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TR MMER/RM-73-121

JUNE 1973

SYSTEM COST RELIABILITY ANALYSIS PROGRAM

(SCRAP)

DOCUMENTATION

PREPARED BY MMER
RELIABILITY SECTION

SERVICE ENGINEERING
DIVISION

OGDEN AIR MATERIEL AREA
HILL AFB, UTAH 84406

TECHNICAL
REPORT

TR-MMER/RM-73-121

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Reliability Section (MMERR)
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(SCRAP)

DOCUMENTATION

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ABSTRACT

This document presents documentation necessary to use the System Cost Reliability Analysis Program (SCRAP). This program, developed by OOAMA/MMERR, was established to realistically determine, <u>in real time</u>, the Total Annual Logistic cost of an aircraft weapon subsystem or system and to perform cost sensitivity analyses on these weapon subsystems or systems.

1.0 BACKGROUND

One of the most complex areas of endeavor within the Air Force Logistic Command (AFLC) is to reduce the total recurring annual logistic cost of a weapon system (the cost to operate and support a weapon system). It is the purpose of this document to show how existing maintenance, failure, and cost data available within the Air Force can be used to formulate a realistic method to determine total recurring annual logistic cost. Then, the document will show how this method can be used to determine high cost areas within a weapon system, and how the method may be used to determine whether a proposed modification to a weapon system is economically sound. Finally, the document will present details on how to work with the SCRAP and SORTSUM computer programs.

2.0 BACKGROUND

Prior to the determination of which weapon system areas are the most costly and whether a modification to a weapon system is economically sound, a complete cost analysis must be performed to determine present total recurring annual logistic cost of the weapon system in question. Determination of total recurring annual logistic cost would then result in performing a cost of ownership (annual logistic cost) analysis and a cost sensitivity analysis of a weapon system.

It is apparent that in order to perform a cost analysis of a large, complex weapon system, a great deal of data must be available. Within the Air Force Logistic Command such data does exist in the AFM 66-1 data system. The time taken to repair an item in the field, MTBF (Mean-Time-Between-Failure), cost of material per repair, and many other data items are also available from the AFM 66-1 data system.

Every weapon system is divided into subsystems. These subsystems are further reduced to the LRU (Line Replaceable Unit) level. For example, the F-4C fighter aircraft is considered a weapon system; items such as the engine, navigation equipment, and radar are considered subsystems; and items such as the antenna of a radar are considered LRU's. Thus, a weapon system may be made up of thousands of subsystems and LRU's. To insure that the data kept for each subsystem and LRU is easily accessible, numbers are attached to each subsystem, LRU, or major part of a LRU. For example, the jet engine has the number 23000; the ejector nozzle assembly, a LRU of the engine, has the number 23530; and the nozzle itself, a part of the ejector nozzle assembly, has the number 2353A attached to it. These numbers are referred to as Work Unit Codes (WUC). Some of the AFM 66-1 data is organized by means of these WUC's. Data such as manhours expended to adjust, overhaul, clean a LRU, is listed under a WUC within the AFM 66-1 data system.

In addition to the AFM 66-1 data system, depot data exists in the LOG-K65 of the G072A data system. This is an AFLC data system which contains depot information such as time required to overhaul a particular LRU, cost of parts replaced, number of LRU's condemned at the depot, and cost per manhour of overhaul. Additionally, data such as the cost of the subsystem or LRU, the number of items in the inventory, the number of parts, exists within the Air Force--in other words, the physical parameters of the weapon system in question.

Adequate raw data does exist to conceivably perform a cost analysis. Within the AFLC "library" also exists a document called AFLCM 66-18. In Chapter 15 (Cost Analysis - AFLC Increase

Reliability of Operational Systems (IROS) Program) of this manual, equations are presented which, when implemented, will result in total recurring annual logistic cost. Thirty-eight parameters are required to implement the equations listed in Chapter 15.

It is the intent of the next section to show how the existing raw data and the basic equations of AFLCM 66-18, Chapter 15, are used to provide a means of determining the total recurring annual logistic cost for a weapon system, and a breakout of the cost into its relevant categories (e.g., labor, material, etc.).

3.0 TOTAL RECURRING ANNUAL LOGISTIC COST BASELINE

Prior to making any decisions with regard to total recurring annual logistic cost, an annual logistic cost baseline must be determined. To establish this baseline, the data in AFM 66-1, G072A, and the basic equations in AFLCM 66-18 must be used. To integrate the raw data with the equations of AFLCM 66-18, a computer program called System Cost Reliability Analysis Program (SCRAP) was written. There are 31 variables required to drive the cost program SCRAP. (See Appendix A for a listing of the 31 variables.) It should be noted that some of the variables shown in AFLCM 66-18 are actually constants and thus included in the program body. The first six pertain to on-weapon system actions; the next nine pertain to base shop actions; and the last eleven provide general information required for cost computation. Variable A(15), Base Material Cost Standard for Non-Failure Maintenance, is assumed to be zero in many cases since data from the field, to even approximate this standard, is usually not available. It should be noted that variable A(20) is a decision factor for handling the situation of two labor standards existing in the depot--one for condemnation, one for overhaul--and is therefore not a true data element.

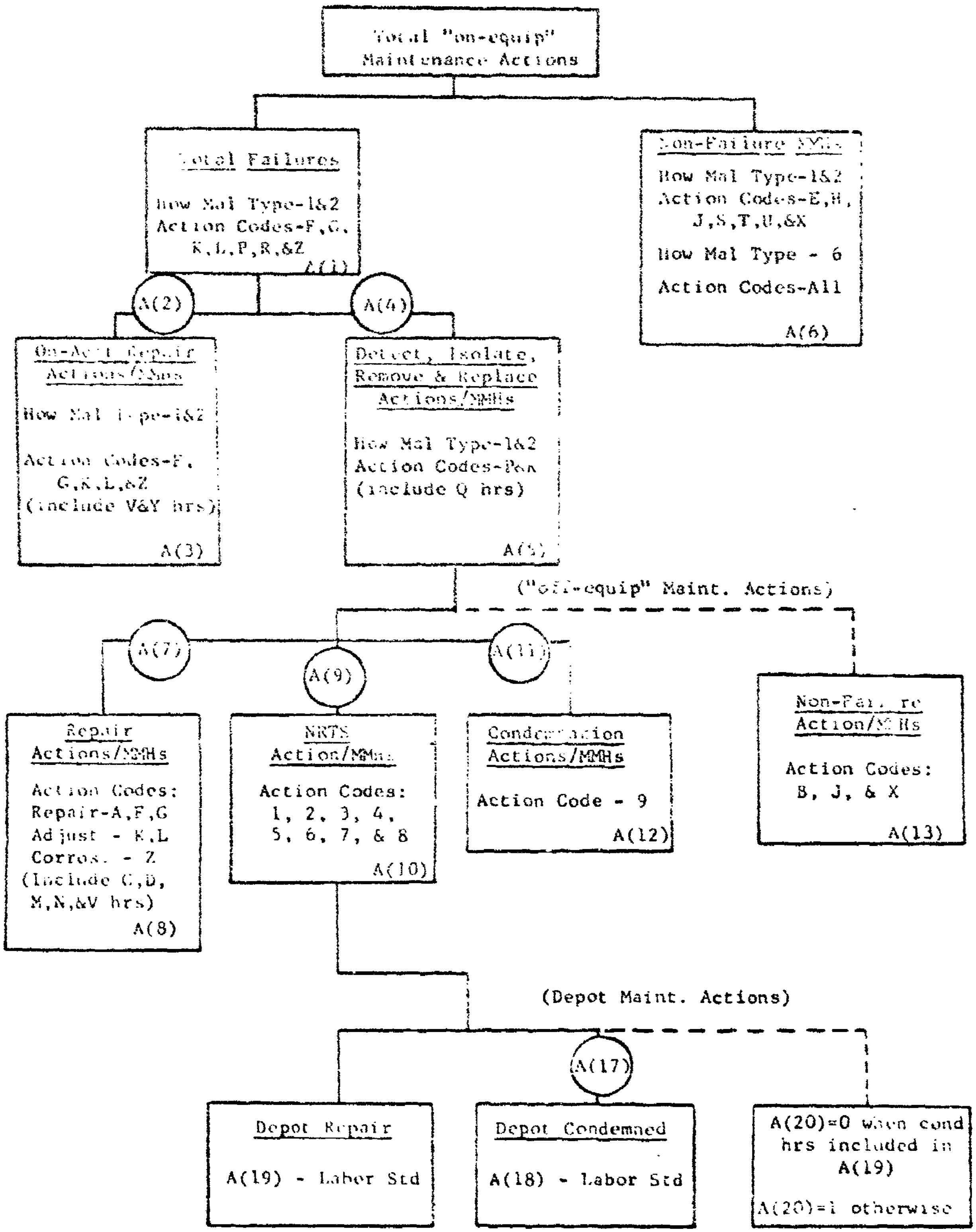
The first fourteen variables are generated from AFM 66-1 data; the depot data, variables A(16) - A(21), comes from the LOG K65 of the G072A system (a depot data management system); and the last eleven variables are provided by the respective item and system managers.

