPORT EQUIPMENT DATA

| SE INDEX (L) | SE NOMENCLATURE (SENODE) | SE PART NO. (SENUM) | SE UNIT COST (CSE) | FRACTION UNIT COST TO MAINTAIN (FSE) | CCP.ON-SITE(1) CCR.PROCUR.(2) PROCURE(3) (SETYPE) | NUMBER OF TECH ORDER PAGES (DATAS) | SE SUPPORT COST (SEEQB) |
|---|---|---|---|---|---|---|---|
| 1 | COMMON 1 | SE001 | 10000. | 0.100 | 1 | 10 | 500. |
| 2 | COMMON 2 | SE002 | 10000. | 0.100 | 1 | 10 | 500. |
| 3 | PECULIAR 1 | SE003 | 1000. | 0.100 | 1 | 10 | 500. |
| 4 | COMMON 3 | SE004 | 10000. | 0.100 | 1 | 10 | 500. |
| 5 | PECULIAR 2 | SE005 | 10000. | 0.100 | 1 | 10 | 500. |
| 6 | COMMON 4 | SE006 | 10000. | 0.100 | 3 | 10 | 500. |
| 7 | AGS | SE007 | 100000. | 0.010 | 2 | 50 | 50000. |
| 8 | ACT | SE008 | 100000. | 0.010 | | 50 | 50000. |

INPUT TABLE 6: ITEM EQUIPMENT DATA

| ITEM INDEX (I) | NOMENCLATURE (INCOS) | PART NUMBER (PTNLR) | LEARN RATE (LFAC) | LRU(Y) OR SRU(C) (LRL) | NEXT HIGHER ITEM (NHI) | GFE INDI-CATOR (GFE) | INTE-GRATION ITEMS (INTEG) | ITEM UNIT COST (J$) | REPAIR MATERIALS FACTOR (RM) | ITEM WEIGHT (WT) | PIECE PART COUNT (PA) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | LRU 1 | A51G1 | 0.95 | Y | 0 | N | 0 | 4000. | .0 | 10.00 | 4.0 |
| 2 | LRU 2 | AA1G2 | 0.95 | Y | 0 | N | 0 | 5000. | .0 | 10.00 | 0.0 |
| 3 | LRU 3 | AA1G3 | 0.95 | Y | 0 | N | 0 | 3000. | .0 | 10.00 | 0.0 |
| 4 | LRU 4 | A51G4 | 0.95 | Y | 0 | N | 0 | 4000. | .0 | 10.00 | 10.00 |
| 5 | LRU 5 | AA1G5 | 0.95 | Y | 0 | N | 0 | 1000. | .0 | 10.00 | 0.0 |
| 6 | LRU 6 | A51G7 | 0.95 | Y | 0 | N | 0 | 3000. | .0 | 10.00 | 0.0 |
| 7 | SRU 1 | AAB1G | 0.90 | C | 1 | N | 0 | 1000. | .100 | 1.00 | 10.00 |
| 8 | SRU 2 | AAB12 | 0.90 | C | 1 | N | 0 | 1000. | .100 | 1.00 | 10.00 |
| 9 | SRU 3 | AAB13 | 0.90 | C | 2 | N | 0 | 1000. | .100 | 1.00 | 10.00 |
| 10 | SRU 4 | AAB14 | 0.90 | C | 2 | N | 0 | 1000. | .100 | 1.00 | 10.00 |
| 11 | SRU 5 | AAB15 | 0.90 | C | 3 | N | 0 | 1000. | .100 | 1.00 | 10.00 |
| 12 | SRU 6 | AAB17 | 0.90 | C | 3 | N | 0 | 1000. | .100 | 1.00 | 10.00 |
| 13 | SRU 7 | AAB1b | 0.90 | C | 4 | N | 0 | 1000. | .100 | 1.00 | 10.00 |
| 14 | SRU 8 | AAB19 | 0.90 | C | 4 | N | 0 | 1000. | .100 | 1.00 | 10.00 |
| 15 | SRU 9 | AAB21 | 0.90 | C | 5 | N | 0 | 1000. | .100 | 1.00 | 10.00 |
| 16 | SRU 10 | AAB22 | 0.90 | C | 5 | N | 0 | 1000. | .100 | 1.00 | 10.00 |
| 17 | SRU 11 | AAB23 | 0.90 | C | 6 | N | 0 | 1000. | .100 | 1.00 | 10.00 |
| 18 | SRU 12 | AAB24 | 0.90 | C | 6 | N | 0 | 1000. | .100 | 1.00 | 10.00 |
| 19 | SRU 13 | AAB25 | 0.90 | C | 7 | N | 0 | 1000. | .100 | 1.00 | 10.00 |

