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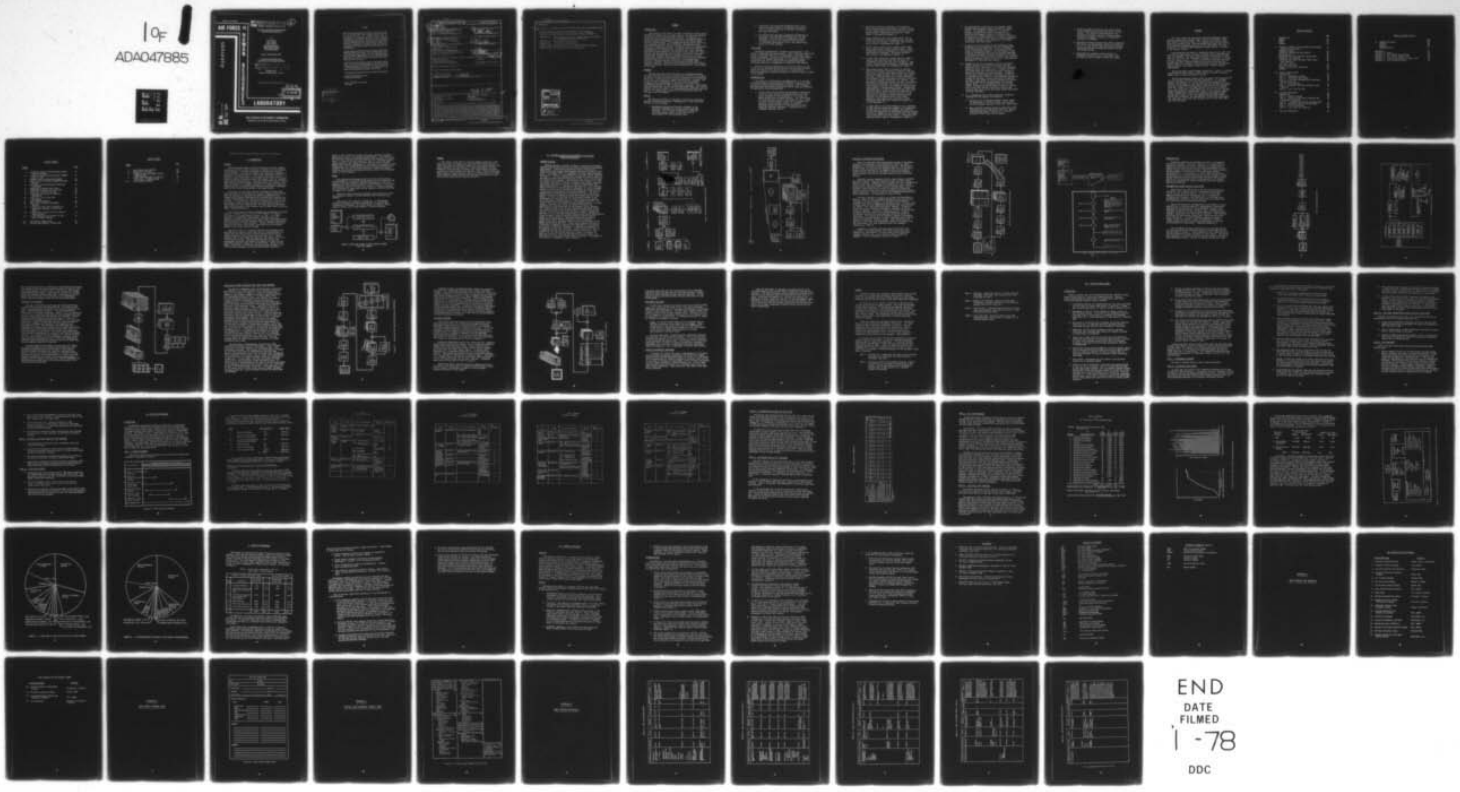

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AIR FORCE HUMAN RESOURCES LABORATORY

HISTORICAL WEAPON SYSTEM RESOURCE UTILIZATION METHODOLOGY

By

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AIR FORCE SYSTEMS COMMAND
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This final report was submitted by Boeing Aerospace Company, Seattle, Washington 98124, under contract F33615-76-C-0062, project 1959, with Advanced Systems Division, Air Force Human Resources Laboratory (AFSC), Wright-Patterson Air Force Base, Ohio 45433. Major Duncan L. Dieterly, Personnel and Training Requirements Branch, was the contract monitor.

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Advanced Systems Division

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This report presents recommended methods and practices to be considered for implementation during future Historical Weapon Systems Analysis efforts. Recommended methodology contained within this final report includes: (a) contract performance planning; (b) review of published literature; (c) documentation search and data acquisition techniques; (d) historical data analyses; (e) task analyses of selected Air Force Specialties personnel (maintenance and operations); and (f) life cycle costing. Recommendations contained within this final report are presented in functional/sequencial flow formats. They represent the results of "lessons learned" by investigators during their implementation of Phase I of Project 1959, viz: "C-130E Historical Weapon System Analysis," encompassing 15 years (1962–1976). All methodologies, portrayed in functional flow sequences, are general in nature and encompass → next page

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three tiers of logic: i.e., zero indenture or top level, first indenture or second level, and second indenture or third level.

Highlights of problem areas to be expected in future HWSA efforts are also presented.

This document is the fourth technical report emanating from Phase I of Project 1959, namely:

AFHRL-TR-77-40	*C-130E Hercules Aircraft: Review of Published Literature and Structured Interviews* (Available to U.S. Government Agencies only.)
AFHRL-TR-77-48	*Historical Analysis of C-130E Resources*
AFHRL-TR-77-46	*Life Cycle Cost of C-130E Weapon System*
AFHRL-TR-77-64(I)	*Historical Weapon System Resource Utilization Methodology* (This Issue)
AFHRL-TR-77-64(II)	*Historical Task Analysis of C-130E Maintenance Jobs*

SUMMARY

INTRODUCTION

This report is the final in a series of technical reports which document the results of a six-task study of the historical resource utilization of the C-130E Hercules aircraft. It describes in functional flow formats and associated text, recommended methods to be considered when implementing future Historical Weapon System Analyses (HWSA) efforts. All recommended methods and practices not only represent the most logical planning, implementation and analytical progression, but more importantly, serve as a methodology for future investigative efforts. Numerous actions planned and implemented by the investigators throughout this study, required modification and replanning. During this study, some 27 Air Force archives and installations were visited; 30 to 40 Air Force data systems were reviewed; 900 plus documents and over six million records were acquired and analyzed; and all this data was organized and summarized into a useful product of a few hundred pages. Success in accomplishing this large task was dependent upon a systematic approach. Sequential flows depicted within this report, therefore, represent the most optimal methodology for future studies of this type.

APPROACH

The approach used in the formulation of recommended methods and practices to be considered in future HWSA efforts was to assess successes, failures and other problems encountered when implementing the 15-year C-130E Historical Weapon System Analysis program. Each of the six tasks implemented during this effort was carefully reviewed prior to development of functional flows depicting recommended planning and other investigative sequences. Those flows, with associated text, portray the best approaches based upon "lessons learned" during this study. All recommendations contained within the body of this report were reviewed by all investigators prior to inclusion into the document.

RESULTS

Retrospective analyses of successes, failures and associated problems encountered throughout implementation of this study have resulted in the following:

1. Recommended methods and practices conducive to the effective development of program planning have been developed. This includes a tabulation of USAF and other Governmental agency devices that must be incorporated into future program plans.

2. Functional flows depicting recommended steps to be taken during the conduct of structured interviews as well as conducting reviews of published literature have been formulated.

3. Functional flows depicting recommended methodology in the conduct of other HWSA activities have also been developed. This includes: a) documentation search and data acquisition, b) historical data analyses, c) historical task analysis of Air Force Specialties, and d) life cycle costing.

CONCLUSIONS

Successful implementation of weapon system analyses in the future is contingent upon many factors. Some of the more significant factors include the need for a well developed, time-tested data control, management, cataloging, and filing technique that enables investigators to conduct the program in a systematic manner. A centralized data file, coupled with an automated/mechanized cataloging technique is fundamental to successful data control.

Detailed conclusions germane to the 15-year analyses of the C-130E Hercules Advanced Medium Short Take-Off and Land Transport (AMST) are contained in previous reports. Recommendations concerning problems encountered during this study have been included in this report.

RECOMMENDATIONS

The intent of including these recommendations is to provide a centralized summary of solutions and corrective actions put forth in three previously developed technical reports. The following are based upon observations covering the entire study and reference the appropriate study documentation.

1. The Air Force should develop and implement an integrated historical data center to accumulate and maintain the seven categories of data developed in this study, by weapon system (Mission Design Series). This would allow Air Force agencies and their contractors to use a common data base in making trade studies and in responding to proposals for new weapon systems and equipment. (Reference AFHRL-TR-77-40, "C-130E Hercules Aircraft: Review of Published Literature." Available to U. S. Government Agencies only.)[1]

2. Additional historical data bases on selected Air Force systems should be developed in a manner similar to that accomplished on the C-130E Hercules aircraft weapon system. (Reference same technical report noted in recommendation number 1.)

3. Future studies of this type should extend from 18 months to 24 months to allow adequate time for data acquisition and analysis. (Reference same technical report noted in recommendation number 1.)

4. Similar studies should cover a weapon system (MDS) family rather than a single selected model. Family differences could be accounted for in equipment and configuration differences. (Reference technical report noted in recommendation number 1.)

5. A study of Air Force data systems should be made to identify data deficient areas and the means for accumulating actual data for missing elements. Much of this could be done by sampling. (Reference same technical report noted in recommendation number 1.)

6. The current process that is required to identify, collect, and analyze historical information over the life cycle of an Air Force weapon system is extremely awkward and time-consuming, and in many areas results in voids. Currently there are no formal procedures that attempt to track and collect published information on a specific weapon system over its lifetime. Such procedures would be very useful, not only in supporting the periodic assessment of a specific system's life cycle progress, but also, for supporting various trade study aspects of future weapon systems. Headquarters USAF/ACMCA has an existing "Operating and Support Cost Reporting (OSCR)" system that was initiated for all USAF aircraft systems in fiscal year 1975, and if continued and expanded to capture additional data elements it could eventually be a very useful operational and support cost information system. (Reference AFHRL-TR-77-48, "Historical Analysis of C-130E Resources.")[2]

7. In cases where an Air Force weapon system is deployed to more than one operational command, each command has its own peculiar reporting system(s) and guidelines. It would be appropriate to standardize reporting systems within all commands to insure consistency of data banks, data elements and reporting criteria. (Reference same technical report noted in recommendation number 6.)

8. The methodologies contained in this technical report provide sound approaches toward implementing future studies. The sequence to follow is: 1) identify sources, 2) contact and acquire information, 3) establish bibliographic system, 4) review and sort information for appropriateness, 5) analyze information, 6) generate structured interviews, 7) collect responses, 8) analyze responses, and 9) synthesize information information into final report.

9. A range of 52 to 61 percent of the maintenance tasks performed by C-130 maintenance AFSs are accounted for in Air Force Manual (AFM) 39-1, Enlisted Personnel Airman Classification Manual.[3] As this manual is used widely by governmental and civilian contractor agencies in developing Personnel Planning Information (PPI) data, corrective steps should be taken to derive more sensitive planning guidelines responsive to AFM 66-1, (Maintenance Management,)[4] individual work centers.

10. Nineteen of the 27 Cost Analysis and Cost Estimation (CACE) formulae deal directly with human resource categories (e.g., military pay, civilian pay, permanent change of status (PCS) costs, etc.) Further, 60.1% of the C-130E total life cycle cost by major category is directly attributable to human resources. It matters little from a cost standpoint if hardware reliability is improved several times if related manpower attenuation changes are not made. Concept and design innovations included in new systems to improve hardware utilization, must be accompanied by related changes in the human support needs. It is recommended that the real cost drivers in weapon systems be ranked in order of most to least costly and that this rank order serve as the priority upon which future USAF weapon system acquisition contracts are based.

11. It is recommended that further analytical studies be conducted for the purpose of developing:

    a. Operations and maintenance manpower models usable by contractors in defining officer, enlisted and civilian manpower required at USAF work center level.

    b. More sensitive Personnel Planning Information (PPI) guidelines than are contained in AFM 36-1, Officer Classification Manual,[5] and AFM 39-1, Enlisted Personnel Airman Classification Manual.

c. Assigned manpower profiles at work center levels within single-engine and multiple-engine aircraft systems. This should include operations and maintenance personnel across Air Defense Command, Tactical Air Command, Military Air Command and Strategic Air Command.

d. Detailed Air Force specialty code (AFSC) inventories that depict all duties/tasks actually performed by 3-, 5-, 7-, and 9-skill level maintenance personnel (organizational and intermediate levels) on major USAF weapon systems.

e. Attenuated ATC resident training courses of maintenance personnel with a concomitant "Task Oriented Training" program at operational bases.

PREFACE

This final report was prepared by the Boeing Aerospace Company Logistics Support and Services (LS&S), Seattle, Washington, under USAF Contract F33615-76-C-0062. This contract was initiated under phase one of Project 1959. Work was accomplished under the direction of the Advanced Systems Division of the Air Force Human Resources Laboratory, Air Force Systems Command with Major Duncan L. Dieterly as the Project Officer.

Data emenating from Phase 1, "Historical Analysis of C-130E Life Cycle Costs," consisted of a series of reports to be completed under work unit 19590001. The total study provides a unique body of data, which for the first time, attempted to document the actual life cycle cost of a Weapon System. A series of analytical techniques employed by AFHRL and other cognizant agencies were used to evaluate the Weapon System in an attempt to minimize future resource requirements. Specific emphasis was placed on the reduction of human resource requirements.

Boeing Aerospace program manager was George R. Herrold. Principal program analysts were Frank D. Brown, Donald E. Griswold, Donald K. Hindes, Gary A. Walker and David H. Wilson.

The Boeing Aerospace Company wishes to express their appreciation for the technical assistance and data provided by: 1) USAF Headquarters, Washington, D.C.; 2) Air Force Systems Command (AFSC), Andrews AFB, Maryland; 3) AFLC Headquarters, and Aeronautical Systems Division, Wright-Patterson AFB, Ohip; 4) Military Airlift Command, Scott AFB, Illinois; 5) All CONUS Aircraft Air Logistics Centers (e.g., San Antonio ALC, Warner-Robins ALC, et al.); 6) Air Training Command Headquarters, Randolph AFB, Texas; 7) Air Training Command Center, Sheppard AFB, Texas; 8) Occupational Measurement Center, Lackland AFB, Texas; 9) Air Force Inspection and Safety Center, Norton AFB, California; 10) 62nd MAW Wing, McChord AFB, Washington; 11) 314th TAW, Little Rock AFB, Arkansas; and 13) 317th TAW, Pope AFB, North Carolina.

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I - INTRODUCTION

PURPOSE

Each individual member of the United States Air Force, whether active duty military or civil service, is the most critical resource in the inventory. In order to adequately allocate this resource some technique is required to determine the requirements necessary to accomplish the desired mission. This report represents the first phase of a four phase effort. The purpose of the entire effort is to establish methods for human resource requirements relative to weapon system design characteristics. Once the relationships are established then life cycle cost estimates of design options can be made. Thus the ultimate goal is to obtain a capability to reduce LCC, especially ownership costs, by providing human resource requirement information early in the initial design phase of the weapon system.

This phase of the larger advanced development, Project 1959, Advanced System for Human Resources Support of Weapon System Development, was designed to determine the necessary methodology for computing the resource requirements for an operational aircraft and to apply the methodology for the requirements of the C-130E Hercules aircraft. This report will summarize the methodology so that it may be applied to other systems and provide an overview of some of the data gathered for the C-130E system. For more detailed information about various aspects of this research see the other reports published. (Note: Reference Section.)

This final report provides a comprehensive compendium of "lessons learned" throughout Phase I, Project 1959 "Analysis of Resource Utilization of Present Operation System - C-130E". It further provides: a) recommended investigation, data acquisition and analytical methods and practices for use on other USAF Weapon Systems, and b) historical duty/task analyses results of selected maintenance Air Force Specialist (AFS) personnel. Special problems encountered through the planning, data review, data acquisition and analyses phases of this study are also included.

The overall goal is to provide improved future weapon system planning and to develop a technology that will enable managers to insure that the human resources provide maximum contribution to mission capability while reducing the life cycle costs. Human resources rank as the number one operations and support cost driver of most weapon systems. Weapon system planning, design, and development techniques that address the demand for operations and maintenance manpower loading must be established. Design requirements, limitations or impositions translated into solutions; i.e., first articled equipment, carry with them inherent benefits or

debits as they relate to the human resources required to operate, maintain and control fixed weapon system hardware. The elements of the Personnel Subsystem, have continuously been relegated to "second chair" in spite of the well known fact that it is the major weapon system operations and support resource item and dollar consumer. Methods and practices recommended, if followed by future weapon system investigators, will enable more proficient historical weapon system analyses thus serving to provide solutions to improved Personnel Subsystem participation throughout planning, design, and development phases of future systems.

SCOPE

This research was planned to consist of six distinct tasks: 1) Development of a Historical Weapon System Analysis (HWSA) Program Plan; 2) Historical Review of Published Literature; 3) Air Force Documentation Search and Collection; 4) Data Analysis; 5) Historical Task Analysis; and 6) Life Cycle Cost Analysis. Figure 1 provides an illustration of these tasks and the respective interrelationships throughout this research.