In the writing of the computer program, it is assumed that maintenance is accomplished on these levels: on-weapon system (on equipment), base-shop (off-equipment), and depot overhaul. A flow diagram outlining the different maintenance accomplished at each level and the interconnection of levels is given in Fig 1. The following abbreviations are used in Fig. 1. NRTS - not reparable this station, MMHs - maintenance manhours, ACFT - aircraft, equip - equipment, hrs - hours, Mal - malfunction.

The respective variables (A(1) - A(13), A(17) - A(20)) applying to each block are also included on the diagram. These are the variables used in the computer program. The definitions dictating which AFM 66-1 data elements apply to each block are given in Appendix B. These definitions are based on the criteria set forth in AFLCM 66-18, Chapter 15, and on the individual definition of each, as defined in the technical manuals. The depot rates and standards come directly from depot data products and are not derived from AFM 66-1 data. The different rates (A(2), A(7), etc.) denote the percentage of action accomplished in that block. The rates are derived by taking the ratio of the number of actions accomplished in

FIG. 1

LABOR EXPENDITURE



a particular block to the total actions accomplished at that maintenance level. The labor standard for each block is derived by taking the ratio of maintenance manhours reported to the number of actions reported for each block. This indicates the average manhours expended per action for that particular block.

The cost of material expended per repair action at the depot, A(16), is reported directly in the LOG K65 data product. The material cost per repair action at the base shop A(14), is not reported directly. An estimate of the material cost at the base shop was made by taking the total cost of the bits and pieces reported as being replaced in the AFM 66-1 data and dividing by the number of repair actions. This gives an average material cost per repair action at the base shop.

The basic differences between the SCRAP computer program and the equations in AFLCM 66-18 lie in the definition of failure and in the breakout of maintenance repair areas. AFLCM 66-18 defines a failure as type 1 How Malfunction Code with only F, P and R actions and only P and R actions not followed by a B action Code in the base shop. (See Appendix B for definitions of actions and How Mal codes.) The SCRAP program defines a failure as type 1 or 2 How Mal Codes with action codes F, G, K, L, P, R and Z. It simply makes sense to call a required adjustment a failure if the mission must be scrapped because of this maladjustment. Additionally, AFLCM 66-18 assumes that all failures result in a removal of the item from the weapon system. This contradicts their definition of failure since an F action code denotes on equipment (weapon system) repair. The SCRAP program allows for the fact that some repair actions are accomplished on the weapon system. Lastly, the AFLCM 66-18 equations group all base shop data together to give one labor standard for repair. The SCRAP program breaks out this data, which enables the sensitivity of all various actions to be determined. A detailed procedure of how to enter data and a listing of the SCRAP program is contained in Appendix C. The program incorporates the modified equations of AFLCM 66-18, as previously mentioned, (lines 1060 - 1360), plus other features which allow a cost sensitivity analysis to be performed. The program is written in FORTRAN IV computer language. To drive the program, the previously mentioned 31 variables must be entered. To find variables A(1) - A(14) calculations are required. The program allows raw data to be fed to it and it will calculate A(1) through A(14), lines 150 - 570 of the program, thereby simplifying the cost analysis. The raw data items (denoted by S(1) through S(23)) used to calculate A(1) through A(14) are listed in Fig 2. Fig 2 also shows from which data products S(1) through S(23) are obtained.

Once S(1) through S(23) and A(15) through A(31) are entered, a resultant cost analysis will be performed. If more than one run is anticipated of any given work unit code, and if A(1) through

FIG. 2 - BASE SHOP DATA

From 3-LOG-K261 (AFM 66-1)

S(1) = Type 1 & 2, S Actions
S(2) = Type 1 & 2, S MMHs
S(3) = Type 1 & 2, V+Y MMHs
S(4) = Type 1 & 2, P Actions
S(5) = Type 1 & 2, R Actions
S(6) = Type 1 & 2, P&R MMHs
S(7) = Type 1 & 2, True Actions Summary
S(8) = Type 1 & 2, True MMHs Summary
S(9) = Total MMHs Summary

From 4-LOG-K261 (for all types AFM 66-1)

S(10) = V MMHs
S(11) = Z Actions
S(12) = Z MMHs
S(13) = 9 MMHs

From 5-LOG-K261 (for all types AFM 66-1)

S(14) = AFG, Repair + KL, Adjustment Actions
S(15) = AFG, Repair + KL, Adjust + CDMN, Delayed MMHs
S(16) = 1 - 8, NRTS Actions
S(17) = 1 - 8, NRTS and 9, Condemned MMHs
S(18) = 9, Condemned Actions
S(19) = BJ + VXZ, Clean/Test/Corrosion Actions
S(20) = BJ + VXZ, Clean/Test/Corrosion MMHs
S(21) = Total Cost of Parts replaced
S(22) = Type 1, 2 and 6, Q Actions
S(23) = Type 1, 2, and 6 Q MMHs

A(14) have been previously calculated, it is possible to enter A(1) through A(31) and obtain the same results. Sample printouts from the program are shown in Appendix D. The top portion shows data entry and a printout of the calculated variables A(1) through A(14), Page D-1. These variables deal with on-weapon system actions and base (field) shop maintenance actions. Page D-2 provides a printout of the program results based on the previously calculated variables plus the remaining eighteen variables required to complete the data (Appendix A).

As previously mentioned, a sensitivity analysis is also an option to the SCRAP program. A sample of the printout from a sensitivity analysis is shown in Appendix D, page D-3.

Operation of the analysis involves entering (1) number of variables to be changed, (2) which variables these are, and (3) percentage of change desired. Only the number of the variable has to be entered; i.e., for A(1) enter 1. The program is keyed to reductionsof that variable by the percentage entered. If a negative percentage (i.e., -10) is entered, the variable is increased by that percentage. The only exception is when a change to a labor or other rate is desired. In this case the value of the new rate must be entered. The program then calculates the new total recurring annual logistic cost (TALC), the resulting amount of reduction in TALC, and the percentage reduction in TALC. (See Appendix D, Page D-2 for an example.)

The next sections will cover what applications are possible using this method of obtaining total recurring annual logistic cost.

4.0 THE HIGH COST AREAS OF A WEAPON SYSTEM

In the previous section, 3.0, a method for determining a baseline for total recurring annual logistic cost was developed. Assuming that a baseline for several WUC's was calculated, it will be shown how the high cost areas of a weapon system or subsystem are determined.

Perhaps the most obvious way to approach this is to take all the total recurring annual logistic costs calculated by SCRAP and rank them by decreasing cost. Subsequent to ranking this total recurring annual logistic cost, a cumulative sum and percentage should be taken. This is necessary to find the high cost items. For example, after ranking and calculating the cumulative percentages, it is found that three or four out of perhaps twenty items comprise 95% of the total recurring annual logistic cost, it would be advantageous to expend engineering effort and money on those three or four items rather than the rest.