INPUT TABLE 9A: STEP PERFORMANCE DATA

INPUT TABLE VI: TECHNICAL USERS, TRAINING AND UCT FACILITIES

| ITEM INDEX (I) | NUMBER OF TECH. DATA PAGES FOR EACH UNIT (LAIAC) | BASE (DATAE) | NO. OF HOURS PER UNIT ? TRAINING (TIPLI) | UCT EVENT COST ($C12LV) |
|---|---|---|---|---|
| 1 | 10 | 10 | 9 | 40000. |
| 2 | 10 | 10 | 9 | 0. |
| 3 | 10 | 10 | 9 | 0. |
| 4 | 20 | 10 | 9 | 0. |
| 5 | 20 | 10 | 9 | 40000. |
| 6 | 22 | 10 | 9 | 20000. |
| 7 | 20 | 10 | 9 | 10000. |
| 8 | 20 | 10 | 9 | 10000. |
| 9 | 20 | 10 | 9 | 10000. |
| 10 | 20 | 10 | 9 | 10000. |
| 11 | 20 | 10 | 9 | 10000. |
| 12 | 20 | 10 | 9 | 10000. |
| 13 | 20 | 10 | 9 | 1.000. |
| 14 | 20 | 10 | 9 | 10000. |
| 15 | 20 | 10 | 9 | 10000. |
| 16 | 20 | 10 | 9 | 10000. |
| 17 | 20 | 10 | 9 | 1.000. |
| 18 | 20 | 100 | 9 | 1.000. |
| 19 | 20 | 100 | 9 | 10000. |

INPUT TABLE 16A: ITEM/SE CROSS REFERENCE DATA - LAST LEVEL, PSL ONLY

INPUT TABLE 1CC: ITEM/SE CROSS REFERENCE DATA - CASE LEVEL, RES

| ITEM INDEX (I) | NUMB. OF SE TYPE RECD (N-SA) | SE INDEX NO. (A) | SE QUAN- TITY (N-SA) | SE INDEX NO. (A) | SE QUAN- TITY (N-SA) | SE INDEX NO. (A) | SE QUAN- TITY (N-SA) | SE INDEX NO. (A) | SE QUAN- TITY (N-SA) | SE INDEX NO. (A) | SE QUAN- TITY (N-SA) | SE INDEX NO. (A) | SE QUAN- TITY (N-SA) | SE INDEX NO. (A) | SE QUAN- TITY (N-SA) | SE INDEX NO. (A) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 5 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 7 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 10 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 11 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 13 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 14 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 16 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 17 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 18 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 19 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 20 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 21 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 22 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 23 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 24 | 1 | 6 | 201. | | | | | | | | | | | | | |
| 25 | 1 | 6 | 201. | | | | | | | | | | | | | |

INPUT TABLE 11: ITEM CONFIGURATIONS ON PLATFORMS - AFTER(I,AT)

AVG. NUMBER OF ITEMS INSTALLED ON PLATFORM TYPE

ITEM
INDEX
(I)