Plans and results acquired throughout each of these six tasks are explained in detail in three previously published technical reports.

The scope of this report is limited to: 1) recommended historical resource utilization methodology; 2) possible data extrapolation techniques; 3) costing values; 4) special problem areas to expect; and 5) some examples of results obtained.

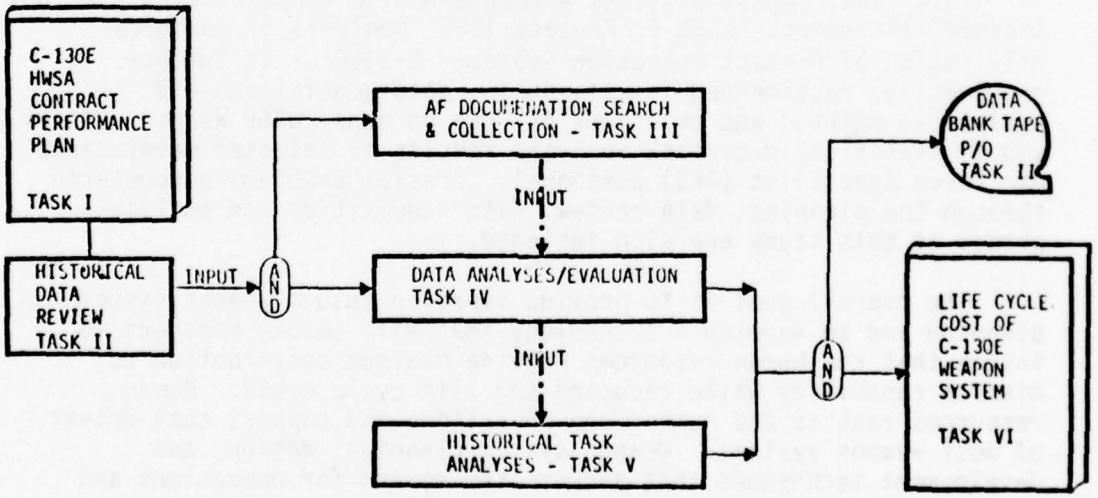


Figure 1 Historical Weapon Systems Analyses (HWSA) Task Flow Summary

SUMMARY

This report is the last in a series completed under this study. "Lessons learned" throughout the study have been translated into logic flows depicting planning, acquisition and analyses progressions to be considered for application to future investigative studies. Analytical tools required to conduct such investigations have been juxtaposed to tasks contained in the logic flows. Attempts have been made to portray these functional flows in a progression of the simple to the complex, without getting into the intricate mechanics of how each distinct step should or must be followed.

II - HISTORICAL WEAPON SYSTEM RESOURCES UTILIZATION ANALYSES METHODOLOGY

PROGRAM PLANNING

Methods employed, as shown in Figure 2, during the development program planning must always be sensitive and responsive to defined requirements. Experiences acquired during this study clearly demonstrated that progressions/sequences depicted in Figure 3 would serve as a workable model in development of future HWSA performance plans. This figure is a sub-indenture to the TASK 1 block contained in Figure 2. The five planning steps iterated in Figure 3 serve as the mode via which the performance plan evolves into a final product for release to the manager. The customary time constant of 30 days of elapsed time prior to release of program plans usually precludes the planner from having a series of technical interchanges with agency representatives. Contrary to some opionions, it is believed that initiation of a kickoff meeting subsequent to initial document release is sufficient to dispose of differences and amend the plan in accordance with technical interchange agreements. The plan is amended during review/kickoff meetings then serves as the springboard from which the remaining future HWSA studies would be implemented. Critical to this phase of future HWSA planning is the development of a comprehensive list of data sources and agencies to be contacted at various stages of future HWSA activities. This listing must identify cognizant military command agencies, civilian centers, libraries, etc., that are thought or known to be respositories of data pertinent to the system(s) being analyzed. This listing further serves as the cornerstone upon which letters for request of data can be issued as well as locations/sites that must be visited during the data acquisition process. Appendix B provides a list of the data sources/agencies that may be considered for future programs. Equally important during the early planning stages is the formation of a cataloging/data source tracking system that enables control and master filing of agencies, organizations and/or personnel known to have data pertinent to the weapon system being analyzed. A data source summary form such as illustrated in Appendix B enables the investigators to accumulate and collate an important "directory" of agencies and personnel to be contacted during site visitation. These summary forms serve as a telephone directory for post data collection follow-up. They further serve as the nucleus upon which letters for request of data and structured interview questionnaires can be issued. The development of such a data source summary directory is fundamental to the successful management of HWSA activities.

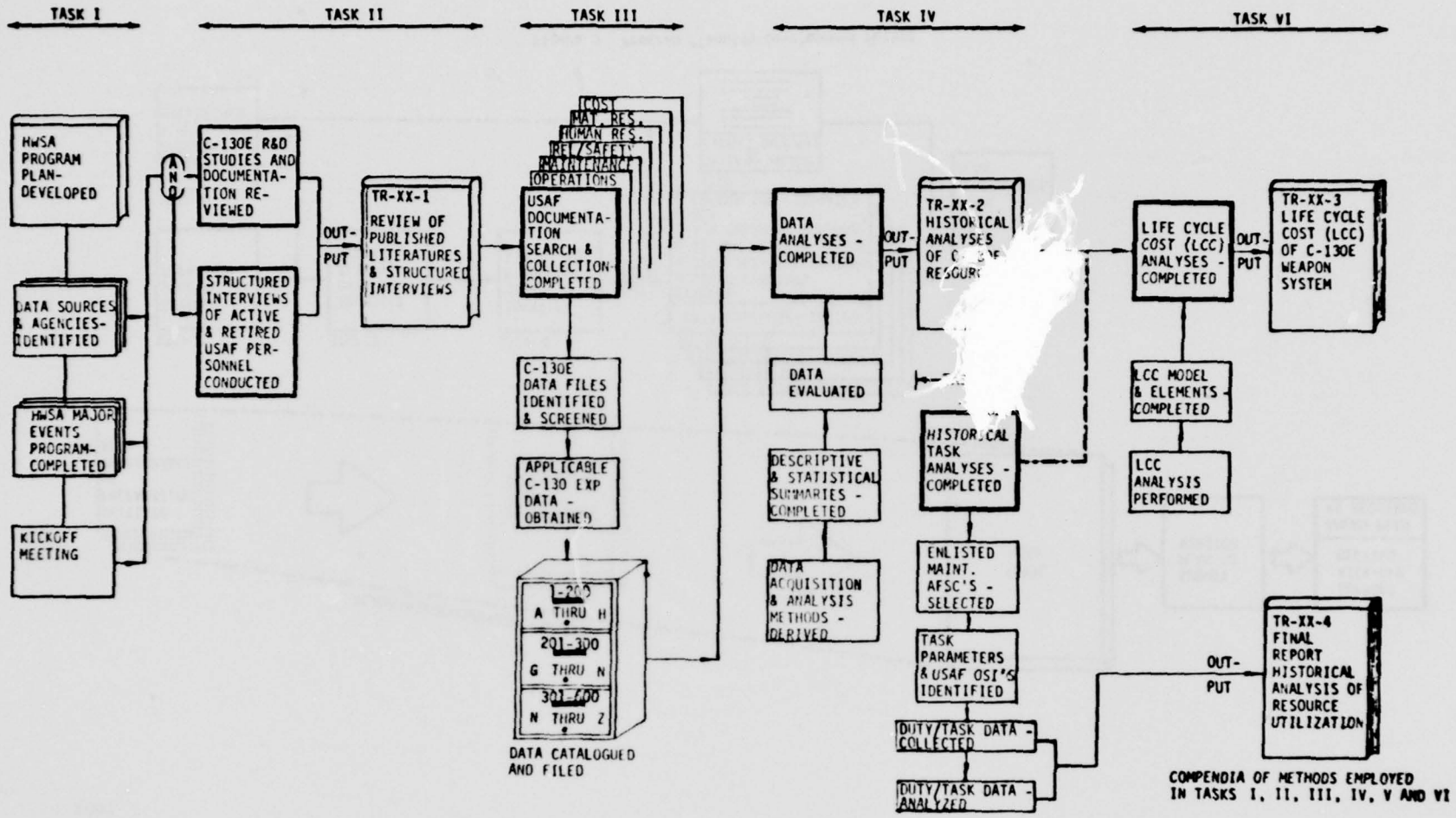


Figure 2 Historical Weapon System Analysis Program Flow

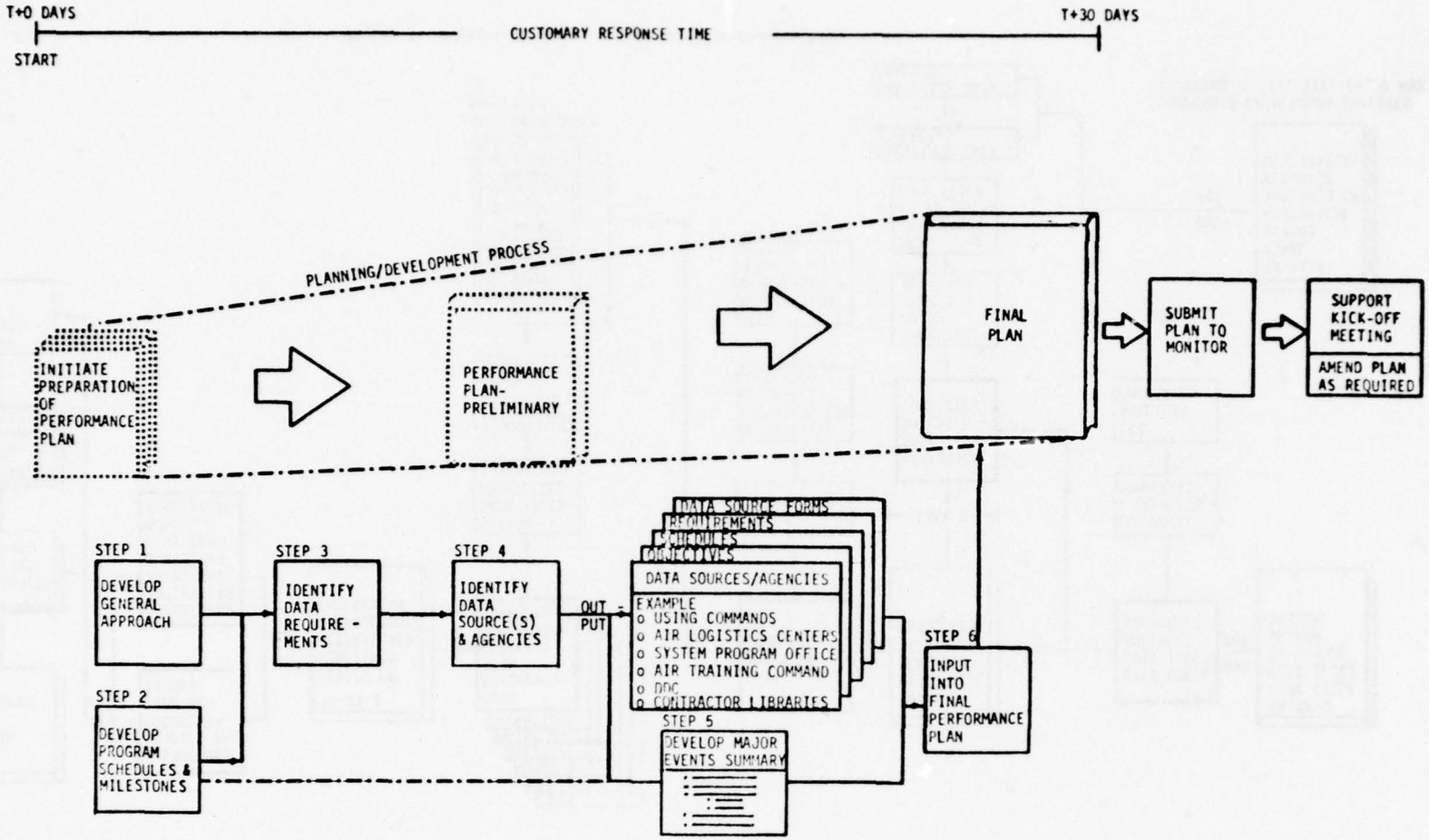


Figure 3 Program Planning Development Method

HISTORICAL INFORMATION DATA REVIEW

Search of applicable USAF documentation germane to the weapon system(s) being analyzed is the next logical step to be taken subsequent to completion of HWSA program planning. The end result of this phase is a centralized, cataloged data file of available historical data pertinent to the weapon system being analyzed. It further enables investigators to identify missing or incomplete data categories that must be obtained during the data acquisition process.

Technical reports, magazine articles, news releases, brochures and other technical data published by the USAF and other sources must be considered. Emanating from this phase will be a comprehensive technical data file bibliography with summaries of weapon system strong points, weaknesses and/or existing problem areas. Review of historical data begins with a scientific technical information (STINFO) search of data sources and is expanded into other sources where appropriate. Figure 4, portrays the recommended documentation review techniques to be considered in future efforts.

The steps iterated in Figure 4 are largely self-explanatory. However, central to the recommended methods and practices outlined in Figure 4 is the existence of a time-tested and integrated automated data entry, storage, and retrieval system. For this study a system known as MECCA (MECHANIZED CATALOGING) was used throughout all phases. This system was continuously updated. In order to limit the amount of material collected, a systematic screening system is required. A series of selection criteria are established to reduce possible sources to only those necessary. Figure 5 illustrates the decision screen employed during the review of literature. This process must be carefully adhered to throughout the literature review process in order to maximize source data and maintain a reasonable retrieval system. Data determined to be useful are then filed into a repository center in accordance with the same history file code contained within the automated catalog (e.g., MECCA.)

Appendix C illustrates the exact History Code form used during the C-130E HWSA program. This entry form, after being completed by investigators, is then secured to each applicable document, brochure, etc., prior to being filed in numerical sequence. This is portrayed as Step 6 in Figure 4.