These calculations may be handled manually, but for larger systems it becomes imperative to use a computer program to handle the calculations. A computer program was written to rank the total recurring annual logistic cost calculated by SCRAP. The program called "SORTSUM", ranks cost in decreasing order or increasing order. The program also prints out the WUC associated with a given total recurring annual logistic cost, and the cumulative sums and percentages. For a detailed instruction of using the program and listing of the program see Appendix E, pages E-1 to E-4.

Thus, high cost areas of a weapon system can be readily determined by first finding the baseline cost data using SCRAP and the using SORTSUM to rank these costs. A sample printout of the ranking is given in Appendix E, Page E-4. SORTSUM may also be used to rank failures, manhours, or any other factors associated with total recurring annual logistic cost. The sample printout, page E-4 shows that failures as well as costs are ranked. The capability to do this is another useful tool in the determination of high cost areas. In the sample printout it should be noted that the first item of the seven listed comprises 98.14% of the total cost, yet only 33.53% of the total failures. Consequently, it can be concluded that the cost per failure of the 23000 WUC is proportionally higher than the other WUC's. Thus, a reduction in failure of that WUC would result in the greatest savings.

The value of knowing total recurring annual logistic and the top high cost items now becomes apparent. Any endeavor in engineering requiring changes to a weapon system should not be undertaken unless a detailed cost analysis is performed.

5.0 THE COST EFFECTIVENESS OF AN ECP (ENGINEERING CHANGE PROPOSAL)

One of the areas stressed in section 3.0 was the capability of SCRAP to perform a sensitivity analysis on any variable in the program; that is, an analysis showing the amount of change in total recurring annual logistic cost due to a change in one of the variables making up annual logistic cost. This capability lends itself to the evaluation of an ECP (Engineering Change Proposal).

Often ECP's are accepted or bought because they sound appealing. But, are they economically sound? Without a program like SCRAP it is rather difficult to assess the financial worth of an ECP.

Prior to making any decision on the worth of an ECP, the methods formulated in section 3.0 must be used to find the baseline annual logistic data. Then the manufacturer's proposal must be evaluated to pin down which area of the ECP is to be improved, how it is to be improved (i.e., reduction in maintenance manhours, reduction in failures), and by how much each area may be improved. Having established an annual logistic cost baseline and quantified the proposed modification, it is now possible to enter the amount of reduction the proposed modification calls for on any given variable. This is done to every variable for which reductions are claimed within a WUC. It is also done to every WUC affected by the modification. A new resultant annual logistic cost will be found for the system in question, and the savings realized will also be found.

This savings can then be compared to the total cost of the modification, and a judgment can be made as to the worth of the ECP. For example, if the manufacturer claims a reduction in failures of 10%, a reduction of 10% on variable A(1) is entered into the sensitivity analysis. The sample analysis of WUC 23000, Appendix D, page D-3 above that reducing A(1) by 10% results in a savings of $1,818,125. It is now possible to weigh the cost of the modification against the predicted savings. If the amortization time is acceptable the ECP should be accepted,

The sensitivity analysis also shows that the 10% reduction in failures of the 23000 WUC results in savings of 9.23%, or almost all the cost is associated with failures. This is not always the case. The sample analysis of WUC 2361B, Appendix D, page D-5 shows that a 50% reduction in failures yields only a 22% savings in total annual logistic cost. Therefore without SCRAP, it is difficult to evaluate, realistically and in real time, an ECP from an economic standpoint.

6.0 CONCLUSION

The uncertainties in the determination of the total recurring annual logistic cost can be greatly reduced by using the procedures developed in section 3.0. Therefore, guessing at this cost will no longer be necessary. This report has shown how existing maintenance, failure, and cost data available within the Air Force can be used to determine annual logistic cost. It was then shown how the method developed in section 4.0 can be used to determine high cost areas of a weapon system. This is extremely important in allocating time and money to improve the appropriate portion of the weapon system; because, little is gained by expending engineering time and money on a low cost portion of a weapon system. Lastly, section 5.0 shows how it is possible to use SCRAP to determine whether a proposed modification to a weapon system is economically sound. A complete cost analysis done by the methods developed in this report provides an invaluable data base to be used in future decisions dealing with modifications or the operating cost of a weapon system. With this data base and SCRAP, sensitivity analyses are possible at any time, in real time, reducing the unknowns present in making a decision on the economics of engineering and management problems of a weapon system.

APPENDIX A

SCRAP PROGRAM VARIABLES

A(1) = Total Failures
A(2) = On-Aircraft Repair Rate
A(3) = On-Aircraft Repair Labor Standard
A(4) - Remove and Replace Rate
A(5) = Remove and Replace Labor Standard
A(6) = Non-Failure MMHs (On-Equipment)
A(7) = Base Shop Repair Rate
A(8) = Base Shop Repair Labor Standard
A(9) = Base Shop NRTS Rate
A(10) = Base Shop NRTS Labor Standard
A(11) = Base Shop Condemnation Rate
A(12) = Base Shop Condemnation Labor Standard
A(13) = Base Shop Non-Failure MMHs
A(14) = Base Mat'l Cost Standard for Repair ($/repair)
A(15) = Base Mat'l Cost Standard for Non-Failure Maintenance ($/hour)
A(16) = Depot Mat'l Cost Standad for Repair
A(17) = Depot Condemnation Rate
A(18) = Depot Condemnation Labor Standard (hrs/cond action)
A(19) = Depot Repair Labor Standard (hrs/repair action)
A(20) = Decision Factor (equals 0 when Repair - Condemned hrs in one std; 1 otherwise)
A(21) = Percent Condemned Items to be Reprocured
A(22) = Total Annual Flying Hours
A(23) = Weight (lbs)
A(24) = Percent Aircraft Conus
A(25) = Percent Aircraft Overseas
A(26) = Number of Items Managed
A(27) = Standard Unit Cost of Item
A(28) = Salvage Value ($/lb)
A(29) = Number of Stock Listed Parts and Subassemblies
A(30) = Number of Applicable T.O. pages
A(31) = Other Significant Recurring Costs

APPENDIX B

SCRAP PROGRAM

AFM 66-1 DATA DEFINITION

Noun	How Mal Type	Action Codes
(Base "On-Equip." 3/5-Log-K261)		
Total Failures	1 & 2	F,G,K,L,P,R,Z
On-Aircraft Repair Actions	1 & 2	F,G,K,L,Z
On-Aircraft Repair MMHs	1 & 2	F,G,K,L,Z,V,Y
Detect, Isolate, Remove, Replace Actions	1 & 2	P,R
Detect, Isolate, Remove, Replace MMHs	1 & 2	P,R,Q
Non-Failure MMHs	1,2 and 6	E,H,J,S,T,U,X All Codes
(Base "Off-Equi ." 4/5-Log-K261)		
Shop Repair Actions	N/A	A,F,G,K,L,Z
Shop Repair MMHs	N/A	A,F,G,K,L,Z,C,D, M,N,V
Shop NRTS Actions	N/A	1,2,3,4,5,6,7,8
Shop NRTS MMHs	N/A	1,2,3,4,5,6,7,8
Shop Condemnation Actions	N/A	9
Shop Condemnation MMHs	N/A	9
Shop Non-Failure Actions	N/A	B,J,X
Shop Non-Failure MMHs	N/A	B,J,X

ACTION TAKEN CODES

A - Bench Checked and Repaired. Bench check and repair of any one item is accomplished at the same time. (Also see Code F.)

B - Bench Checked-Serviceable. (No repair required)- Item is bench checked and no repair required.

C - Bench Checked-Repair Deferred. Bench check is accomplished and repair action is deferred. (See Code F.)

D - Bench Checked-Transferred to Another Base or Unit. Item is bench checked at a forward operating base, dispersed operating base or enroute base and is found unserviceable and transferred to a main operating base or home base for repair. This code will not be used for items returned to a depot for overhaul. This code will also be used when PME or other equipment is sent to another base or unit for bench check, calibration, or repair and is to be returned, and for items forwarded to contractors on base level contracts.

E - Initial Installation. For installation actions that are not related to a previous removal action such as installation of additional equipment or installation of an item to remedy a ship-short condition. This code will be used only for equipment managed under the advanced configuration management system. Reference T.O.'s 00-20-2-3, 00-20-2-5, and 00-20-2-7 must be used with How Mal Code 799.