OBJECT TABLE 1: SUMMARY BY IOC-LEVEL CCSS ELEMENTS
(IN MILLIONS OF CONSTANT DOLLARS)

| PROGRAM CCSS | DEVELOPMENT | PRODUCTION | SUPPORT | TOTAL |
|---|---|---|---|---|
| FULL SCALE ENG. DEVT | 20.06 | 0.0 | 0.0 | 20.06 |
| P.M.../HARDWARE | 0.0 | 4.08 | 0.0 | 4.08 |
| DIAGNATICS | 0.0 | 52.06 | 0.0 | 52.06 |
| OPERATIONS | 0.0 | 0.0 | 0.06 | 0.06 |
| MOD/INSTALLATION | 0.0 | 47.11 | 0.0 | 47.11 |
| SPARES:REPLENMENT | 0.0 | 1.36 | 0.0 | 1.36 |
| REPLACEMENT | 0.0 | 0.0 | 17.18 | 17.18 |
| SUPPORT EQUIPMENT | 0.31 | 2.78 | 0.0 | 3.08 |
| OS EQUIPMENT | 0.0 | 0.0 | 0.56 | 0.56 |
| OFF EQUIPMENT | 0.0 | 0.0 | 12.46 | 12.46 |
| TRAINING | 0.0 | 0.0 | 0.95 | 0.95 |
| INVENTORY MANAGEMENT | 0.0 | 0.0 | 0.57 | 0.57 |
| TECHNICAL ORDERS | 0.0 | 0.59 | 0.0 | 0.59 |
| TOTAL COST | 20.37 | 162.35 | 31.82 | 238.54 |

OUTPUT TABLE 2: PLATFORM-BY MODIFICATION/INSTALLATION COSTS
(IN MILLIONS OF CONSTANT DOLLARS)

***RECURRING ROL/1 COST TOTALS BY PLATFORMS***

| PLAT-FORM INDEX (NO) | PLATFORM NAME | FIXED PLAT. PREP INSTR. | A-KIT EQUIP. FIRST | ROL/1 LABOR | AIRC-KIT PROD/1 TOTAL | PROD-TION PROD/1 TOTAL | TOTAL | A-KIT PLUS LABR COEFF. BY AREA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | ANTENNA | ELEC.BOX | CSTL.HL | CABLING |
| 1 | AC135 ABDCF | 11.256 | 0.160 | 0.036 | 11.394 | 0.0 | 11.394 | 0.033 | 0.033 | 0.033 | 0.033 |
| 2 | 24B ABDCF | 11.192 | 0.016 | 0.005 | 11.213 | 0.0 | 11.213 | 0.005 | 0.005 | 0.005 | 0.005 |
| 3 | BC-/BC135 FL | 7.485 | 0.027 | 0.009 | 7.521 | 0.0 | 7.521 | 0.0 | 0.012 | 0.012 | 0.012 |
| 4 | B52 ABDIL | 9.977 | 0.016 | 0.077 | 10.069 | 0.0 | 10.069 | 0.0 | 0.364 | 0.364 | 0.364 |
| 5 | FK111 ABDIE | 7.272 | 0.601 | 0.078 | 7.952 | 0.0 | 7.952 | 0.0 | 0.093 | 0.052 | 0.093 |
| 6 | FIKEL GBDCF | 0.535 | 0.033 | 0.013 | 0.761 | 0.0 | 0.561 | 0.0 | 0.015 | 0.015 | 0.015 |
| 7 | FIK/THAN IL | 0.570 | 0.057 | 0.022 | 0.649 | 0.0 | 0.649 | 0.0 | 0.024 | 0.024 | 0.024 |
| 8 | AC-135 ABDFL | 32.505 | 0.591 | 0.200 | 33.296 | 0.0 | 33.296 | 0.0 | 0.264 | 0.264 | 0.264 |
| | COST TOTALS | 74.633 | 1.441 | 0.039 | 77.114 | 0.0 | 77.114 | 0.039 | 0.814 | 0.814 | 0.814 |

OUTPUT TABLE 3: OPERATION AND LOGISTICS SUPPORT COST ELEMENTS
(IN MILLIONS OF CONSTANT DOLLARS)