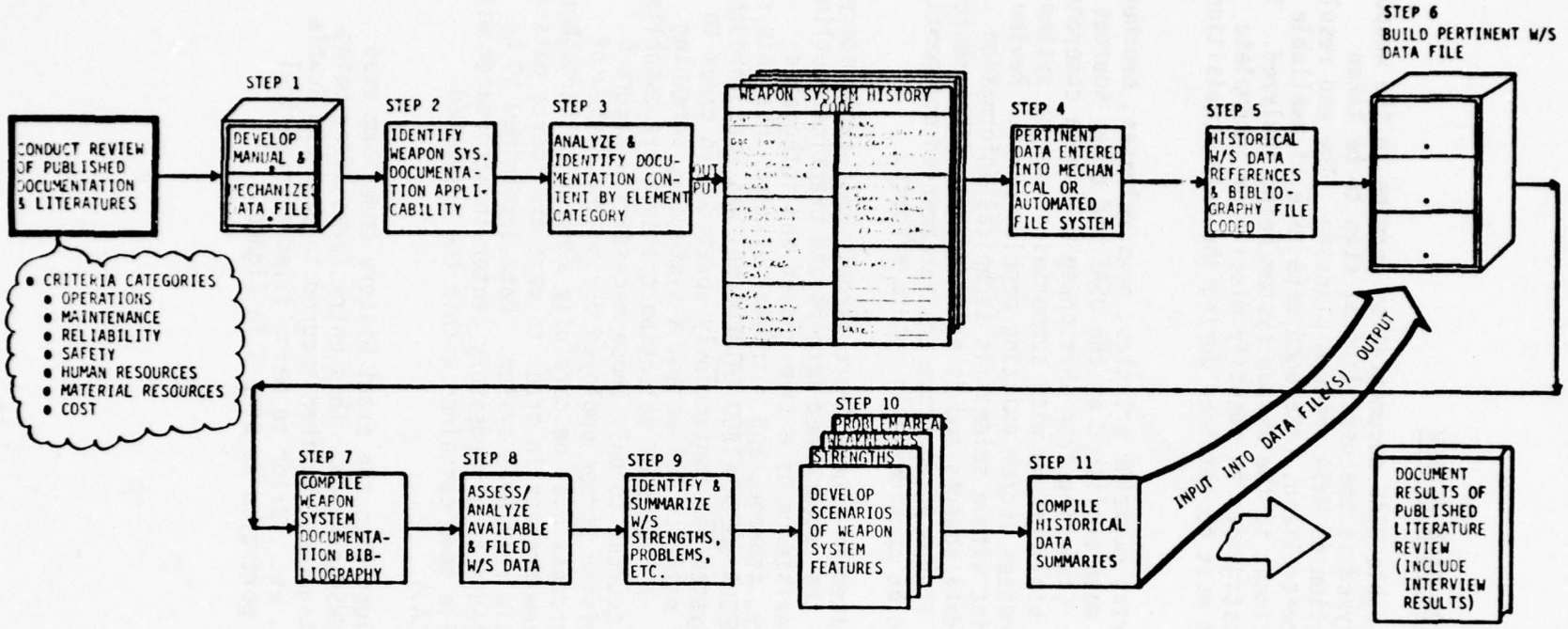


Figure 4 Logic Flow of Historical Information Data Reviews

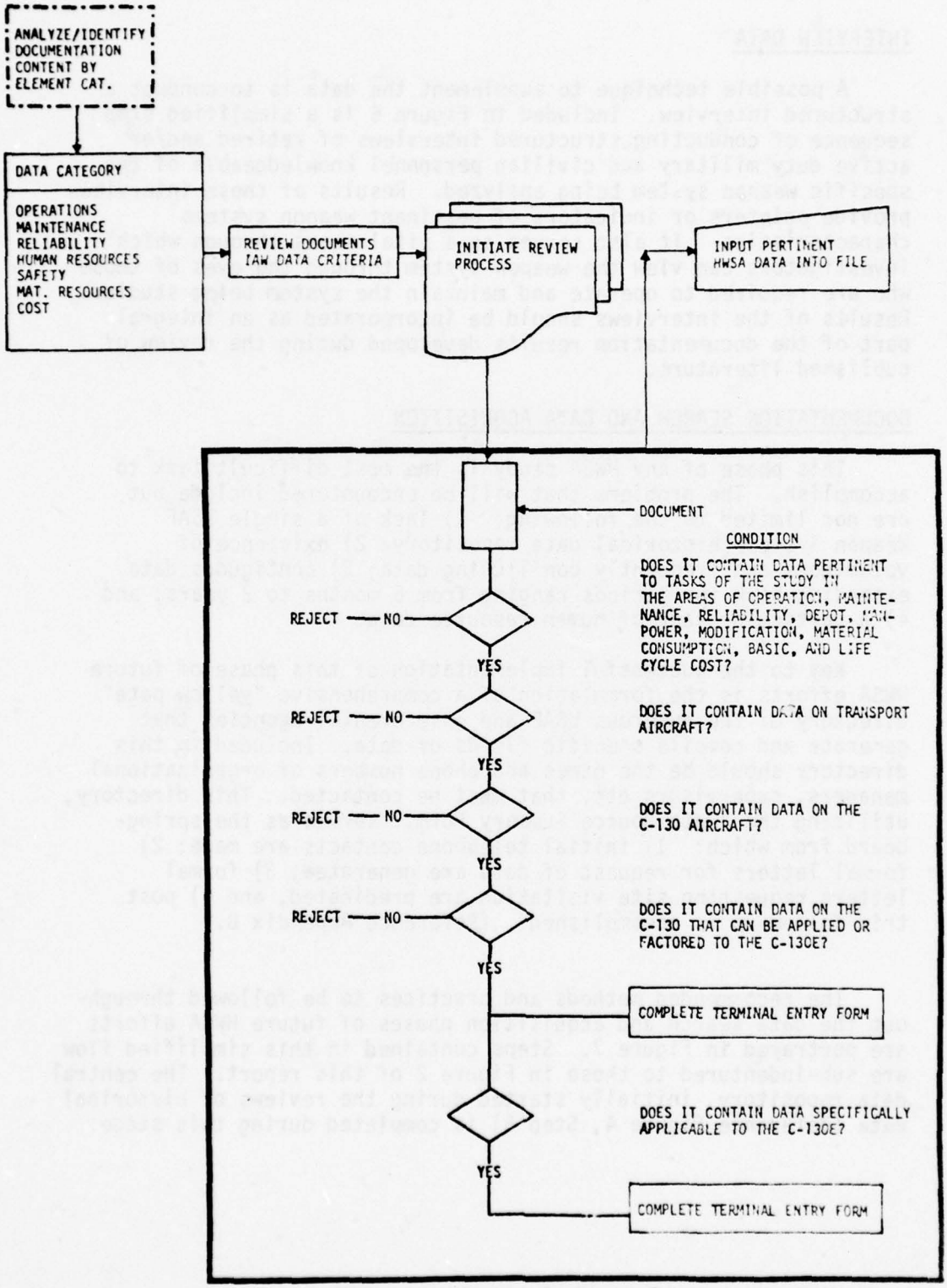


Figure 5 Decision Logic For Reviews of Published Literature

INTERVIEW DATA

A possible technique to supplement the data is to conduct a structured interview. Included in Figure 6 is a simplified step sequence of conducting structured interviews of retired and/or active duty military and civilian personnel knowledgeable of the specific weapon system being analyzed. Results of these interviews provide pointers or indicators of pertinent weapon systems characteristics. It also serves as a vital means through which investigators can view the weapon system through the eyes of those who are required to operate and maintain the system being studied. Results of the interviews should be incorporated as an integral part of the documentation results developed during the review of published literature.

DOCUMENTATION SEARCH AND DATA ACQUISITION

This phase of any HWSA study is the most difficult task to accomplish. The problems that will be encountered include but are not limited to the following: 1) lack of a single USAF Weapon Systems historical data repository; 2) existence of voluminous and frequently conflicting data; 3) contiguous data extending back for periods ranging from 6 months to 2 years; and 4) a particular lack of human resource data.

Key to the successful implementation of this phase of future HWSA efforts is the formulation of a comprehensive "yellow page" directory of the numerous USAF and governmental agencies that generate and compile specific fields of data. Included in this directory should be the names and phone numbers of organizational managers, supervisors etc. that must be contacted. This directory, utilizing the "Data Source Summary Form," serves as the springboard from which: 1) initial telephone contacts are made; 2) formal letters for request of data are generated; 3) formal letters requesting site visitation are predicated, and 4) post trip follow-up is accomplished. (Reference Appendix B.)

The recommended methods and practices to be followed throughout the data search and acquisition phases of future HWSA efforts are portrayed in Figure 7. Steps contained in this simplified flow are sub-indentured to those in Figure 2 of this report. The central data repository, initially started during the reviews of historical data (Reference Figure 4, Step 6) is completed during this stage.

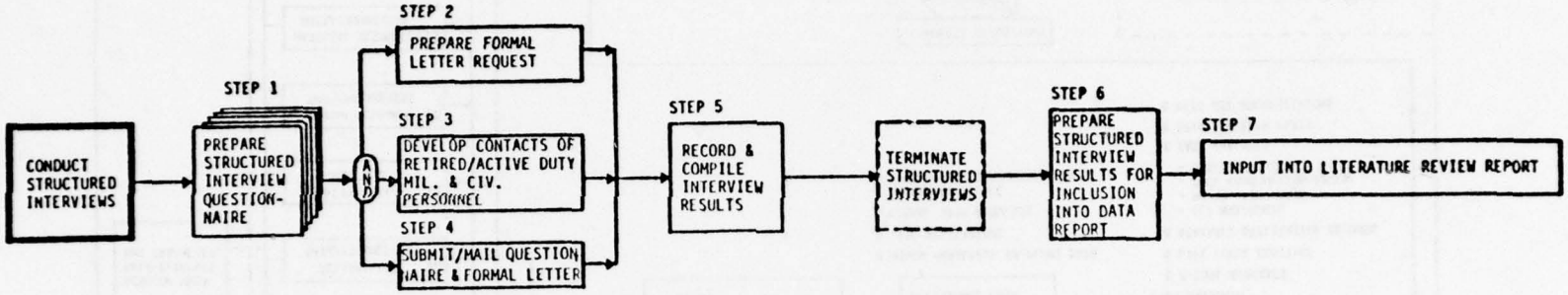


Figure 6 Structured Interview Logic Flow

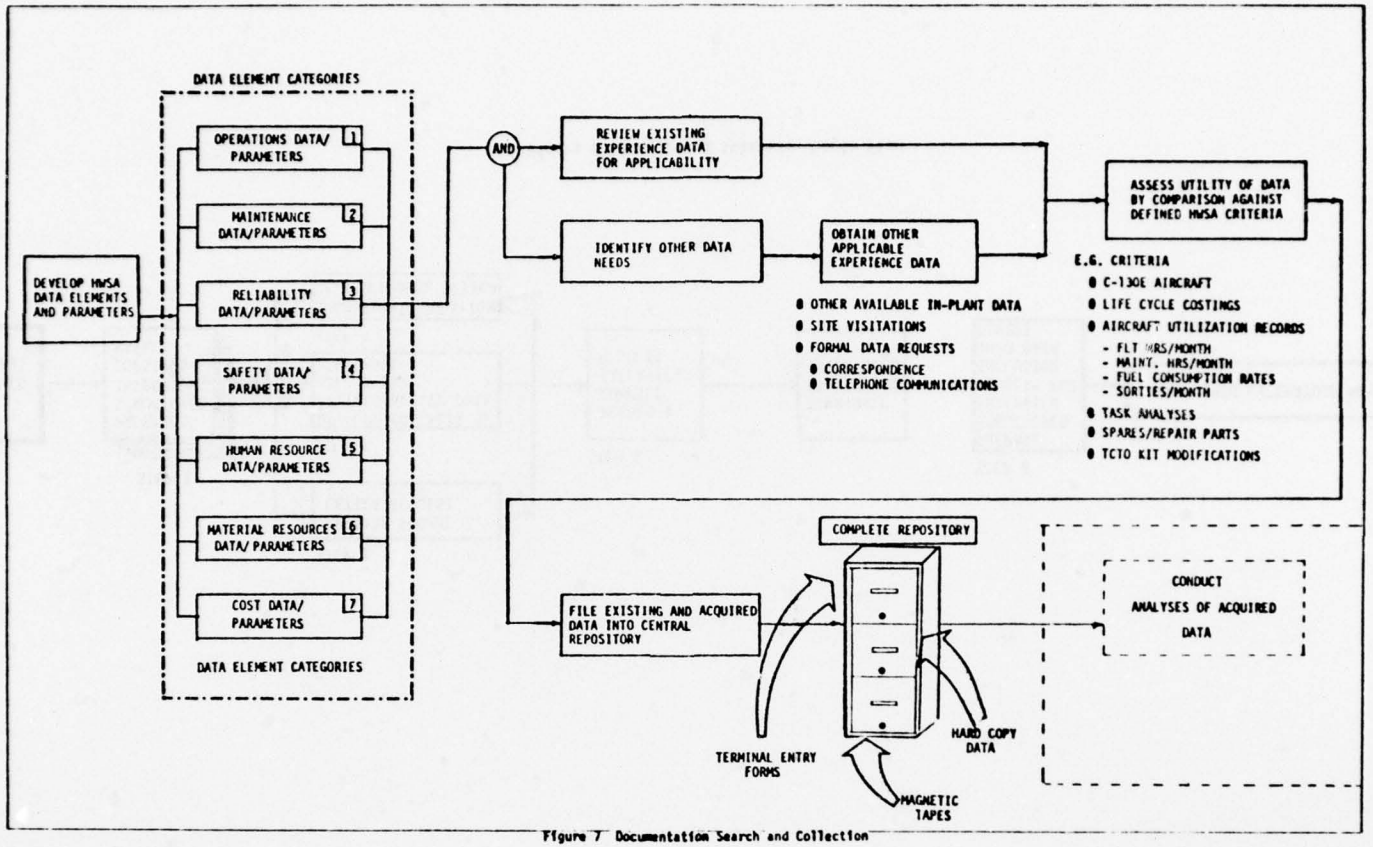


Figure 7 Documentation Search and Collection

This centralized data file, containing all applicable weapon systems data, serves as the data pool from which analyses of data can flow in a logical manner. As can be seen, a set of major data element categories were established. Each category consisted of a finite set of data elements deemed appropriate. Cataloging via terminal keyboard and the filing of acquired data via an alphanumeric history code are completed during the data acquisition phase.

HISTORICAL DATA ANALYSES

Analyses of acquired and cataloged data follow methods and practices common to most analytical efforts. Pertinent to this stage is the formulation and completion of explicit categories of data. (Reference Figure 8, Step 1). This must precede the formulation of analytical techniques. Steps 1 and 2, as summarized in this figure, constitute important analytical housekeeping steps that must occur before detailed analyses are initiated. Failure to adhere to these precursor analytical steps will result in inefficient and frequent analytical duplication. It is only after completion of Step 4 "Prepare Data Matrices," that the analysts will have a comprehensive awareness of the adequacies and completeness of data. Missing and/or incomplete data files frequently will necessitate extrapolative or interpolative action. Most data acquired from USAF agencies are near-term, that is, within the last 12 to 24 months. This common data problem will force analysts/investigators to normalize or extrapolate backward in time. It is expected that this problem will continue to exist until the USAF, as well as other governmental agencies, finally come to grasp with the need to have at least one comprehensive historical data repository acquiring and retaining selected data from the numerous operating AF agencies.

A salient caution to be added is the need for all analysts to rigorously adhere to the automated and/or mechanical data cataloging procedures previously discussed in this report. Failure to comply with these very important procedures will result in the loss of data via misfiling, or failure to refile. An effective solution is the appointment of a single-point data manager, coupled with the release of a complete data summary directory to all analysts using the data. Results emanating from the data analyses phase serve as the baseline upon which life cycle costs are established.

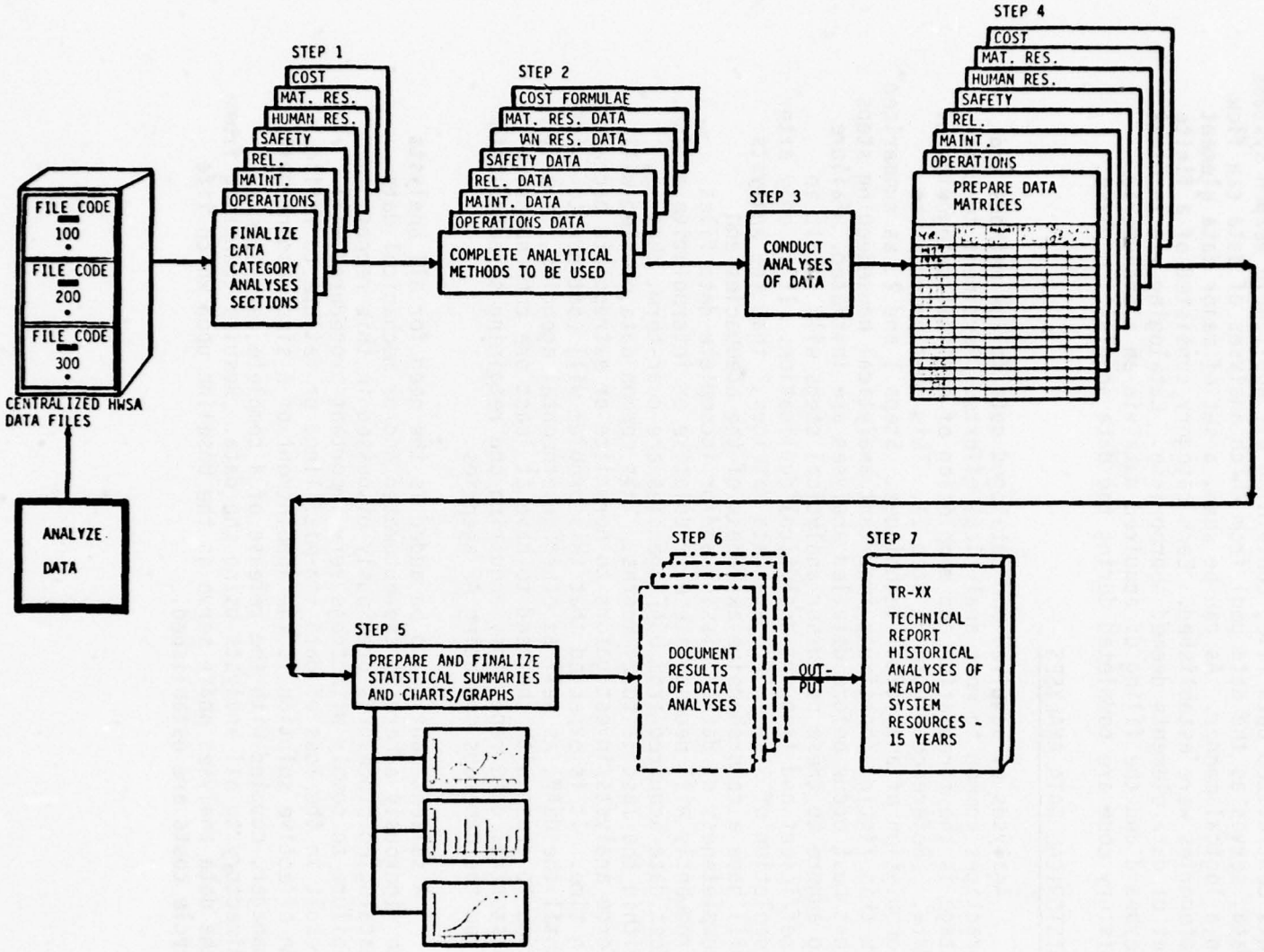


Figure 8 Logic Flow, Analyses of Data

HISTORICAL AIR FORCE SPECIALTY CODE (AFSC) TASK ANALYSES

The methods recommended during the preparation, acquisition and analyses of Air Force specialty (AFS) personnel duties and tasks are illustrated in Figure 9. During the planning and conduct of the program, attempts were made to generate detailed AFSC maintenance duties and tasks. Air Force Manual 39-1, Enlisted Personnel Airman Classifiication Manual, was used as a means of defining the general scope of assigned task responsibilities. It soon became evident that this would not permit the definition of explicit task responsibilities without the use of C-130E technical orders. Tasks described within technical orders (TO) were: 1) too voluminous in nature; 2) would have required extensive time for individual AFSs to use; and 3) were insensitive to which AFSCs were responsible for performing discrete tasks within the TOs. A final solution was provided by obtaining Occupational Survey Inventories (OSI) and Occupational Survey Reports (OSR) for each of the 11 selected maintenance AFSs evaluated. These OSIs provide the most comprehensive AFSC duty and task acquisition tool available. The OSIs contain discrete sections enabling establishment of: 1) background information; 2) maintenance quipment used on the job; 3) training courses completed; and 4) detailed duties/tasks. The latter portion of these OSIs is divided into functional work categories such as: 1) Organizing and Planning; 2) Directing and Implementing; 3) Inspecting and Evaluation; 4) Training; 5) Working with Forms, Records, Reports, etc.; 6) Performing Specific Maintenance Functions, etc. Each of these functions, in turn contain an average of 38 detailed tasks. Each OSI averages about 570 tasks spread among an average of 15 major functional (duty) areas.