F - Repair. Not to be used to code "on-equipment" work if another code will apply. When it is used in a shop environment, this code will denote repair as a separate unit of work after a bench check. Shop repair includes the total repair manhours and includes cleaning, disassembly, inspection, adjustment reassembly and lubrication of minor components incident to the repair when these services are performed by the same work center. For precision measurements equipment, this code will be used only when calibration of the repaired item is required (See Code G).

G - <u>Repair and/or Replacement of Minor Parts, Hardware and Softgoods.</u> (Seals, gaskets, electrical connectors, fittings, tubing, hose, wiring, fasteners, vibration isolators, brackets, etc.) Work Unit Codes do not cover most non-repairable items; therefore, when items such as those identified above are repaired or replaced, this action taken code will be used. When this action taken code is used, the Work Unit Code will identify the assembly being serviced or most directly related to parts being repaired or replaced. For example, if an electrical connector was repaired and was attached to a radio transmitter, the Work Unit Code for the transmitter would be used with this action taken code. For precision measurement equipment, this code will be used for repairs that do not require calibration of the repaired item (see Code F).

H - <u>Equipment Checked-No Repair Required (For "On-Equipment" Work Only).</u> All discrepancies which are checked and found to require no further maintenance action. This code will be used only if it is definitely determined that a reported deficiency does not exist or cannot be duplicated. Must be used with the How Mal Code 799, 812 or 948.

J - <u>Calibration-No Adjustment Required.</u> Use this code when an item is calibrated and found serviceable without need for adjustment, or is fo nd to be in tolerance but is adjusted merely to peak or maximize the reading. If the item requires adjustment to actually meet calibration standards or to bring in toleran ce, use Code K.

K - <u>Calibrated-Adjustment Required.</u> Item must be adjusted to bring it in tolerance or meet calibration standards. If the item was repaired or needs repair in addition to calibration and adjustment, use Code F.

L - <u>Adjust.</u> Includes tighten, adjust, bleed, balance, rig, and fit, or actuating reset button or switch. A particular discrepancy is cleared by adjusting, etc., the item. If the identified component also requires replacement bits and pieces as well as adjustment (new points, condensers, tubes, etc.), enter the appropriate repair code instead of L.

M - <u>Disassemble.</u> Disassembly action when the complete maintenance job is broken into parts and reported as such. Do not use for on-equipment work.

N - Assemble. Assembly action when the complete maintenance job is broken into parts and reported as such. Do not use for on-equipment work

P - Removed. Item is removed and only the removal is to be accounted for. In this instance delayed or additional actions will be accounted for separately. (Also see Codes Q, R, S, T, AND U.) Do not use for off-equipment work.

Q - Installed. Item is installed and only the installation action is to be accounted for. (Also see Codes E, P, R, S, T, and U.) Do not use for off-equipment work.

R - Remove and Replace. Item is removed and another like item is installed. (Also see Codes T and U.) Do not use for off-equipment work.

S - Remove and Reinstall. Item is removed and the same item reinstalled. (Also see Codes T and U.) Do not use for off-equipment work. Must be used for How Mal Code 800, 804, or 805.

T - Removed for Cannibalization. A component is cannibalized. The Work Unit Code will identify the component being cannibalized. Do not use this code for off-equipment work. Must be used with How Mal Code 799.

U - Replaced After Cannibalization. This code will be entered when a component is replaced after cannibalization. Do not use this code for off-equipment work. Must be used with How Mal Code 799.

V - Clean. Cleaning is accomplished to correct discrepancy and/or cleaning is not accounted for as part of a repair action such as Code F. Includes washing, acid bath, buffing, and blasting, degreasing, decontamination, etc. Cleaning and washing of complete items such as ground equipment, vehicles, missiles or airplanes should be recorded by utilizing support general codes.

X - Test-Inspection-Service. Item is tested or inspected or serviced (other than bench check) and no repair is required. This code does not include servicing or inspection chargeable to support general Work Unit Codes.

Y - Troubleshoot. Time expended in locating a discrepancy is great enough to warrant separating the troubleshoot time from the repair time. Use of this code necessitates completion of two separate line entries, or two separate forms, one for the troubleshoot phase and one for the repair phase. When recording the troubleshoot time separate from the repair time, the total time taken to isolate the primary cause of the discrepancy should be recorded utilizing the Work Unit Code of the defective subsystem or system. Do not use for off-equipment work.

Z - Corrosion Repair. Includes cleaning, treating, priming and painting of corroded items. This code should always be used when actually treating corroded items, either on equipment or in the shop. The Work Unit Code should identify the item that is corroded. Use support general code for painting or corrosion preventive treatment prior to an item becoming corroded.

1 - Bench Checked-NRTS (Not Repairable This Station - Repair Not Authorized). Shop is not authorized to accomplish the repair. This code shall only be used when the repair required to return an item to serviceable status is specifically prohibited by current technical directives. This code shall not be used due to lack of authority for equipment, tools, facilities, skills, parts or technical data.

2 - Bench Checked-NRTS-Lack of Equipment, Tools or Facilities. Repair is authorized but cannot be accomplished due to lack of equipment, tools, or facilities. This code shall be used without regard as to whether the equipment, tools, or facilities are authorized or unauthorized.

3 - Bench Checked-NRTS-Lack of Technical Skills. Repair cannot be accomplished due to lack of technically qualified people.

4 - Bench Checked-NRTS-Lack of Parts. Parts are not available to accomplish repair.

5 - Bench Checked-NRTS-Shop Backlog. Repair cannot be accomplished due to excessive shop backlog.

6 - Bench Checked-NRTS-Lack of Technical Data. Repair cannot be accomplished due to lack of maintenance manuals, drawings, etc., which describe detailed repair procedures and requirements.

7 - Bench Checked-NRTS-Excess to Base Requirements. Repair will not be scheduled for shop repair due to item being excess to base requirements.

8 - Bench Checked-Return to Depot. Returned to depots by direction of System Manager (SM) or Item Manager (IM). Use only when items that are authorized for base level repair are directed to be returned to depot facilities by specific written or verbal communication from the IM or SM, or when items are to be returned to depot facilities for modification in accordance with a Time Compliance Technical Order (TCTO), or as UR Exhibits.

9 - Bench Checked-Condemned. Item cannot be repaired and is to be processed for condemnation, reclamation or salvage. This code will also be used when a (condemned) condition is discovered during field maintenance disassembly or repair.

HOW MALFUNCTION CODES

Type 1 How Malfunction Codes - These codes indicate that the item no longer can meet the minimum specified performance requirement due to its own internal failure pattern. All valid how malfunction codes not listed under types 2 of 6 below are considered type 1.

Type 2 How Malfunction Codes - These codes indicate that the item no longer can meet the minimum specified performance requirement due to some induced condition and not due to its own internal failure pattern. The following codes apply:

086 - Improper Handling
092 - Mismatched - Wheel halves, Electronic Parts, etc.
105 - Loose or Damaged Bolts, Nuts, Screws, etc.
106 - Missing Bolts, Nuts, Screw, etc.
108 - Broken, Faulty, or Missing Safety Wire or Key
158 - Launch Damage
167 - Torque Incorrect
230 - Dirty
246 - Improper or Faulty Maintenance
301 - Foreign Object Damage
303 - Bird Strike Damage
447 - Wrong Logic
518 - Improper Routing
553 - Does Not Meet Specification, Drawing, or Other Conformance Requirements

602 Failed or Damaged Due to Malfunction of Associated Equipment or Item
638 - Parameters Activated
639 - Argon Gas Expended
697 - Faulty Tape
698 - Faulty Card
709 - Administrative Condemnation
731 - Battle Damage
877 - Transportation Damage
878 - Weather Damage
931 - Accidental or Inadvertent Operation, Release, or Activation
942 - Illegal Address
948 - Operator Error

Type 6 How Malfunction Codes - These codes indicate maintenance resources were expended due to policy modification, location, or cannibalization and no defect existed at the time of maintenance. The following codes apply:

632 - Expended (Thermal battery, fire extinguisher, etc.)
793 - No Defect - TCTO kit received by base supply or parts are available in supply
796 - No Defect - Removed for reliability assessment
797 - No Defect - Technical order previously complied with
798 - No Defect - Technical order not applicable (equipment to be replaced, modified, or not installed)
799 - No Defect
800 - No Defect - Component removed/reinstalled to facilitate other maintenance
801 - No Defect - Technical order compliance
802 - No Defect - Partial technical order compliance
803 - No Defect - Removed for time change
804 - No Defect - Removed for scheduled maintenance
805 - No Defect - Not otherwise coded
812 - No Defect - Indicated defect caused by associated equipment malfunction
911 - Engine TCTO correction Code

A P P E N D I X C

Program SCRAP is written in FORTRANS IV Computer language. The program is stored in the USAF/AFLC CREATE time share computer system. Therefore, this program may be accessed from any CREATE terminal by using the following program nomenclature:

OLD CRYSTAL/SCRAP, R

Once the computer program is accessed and the command "RUN" is given, the program will request the information required to make cost analysis possible. First, the program asks whether a complete printout is desired. If the answer is "yes" (NOTE: Simply enter "Y" for "yes" and "N" for "no"), a printout as shown on page D-1 results. If "No", a printout as shown on page D-4 results. The various variables CØ1, CØ2, etc. listed in the abbreviated printout on page D-4 correspond to the equations, lines 1060 to 1360 in the program.

Next, the program asks whether A(1) through A(14) are available. A "yes" or "no" (Y or N) answer is required. Then the program asks for the WUC. This code should be entered by the following format:

1234 X

NOTE: A space should be left between the first four numbers and the fifth number or letter. The program then allows a description of the WUC to be entered.

If (A(1) through A(14) are not available, the program would ask that S(1) through S(23) be entered. If A(1) through A(14) are available, the program would ask that A(1) through A(31) be entered. These variables should be entered as shown on sample printouts, page D-1 through D-4.

If S(1) through (23) were entered, the program would calculate and print A(1) through A(14). If A(1) through A(31) were entered, the program would ask for any changes to these variables. This allows corrections to be made to the input data. If corrections are required, "yes" should be entered. The program will ask for the number of changes, the designation of the variable (1 for A(1), 2 for A(2), etc.), and the new value of the variable. The program will then calculate and print the annual logistic cost data desired.

After the program prints out the annual logistic cost data, the program will ask whether a sensitivity analysis is desired. If the labor or other rates are to be changed, "R" should be entered. If the other variables are to be varied, "Y" should be entered and if no sensitivity analysis is required, enter "N". When "Y" or "R" are entered, the program asks for the number of variables to be changed, which variables (1) for A(1), 2 for A(2), etc), and the amount of change. When performing sensitivity analysis on rates, the new rate would be entered. When performing sensitivity analysis on the other variables, the percent reduction should be entered (i.e., 10, 20). The program then calculates a new total annual logistic cost (TALC) based on the changes made to the input variables. The program allows this sensitivity analysis to be done as often as desired.

If a sensitivity analysis is not desired, the program allows a new analysis to be performed on the same WUC. This analysis allows any variable to be changed and new annual logistic cost data is printed out. After the new annual logistic cost data is printed, new sensitivity analyses may be performed.

Once the additional analyses are completed, the program will ask if a new WUC is to be analyzed. If "yes", the program will start from the beginning; if "no", the program will stop.