| COST ELEMENT | INITIAL | RECURRING | TOTAL | INDEP BASES | CIRF BASES | SATEL BASES | BASE TOTAL | AIR BASES | GROUND BASES | DEPOT TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| OPERATIONS LABOR | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| ADDED FUEL | | 0.06 | 0.06 | 0.02 | 0.05 | 0.0 | 0.06 | 0.06 | 0.0 | |
| INITIAL SPARES | 1.36 | | 1.36 | 0.37 | 0.43 | 0.16 | 0.95 | 0.60 | 0.34 | |
| REPLACE. SPARES | | 17.18 | 17.18 | 6.72 | 4.52 | 5.94 | 17.18 | 9.26 | 7.92 | 6.41* |
| ON-EQUIP. MAINT. | | 0.56 | 0.56 | 0.29 | 0.18 | 0.13 | 0.56 | 0.27 | 0.29 | |
| OFF-EQUIP. MAINT. | | 12.48 | 12.48 | 3.79 | 4.51 | 0.0 | 8.30 | 5.75 | 2.55 | 4.16 |
| SUPPORT EQUIPMENT | | | | | | | | | | |
| COMMON | 1.62 | 0.80 | 2.42 | 0.53 | 1.17 | 0.0 | 1.70 | 1.31 | 0.39 | 0.72 |
| PECULIAR | 0.30 | 0.05 | 0.36 | 0.0 | 0.23 | 0.0 | 0.23 | 0.23 | 0.0 | 0.31 |
| INVENTORY MANAG. | 0.01 | 0.56 | 0.57 | 0.14 | 0.07 | 0.01 | 0.21 | 0.16 | 0.06 | 0.36 |
| MAINT. TRAINING | 0.49 | 0.46 | 0.95 | -- | -- | -- | 0.52 | -- | -- | 0.43 |
| TECH. DATA | 0.19 | 0.80 | 0.99 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.59 |
| TOTALS | 3.97 | 32.96 | 36.93 | 11.85 | 11.12 | 6.24 | 29.73 | 17.65 | 11.55 | 7.20 |

(* MAINT. TRAINING IS ALLOCATED TO BASE TOTAL AND DEPOT TOTAL BUT IS NOT FURTHER ALLOCATED AMONG BASE TYPES )

NUMBER OF BASES:

| | | | | |
|---|---|---|---|---|
| INDEP. = | 23. | | AIR BASES = | 26. |
| CIRF = | 9. | | GROUND BASES = | 21. |
| SATEL. = | 15. | | TOTAL = | 47. |
| TOTAL = | 47. | | | |

301

OUTPUT TABLE ...: ITEM-SPECIFIC MAINTENANCE AND COSTS CHARACTERISTICS

(COSTS IN THOUSANDS OF CONSTANT DOLLARS)

| ITEM INDEX | SYSTEM NO. OF INSTALLED ITEMS | TOTAL NO. OF INITIAL PART SPARES | TOTAL NO. OF INITIAL LABOR SPARES | ORDERED NO. OF ITEMS | NO. OF LIFE FAILS /YR | NO. OF LIFE CYCLE FAILS (EXCLUDING FALSE PULLS) | LEARNED UNIT COST | PRODUCTION CONTRACT PROCUREMENT QUANTITY |
|---|---|---|---|---|---|---|---|---|

OUTPUT TABLE 4C: SYSTEM-WIDE MAINTENANCE CHARACTERISTICS

AVERAGE CORRECTIVE MAINTENANCE COST
PER FAILURE ($K) FOR

| LRUS | SRUS |
|------|------|
| 0.215 | 0.362 |

TOTAL NUMBERS OF LRU FAILURES:

| MONTHLY | LIFETIME |
|---------|----------|
| 375. | 67494. |

OUTPUT TABLE 5: SUPPORT EQUIPMENT REQUIREMENTS AND COSTS
(COSTS IN DOLLARS)