The preparation, implementation and analytical steps illustrated in Figure 9 are self-explanatory. Step 6 "Conduct Pilot Run of AFSC Duties/Tasks" is an important step in the methodology portrayed. This enables the investigators to prepare for the final acquisition of comprehensive duty/task data. Results acquired during a pilot run, utilizing actual maintenance AFSCs (preferably skill levels 7 and 9), enable the investigators to amend the OSIs to include maintenance tasks not identified in current OSIs. In this manner, the OSIs are amended to enable acquisition of specific weapon system maintenance tasks. A salient point to be emphasized is the need for future investigators to be intimately aware of personal questions that fall within the purview of the United States Privacy Act. These questions; such as full name, place of birth, social security number, personal telephone number etc., must be removed from the OSIs before they are released.

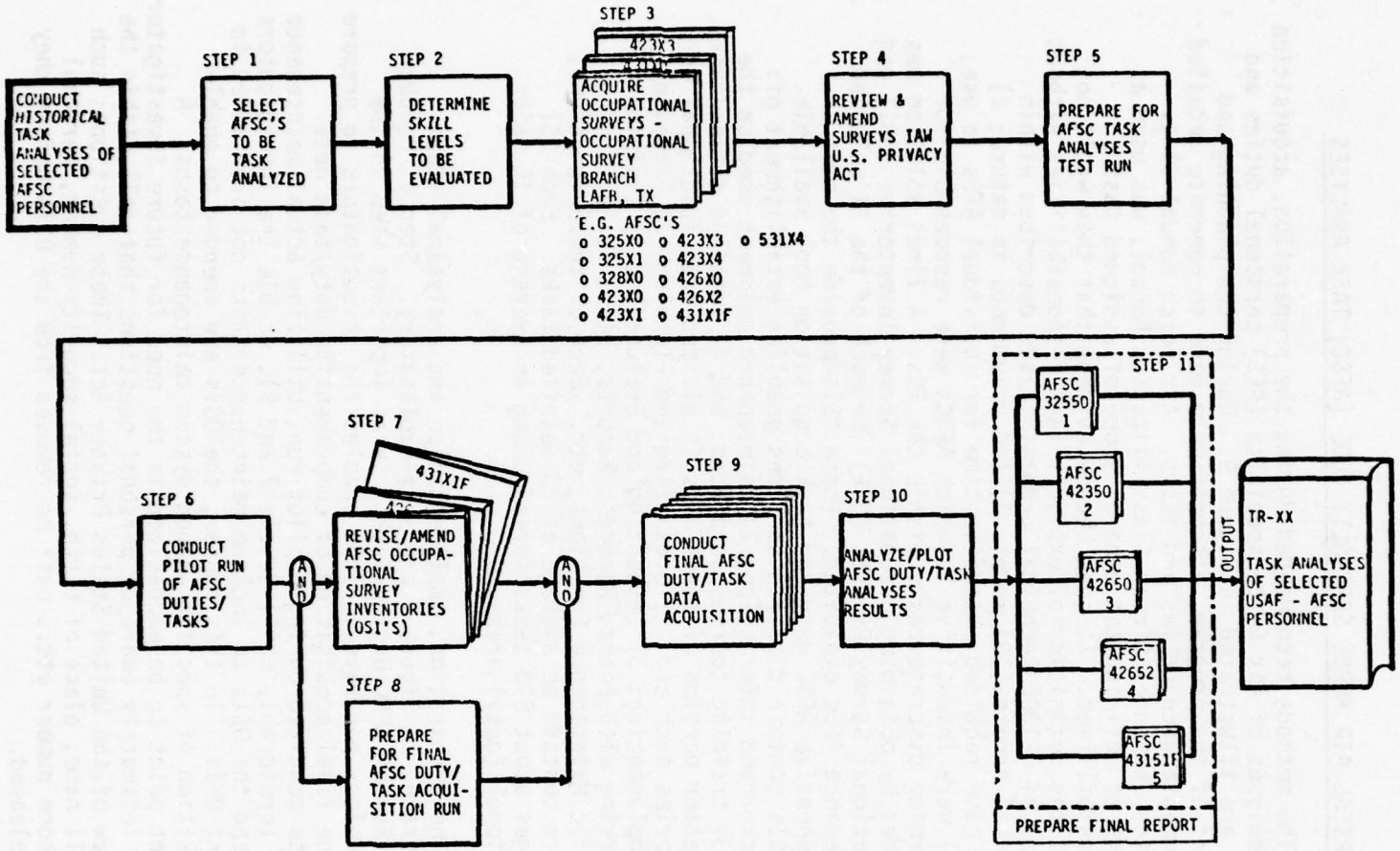


Figure 9 Historical AFSC Duty/Task Analyses Methodology

Personnel in AFSs at operational bases require an average of 55 minutes to complete the inventory with a range of 40 to 68 minutes. Prior to initiating the pilot run or the final inventories, contact and approval via formal letter of request must be issued to the cognizant command office (e.g. Deputy Command of Maintenance - 314th Tactical Airlift Wing) stipulating: 1) the purpose of the inventories; 2(justification; 3) time and area for conducting the inventories; 4) completion time required for each AFSC; 5) total numbers of AFSs to be inventoried; and 6) facilities required to conduct the task inventories. Success of acquiring the cooperation of the cognizant officer (such as the DCM) is dependent upon the scheduling of the inventories during low work activity periods. Launching of aircraft as well as maintaining maintenance schedules in accordance with job control work loads must not be abrogated by information gathering activities.

LIFE CYCLE COSTING

The existing USAF Cost Analysis and Cost Estimating (CACE) model contained in AFR 173-10 USAF Cost and Planning Factors, Department of the Air Force, (6 February 1973)[6] is recommended for future weapon systems life cycle cost activities. It will be necessary to modify the model variables in accordance with the dictates and limits imposed by the integrity and completeness of historical data. Subtasks recommended to be followed when establishing values denoting life cycle utilizing the CACE model are depicted in Figure 10. The nine basic steps contained within this figure are sub-indentured to Task VI of Figure 2.

Experience demonstrated that actual historical data, augmented by existing cost estimating factors, can be utilized to establish weapon system life cycle cost values. Future HWSA life cycle costing of existing operational weapon systems should encompass the three major life cycle phases, namely: 1) Research and Development; 2) Procurement/Production; and 3) Operations and Support. HWSA studies conducted by future investigative agencies must also consider the Conceptual and Disposal phases. The latter, i.e., Disposal Phase, can only be accomplished after retirement of that designated system from the USAF inventory. Conceptual phase data and costs are difficult to acquire.

Although the phases annotated above are somewhat artificial in nature in that the process is iterative and the phases overlap, they do convey a chronological sequence of birth-to-death progressions typical of any system.

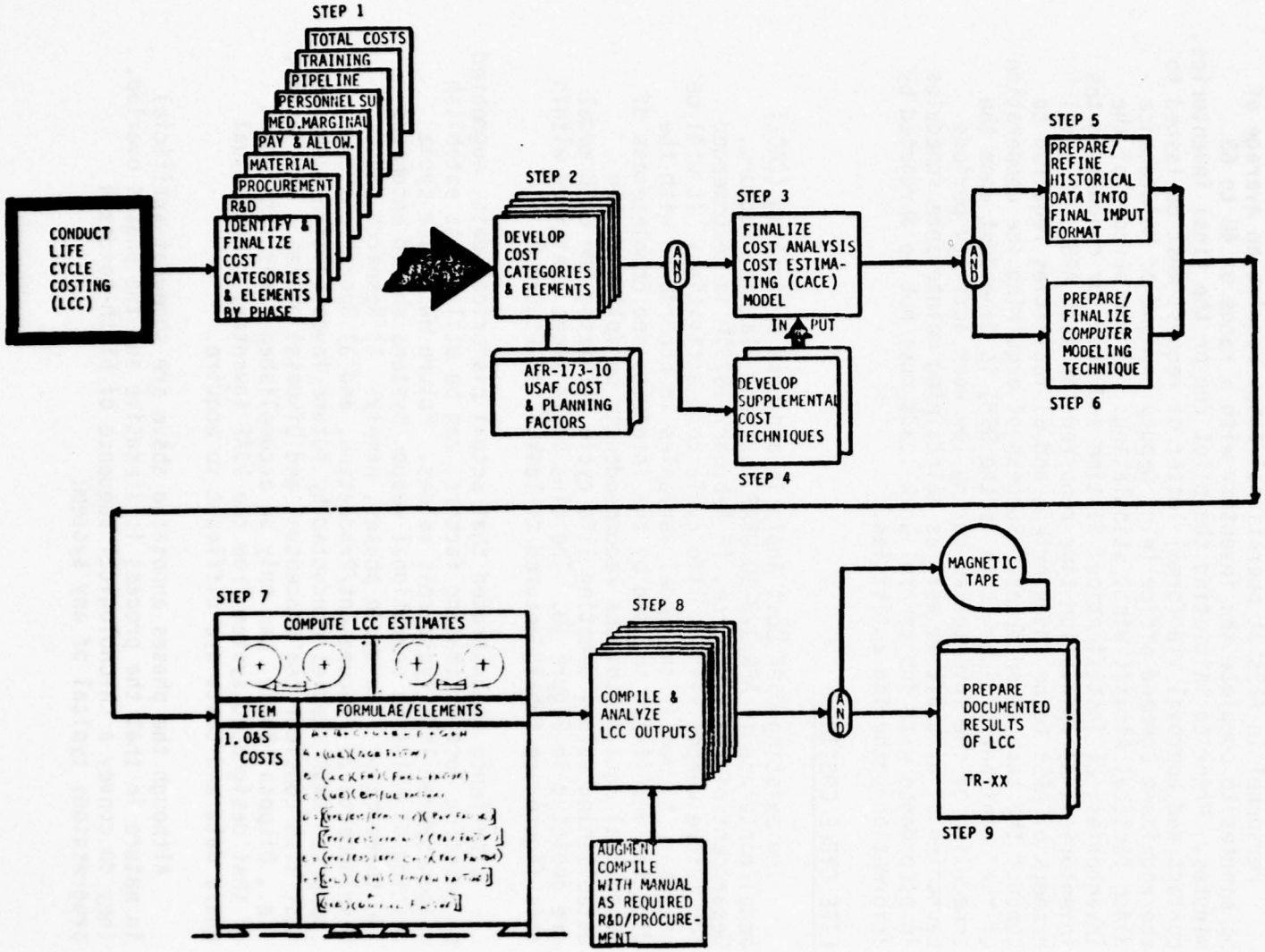


Figure 10 Flow Logic, Life Cycle Cost Methodology

Conceptual phase data were not acquired during the C-130E HWSA program as historical data were not available and were listed as sunk costs (past expenditures that cannot be captured). If the weapon system has not been retired, disposal phase data will not be obtainable.

CACE MODEL SELECTION

The Air Force standard Cost Analysis and Cost Estimating (CACE) model, was selected as the primary life cycle analytical model. Adjustments were necessary in accordance with problems and situations unique to future HWSA efforts. The CACE model computes steady state operating costs at the aircraft squadron level. Because of this it will be necessary to incorporate the Acquisition and Disposal costs as applicable, on a manual basis. In selecting any model it should be reviewed for adequacy as follows:

> First: An initial stratification of cost elements desired for this study needs to be identified, and Second: these elements have to be compared with the basic CACE model to ensure that all categories and elements of cost are included or can be easily added either manually or by slight modifications to the basic model.

The basic CACE model, suitably modified, adequately satisfies the objectives of life cycle cost analyses. This is particularly true when the emphasis of life cycle costing is placed principally in the operations and support area. Verification of the CACE model (Reference Step 3 of Figure 10 must be accomplished subsequent to development and inclusion of supplemental analytical techniques. (Step 4 of Figure 10. This is described in further detail below.)

DEVELOP SUPPLEMENTAL TECHNIQUES

To capture and display the total C-130E elements of life cycle costs previously discussed, supplemental informational and model revisions were required (Reference Step 4 of Figure 10.) Additional dollar expenditures not normally captured by the basic model will be in the areas of research and development, actual aircraft procurement, peculiar support equipment, training devices, etc. Each of these areas therefore must be handled on an individual basis with a "by year" dollar expenditure. These values are then added to the model results manually.

Since the CACE model is designed as an analysis tool at an aircraft squadron level, and not fleet, further modifications are necessary. The basic CACE model must be expanded to determine total O&S cost for an aircraft fleet on a specified aircraft life, in years. Additional refinements will include such amenities as: 1) geographic location inputs and displays; 2) various manpower inputs depending on data availability, and sub-routine requirements; 3) the inclusion of a delivery schedule input table to cover specified years; and 4) model acceptance of annual aircraft deliveries for yearly computations.

SUMMARY

Historical Weapon System Analysis (HWSA) methods and practices utilized in this study were contingent upon specific criteria. Technical requirements and tasks defined within this study established the premise upon which the C-130E HWSA Program was implemented.

The objective was to provide a capability to determine the resource utilization of a weapon system. The C-130E was selected as the baseline system. An arbitrary time frame was defined as fifteen years (1961-1976). The methodology that was developed produced a vast amount of data concerning the C-130E system. This data, which is historical, may be used to make initial decisions about future systems. The methodology may be applied against other weapon systems with a high probability of obtaining the same quality of results.

Figure 10, summarizes the general methods (1st - indentured flow) and progressions used throughout the program. This flow expands on the illustration summarized in Figure 2. Second - indentured flows, depicting more finite methods and practices employed during the conduct of each of the six tasks, are contained in subparagraphs below. Data cateloging forms or records and other analytical tools critical to the successful completion of each task are also presented. (See Appendix.)

As can be seen in Figure 10 each task culminates in a product, either a report or data bank. To use the complete methodology requires that all tasks be accomplished. If a modified effort would be more appropriate, at least two tasks would be required: Program Plan and any other. Task III, Data File Creation, is a necessary task if Task IV, Resource Analysis of Task IV, Life Cycle Cost, is required. A brief description of the outcomes of each task is provided.

TASK 1 - Program Plan: Establishes the type of data required, the tasks to be completed, the time necessary, milestones and costs.

TASK 2 - Historical Review of Published Literature: Selects and collects all published information about the system. Reviews and analyzes the information to provide brief single source of all available resource information.

TASK 3 - Data Bank: Identifies sources, collects data and integrates into master data containing all data prescribed in Task 1.

TASK 4 - Analysis of Resources: Analysis of data bank information, includes generating missing data and general descriptive statistics.

TASK 5 - Task Analysis: Provides detailed analysis of what tasks are performed, time required and skill level of selected critical AFSCs.

TASK 6 - Life Cycle Cost: Uses cost analysis and cost estimating model and data bank to compute LCC for selected weapon system.

III - SPECIAL PROBLEM AREAS

INTRODUCTION

General problems that can be expected during the conduct of future weapon system historical studies are summarized below. Specific problems encountered by investigators are explained in more detail within each separate technical report released.

1. A performance period of 12 months which was the time established for this study for future HWSA efforts is too brief. Future HWSA studies should permit at least an 18-month research period.

2. Dependence on data via formal letters of request, result in the following, namely: a) failure of the respondee to deliver requested data; b) the release of incomplete and sometimes wrong data; and c) inordinate delays in the receipt of requested data.

3. The review of historical data, available via various agencies, libraries, etc. is singularly the most important part of future HWSA studies and will take a minimum of five months.

4. Dependence upon Air Force documentation search and data collection, for completed data files, will require a minimum of seven months to accomplish.

5. Acquisition of data via site visitation must be preceded by letters of justification to the target data agencies. Failure to follow this important practice will result in outright reticence on the part of various USAF governmental agencies to release data.

6. Acquisition of data from the CONUS Air Logistics Centers (ALC's) will be the most difficult problem facing future HWSA investigators as they are generally reticent to release data to contractor personnel in spite of contract letters justifying data needs.

7. Data control, cataloguing and file control, must be accomplished via an automated system.

8. There is a lack of contiguous, historical data beyond periods of the last 12 to 18 months. This will necessitate the need to plan and conduct numerous trips to cognizant command centers. Present USAF directives/policies dictate the retention of near-term data (e.g., up to 24 months) prior to purging. This has resulted in: 1) the marked reduction in filing and subsequent storage costs; and 2) loss of valuable quantitative operational data so badly needed when conducting historical weapon systems analyses.

9. Failure to acquire contiguous historical data (the assigned manpower profiles over a 15-year period) forces data analyst to extrapolate back in time. Extrapolative and/or interpolative data analyses is always "second best" when attempting to derive quantitative values.