The following is a complete listing of SCRAP:

```
10 ASCII ANS,WUC(2),DES,FA,AWUC,FB,PO,ANAL
20 DIMENSION A(31),IND(31),S(23),INDA(31),DUM(31),B(31)
30 902 PRINT:"DO YOU WANT COMPLETE PRINTOUT?"
40 READ: PO
50 KODE=0
60 PRINT:" DO YOU HAVE A(1)-A(14)?"
70 READ: FB
80 PRINT:"


          WUC"
90 READ:WUC
100 PRINT:" DESCRIPTION"
110 READ:DES
120 IF(FB.EQ."Y") GO TO 15
130 PRINT:"ENTER S(1)-S(23)"
140 READ:S
150 A(1)=S(7)-S(1)
160 IF (A(1)) 101,102,101
170 101 A(2)=(A(1)-S(4)-S(5))/A(1)
180 A(4)=(S(4)+S(5))/A(1)
190 GO TO 103
200 102 A(2)=0
210 A(4)=0
220 103 IF (A(1)-S(4)-S(5)) 105,106,105
230 105 A(3)=(S(8)-S(6)-S(2)+S(3))/(A(1)-S(4)-S(5))
240 GO TO 107
250 106 A(3)=0
260 107 IF(S(22)) 1313,1314,1313
270 1313 ZZ=S(23)/S(22)
280 GO TO 1315
290 1314 ZZ=0
300 1315 IF(S(4)+S(5)) 110,111,110
310 110 A(5)=(S(6)+((ZZ)*S(4)))/(S(4)+S(5))
320 GO TO 112
330 111 A(5)=0
340 112 A(6)=S(9)-S(8)+S(2)-S(3)-((ZZ)*S(4))
350 IF (S(14)+S(16)+S(18)+S(19)) 113,114,113
360 113 A(7)=(S(14)+S(11))/(S(14)+S(16)+S(18)+S(19))
370 A(9)=S(16)/(S(14)+S(16)+S(18)+S(19))
380 A(11)=S(18)/(S(14)+S(16)+S(18)+S(19))
390 GO TO 115
400 114 A(7)=0
```

```
410 A(9)=0
420 A(11)=0
430 115 IF (S(14)+S(11)) 116,117,116
440 116 A(8)=(S(15)+S(10)+S(12))/(S(14)+S(11))
450 A(14)=S(21)/(S(14)+S(11))
460 GO TO 118
470 117 A(8)=0
480 A(14)=0
490 118 IF (S(16)) 119,120,119
500 119 A(10)=(S(17)-S(13))/S(16)
510 GO TO 121
520 120 A(10)=0
530 121 IF (S(18)) 122,123,122
540 122 A(12)=S(15)/S(18)
550 GO TO 124
560 123 A(12)=0
570 124 A(13)=S(20)-S(10)-S(12)
580 IF(PO.EQ."Y") GO TO 801
590 PRINT 1,A(1)
600 PRINT 2,A(2)
610 PRINT 3,A(3)
620 PRINT 4,A(4)
630 PRINT 5,A(5)
640 PRINT 6,A(6)
650 PRINT 7,A(7)
660 PRINT 8,A(8)
670 PRINT 9,A(9)
680 PRINT 10,A(10)
690 PRINT 11,A(11)
700 PRINT 12,A(12)
710 PRINT 13,A(13)
720 PRINT 14,A(14)
730 GO TO 2001
740 801 PRINT 21,A(1)
750 PRINT 22,A(2)
760 PRINT 23,A(3)
770 PRINT 24,A(4)
780 PRINT 25,A(5)
790 PRINT 26,A(6)
800 PRINT 27,A(7)
810 PRINT 28,A(8)
820 PRINT 29,A(9)
830 PRINT 30,A(10)
840 PRINT 31,A(11)
```

```
850 PRINT 32,A(12)
860 PRINT 33,A(13)
870 PRINT 34,A(14)
880 PRINT:

890 2001 PRINT: "ENTER A(15)-A(31)"
900 READ: (A(K),K=15,31)
910 GO TO 931
920 15 PRINT: "ENTER A(1)-A(31)"
930 READ:A
940 931 PRINT:"DO YOU DESIRE TO CHANGE ANY PARAMETERS?"
950 READ: ANS
960 IF(ANS.EQ."N") GO TO 200
970 PRINT:"HOW MANY CHANGES?"
980 READ: NRCHNG
990 PRINT 1001,NRCHNG
1000 1001 FORMAT(1H ,"WHICH ",I2," PARAMETER(S)?")
1010 READ:(IND(JJ),JJ=1,NRCHNG)
1020 PRINT:"INPUT NEW VALUES"
1030 DO 201 INR=1,NRCHNG
1040 201 READ:(A(IND(INR)),INR=1,NRCHNG)
1050 200 IF (A(1)) 202,203,202
1060 202 C01=A(22)/A(1)
1070 GO TO 205
1080 203 C01=999999.99
1090 205 C11=A(1)/A(26)
1100 C04=11.91*A(4)*A(5)*(A(19)*(1-(A(17)*A(20)))+(A(17)*A(18)
1110&*A(23)))
1120 C03=9.37*((A(2)*A(3))+A(4)*(A(5)+(A(7)*A(8))+(A(9)*A(10))
1130&+(A(11)*A(12))))
1140 C05=C03+C04
1150 C08=(A(14)*A(4)*A(7))+(A(16)*A(4)*A(9)*(1-A(17)))
1160 C09=2*A(23)*A(4)*A(9)*((A(24)*.374706)+(A(25)*.605274))
1170 C12=C11*(C05+C08+C09)
1180 C20=A(1)*(C05+C08+C09)
1190 C13=((A(6)+A(13))*(9+A(15)))/A(26)
1200 C14=(A(1)*A(4)*(A(11)+(A(9)*A(17)))*A(21)*(A(27)-(A(23)
1210&*A(28))))/A(26)
1220 C15=(A(29)*104.2)/A(26)
1230 C16=(A(30)*8)/A(26)
1240 C17=A(31)/A(26)
1250 IF (A(1)) 30002,30001,30000
1260  30001 C06=0
```

```
1270 GO TO 30002
1280 30000 C06=A(14)*A(7)*A(4)
1290 30002 C07=A(16)*A(9)*A(4)*(1-A(17))
1300 C10=C05+C08+C09
1310 C19=A(26)*(C12+C13+C14+C16+C15+C17)
1320 IF(KODE) 997,245,997
1330 245 TALC=C19
1340 997 KODE=1
1350 C18=C19/A(26)
1360 C02=A(1)/A(22)
1370 IF(ANAL.EQ."Y") GO TO 157
1380 IF(ANAL.EQ."R") GO TO 157
1390 GO TO 159
1400 157 PRINT 158,C19
1410 X30=((TALC-C19)/TALC)*100
1420 X31=TALC-C19
1430 PRINT 199,X31
1440 PRINT 196,X30
1450 PRINT:"
                 ============================="
1460 DO 173 J2=1,31
1470 173 A(J2)=DUM(J2)
1480 158 FORMAT(1H ,"
                          ----TALC=........",F14.2)
1490 199 FORMAT(1H ,"
                          ----AMT OF REDUC=",F14.2)
1500 196 FORMAT(1H ,"
                          ----% OF SAVING=.",F14.2)
1510 GO TO 171
1520 159 PRINT 75,WUC
1530 IF(PO.EQ."N") GO TO 35
1540 PRINT 500,C01
1550 PRINT 550,C02
1560 PRINT:"
 "
1570 PRINT 700,C03
1580 PRINT 800,C04
1590 PRINT 1000,C05
1600 PRINT 1075,C06
1610 PRINT 1076,C07
1620 PRINT 2000,C08
```

```
1630 PRINT 3000,C09
1640 PRINT 1077,C10
1650 PRINT: "

1660 PRINT 600,C11
1670 PRINT 4000,C12
1680 PRINT 5000,C13
1690 PRINT 6000,C14
1700 PRINT 7000,C15
1710 PRINT 8000,C16
1720 PRINT 9000,C17
1730 PRINT 11000,C18
1740 PRINT: "

1750 PRINT 1074,C20
1760 PRINT 12000,C19
1770 PRINT 10500
1780 GO TO 100
1790 35 PRINT 36,C01
1800 PRINT 37,C02
1810 PRINT: "

1820 PRINT 39,C03
1830 PRINT 40,C04
1840 PRINT 41,C05
1850 PRINT 1078,C06
1860 PRINT 1079,C07
1870 PRINT 42,C08
1880 PRINT 43,C09
1890 PRINT 1080,C10
1900 PRINT: "

1910 PRINT 38,C11
1920 PRINT 44,C12
1930 PRINT 45,C13
1940 PRINT 46,C14
1950 PRINT 47,C15
1960 PRINT 48,C16
1970 PRINT 49,C17
1980 PRINT 52,C18
1990 PRINT: "

2000 PRINT 1073,C20
2010 PRINT 50,C19
2020 PRINT 51
```

```
1 FORMAT(1H ,"
 TOTAL FAILURES=A(1)=..............................",F12.2)
2 FORMAT(1H ," ON AIRCRAFT REPAIR RATE=A(2)=.................",F12.2)
3 FORMAT(1H ," ON AIRCRAFT REPAIR LABOR STANDARD=A(3)=.......",F12.2)
4 FORMAT(1H ," DETECT,ISO,REMV,REP RATE=A(4)=................",F12.2)
5 FORMAT(1H ," DETECT,ISO,REMV,REP LABOR STANDARD=A(5)=......",F12.2)
6 FORMAT(1H ," NON-FAILURE MMH'S(ON EQUIP)=A(6)=.............",F12.2)
7 FORMAT(1H ," SHOP REPAIR RATE(RTS)=A(7)=...................",F12.2)
8 FORMAT(1H ," SHOP REPAIR LABOR STANDARD=A(8)=..............",F12.2)
9 FORMAT(1H ," SHOP NRTS RATE=A(9)=..........................",F12.2)
10 FORMAT(1H ," SHOP NRTS LABOR STANDARD=A(10)=...............",F12.2
11 FORMAT(1H ," SHOP CONDEMNATION RATE=A(11)=.................",F12.2
12 FORMAT(1H ," SHOP CONDEMNATION LABOR STANDARD=A(12)=.......",F12.2
13 FORMAT(1H ," SHOP NON-FAILURE MMH'S=A(13)=.................",F12.2
14 FORMAT(1H ," BASE MATERIAL COST STANDARD FOR REPAIR=A(14)=",F12.2
500 FORMAT(1H ,"
 MTBF=......................................",F12.2)
550 FORMAT(1H ," FAILURE RATE=...................................",F18.10)
600 FORMAT(1H ," NUMBER OF FAILURES/UNIT/YEAR=...............",F12.2)
700 FORMAT(1H ," BASE LABOR COST/FAILURE=.....................",F12.2)
800 FORMAT(1H ," DEPOT LABOR COST/FAILURE=...................",F12.2)
1000 FORMAT(1H ," LABOR COST / FAILURE=......................",F12.2)
1074 FORMAT(1H ," TOTAL COST OF FAILURES......................",F12.2)
1075 FORMAT(1H ," BASE MATERIAL COST / FAILURE...............",F12.2)
1076 FORMAT(1H ," DEPOT MATERIAL COST / FAILURE...............",F12.2)
1077 FORMAT(1H ," TOTAL COST / FAILURE.......................",F12.2)
2000 FORMAT(1H ," MATERIAL COST / FAILURE=..................",F12.2
3000 FORMAT(1H ," TRANSPORTATION AND PACKING COST / FAILURE=",F12.2
4000 FORMAT(1H ," COST OF FAILURES / UNIT / YEAR=............",F12.2
5000 FORMAT(1H ," OTHER MAINT ACT COST / UNIT / YEAR=........",F12.2
6000 FORMAT(1H ," COST OF REPLACING COND ITEMS/UNIT/YR=......",F12.2
7000 FORMAT(1H ," SUPPLY MANAGEMENT RECURRING COST/UNIT/YR=.",F12.2
8000 FORMAT(1H ," TECHNICAL DATA MANAGEMENT COST/UNIT/YR=...",F12.2
9000 FORMAT(1H ," OTHER SIGNIFICANT RECUR COST/UNIT/YR=.....",F12.2
10000 FORMAT(1H ," TOTAL RECURRING ANNUAL LOGISTIC COST=.....",F12.
12500 FORMAT(1H+,42X,"_____________")
11000 FORMAT(1H ," RECUR ANNUAL LOGISTIC COST/UNIT/YR=.......",F12.
21 FORMAT(1H ,"
 A(01)=",F12.2)
22 FORMAT(1H ," A(02)=",F12.2)
23 FORMAT(1H ," A(03)=",F12.2)
24 FORMAT(1H ," A(04)=",F12.2)
```

```
2420 25 FORMAT(1H ," A(05)=",F12.2)
2430 26 FORMAT(1H ," A(06)=",F12.2)
2440 27 FORMAT(1H ," A(07)=",F12.2)
2450 28 FORMAT(1H ," A(08)=",F12.2)
2460 29 FORMAT(1H ," A(09)=",F12.2)
2470 30 FORMAT(1H ," A(10)=",F12.2)
2480 31 FORMAT(1H ," A(11)=",F12.2)
2490 32 FORMAT(1H ," A(12)=",F12.2)
2500 33 FORMAT(1H ," A(13)=",F12.2)
2510 34 FORMAT(1H ," A(14)=",F12.2)
2520 36 FORMAT(1H ,"

                C01=",F12.2)
2530 37 FORMAT(1H ," C02=",F18.10)
2540 38 FORMAT(1H ," C11=",F12.2)
2550 39 FORMAT(1H ," C03=",F12.2)
2560 40 FORMAT(1H ," C04=",F12.2)
2570 41 FORMAT(1H ," C05=",F12.2)
2580 42 FORMAT(1H ," C08=",F12.2)
2590 43 FORMAT(1H ," C09=",F12.2)
2600 44 FORMAT(1H ," C12=",F12.2)
2610 45 FORMAT(1H ," C13=",F12.2)
2620 46 FORMAT(1H ," C14=",F12.2)
2630 47 FORMAT(1H ," C15=",F12.2)
2640 48 FORMAT(1H ," C16=",F12.2)
2650 49 FORMAT(1H ," C17=",F12.2)
2660 50 FORMAT(1H ," C19=",F12.2)
2670 51 FORMAT(1H+,4X,"_____________")
2680 52 FORMAT(1H ," C18=",F12.2)
2690 1073 FORMAT(1H ," C20=",F12.2)
2700 1078 FORMAT(1H ," C06=",F12.2)
2710 1079 FORMAT(1H ," C07=",F12.2)
2720 1080 FORMAT(1H ," C10=",F12.2)
2730 75 FORMAT(1H ,"

                WUC=",A4,A4)
2740 100 CONTINUE
2750 171 PRINT:"

                SENSITIVITY ANALYSIS--ENTER R FOR RATES,
2760&Y FOR OTHERS,N FOR NONE"
2770 READ:ANAL
2780 DO 154 J2=1,31
2790 154 DUM(J2)=A(J2)
```

```
IF(ANAL.EQ."Y") GO TO 152
IF(ANAL.EQ."R") GO TO 152
PRINT:"

          FURTHER ANALYSIS?"
READ:FA
KODE=0
IF(FA.EQ."Y") GO TO 901
PRINT:"




          NEW WUC?"
READ:AWUC
IF(AWUC.EQ."Y") GO TO 902
GO TO 2333
152 PRINT:"HOW MANY A'S?"
READ:NCHNG
PRINT 153,NCHNG
153 FORMAT(1H ,"WHICH ",I2," PARAMETER(S)?")
READ:(INDA(J),J=1,NCHNG)
IF(ANAL.EQ."Y") GO TO 236
IF(ANAL.EQ."R") GO TO 235
235 PRINT:"ENTER NEW RATES"
GO TO 333
236 PRINT: "ENTER % REDUCTION, I.E. 10 20 ..."
333 IF(ANAL.EQ."Y") GO TO 334
IF(ANAL.EQ."R") GO TO 335
334 READ:(B(INRA),INRA=1,NCHNG)
DO 156 J1=1,NCHNG
156 A(INDA(J1))=A(INDA(J1))-((B(J1)/100)*A(INDA(J1)))
GO TO 200
335 READ:(A(INDA(INRA)),INRA=1,NCHNG)
GO TO 200
2333 STOP;END
```