| SE INDEX (L) | SUPPORT EQUIP. NAME | SUPPORT EQUIPMENT UNITS REQUIRED AT: | | | | | SYSTEM TOTAL REQUIRED UNITS (1) | UNIT LIFE-TIME COST (2) | TECH. ORDER COST (3) | SE DEPOT COST (4) | SYSTEM LIFE-TIME COST ($K) (1)*(2)+(3)+(4) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | INDEP BASES | CINF BASES | AIR BASES | GROUND BASES | THE DEPOT | | | | | |
| 1 | COSMOS 1 | 4. | 3. | 4. | 3. | 0.9 | 7. | 25000. | 10400. | 2500. | 195. |
| 2 | COSMOS 2 | 0. | 0. | 0. | 0. | 1.6 | 2. | 25000. | 10400. | 2500. | 54. |
| 3 | PECULIAR 1 | 0. | 0. | 0. | 0. | 0.0 | 0. | 25000. | 10400. | 2500. | 16. |
| 4 | COSMOS 3 | 6. | 7. | 8. | 5. | 0.8 | 18. | 25000. | 10400. | 250. | 304. |
| 5 | PECULIAR 2 | 5. | 1. | 5. | 4. | 0.8 | 10. | 25000. | 10400. | 2500. | 266. |
| 6 | COSMOS 4 | 0. | 2. | 3. | 3. | 1.6 | 8. | 25000. | 10400. | 150. | 216. |
| 7 | SBS | 0. | 7. | 2. | 0. | 1.0 | 3. | 115000. | 52000. | 50000. | 447. |
| 8 | UCT | 0. | 7. | 7. | 0. | 5.0 | 12. | 115000. | 52000. | 50000. | 1404. |

SUBTOTAL = 3045.

UCT SOFTWARE DEVELOPMENT COST = 200.
                                 --------
TOTAL SUPPORT EQUIPMENT COST = 3245.

OUTPUT TABLE 6: PLATFORM/TERMINAL FAILURE RATE DATA

| PLAT-FORM INDEX (DB) | PLATFORM NAME | SYSTEM NO. OF PLAT- FORMS | PPL THR. FLR. RATE (R/RFL) | FAILS/ FORTH PER FLAT | FAILS/ FORTH PER TERM. | FAILS/ MIL-HRS PER FLAT | FAILS/ MIL-HRS PER TERMINAL | PROC. COST PER PLAT TYPE (1K) |
|---|---|---|---|---|---|---|---|---|
| 1 | BC135 ABBLL | 45. | 1.00 | 0.676 | 0.676 | 5360. | 5360. | 467. |
| 2 | AAL ABALL | 6. | 1.00 | 4.373 | 4.373 | 4776. | 22776. | 2527. |
| 3 | AC-/AC135 FL | 9. | 1.00 | 0.466 | 0.466 | 5360. | 5360. | 1136. |
| 4 | B56 ABBLL | 27. | 1.00 | 0.296 | 0.296 | 5360. | 5360. | 67. |
| 5 | B611T ABBLL | 67. | 1.00 | 0.406 | 0.406 | 5360. | 9360. | 175. |
| 6 | BLABU GRCLL | 11. | 1.00 | 3.792 | 3.792 | 3600. | 3600. | 939. |
| 7 | AAA/TERR FL | 19. | 1.00 | 5.694 | 5.694 | 7600. | 7600. | 556. |
| 8 | AC-135 ABBLL | 197. | 1.00 | 0.626 | 0.626 | 14460. | 14460. | 80. |

* THESE FAILURES INCLUDE EVERY EVENT REQUIRING MAINTENANCE ACTION (INCLUDING REPAIR-IN-PLACE). THEY DO NOT INCLUDE FALSE PULLS.

OUTPUT TABLE 7: BARRACKS REQUIREMENTS

| BASE TYPE (BS) | BARRACKS PER YEAR PER BASE | TOTAL BARRACKS PER YEAR PER BASE | TOTAL BARRACKS PER YEAR/BASE TYPE | TOTAL BARRACKS IN YEAR/BASE TYPE |
|---|---|---|---|---|
| | MAINT. MGMT. DATA | | | |
| 1 | 63. | 0.7 | 97. | 0.7 |
| 2 | 757. | 0.5 | 1867. | 7.5 |
| 3 | 659. | 0.5 | 805. | 0.0 |
| 4 | 279. | 0.13 | 457. | 3.3 |
| 5 | 622. | 0.33 | 722. | 0.3 |
| 6 | 160. | 0.7 | 166. | 0.7 |
| 7 | 436. | 0.6 | 5035. | 2.6 |
| 8 | 920. | 0.6 | 2635. | 3.6 |
| 9 | 252. | 0.5 | 4650. | 2.0 |
| 10 | 1116. | 0.7 | 10350. | 6.0 |
| BASE TOTAL | -- | -- | 33069. | 19.0 |
| DEPOT TOTAL | -- | -- | 7668. | 4.9 |
| TOTAL | -- | -- | 40637. | 23.9 |