10. Future HWSA efforts necessitating the acquisition and analyses of AFSC duties and tasks will be faced with the problem of acquiring these data at operational bases. There is understandable reticence on the part of operational commanders to release maintenance personnel during shift activities.

11. Problems will be encountered in future studies when attempting to establish conceptual and early research and development costs. These data are usually not obtainable in weapon systems that have been in inventory over extended periods (e.g., 15 years).

12. Cost estimating formulae/techniques used to establish historical cost values will not pose any problems. However, quantitative values (either variables or constants) inserted within mathematical protocols will be subject to many extenuating circumstances unique to each HWSA effort. All mathematical factors contained within AFR 173-10 must be carefully assessed to determine if other data, germane to the system being assessed, should replace factors contained within this document. The lack of contiguous historical data will usually force analysts to defer to constant values contained within AFR 173-10. Some of the factors such as officer, airman, and civilian pay are actuals and will always be used.

Problem highlights unique to each of the tasks are annotated below. Problems encountered in one task frequently caused concomitant problems in other tasks. For example, lack of contiguous data over periods beyond the last 18 to 24 months precluded quantitative analysis on actual data over a 15 year period. This frequently necessitated data extrapolation during Task IV, "Analyses of Data," and Task VI, "Life Cycle Costing."

TASK I - PERFORMANCE PLANNING

No special problems unique to Task I were encountered.

TASK II - HISTORICAL DATA REVIEW

In some cases the source of the information obtained, was not the originator of the information. For example, of the 76 documents ordered and received through the Defense Documentation Center, some were actually provided by the Government-Industry Data Exchange Program (GIDEP) and other government agencies such as Rome Air Development Center.

In attempting to accumulate the descriptive information, the following problems were significant enough to warrant being highlighted here to assist in similar efforts in the future.

1. There is no single data repository/system that provides visibility into weapon system historical documentation.

2. It became necessary to first identify all of the various repositories and then to select and collect the information from each for the specific weapon system being studied.

3. Information that had to be ordered from some data repositories required extremely long lead time prior to actual information delivery. In some cases, even after repeated requests for the data, the data were not furnished thereby leaving gaps and inconsistencies which require normalization to obtain acceptable study results.

4. Some data repositories did not have large mechanized systems or had only one document on file (usually hard copy). This resulted in a time-consuming effort for review and reproduction and frequently reduced or eliminated the possibility of acquiring needed information. Along these same lines, future study investigators will find data repositories that have copious documents, listings, and reports that can be borrowed. This will require either laborious data extraction, or disassembly - reproduction - assembly and return to the home office which requires significant manhours for accomplishment.

5. Obtaining need-to-know and/or proper management level attention was very time-consuming particularly in situations where organizations or individuals, with needed information, would not release the information without "proper" management approval even when "need-to-know" had been established.

6. The predominate USAF policy of retaining historical data for only short durations (6 to 24 months) or as in most cases (6 to 12 months) prior to purge, had a profound effect on the ability to get contiguous historical information beyond near term periods.

7. Changes in reporting systems as to format, deletion of key data elements, or in some cases the total elimination of the reporting system caused inconsistencies and data gaps. This problem had added emphasis when the data were computer generated or had to be processed by a computer.

8. Computerized data on magnetic tape, the most desirable form for large quantities or years of data caused long delays and excessive computer time as the tape formats were frequently incompatible and required correction.

9. The variance in data systems and repositories queried presented a unique situation. Depending on the data system or repository, each had its own "in-house peculiar language" that is used when discussing and/or retrieving the information in that system.

10. At some of the sites visited, interview questionnaires were accepted by the individual and left to be completed and returned later. In these cases, a low number was actually returned. Although this is expected to a certain degree, it resulted in excessive investigation time for follow-up. In other cases, some individuals flatly refused to complete a questionnaire even though the individuals were knowledgeable and could have contributed to the study.

TASK III - AIR FORCE DOCUMENTATION SEARCH AND DATA ACQUISITION

Problems encountered during Task II also occurred during Task III implementation with the following additions, viz:

1. Unique data documentation languages used within various USAF agencies necessitated investigators to become self-educated in short periods of time.

2. Lack of mechanization in USAF documentation resulted in acquisition of large volumes of raw data.

3. Changes in USAF documentation practices, forms, and associated data fields throughout the 1962-1976 study period frequently caused loss of contiguous data.

TASK IV - DATA ANALYSES

Some of the more significant problems encountered during data analysis were:

1. Massive amounts of data (6.1 million records and 900 reports, papers, articles, etc.) were collected and evaluated. Packaging and evaluating these data for logical presentation in a relatively few pages was a formidable task. There are any number of combinations in which the data could be packaged and displayed. The available time and study resources allocated did not permit investigation into the best displays or most practical approach. The contractor overcame this problem by the use of skilled personnel methods, techniques, computer programs and displays previously developed during twenty years of acquiring data from Air Force data system/sources and applying the analyzed results to numerous Air Force programs.

2. Much difficulty was encountered in sorting C-130E data from gross data on the C-130 MDS. This was especially true in the cost category and in the depot area.

3. Conflicting data (e.g., number of possessed C-130E aircraft per year from 1962-1976), obviated or attenuated analytical progress. In some cases these conflicts could not be satisfactorily resolved.

4. Compilation of fragmented and/or discontinuous data resulted in formulation of some scattered, discontinuous analytical results.

TASK V - HISTORICAL AIR FORCE SPECIALTY TASK ANALYSES

1. Times required to accomplish actual maintenance tasks are difficult to obtain.

2. Acquisition of maintenance tasks actually accomplished by maintenance personnel beyond periods of 75 minutes during duty periods is difficult to obtain.

3. Job control commitment of planned maintenance activities can preclude AFS duty/task analyses at operational bases.

4. Acquisition of historical Personnel Planning Information (PPI) data such as Qualitative and Quantitative Personnel Requirements Information (QQPPI) documentation is difficult.'

TASK VI - LIFE CYCLE COSTING

1. Contiguous, real time costing of the C-130E weapon system was not accomplished over the 1962 through 1976 time period. This was due to failure by the USAF to maintain at least one single weapon system data repository.

2. R&D costs germane to the C-130E aircraft could not be found. C-130A thru D R&D costs served as the basis for quantifying C-130E costs.

3. Acquisition of training, training equipment and technical order data from the USAF was not possible. This further prevented the development and use of real time C-130E cost data when performing life cycle cost analysis.

IV - APPLYING METHODOLOGY

INTRODUCTION

The methods and practices previously portrayed in illustrative format are single thread flows of progressions to be followed when implementing each discrete task. When actually applying these methods, it becomes apparent that several of these tasks should be implemented together. For example, Task I, "Development of Performance Plan," must be accomplished prior to implementing other HWSA tasks. Tasks II, III, and IV requiring historical data review, data acquisition and data analyses respectively, can be conveniently grouped into one homogeneous group. Tasks II and III establish the basis upon which Task IV, "Data Analyses," is accomplished. Record files containing applicable published literature, and other USAF data are initiated in Task II and are completed under Task III. Specific features/highlights unique to each of the six tasks are summarized below.

TASK I - PROGRAM PLANNING

Future HWSA research efforts should fall within the milestones and schedules illustrated in Figure 11.

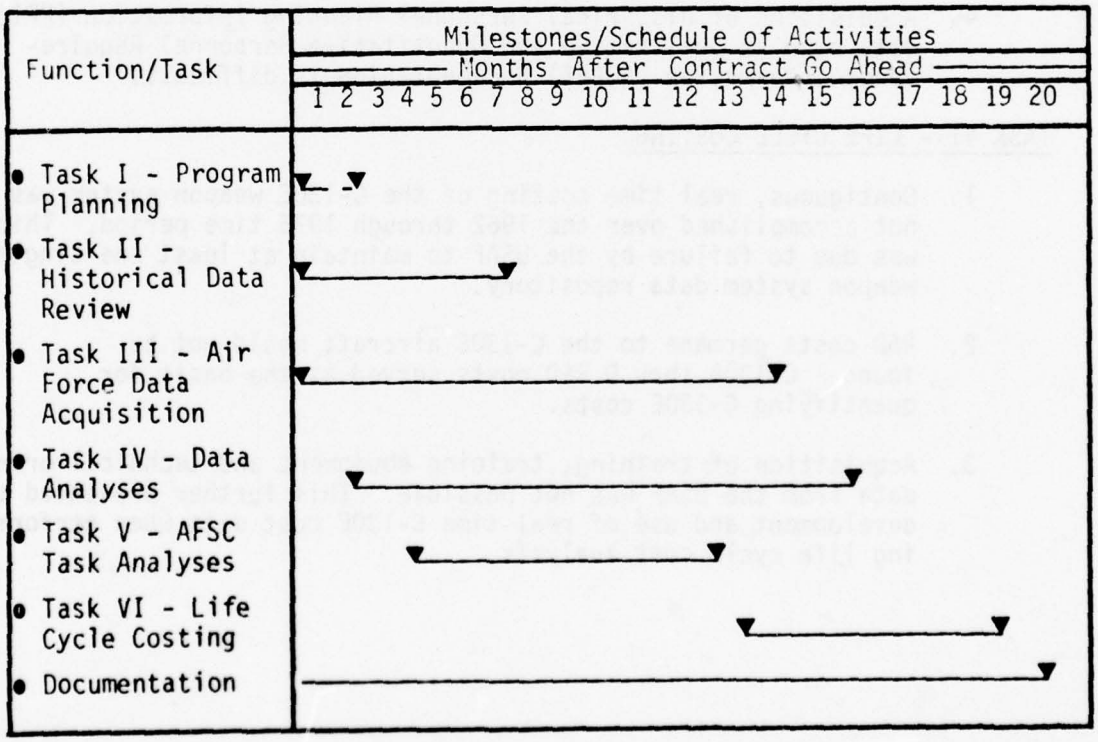


Figure 11 HWSA Program Schedules

Future historical weapon systems analyses of the scope completed under Phase I of project 1959 should be accomplished within a period of 18 to 20 months. Further, the proportional times generally allocated for each of the tasks and the concomitant hours required to satisfactorily complete future research tasks are annotated below, namely:

TASK		ALLOCATION (%)	HOURS REQ'D
I	Program Planning	5%	400 Hrs.
II	Published Literature Review & Acquisition	12.5%	1000 Hrs.
III	Air Force Documentation Review & Acquisition	20%	1600 Hrs.
IV	Data Analyses	35%	2800 Hrs.
V	AFSC Task Analyses	15%	1200 Hrs.
VI	Life Cycle Costing	12.5%	1000 Hrs.
		$\Sigma=$ 100%	$\Sigma=$ 8000 Hrs.

The allocation of hours noted above represent those proportional times expended on the C-130E HWSA effort. The total of 8000 hours is (17.5%) above that expended (6600 Hrs.) on the Phase I project.

TASK II - REVIEW OF PUBLISHED LITERATURE AND STRUCTURED INTERVIEWS

The identification of repositories containing historical C-130E published literature and subsequent acquisition was the primary purpose of Task II. As previously mentioned, Task III had the same purpose for data systems. Table 1 lists in alphabetical order by agency, the results of the searches for both tasks as well as the type of information available from the repository/system. Program task applicability is also shown.

The major forms and amounts of data acquired from the respective data centers were: a) 240 documents/reports; b) 366 magazine articles; c) 274 monthly reports; d) 51 computer listings; and e) 11 indexes.

TABLE 1

DATA SOURCES AND AGENCIES

AGENCY	LOCATION	OFFICE SYMBOL(S)/FUNCTION	TYPES OF LITERATURE/ DATA FILES	TASK APPLICABILITY
Acquisition Logistics Division	Wright-Patterson AFB, OH	RAXA - Studies and Analysis Branch	- -	II
Aeronautical Systems Division	Wright-Patterson AFB, OH	HO - History Office ACC - Cost Analysis ACL - Joint AFLC/AFLC LCC Working Group	Documents Documents, Backfill Report LCC Studies	II
Aerospace Daily Ziff Davis Publishing Co.	Washington, D.C.	- -	Aerospace Daily Articles	II
Air Force Logistics Command	Wright-Patterson AFB, OH	PRPL - Program Requirements ACVMP - Inventory, Status and Performance Branch HO - History Office ACRC - Cost Analysis ACVRC - Depot Usage LOLMF - Data Collection Requirements LOLMA - Data Requirements LOAP - Material Support Division	1-HAF-A1-110-12 D056E G033B B-4 C-4 Index, Documents 1-HAF-A1-110-12 - - D041 H036B - - K051 PDM Brochure	II and III
Air Force Systems Command	Andrews AFB, MD	HO - Historical Office ACCM - Cost Analysis Division	Articles Authorization for AFM 66-1, 65-110 and 400-1	II
Air Force Inspection and Safety Center	Norton AFB, CA	SEFB - C-130 Safety Project Officer SER - Accident/Incident Reporting and Data Collection SEDA - Education Office	Articles Accidents/Incidents Listings Safety Magazine Articles	II

TABLE 1 (continued)
DATA SOURCES AND AGENCIES

AGENCY	LOCATION	OFFICE SYMBOL(S)/FUNCTION	TYPES OF LITERATURE/ DATA FILES	TASK APPLICABILITY
Air Training Command	Sheppard AFB, TX	TFTO - 3785 Field Training Group LGMET - Configuration Management TTRE - Training Equip. and Design TTP - Training Programs Management TTA - Systems/Resident Training TTAB - Technical/Training Resident ACMFB - Finance Office	UDL CTS POI TOT Config. Records - - Training Course Data File - - - - AFM-177-388 Data	II
Air University - Air Command and Staff College	Maxwell AFB, AL	Air University Library (Index to Military Periodicals)	Articles from 69 Different Military and Aeronautical Periodicals	II
Aviation Week and Space Technology	New York, NY	Aviation Week and Space Technology Reference Library	Index of Published Articles	II
Congressional Information Service Inc.	Washington, D.C.	- -	Working Papers of the U.S. Congress	II
Defense Market System (DMS) Inc	Greenwich, CT	- -	Defense Marketing Information	II
Defense Supply Agency (DSA)	Alexandria, VA	DDC (Defense Documentation Center) Referral Data Bank	Data Search Index/Documents	II
Engineering Index Inc.	New York, NY	- -	File Indexes of Citations and Abstracts From Engineering Journals and Selected Government Documents	II
Front & Sullivan Inc.	New York, NY	- -	Defense Contracts/ Cost Information	II

TABLE 1 (continued)
DATA SOURCES AND AGENCIES

AGENCY	LOCATION	OFFICE SYMBOL(S)/FUNCTION	TYPES OF LITERATURE/ DATA FILES	TASK APPLICABILITY
Headquarters USAF	Washington, D.C.	ACMCA - Cost Analysis Division	OSCR C-130E Report	II
H. W. Wilson Company	Bronx, NY	Applied Science and Technology Periodicals	Index of Published Periodicals	II
Logistics Management Institute (LMI)	Washington, D.C.	Research Agency	LMI Studies Index and Documents	II
Military Airlift Command	Scott AFB, IL	ACMF - Economical Analysis and Cost ACMFB - Alternative Costing Branch LGXA - Logistics Analysis Division	Training Costs Training Costs Monthly Maint. Digest, MACR 57-2, 65-5, Aborts	II
Military Personnel Center	Randolph AFB, TX	XPMRT - Manpower Division DPMDQ - Division Executive - Requirements DPMYP - Research Division DPMDQYS - Requirements Analyst	Manpower Standards, UDL, Field Training Manpower Plans Survey Research Requirement Manpower Profile, Training Records	II
National Aeronautics and Space Administration (NASA)	Washington, D.C.	NASA/Scientific and Technical Information Office NASA/Directory of Aerospace Safety Specialized Information Sources	Data Search Index and Documents Data Search Index and Documents	II
National Technical Information Service	Springfield, VA		Government Research Contract Information	II
USAF Occupational Measurement Center (ATC)	Lackland AFB, TX	OMY - Occupational Survey Branch	Survey Reports Survey Task	II

TABLE 1 (continued)
DATA SOURCES AND AGENCIES

AGENCY	LOCATION	OFFICE SYMBOL(S)/FUNCTION	TYPES OF LITERATURE/ DATA FILES	TASK APPLICABILITY
Oklahoma Air Logistics Center	Tinker AFB, OK	MMEAM - Material Analysis Branch MMIRA - Engineering & Analysis Branch MMII - Investment & Replacement Branch	D041 Fetch D041, F91A D041	III
Rand Corporation	Santa Monica, CA	- -	Technical Reports	II
Rome Air Development Center	Griffiss AFB, NY	RADC/Reliability Analysis Center	Reliability Studies/Analysi Information	II
Sacramento Air Logistics Center	McClellan AFB, CA	MMII - Investment & Replacement Branch ACDCN - Logistics Systems Section ACDCG - Commodity Stock Control and Distribution Section	D041 K051 D049	III
San Antonio Air Logistics Center	Kelly AFB, TX	MMEAI - Quality Improvement Section MMMR - Requirements Branch MMECD - Operational Flight Program Section HO - History Office	G095 D041 D062 G098 Engine Data	III
U.S. Army Logistics Management Center	Fort Lee, VA	DLSIE (Defense Logistics Studies Information Center) Referral Data Bank	Data Search Index and Documents	II
Warner-Robins Air Logistics Center	Warner-Robins AFB, GA	MMEAA - Maintenance Data Analysis MMSRBA - Engineering & Reliability MMSSS - Material Support Branch HO - History Office MMISCA - Material Support - Data Processing and Control Section MMJB - C-130 System Program Office MABGPA - Depot Planning Maintenance	K261/K262 D047 (TCTO Data) NORS Data D20 Reports D041 D032 AGE TA's G037 G004	III

TASK III - DOCUMENTATION SEARCH AND COLLECTION

The purpose and interelationship of this Task III to the past and future tasks has been previously well documented and discussed. This section will enumerate the type, quality, quantity, and categories of data. Data were grouped and evaluated under one of the following seven categories: 1) Operations; 2) Maintenance; 3) Reliability; 4) Safety; 5) Human Resources; 6) Material Resources; and 7) Cost, and the respective salient features of the data are detailed in Appendix D.