APPENDIX D

The following are sample runs of the Computer Program SCRAP:

```
DO YOU WANT COMPLETE PRINTOUT?
= Y
DO YOU HAVE A(1)-A(14)?
= N


WUC
= 2300 0
DESCRIPTION
= ENGINE
ENTER S(1)-S(23)
= 0 0 612.5 85.5 333 7948.4 462 17872.6 70821.4 0 0 0 0 2 12.1
= 85 52 0 0 0 374495 0 0


TOTAL FAILURES=A(1)=..........................          462.00
ON AIRCRAFT REPAIR RATE=A(2)=.................            0.09
ON AIRCRAFT REPAIR LABOR STANDARD=A(3)=.......          242.22
DETECT,ISO,REMV,REP RATE=A(4)=................            0.91
DETECT,ISO,REMV,REP LABOR STANDARD=A(5)=......           18.99
NON-FAILURE MMH'S(ON EQUIP)=A(6)=.............        52336.30
SHOP REPAIR RATE(RTS)=A(7)=...................            0.02
SHOP REPAIR LABOR STANDARD=A(8)=..............            6.05
SHOP NRTS RATE=A(9)=..........................            0.98
SHOP NRTS LABOR STANDARD=A(10)=...............            0.61
SHOP CONDEMNATION RATE=A(11)=.................            0.
SHOP CONDEMNATION LABOR STANDARD=A(12)=.......            0.
SHOP NON-FAILURE MMH'S=A(13)=.................            0.
BASE MATERIAL COST STANDARD FOR REPAIR=A(14)=        187247.50
ENTER A(15)-A(31)
= 0 11654.58 0 0 1872.14 0 0 100531 5050 .59 .41 155300@@@@@@
= A
"A" IS AN ILLEGAL INPUT CHAR.--PLS. RETYPE ALL INPUT
= 0 11654.58 0 0 1872.14 0 0 100531 5050 .59 .41 686 155300 .02
= 9553 5084 0
DO YOU DESIRE TO CHANGE ANY PARAMETERS?
= N
```