TOTAL BARRACKS PER YEAR
IN TRAINING

FIRST YEAR            13.6

EACH SUBSEQUENT YEAR   1.4

SSS LCC MODEL

ILLUSTRATIVE RUN 2

1 INPUT TABLE

2 OUTPUT TABLES

INPUT TABLE 5A:  ITIP MAINTENANCE DATA

OUTPUT TABLE 1: SUMMARY BY TOP-LEVEL COST ELEMENTS
(IN MILLIONS OF CONSTANT DOLLARS)

| PROGRAM COST | DEVELOPMENT | PRODUCTION | SUPPORT | TOTAL |
|---|---|---|---|---|
| FULL SCALE ENG. DEV. | 20.00 | 0.0 | 0.0 | 20.00 |
| P.R.I.:...ABLE | 0.0 | 4.00 | 0.0 | 4.00 |
| INTEGRATION | 0.0 | 92.00 | 0.0 | 92.00 |
| OPERATIONS | 0.0 | 0.0 | 0.66 | 0.66 |
| RDG/INSTALLATION | 0.0 | 67.11 | 0.0 | 67.11 |
| SPARES:INVESTMENT | 0.0 | 1.24 | 0.0 | 1.24 |
| SPARES: REPLACEMENT | 0.31 | 0.0 | 17.74 | 17.74 |
| SUPPORT EQUIPMENT | 0.0 | 2.72 | 2.56 | 2.66 |
| OD EQUIPMENT | 0.0 | 0.0 | 0.56 | 0.56 |
| TRAINING | 0.0 | 0.0 | 11.67 | 11.67 |
| OJT EQUIPMENT | 0.0 | 0.0 | 0.63 | 0.63 |
| INVENTORY MANAGEMENT | 0.0 | 0.0 | 0.54 | 0.54 |
| TECHNICAL ORDERS | 0.0 | 0.55 | 0.0 | 0.59 |
| TOTAL COST | 20.33 | 186.66 | 36.56 | 233.49 |

OUTPUT TABLE 4A: ITEM-SPECIFIC MAINTENANCE AND COSTS CHARACTERISTICS

(COSTS IN THOUSANDS OF CONSTANT DOLLARS)