A subjective view of the total acquired data via a percentage completeness of each category as they applied to the study objectives would find operations and safety nearing 100 percent. Maintenance and reliability would approach 55 percent completion whereas human and material resources were about 20 percent complete. Actual documented historical cost data was approximately 10 percent complete. Definite points that should be coupled with the above category percentages is that the study period was to cover fifteen years and subsequently missing years would reduce the percentage value. Also, missing data elements within a given category would decrease the percentage value as would data not applicable to the "E" series of the C-130. These incomplete data/years were filled in via data normalization and regression analysis techniques in Task IV data anlysis.

TASK IV - HISTORICAL ANALYSIS OF RESOURCES

The total amounts of data acquired in Task II (over 900 documents/reports/etc.), and Task III (over six million individual transactions from the various data systems), were utilized in this data analysis task. As discussed in Task III, varying percentages of data covering the C-130E for 15 years within the seven categories was acquired. To compensate for the incompleteness of data and prior to the development of standard statistical values/rates i.e., manhours, failures, tasks, etc., a normalizaton - regression analysis technique was applied to the known data.

In the categories of operations and safety, normalization was not required as the available data adequately covered the C-130E for the 15 years. Table 2 illustrates the completeness of operations data that were obtained.

In the maintenance and reliability categories, normalization analysis increased the value of these areas such that they would rank third and fourth behind operations and safety with respect to completeness. Human and material resource and cost category data were not applicable to the normalization analysis and was used as acquired throughout the study.

Table 2 Operations Statistics

OPERATIONAL PARAMETERS	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	15 YEAR AVERAGE/ TOTAL
POSSESSED AIRCRAFT (AVERAGE)	11	83	226	315	295	291	279	289	304	323	298	293	295	296	297	260
AIRCRAFT FLIGHT HOURS TOTAL	*18,800	*82,274	231,069	347,008	444,263	366,609	310,185	255,373	245,153	246,979	220,070	190,734	169,867	170,360	164,553	3,463,317
AVERAGE UTILIZATION (FLT. HRS./ACFT./MO.)	* 190	* 83	85	92	126	105	93	74	67	64	61.5	54.2	48.0	48.0	46.2	75.2
AVERAGE MISSION LENGTH (FLIGHT HOURS)	-	-	-	4.33	4.11	2.89	1.89	1.89	1.94	2.19	2.78	2.58	2.91	2.82	2.57	2.63
AVERAGE LANDINGS/FLIGHT HOUR	-	0.86	0.64	0.55		1.7	0.7	0.9	1.0	1.1	1.1	1.0	1.2	1.1	1.1	1.00
PERCENT OPERATIONAL READY	85.9	80.7	74.9	72.9	69.5	74.3	74.1	73.2	68.0	68.7	69.3	68.2	69.0	63.9	61.1	69.9
PERCENT NOT OPERATIONAL READY SUPPLY	3.7	6.7	7.9	5.3	6.4	2.4	1.7	2.0	3.5	3.4	3.3	4.4	3.7	4.3	4.0	4.0
PERCENT NOT OPERATIONAL READY SUPPLY-FLYABLE	-	-	-	-	-	1.4	2.2	0.8	1.4	1.7	5.0	7.0	8.0	6.6	6.4	[1]
PERCENT NOT OPERATIONAL READY SUPPLY-GROUNDED	-	-	-	-	-	2.0	1.6	2.0	3.5	3.4	3.3	3.7	3.7	4.3	4.0	[1]
PERCENT NOT OPERATIONAL READY MAINTENANCE	10.4	12.6	17.2	21.8	24.1	23.3	24.0	24.8	28.5	27.9	27.4	27.4	27.3	31.8	34.9	26.1
PERCENT NOT OPERATIONAL READY MAINTENANCE - FLYABLE	-	-	-	-	-	-	-	-	-	-	-	5.0	4.9	6.2	8.8	[1]
PERCENT NOT OPERATIONAL READY MAINTENANCE - GROUNDED	-	-	-	-	-	-	-	-	-	-	-	22.4	22.4	25.6	26.1	[1]
PERCENT NOT OPERATIONAL READY MAINTENANCE - TCTO	0.2	0.6	0.7	0.6	0.7	0.9	1.0	0.1	0.6	0.1	0.1	Not Reported	Not Reported	Not Reported	Not Reported	[1]

[1] — INCONSISTANT REPORTING

* ESTIMATED

TASK V - AFSC TASK ANALYSES

Occupational Survey Inventories (OSIs) serve as excellent vehicles through which Air Force specialists can identify explicit tasks they perform in the operational environment. The OSI's must be amended to include unique functions accomplished by personnel prior to acquisition of final duty/task data.

During Phase I of Project 1959, 50 43151F aircraft maintenance personnel were task inventoried at Little Rock Air Force Base, Arkansas. The results of this task analysis are portrayed in Table 3 and Figure 12. As noted in Table 3, 76.6630% or 749 of the 977 possible tasks contained in 23 functional categories are accomplished by the personnel evaluated. Proportionally, most daily tasks are accomplished in functional categories requiring general aircraft maintenance (Function G), maintaining flight control systems (Function K), general engine maintenance (Function Q), and maintaining landing gear systems (Function I). Over 59% of this AFS's time is spent performing direct maintenance tasks on the C-130 aircraft. The remaining time, i.e., 40% is used in performing non-direct or maintenance support activities.

Apparent during the conduct of a pilot run conducted at McChord Air Force Base, Washington, is the fact that skill level five maintenance personnel are the principal or direct maintenance force, with seven and nine skill level personnel performing less direct maintenance and more supervisory planning and organizing tasks. Comparisons of AFSC duties defined in AFM 39-1 and Systems Requirements Analyses (SRA) planning data with those data denoting actual tasks performed in the operational environment reflect low levels of awareness on behalf of the contractor of real time demands expected of maintenance personnel. Such large voids in planning information during the system development stages do little to effectively support personnel loading conferences, training, planning conferences, etc., sponsored by the various USAF commands. Although the results of only one of the 11 AFSC's are shown, the same discrepancies or levels of apparent disagreement between planned tasks versus actual tasks performed by ten other AFSC's were observed by Personnel Subsystem Specialists. These results are contained in Volume II of this final report.

TASK VI - LIFE CYCLE COST ANALYSIS

The problem addressed in this task was to perform a historical life cycle cost analysis of the Air Force C-130E aircraft. The life cycle period was defined as the past fifteen years (1962-1976).

The approach to the life cycle cost analysis was to: 1) Utilize the standard USAF Cost Analysis and Cost Estimating (CACE) model as outlined in AFR 173-10 (Reference 6) modified as necessary to satisfy the specific requirements of this study; 2) to the extent possible, utilize the actual historical data that were collected and analyzed in prior tasks of this study, as the model input data variables; 3) utilize AFR 173-10 cost estimating factors for the model input variables where actual data was not available or could not be obtained; and 4) utilize a local (IBM-370) computing system for model development and life cycle cost computations.

Table 3 Summary
of
OSI Functional Titles/Nomenclatures

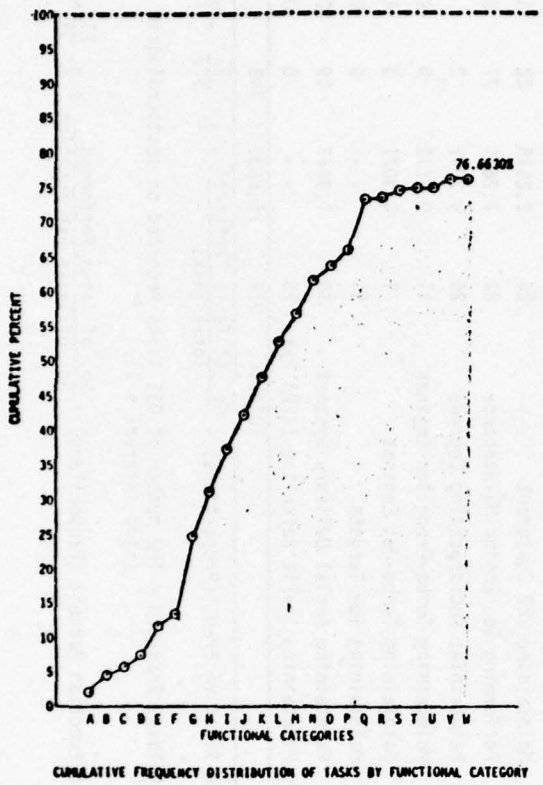
AFSC OSI: 43151F Aircraft Maintenance Career Ladder
(AFPT 90-431-210)

1	2	3	4	5	6
FUNCTION	TITLES/NOMENCLATURES	NUMBER OF TASKS	REL. FREQ.(%)	TASKS RECORDED	FUNCTION PERCENT
A	Organizing and Planning	33	2.1493	21	63.64
B	Directing and Implementing	28	2.4565	24	85.71
C	Inspecting and Evaluating	19	1.2282	12	63.16
D	Training	15	1.5353	15	100.00
E	Maintaining Forms and Records	50	4.2989	42	84.00
F	Performing Supply Functions	19	1.7400	17	89.47
G	Performing Gen. Acft Maintenance	127	11.3613	111	87.40
H	Performing Grd Handling of Aircraft	68	6.3459	62	91.18
I	Maintaining Landing Gear Systems	80	6.2436	61	76.25
J	Maintaining Utility Systems	50	4.8106	47	94.00
K	Maintaining Flight Control Systems	66	6.6295	55	83.33
L	Maintaining Pneudraulic Systems	58	5.1137	50	86.21
M	Maintaining Electrical Systems	40	3.8895	38	95.00
N	Maintaining Fuel Systems	51	4.9130	48	94.12
O	Maintaining Non-Powered AGE	36	2.0471	20	55.55
P	Maintaining 780 Equipment	26	2.2518	22	84.62
Q	Performing Ge. Engine Maintenance	82	7.2671	71	86.59
R	Maintaining Reciprocating Engines	26	0.2047	2	7.69
S	Maintaining Turbo-Propeller Engines	11	0.9212	9	81.82
T	Maintaining Turbo-Jet Engines	7	0.3071	3	42.86
U	Maintaining Tow Targets	51	- -	0	00.00
V	Maintaining Aerial Delivery Systems	19	1.9447	19	100.00
W	Maintaining In-Flt Refueling (IFR) Sys	15	- -	0	00.00
	TOTALS	977	76.6630	749	

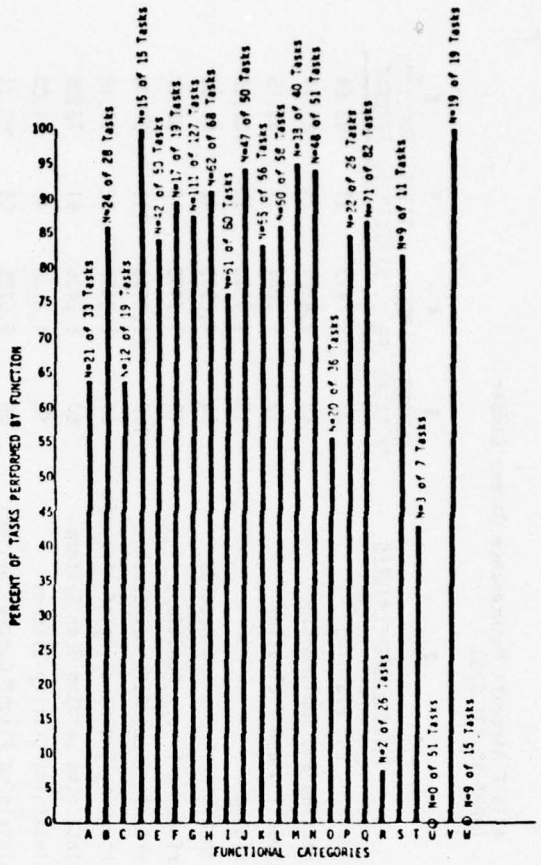
Column 4 Relative Freq. (Proportions) = $\frac{\text{No. of Tasks Performed}}{\text{Total Tasks}}$ e.g. $\frac{21}{977}$ = 2.1493%

Column 5 Tasks Recorded = The number of OSI tasks recorded on scatterdiagram (step interval = 1)

Column 6 Function Percent (Proportions) = $\frac{\text{No. of Tasks Performed}}{\text{No. of Tasks Per Function}}$ e.g. $\frac{21}{33}$ = 63.64%



CUMULATIVE FREQUENCY DISTRIBUTION OF TASKS BY FUNCTIONAL CATEGORY



HISTOGRAM DISTRIBUTION OF AFSC DUTIES/TASKS PER FUNCTIONAL CATEGORY

Figure 12 AFSC 43151F Aircraft Maintenance-Mechanic

The results demonstrated that actual historical data, augmented by existing cost estimating factors, can be utilized to establish weapon system life cycle cost values that are within a reasonable range (90 to 95 percent) of the actual weapon system life cycle cost. Figure 13 illustrates an overview of the cost categories by life cycle phase that were included/not included. The C-130E fifteen year life cycle cost by major life cycle phases was estimated as follows:

Life Cycle Phases	15 Year Total Cost (In Millions) 1976 $	Then Year $	Percent of Total 1976 $	Then Year $
1. R&D	3.221	2.257	.04	.05
2. Procurement/ Production	1257.358	838.54	17.01	18.02
3. Operations and Support	6134.742	3812.346	82.95	81.93
TOTAL - - -	7395.321	4653.143	100	100

In addition, a detailed breakdown of these three phases into their respective categories and the percent each is of the total C-130E LCC is shown in Figure 14. The phase division category grouping in this figure was such that Research and Development stood alone, Procurement/Production encompassed aircraft procurement, peculiar support equipment, and training devices, with the remaining covered under Operations and Support. The top four dollar consumers; military pay, depot maintenance, aircraft procurement, and aviation fuel accounted for 80.5% of the total 15 year estimated expenditures. Since Operations and Support is by far and above the major phase, with over 82% of the total LCC cost, Figure 15 illustrates the percentages each category contributed to total Operations and Support. The major categories, military pay, depot maintenance (68% labor, 32% material), and aviation fuel accounted for over 77 percent. The percentage distributions shown in Figure 14 and 15 are applicable to both 1976 and then year dollars. Details of the life cycle cost task are completely documented in AFHRL-TR-77-46, "Life Cycle Cost of C-130E Weapon System."[7]

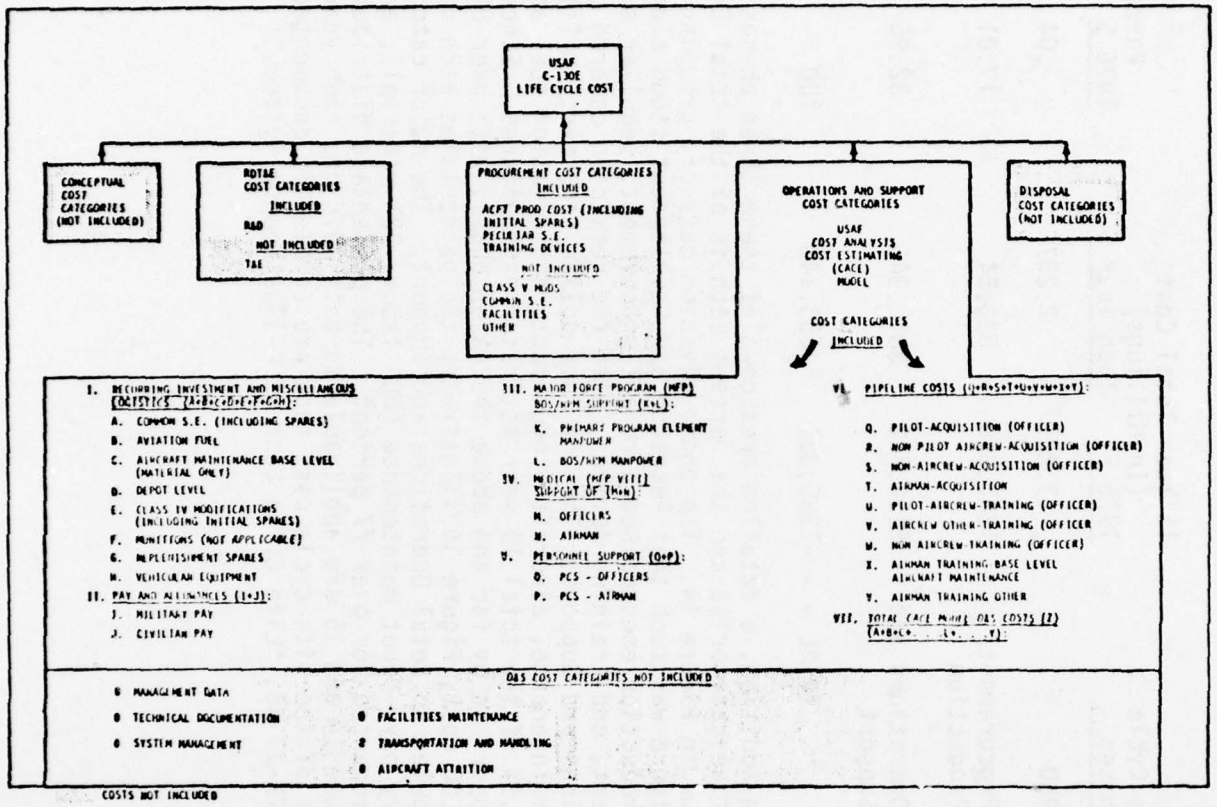


Figure 13 C-130E Life Cycle Cost Categories Included/Not Included By Life Cycle Phase