WUC=23000

MTBF=......................................	217.60
FAILURE RATE=..............................	0.00459560
BASE LABOR COST/FAILURE=..................	381.16
DEPOT LABOR COST/FAILURE=.................	19733.46
LABOR COST / FAILURE=.....................	20114.62
BASE MATERIAL COST / FAILURE..............	3899.24
DEPOT MATERIAL COST / FAILURE.............	10314.54
MATERIAL COST / FAILURE=..................	14213.78
TRANSPORTATION AND PACKING COST / FAILURE=	5024.96
TOTAL COST / FAILURE......................	39353.36
NUMBER OF FAILURES/UNIT/YEAR=.............	0.67
COST OF FAILURES / UNIT / YEAR=...........	26503.28
OTHER MAINT ACT COST / UNIT / YEAR=.......	686.63
COST OF REPLACING COND ITEMS/UNIT/YR=.....	0.
SUPPLY MANAGEMENT RECURRING COST/UNIT/YR=.	1451.05
TECHNICAL DATA MANAGEMENT COST/UNIT/YR=...	59.29
OTHER SIGNIFICANT RECUR COST/UNIT/YR=.....	0.
RECUR ANNUAL LOGISTIC COST/UNIT/YR=.......	28700.25
TOTAL COST OF FAILURES....................	18181250.25
TOTAL RECURRING ANNUAL LOGISTIC COST=.....	19688371.50

```
SENSITIVITY ANALYSIS--ENTER R FOR RATES,Y FOR OTHERS,N FOR NONE
= Y
HOW MANY A'S?
= 1
WHICH  1 PARAMETER(S)?
= 1
ENTER % REDUCTION, I.E. 10 20 ...
= 10

 ----TALC=........   17870246.25

 ----AMT OF REDUC=    1818125.25

 ----% OF SAVING=.          9.23

 ============================

 SENSITIVITY ANALYSIS--ENTER R FOR RATES,Y FOR OTHERS,N FOR NONE
 = R
 HOW MANY A'S?
 = 2
 WHICH  2 PARAMETER(S)?
 = 2,4
 ENTER NEW RATES
 = .1 .9

  ----TALC=........   19577838.00

  ----AMT OF REDUC=     110533.50

  ----% OF SAVING=.          0.56

  ============================
```

```
NEW WUC?
= Y
DO YOU WANT COMPLETE PRINTOUT?
= N
DO YOU HAVE A(1)-A(14)?
= Y


WUC
= 2361 B
DESCRIPTION
= MAIN FUEL CONTROL
ENTER A(1)-A(31)
= 192 .85 3.08 .15 27.07 512 .8 1.03 .2 1 900 0 0 1068.5 0 2136.75
= 0 0 58.4 0 1 100531 49.5 .59 .41 686 6200 .04 600 114 0
DO YOU DESIRE TO CHANGE ANY PARAMETERS?
= N


WUC =2361B


C01=        523.60
C02=          0.00190986


C03=         64.02
C04=         20.87
C05=         84.88
C06=        128.22
C07=         64.10
C08=        192.32
C09=          1.39
C10=        278.60


C11=          0.28
C12=         77.98
C13=          6.72
C14=          0.
C15=         91.14
C16=          1.33
C17=          0.
C18=        177.16


C20=      53491.05
C19=     121531.05
```

```
SENSITIVITY ANALYSIS--ENTER R FOR RATES,Y FOR OTHERS,N FOR NONE
= Y
HOW MANY A'S?
= 1
WHICH  1 PARAMETER(S)?
= 1
ENTER % REDUCTION, I.E. 10 20 ...
= 50

----TALC=........      94785.52

----AMT OF REDUC=      26745.53

----% OF SAVING=.         22.01

============================
```

```
SENSITIVITY ANALYSIS--ENTER R FOR RATES,Y FOR OTHERS,N FOR NONE
= N


FURTHER ANALYSIS?
= Y
DO YOU DESIRE TO CHANGE ANY PARAMETERS?
= Y
HOW MANY CHANGES?
= 1
WHICH  1 PARAMETER(S)?
= 29
INPUT NEW VALUES
= 300



WUC=2361B


C01=      523.60
C02=        0.00190986


C03=       64.02
C04=       20.87
C05=       84.88
C06=      128.22
C07=       64.10
C08=      192.32
C09=        1.39
C10=      278.60


C11=        0.28
C12=       77.98
C13=        6.72
C14=        0.
C15=       45.57
C16=        1.33
C17=        0.
C18=      131.59


C20=    53491.05
C19=    90271.05


SENSITIVITY ANALYSIS--ENTER R FOR RATES,Y FOR OTHERS,N FOR NONE
= N


FURTHER ANALYSIS?
= N

NEW WUC?
= N

PROGRAM STOP AT 3080
*
```

APPENDIX E

Program SORTSUM is written in BASIC computer language. The program may be accessed from any CREATE terminal by using the following program nomenclature:

OLD CRYSTAL/SORTSUM, R

Once the program is accessed, the command "RUN" is given and the program will give instructions, if desired.

The following is a detailed listing of SORTSUM:

LIST SORTSUM

```
ØØØ1Ø DIM A(2ØØ),B$(2ØØ)
ØØØ2Ø PRINT "DO YOU WANT INSTRUCTIONS";
ØØØ3Ø INPUT C$
ØØØ4Ø PRINT "

"
ØØØ5Ø IF C$="YES" THEN 1ØØ1Ø
ØØØ6Ø D$="RANK"
ØØØ7Ø E$=" WUC"
ØØØ8Ø F$="CUM SUM"
ØØØ9Ø G$="CUM %"
ØØ1ØØ READ N,Q$
ØØ11Ø PRINT "INCREASING RANK-ENTER 1--DECREASING RANK ENTER Ø"
ØØ12Ø  INPUT R
ØØ13Ø PRINT "

"
ØØ14Ø IF R=Ø THEN 17Ø
ØØ15Ø K=1
ØØ16Ø GO TO 18Ø
ØØ17Ø K=Ø
ØØ18Ø FOR I=1 TO N
ØØ19Ø READ B$(I)
ØØ2ØØ NEXT I
ØØ21Ø FORI=1TON
ØØ22Ø READA(I)
ØØ23Ø NEXTI
ØØ24Ø PRINT USING 25Ø,D$,E$,Q$,F$,G$
ØØ25Ø: 'LLLL 'CCC 'CCCCCCCC 'CCCCCCC 'EEEEEEEE
ØØ26Ø PRINT "--------------------------------------------------"
ØØ27Ø L=N-1
ØØ28Ø I1=1
ØØ29Ø FOR I=1 TO L
ØØ3ØØ IF K=1 THEN 33Ø
ØØ31Ø IF A(I+1)<=A(I) GO TO 41Ø
ØØ32Ø GO TO 34Ø
ØØ33Ø IF A(I+1)>=A(I) GO TO 41Ø
ØØ34Ø A1=A(I+1)
ØØ35Ø A(I+1)=A(I)
ØØ36Ø A(I)=A1
ØØ37Ø T$=B$(I+1)
ØØ38Ø B$(I+1)=B$(I)
ØØ39Ø B$(I)=T$
ØØ4ØØ I1=I
```

```
00410 NEXT I
00420 IF I1=1 GOTO 450
00430 L=I1-1
00440 GO TO 280
00450 S=0
00460 FOR I=1 TO N
00470 S=S+A(I)
00480 NEXT I
00490 S1=0
00500 FOR I=1 TO N
00510 S1=S1+A(I)
00520 P1=(S1/S)*100
00530 PRINT USING 540,I,B$(I),A(I),S1,P1
00540:####    'CCCCC  ########.##  ########.##  ######.##
00550 NEXT I
10000 GO TO 10090
10010 PRINT "ENTER DATA STARTING LINE 600; ENTER NUMBER OF WUC'S,WHAT"
10020 PRINT "YOU WISH TO RANK,WUC'S, AND DATA TO BE RANKED AS FOLLOWS"
10030 PRINT " 600 DATA 2,FAILURES,'1234A','1234B',12,1"
10040 PRINT "NOTE: USE A QUOTATION MARK INSTEAD OF THE APOSTROPHE"
10050 PRINT "SHOWN WHEN ENTERING AN ALPHANUMERIC BEGINNING WITH A"
10060 PRINT " NUMBER,SUCH AS A WORK UNIT CODE."
10070 PRINT

10080 GO TO 60
10090 END

READY

*
```

```
*RUN

DO YOU WANT INSTRUCTIONS ?NO

INCREASING RANK-ENTER 1--DECREASING RANK ENTER Ø
?Ø
```

RANK	WUC	TALC	CUM SUM	CUM %
1	23ØØØ	19688371.25	19688371.25	98.14
2	2312Ø	21687Ø.ØØ	199Ø5241.25	99.23
3	2361B	133451.23	2ØØ38692.25	99.89
4	23313	11531.ØØ	2ØØ5Ø223.25	99.95
5	23315	7973.23	2ØØ58196.25	99.99
6	2342Ø	1763.89	2ØØ5996Ø.ØØ	1ØØ.ØØ
7	2393A	672.2Ø	2ØØ6Ø632.ØØ	1ØØ.ØØ

```
*RUN

DO YOU WANT INSTRUCTIONS ?N

INCREASING RANK-ENTER 1--DECREASING RANK ENTER Ø
?Ø
```

RANK	WUC	FAILURES	CUM SUM	CUM %
1	23ØØØ	462.ØØ	462.ØØ	33.53
2	2342Ø	289.ØØ	751.ØØ	54.5Ø
3	2361B	252.ØØ	1ØØ3.ØØ	72.79
4	2312Ø	192.ØØ	1195.ØØ	86.72
5	23313	98.ØØ	1293.ØØ	93.83
6	23315	77.ØØ	137Ø.ØØ	99.42
7	2393A	8.ØØ	1378.ØØ	1ØØ.ØØ

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13. ABSTRACT

This document presents documentation necessary to use the System Cost Reliability Analysis Program (SCRAP). This program, developed by OOAMA/MMERR, was established to realistically determine, in real time, the Total Annual Logistic cost of an aircraft weapon subsystem or system and to perform cost sensitivity analyses on these weapon subsystems or systems.

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