| ITEM INDEX (I) | ITEM NAME | LRU INDI- CATOR (LRU) | INITIAL SPARES (ISCA) | REPL. SPARES (RSCA) | ON- EQUIP. MAINT. (OERCA) | OFF- EQUIP. MAINT. (OEPRCA) | MAINT. TRAINING (MTRCA) | TECH. ORDERS (TOC) | ITEM INVEST. MGMT. (IIMCA) | TOTAL AIR SUPPORT COST | COMM. MAINT. COST/FAIL (RSCA+OERCA +OITSCA) | TOTAL SUPPORT COST SRCI (TIAC) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | LRU 1 | 1 | 67.8 | 0.0 | 94.4 | 1082.5 | 91.1 | 79.1 | 6.6 | 1441.4 | 0.107 | 1655.4 |
| 2 | LRU 2 | 1 | 137.8 | 0.0 | 65.1 | 726.4 | 91.1 | 52.0 | 5.2 | 1077.3 | 0.104 | 1310.3 |
| 3 | LRU 3 | 1 | 157.4 | 0.0 | 95.2 | 1236.6 | 91.1 | 51.5 | 5.5 | 1632.6 | 0.105 | 1888.8 |
| 4 | LRU 4 | 1 | 155.6 | 0.0 | 123.0 | 1377.6 | 91.1 | 54.8 | 5.9 | 1801.6 | 0.104 | 2092.1 |
| 5 | LRU 5 | 1 | 51.5 | 7795.7 | 81.9 | 260.5 | 2.0 | 34.7 | 6.6 | 8218.4 | 1.617 | 8245.2 |
| 6 | LRU 6 | 1 | 116.5 | 0.0 | 50.2 | 619.8 | 91.1 | 57.0 | 4.9 | 939.1 | 0.115 | 1136.7 |
| 7 | LRU 7 | 1 | 31.8 | 0.0 | 73.2 | 810.9 | 17.4 | 46.5 | 4.6 | 1052.5 | 0.104 | 1252.2 |
| 8 | SRU 1 | 0 | 31.8 | 590.4 | 0.0 | 362.1 | 17.4 | 39.5 | 24.6 | 1066.4 | 0.296 | 1163.4 |
| 9 | SRU 2 | 0 | 31.8 | 590.4 | 0.0 | 362.1 | 17.4 | 35.2 | 23.6 | 1065.3 | 0.296 | 1148.6 |
| 10 | SRU 3 | 0 | 34.7 | 306.7 | 0.0 | 388.0 | 17.4 | 39.4 | 23.6 | 590.1 | 0.297 | 667.1 |
| 11 | SRU 4 | 0 | 21.5 | 306.7 | 0.0 | 376.5 | 17.4 | 34.5 | 23.6 | 1163.9 | 0.296 | 1205.6 |
| 12 | SRU 5 | 0 | 33.2 | 674.0 | 0.0 | 388.0 | 17.4 | 34.9 | 23.6 | 553.9 | 0.297 | 643.3 |
| 13 | SRU 6 | 0 | 33.5 | 674.0 | 0.0 | 414.0 | 17.4 | 46.2 | 23.6 | 553.9 | 0.296 | 643.3 |
| 14 | SRU 7 | 0 | 54.4 | 1462.4 | 0.0 | 777.1 | 17.4 | 48.0 | 23.6 | 1464.5 | 0.296 | 1306.5 |
| 15 | SRU 8 | 0 | 32.3 | 592.5 | 0.0 | 363.1 | 17.4 | 36.3 | 24.1 | 1266.7 | 0.296 | 2376.2 |
| 16 | SRU 9 | 0 | 32.3 | 592.5 | 0.0 | 363.1 | 17.4 | 36.3 | 24.1 | 1067.6 | 0.296 | 1152.2 |
| 17 | SRU 10 | 0 | 42.5 | 1060.6 | 0.0 | 665.4 | 17.4 | 41.0 | 24.7 | 1067.6 | 0.296 | 1152.4 |
| 18 | SRU 11 | 0 | 37.1 | 756.3 | 0.0 | 665.4 | 17.4 | 35.3 | 24.2 | 1672.4 | 0.296 | 2038.6 |
| 19 | SRU 12 | 0 | 17.1 | 218.6 | 0.0 | 133.1 | 17.4 | 33.4 | 24.4 | 1341.8 | 0.296 | 1453.8 |
| 20 | SRU 13 | 0 | 17.1 | 218.6 | 0.0 | 133.1 | 17.4 | 33.4 | 23.4 | 443.0 | 0.297 | 476.7 |
| | | | | | | | | | | 443.0 | 0.297 | 476.7 |
| COST TOTALS OVER ITEMS | | | 1262.2 | 17186.7 | 563.0 | 11865.5 | 826.4 | 966.2 | 426.9 | 33166.9 | | 36149.6 |

312

SSS LCC MODEL

REPAIR LEVEL ANALYSIS PROGRAM

2 INPUT TABLES

1 OUTPUT TABLE

INPUT TABLE 1: LRU/SRU CROSS REFERENCE DATA    (FROM FILE 8B)

INPUT TABLE 2: TOTAL ITEM SUPPORT COST - TIAC(.,.B)
(COSTS IN THOUSANDS OF DOLLARS)