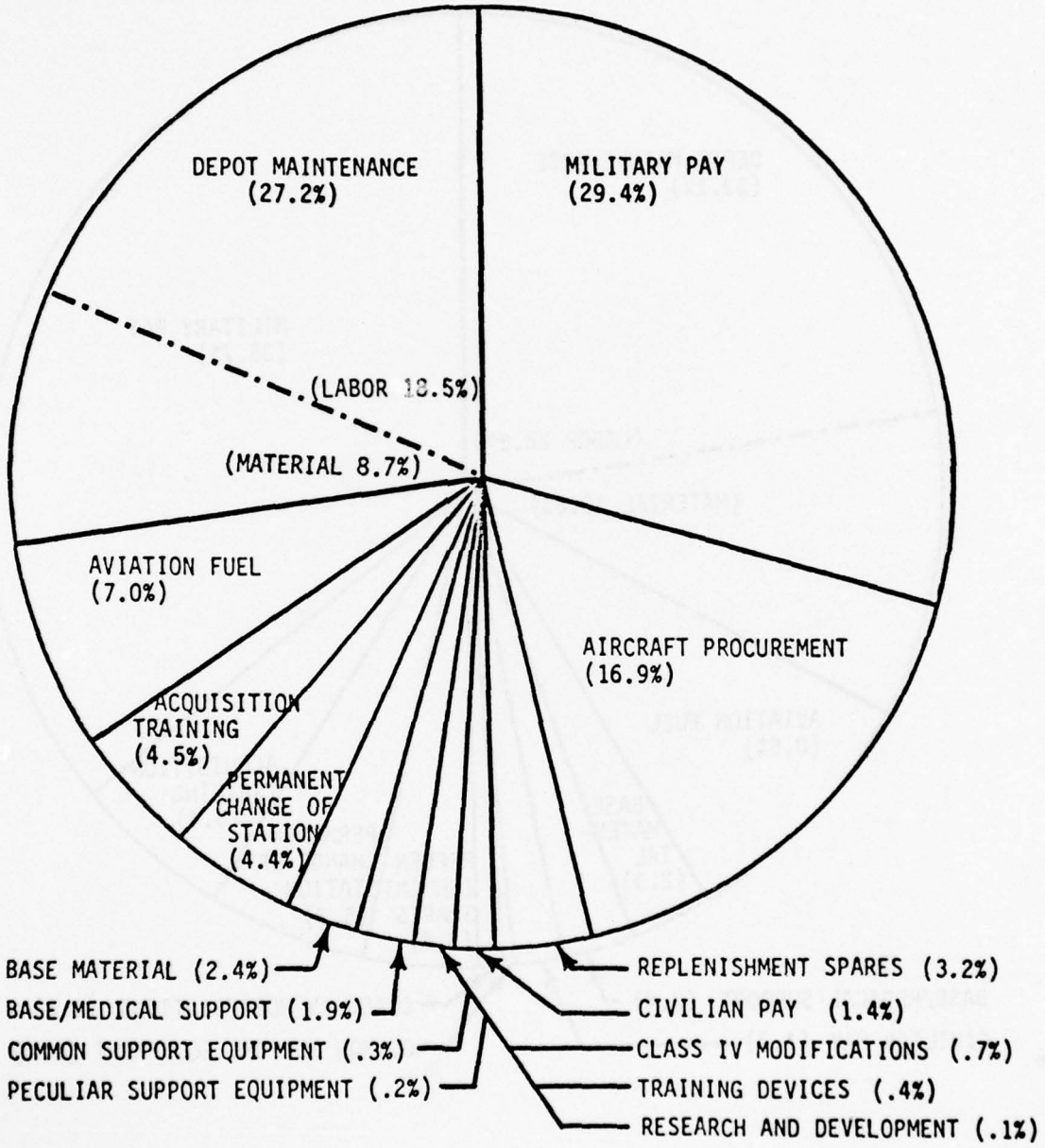


FIGURE 14 C-130E TOTAL 15 YEAR LIFE CYCLE COST BY MAJOR CATEGORY

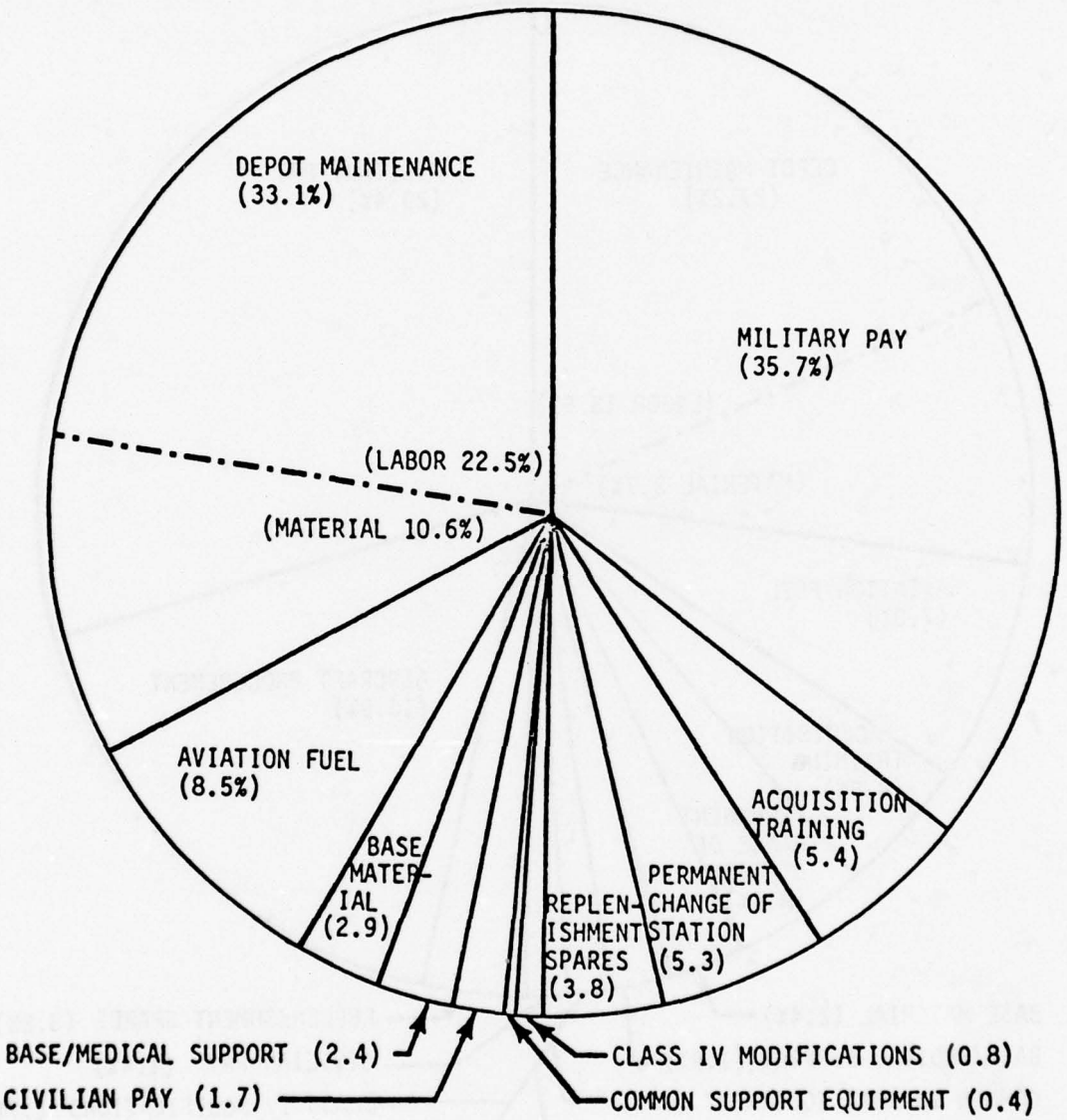


FIGURE 15 C-130E OPERATIONS AND SUPPORT 15 YEAR COSTS BY MAJOR CATEGORY

V - VALUE OF METHODOLOGY

The methods and practices portrayed in the prior sections of this document, along with the "lessons learned" provide the baseline information required to perform future historical weapon system analysis similar in scope to the work completed under this Phase I of the AFHRL Project 1959. The total amount of person hours allocated by task, for each of the six major tasks completed in this study, along with the amount of effort recommended for future similar studies, is reflected in Table 4.

Table 4 Person Hours Required By Task For HWSA Study - Current/Future

Phase I Project 1959 HWSA Study				Future HWSA Studies	
Task	Function	Allocated Person Hrs.	%	Recommended Person Hrs.	%
I	Program Planning	228	3.5	400	5
II	Published Literature Review and Acquisition	1109	16.8	1000	12.5
III	Air Force Documentation Review and Acquisition	1414	21.4	1600	20.0
IV	Data Analysis	1980	30.0	2800	35.0
V	AFSC Task Analysis	1010	15.3	1200	15.0
VI	Life Cycle Costing	859	13.0	1000	12.5
-	-	6600	100	8000	100

The 6600 hours utilized in the Phase I Project 1959 HWSA study included 750 hours of management supervision that was not charged to the program. In addition, there were also several individuals who contributed many hours on a consultant basis that was not charged to the program.

Future HWSA studies recommended hours in Table 4 is based on experiences gained and problems encountered during the Phase I study just completed. The additional 1400 hours recommended for future studies would be to beef-up the Program Planning - Tasks I; Air Force Documentation Review and Acquisition - Task III; and Data Analysis - Task IV. This would allow for the necessary effort required in planning, obtaining, and analyzing some of the essential data that is available but is

costly and time-consuming to obtain, reduce and present. Some examples of these data are as follows:

- Historical Weapon System Direct Manpower by Grade/Skill. Source: USAF Military Personnel Center.
- Ground Support Equipment Inventories and Maintenance Experiences. Sources: ALC's and Operating Units.
- Class IV Modification Material Consumed/Costs. Sources: ALC's and Operating Units.
- Depot Material Consumption Quantities/Costs, Labor Hours/ Costs, and Reliability Information. Sources: ALC's and HQ AFLC.

Recommended methods and practices not only represent the most logical planning, implementation and analytical progression, but more importantly, serve as a methodology for future HWSA efforts. Success in accomplishing a large task similar to this C-130E HWSA study is dependent upon a systematic approach. Therefore, sequential flows depicted within this report, represent the most optimal methodology for future studies of this type. Those flows with the associated text portray the best approaches based upon "lessons learned."

Some of the most significant advantages of this methodology is presented below.

- This methodology captures and utilizes actual historical data to the greatest extent possible in the data analysis and life cycle cost analysis techniques. In addition, for those cases where actual data is not available, alternate methodologies are provided to fill the data voids. These include the data normalization process and the use of standard Air Force cost estimating factors where actual cost experience is not obtained. The data normalization process was developed in-house, in advance of this study and was available for application. It could not have been developed within the scope of the study effort.
- Existing AFM 66-1 data computer processing programs were also developed in-house, in advance of this study and were available for processing nearly six million records of AFM 66-1 data obtained. These, or similar, computer processing programs must also be available prior to obtaining the actual data, otherwise the data processing and reduction will be an unmanageable task.
- Personnel experienced with various Air Force data collection systems and agencies must be selected and utilized, especially for the data sources contacts, on-site visits, and data acquisition/reduction subtasks.

- The current Occupational Survey Inventories (OSI's) should be utilized as the basis and modified as necessary for performing the Air Force specialty code task analysis inventories.

- Utilizing the standard Air Force Cost Analysis and Cost Estimating (CACE) model, modified to include: 1) program phases/cost categories not covered in the basic model; and 2) fleet computations rather than single squadron computations allows the life cycle cost analysis to be a fairly straightforward task. In addition, standard cost estimating factors are available for the formula constants/variables where actual data cannot be obtained. This is an extremely important point to be successful in attempting to estimate historical life cycle cost because of the lack of actual historical cost data on most weapon systems.

VI - SUMMARY CONCLUSION

SYNOPSIS

This report is the final in a series of four technical reports which document the results of a six task study of the historical resource utilization of the C-130E aircraft. It presents recommended methods and practices to be considered for implementation during future historical weapon system analysis efforts. Recommended methodologies contained within this final report include: 1) Contract Performance Planning; 2) Review of Published Literature; 3) Air Force Documentation Search and Data Acquisition; 4) Historical Data Analysis; 5) Task Analysis of Selected Air Force Specialist Personnel; and 6) Life Cycle Costing. The methodologies contained within this final report are presented in functional/sequential flow formats and represent the results of "lessons learned" during the implementation and completion of this AFHRL Project 1959 Phase I study effort.

RESULTS

Retrospective analyses of successes, failures and associated problems encountered throughout implementation of this study has resulted in the following, viz:

1. Recommended methods and practices conducive to the effective development of program planning have been developed. This includes a tabulation of USAF and other governmental agency sources that must be incorporated into future program plans.

2. Functional flows depicting recommended steps to be taken during the conduct of structured interviews as well as conducting reviews of published literatures have been formulated.

3. Successful implementation of weapon system analyses in the future is contingent upon many factors. Some of the more significant factors include the need for a well developed, time-tested data control, management, cataloguing, and filing technique that enables investigators to conduct the program in a regimental manner. A centralized data file, coupled with an automated/mechanized cataloguing technique is fundamental to successful data control.

4. Systematic sequences in the conduct of future Historical Weapon Systemes (HWSA) efforts have been provided.

5. Detailed conclusions germane to the 15 year analyses of the C-130E Hercules Advanced Medium Short Take-Off and Landing Transport (AMST) are contained in previous reports. Recommendations to problems encountered during this study have been included in this report.

RECOMMENDATIONS

The intent of including these recommendations is to provide a centralized summary of solutions and corrective actions put forth in three previously developed Technical Reports (TR's). The following are based upon observations covering the entire study and reference the appropriate study documentation.

1. The Air Force should develop and implement an integrated historical data center to accumulate and maintain the seven categories of data developed in this study, by weapon system (MDS). This would allow Air Force agencies and their contractors to use a common data base in making trade studies and in responding to proposals for new weapon systems and equipment. (Reference AFRHL-TR-77-40, "C-130E Hercules Aircraft: Review of Published Literature and Structured Interviews.")

2. Additional historical data bases on selected Air Force systems should be developed in a manner similar to that accomplished on the C-130E Hercules aircraft weapon system. (Reference same Technical Report noted in recommendation number 1.)

3. Future studies of this type should extend for 18 months to 24 months to allow adequate time for data acquisition and analysis. (Reference same Technical Report noted in recommendation number 1.)

4. Similar studies should cover a weapon system (MDS) family rather than a single selected model. Family differences could be accounted for in equipment and configuration differences. (Reference Technical Report noted in recommendation number 1.)

5. A study of Air Force data systems should be made to identify data deficient areas and the means for accumulating actual data for missing elements. Much of this could be done by sampling. (Reference same Technical Report noted in recommendation number 1.)

6. The current process that is required to identify, collect, and analyze historical information over the life cycle of an Air Force weapon system is extremely awkward and time-consuming, and in many areas results in voids. Currently there are no formal procedures that attempt to track and collect published

information on a specific weapon system over its life time. Such procedures would be very useful, not only in supporting the periodic assessment of a specific systems life cycle progress, but also, for supporting various trade study aspects of future weapon systems. Headquarters USAF/ACMCA has an existing "Operating and Support Cost Reporting (OSCR)" system that was initiated for all USAF aircraft systems in fiscal year 1975, and if continued and expanded to capture additional data elements could eventually be a very useful operational and support cost information system. (Reference AFHRL-TR-77-48, "Historical Analysis of C-130E Resources.")

7. In cases where an Air Force weapon system is deployed to more than one operational command, each command has their individual peculiar reporting system(s) and guidelines. It would be appropriate to standardize reporting systems within all commands to insure consistency of data banks, data elements and reporting criteria. (Reference same Technical Report noted in recommendation number 6.)

8. The methodologies contained in this technical report provide sound approaches toward implementing future studies. The sequence to follow is: 1) identify sources; 2) contact and acquire information; 3) establish bibliographic system; 4) review and sort information for appropriateness; 5) analyze information; 6) generate structured interviews, by AFSC 7) collect responses; 8) analyze responses; and 9) synthesis information into a final report.

9. A range of 52 to 61 percent of the maintenance tasks performed by 11 C-130 maintenance AFSC's are accounted for in Air Force Manual (AFM) 39-1, Airman Classification Manual. As this AFM is used widely by governmental and civilian contractor agencies in developing Personnel Planning Information (PPI) data, corrective steps should be taken to derive more sensitive planning guidelines responsive to AFM 66-1 (Maintenance Management) individual work centers.