GLOBAL MAINTENANCE STRATEGY - B

| ITEM INDEX | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1 | 1773.6 | 1842.1 | 2095.9 | 2861.0 | 2510.6 | 22617.1 |
| 2 | 1283.2 | 1333.4 | 1352.8 | 1746.3 | 1003.1 | 37633.3 |
| 3 | 1871.2 | 1863.1 | 1807.7 | 2235.7 | 2350.0 | 36728.1 |
| 4 | 2079.2 | 2106.4 | 2116.3 | 2647.6 | 2701.9 | 56652.8 |
| 5 | 8235.1 | 8286.1 | 8249.5 | 9508.7 | 8512.2 | 8452.9 |
| 6 | 1046.9 | 1153.5 | 1177.2 | 1847.6 | 1842.6 | 17799.6 |
| 7 | 1287.7 | 1318.0 | 1826.3 | 1742.7 | 1805.0 | 25411.5 |
| 10 | 1309.1 | 1158.2 | 1302.2 | 1005.2 | 3183.8 | 72.9 |
| 11 | 1395.8 | 1163.2 | 1302.2 | 1012.0 | 3183.4 | 72.9 |
| 12 | 793.6 | 688.3 | 1786.3 | 647.3 | 1679.9 | 56.2 |
| 13 | 1809.7 | 1198.2 | 3840.7 | 1089.7 | 3309.4 | 78.3 |
| 14 | 793.3 | 680.6 | 1782.3 | 663.3 | 1679.9 | 56.2 |
| 15 | 793.1 | 680.6 | 1782.3 | 663.3 | 1679.9 | 56.2 |
| 16 | 1885.1 | 1300.1 | 3757.8 | 1135.0 | 3626.9 | 77.9 |
| 17 | 1863.8 | 2845.6 | 7010.3 | 2055.8 | 3626.9 | 77.9 |
| 18 | 2786.0 | 2845.6 | 3198.9 | 2055.8 | 6762.7 | 112.9 |
| 19 | 1358.1 | 1187.2 | 3198.8 | 1008.1 | 3198.9 | 73.1 |
| 20 | 1358.1 | 1187.2 | 3198.8 | 1008.1 | 3198.9 | 73.1 |
| 21 | 1358.1 | 1187.2 | 3198.8 | 1008.1 | 3198.9 | 73.1 |
| 22 | 2356.2 | 2036.3 | 5082.1 | 1771.1 | 5793.7 | 102.1 |
| 23 | 1807.8 | 1887.6 | 8218.8 | 1267.3 | 8078.0 | 82.9 |
| 24 | 893.8 | 878.7 | 1288.9 | 823.7 | 1203.0 | 56.9 |
| 25 | 883.8 | 878.7 | 1288.9 | 823.7 | 1203.0 | 50.9 |

OUTPUT TABLE 1: REPAIR LEVEL ANALYSIS

| ITEM INDEX (I) | LRU (?) OR SRU (U) | REPAIR LEVEL - FL | | | RESULTS DIFF. FROM CONTRACTOR INPUT |
| | | BASE (1) | DEPOT (2) | DISCARD (3) | |

## APPENDIX C

## GLOSSARY OF ACRONYMS

| | |
|---|---|
| ABNCP | airborne command post |
| ABNFE | airborne force element |
| AF | Air Force |
| AFSATCOM | Air Force Satellite Communications System |
| BITE | built-in test equipment |
| CIMF | centralized intermediate maintenance facility |
| CN | contractor |
| CSE | common support equipment |
| DTC/LCC | design to cost/life cycle cost |
| ED | explicit decimal |
| EHF | extremely high frequency |
| FE | force element |
| FI | fixed form |
| FR | free form |
| FIX/TRAN FE | fixed/transportable force element |
| FSED | full scale engineering development |
| FY | fiscal year |
| G&A | general and administrative |
| GFE | government furnished equipment |
| GNDCP | ground command post |
| ID | implicit decimal |
| IND | independent base |
| LCC | life cycle cost |
| LRU | line replaceable unit |
| MBS | maintenance bench set |
| MOD/I | modification/installation |
| MTBMI | mean time between maintenance incidents |
| O&LS | operations and logistics support |
| OJT | on the job training |
| PIUP | planned inventory utilization period |
| PME | prime mission equipment |
| PSE | peculiar support equipment |
| RFP | request for proposal |
| RJ | right justified |
| RLA | repair level analysis |
| SAC | Strategic Air Command |
| SAT | satellite base |
| SHF | super high frequency |
| SOW | statement of work |

## GLOSSARY OF ACRONYMS
### (concluded)

| | |
|---|---|
| SRU | shop repairable unit |
| SSS | Strategic Satellite System |
| TO | technical order |
| TRC | technology repair center |
| UCT | universal card tester |