10. Nineteen of the 27 Cost Analysis and Cost Estimation (CACE) formulae deal directly with human resource categories (e.g., military pay, civilian pay, permanent change of status (PCS) costs, etc.). Further, 60.1% of the C-130E total life cycle cost by major category is directly attributable to human resources. It matters little from a cost standpoint if hardware reliability is improved several times if related manpower attenuator changes are not made. Concept and design innovations included in new systems to improve hardware utilization, must be accompanied by related changes in the human support needs. It is recommended that the real cost drivers in weapon systems be ranked in order of most to least costly and that this rank order serve as the priority upon which future USAF weapon system acquisition contracts are based.

11. It is recommended that further analytical studies be conducted for the purpose of developing:

    a. Operations and maintenance manpower models usable by contractors in defining officer, enlisted and civilian manpower required at USAF work center level.

    b. More sensitive Personnel Planning Information (PPI) guidelines than are contained in AFM 36-1, Officer Classification Manual and AFM 39-1, Enlisted Personnel Airman Classification Manual.

    c. Assisgned manpower profiles at work center levels within single engine, multiple engine aircraft systems. This should include operations and maintenance personnel across Air Defense Command, Tactical Air Command, Military Air Command and Strategic Air Command.

    d. Detailed Air Force Specialty Code (AFSC) inventories that depict all duties/tasks actually performed by 3, 5, 7, and 9 skill level maintenance personnel (organizational and intermediate levels) on major USAF weapon systems.

    e. Attenuated ATC resident training courses of maintenance personnel with a concomitant "Task Oriented Training" program at operational bases.

REFERENCES

1. AFHRL-TR-77-40, C-130E Herculeas Aircraft: Review of Published Literature and Structured Interviews, Air Force Human Resource Laboratory, July 1977.

2. AFHRL-TR-77-48, Historical Analysis of C-130E Resources, Air Force Human Resource Laboratory, July 1977.

3. AFM 39-1, Airman Classification Manual, Department of the Air Force, September 1976.

4. AFM 66-1, Maintenance Management, Department of the Air Force, November 1975.

5. AFM 36-1, Officer Classification Manual, Department of the Air Force, September 1976.

6. AFR 173-10, Cost Analysis - USAF Cost and Planning Factors, Department of the Air Force, 6 February 1973.

7. AFHRL-TR-77-46, Life Cycle Cost of C-130E Weapon System, Air Force Human Resource Laboratory, July 1977.

GLOSSARY OF ACRONYMS

ACP	Airborne Command Post
AFB	Air Force Base
AFHRL	Air Force Human Resources Laboratory
AFLC	Air Force Logistics Command
AFM	Air Force Manual
AFS	Air Force Specialist
AFSC	Air Force Specialty Code
AFSC	Air Force Systems Command
AGE	Aerospace Ground Equipment
ALC	Air Logistics Center
ALDCS	Active Life Distribution Control System
AMST	Advanced Medium Short-Take-Off-And-Landing Transport
ATC	Air Training Command
ATM	Air Turbine Motors
CACE	Cost Analysis and Cost Estimating
CDRL	Contract Data Requirements List
C/O	Checkout
DCM	Deputy Commander for Maintenance
DDC	Defense Documentation Center
HQ	Headquarters
HWSA	Historical Weapon Systems Analysis
IAW	In Accordance With
IFR	In-Flight Refueling
IROS	Increase Reliability of Operational Systems
LCC	Life Cycle Costing
LRAFB	Little Rock Air Force Base (Arkansas)
LS&S	Logistics Support and Services
MAC	Military Airlift Command
MAFB	McChord Air Force Base (Washington)
MAW	Military Airlift Wing
MECCA	MEChanized CAtaloging
MPC	Military Personnel Center
N/A	Not Applicable
O&M	Operations and Maintenance
O&S	Operations and Support
OSI	Occupational Survey Inventory
OSR	Occupational Survey Report
PACS	Pilot Assist Cable Servo System
QC	Quality Control
RAC	Reliability Analysis Center

GLOSSARY OF ACRONYMS (Cont'd)

SGTS	Small Gas Turbine System
SPO	System Program Office
STINFO	Scientific and Technical Information
TAW	Tactical Airlift Wing
T.O.	Technical Order
TR	Technical Report
USAF	United States Air Force
W/S	Weapon System

APPENDIX A

DATA SOURCES AND AGENCIES

DATA SOURCES/TYPE AND AGENCIES

	Source/Type Data	Location
1.	Accident Incident Records	Safety Center, Norton AFB
2.	Actuarial Analysis Program	AFLC, WPAFB
3.	Aircraft Histories (AF Form 781)	Respective Units
4.	Aircraft Structural Integrity Program	Robins AFB
5.	Air Training Command	Randolph AFB
6.	Air University Library	Maxwell, Alabama
7.	C-130 System Program Office	Robins AFB
8.	Cost and Performance Analysis	AFLC, WPAFB
9.	Depot Data	Air Logistics Centers
10.	Defense Documentation Center	Arlington, Virginia
11.	Defense Logistics Studies Information Exchange	Fort Lee, Virginia
12.	Government Industry Data Exchange Program	Corona, California
13.	Increase Reliability of Operational Systems	AFLC, WPAFB
14.	Library of Congress	Washington, D.C.
15.	Logistics Management Institute	Washington, D.C.
16.	Maintenance Data (AFM-66-1)	AFLC, WPAFB
17.	Material Deficiency Reporting System	AFLC, WPAFB
18.	Military Personnel Center	Randolph AFB
19.	National Aeronautics and Space Administration	Washington, D.C.

DATA SOURCES/TYPE AND AGENCIES (CONT)

Source/Type Data	Location
20. National Technical Information Service	Springfield, Virginia
21. Reliability Analysis Center	Griffiss AFB
22. Standard Aerospace Vehicle and Equipment Inventory	AFLC, WPAFB
23. Unit Histories	Respective Historical Offices

APPENDIX B

DATA SOURCE SUMMARY FORM

DATA SOURCE SUMMARY FORM

TYPE:	AGENCY:
COMMAND MEDIA:	LOCATION:

CONTACT NAME: _____ PHONE NO: _____

FUNCTION: _____ BUILDING NO: _____

OFFICE SYMBOL: _____ DATE: _____

ELEMENTS AVAILABILITY

FORM:		VOLUME	YEARS
MAGNETIC TAPE	_____	_____	_____
CARDS	_____	_____	_____
HARD COPY PRINTOUT	_____	_____	_____
FICHE	_____	_____	_____
LOGS/SUMMARY DOC.	_____	_____	_____
RESEARCH DOC.	_____	_____	_____
OTHER	_____	_____	_____

ELEMENTS:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

COMMENTS:

_____

_____

_____

_____

_____

Figure B-1 Data Source Summary Form

APPENDIX C

HISTORY CODE DOCUMENT CONTROL FORM

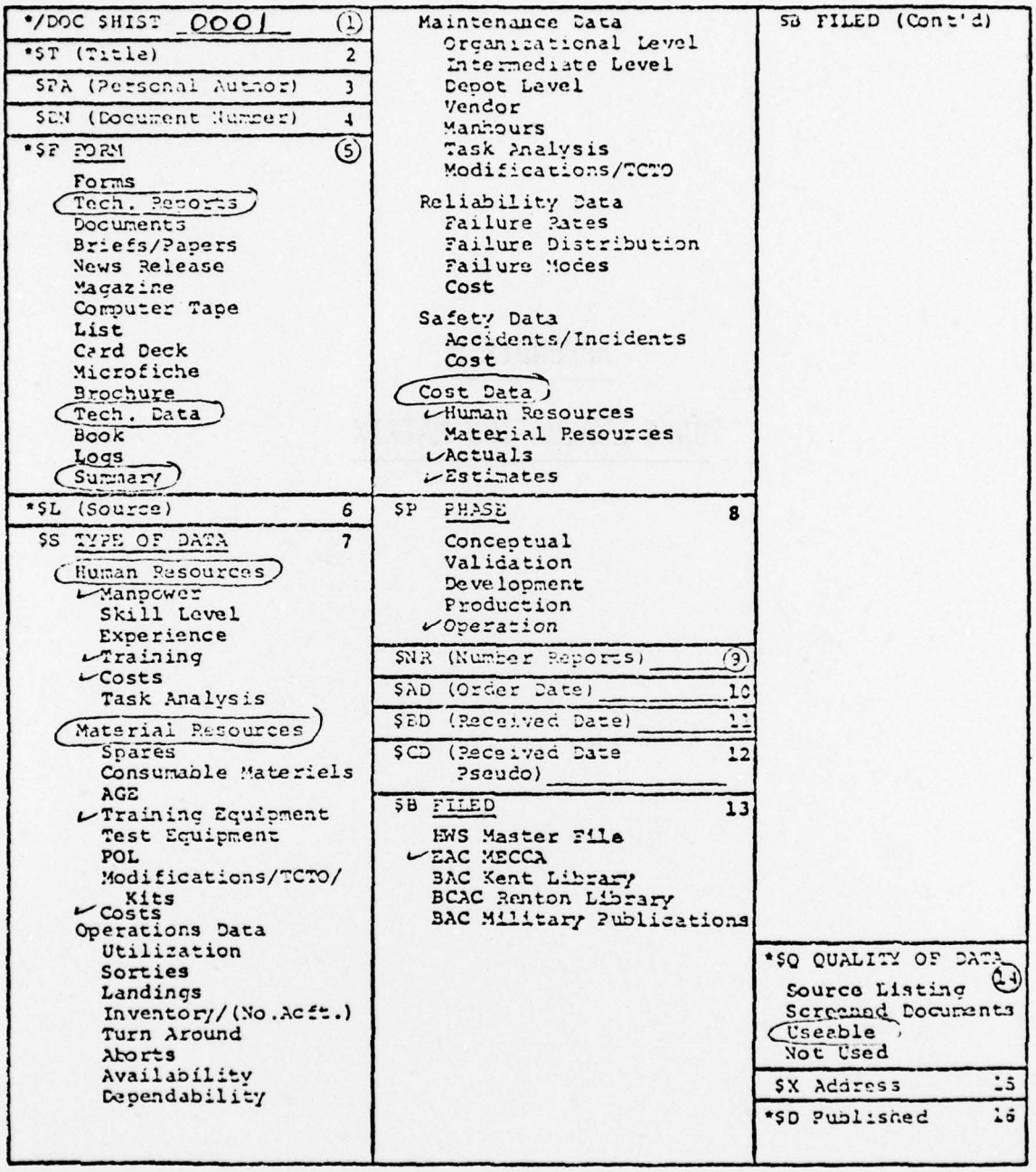


Figure C-1 History Code Document Control Form

APPENDIX D

DATA EVALUATION MATRIX

Table D-1 Data Evaluation Matrix

CATEGORY/ELEMENTS OF DATA	SOURCES/AGENCY	LOCATION	TYPE OF DATA OR DATA FILE	DATA QUANTITY/QUALITY			
				FORM(S)	RECORDS	YEARS	REMARKS
1. OPERATIONS DATA:							
AIRCRAFT UTILIZATION DATA AS FOLLOWS:	AFLC/MO	WPAFB, OHIO	AFM 65-110 (1-HAF-A1-110-12)	HARD COPY	1700	1962-1969	95 MONTHLY REPORTS CONTAINING ALL USAF AIRCRAFT REQUIRED MANUAL EXTRACTION
- NO. OF AIRCRAFT	AFLC/LOAC	WPAFB, OHIO	AFM 65-110 (1-HAF-A1-110-12)	HARD COPY	1900	1970-TO-DATE	84 MONTHLY REPORTS CONTAINING ALL USAF AIRCRAFT REQUIRED MANUAL EXTRACTION
- TOTAL FLIGHT TIME (BY MDS/MONTH)							"
- AIRCRAFT UTILIZATION (FH/ACFT/MO)							"
- TOTAL SORTIES							"
- AVERAGE MISSION LENGTH							"
- TOTAL LANDINGS							"
- NORM RATE							"
- NORS RATE							"
- OR RATE							"
AIRCRAFT ABORTS:							
- OPERATIONS	-	-	-	-	-	-	NOT OBTAINED
- MAINTENANCE	AFLC/ACVMP	WPAFB, OHIO	D056 SERIES REPORTS	TAPE	5,989,175	1971-1976	DATA NEEDS TO BE REFINED TO ELIMINATE DUPLICATE ABORTS REPORTED BY WORK UNIT CODE
- OTHER	-	-	-	-	-	-	NOT OBTAINED
TURN AROUND TIME	-	-	-	-	-	-	NOT OBTAINED
2. MAINTENANCE DATA:							
SYSTEM-MAINTENANCE MANHOURS (ORGANIZATIONAL/INTERMEDIATE) BY YEAR	AFLC/ACVMP	WPAFB, OHIO	D056 SERIES REPORTS	TAPE	5,989,175	1971-1976	DATA WAS PROVIDED IN NORMAL AFM 66-1 BASIC RECORD FORMAT AND REQUIRED USE OF IN-HOUSE PROGRAMS PROCESSING TO ENABLE ADEQUATE DATA CONFIGURATION FOR ANALYSIS
GENERAL SUPPORT MAINTENANCE MANHOURS WORK UNIT CODES 01 THRU 09	C-130E UNITS 62 MAW	MCCHORD AFB, WA	AFM 66-1 MDC/BLIS	LISTING	-	1976	COMPLETE GENERAL SUPPORT DATA MUST BE OBTAINED FROM EACH INDIVIDUAL UNIT AND THE UNITS CURRENTLY MAINTAIN 12 MONTHS OF HISTORY
	314 TAW	LITTLE ROCK AFB, AR	AFM 66-1 MDC/BLIS	LISTING	-	1976	
	317 TAW	POPE AFB, NC	AFM 66-1 MDC/BLIS	LISTING	-	1976	

Table D-1 Data Evaluation Matrix (Cont.)

CATEGORY/ELEMENTS OF DATA	SOURCES/AGENCY	LOCATION	TYPE OF DATA OR DATA FILE	DATA QUANTITY/QUALITY			
				FORM(S)	RECORDS	YEARS	REMARKS
TCTO MAINTENANCE MAN-HOURS	WRALC/MMMSS	WARNER ROBINS AFB GA	D047 SERIES REPORTS	LISTING	21,000	1962-1976	DATA WAS PROVIDED IN BASIC RECORD FORMAT BY AIRCRAFT TAIL NUMBER AND REQUIRED DEVELOPMENT OF IN-HOUSE PROGRAMS TO ENABLE ADEQUATE DATA CONFIGURATION FOR ANALYSIS
PERCENT MAINTENANCE MANHOURS FOR: SCHEDULED MAINT. UNSCHEDULED MAINT. SERVICING BENCH CHECK TROUBLESHOOTING OTHER	AFLC/ACVMP	WPAFB, OHIO	D056 SERIES REPORTS	TAPE	5,989,175	1971-1976	DATA WAS PROVIDED IN NORMAL AFM 66-1 BASIC RECORD FORMAT AND REQUIRED IN-HOUSE PROGRAMS/ PROCESSING TO ENABLE ADEQUATE DATA CONFIGURATION FOR ANALYSIS
SYSTEM MAINTENANCE TASKS (ORGANIZATIONAL/INTERMEDIATE) BY YEAR	AFLC/ACVMP	WPAFB, OHIO	D056 SERIES REPORTS	TAPE	5,989,175	1971-1976	DATA WAS PROVIDED IN NORMAL AFM 66-1 BASIC RECORD FORMAT AND REQUIRED USE OF IN-HOUSE PROGRAMS PROCESSING TO ENABLE ADEQUATE DATA CONFIGURATION FOR ANALYSIS
3. RELIABILITY DATA:							
TOTAL FAILURES BY SYSTEM BY YEAR	AFLC/ACVMP	WPAFB, OHIO	D056 SERIES REPORTS	TAPE	5,989,175	1971-1976	DATA WAS PROVIDED IN NORMAL AFM 66-1 BASIC RECORD FORMAT AND REQUIRED USE OF IN-HOUSE PROGRAMS PROCESSING TO ENABLE ADEQUATE DATA CONFIGURATION FOR ANALYSIS
PERCENT FAILURES a. BEFORE FLIGHT b. IN-FLIGHT c. BETWEEN FLIGHT d. DURING INSPECTION	AFLC/ACVMP	WPAFB, OHIO	D056 SERIES REPORTS	TAPE	5,989,175	1971-1976	DATA WAS PROVIDED IN NORMAL AFM 66-1 BASIC RECORD FORMAT AND REQUIRED USE OF IN-HOUSE PROGRAMS PROCESSING TO ENABLE ADEQUATE DATA CONFIGURATION FOR ANALYSIS
REPAIR DATA (BASE) a. ORGANIZATIONAL b. INTERMEDIATE - BENCH CHECK - NRTS - CONDEMNED							
REPAIR DATA (DEPOT)	AFLC/ACVRC	WPAFB, OHIO	D041 CREATE DATA H036B (MIF PROD. COST D097 I&S GROUPING DATA	TAPE	125,000	FY 1975-1976	DATA FROM EACH DATA SYSTEM WAS PROVIDED ON INDIVIDUAL TAPES AND REQUIRED USE OF IN HOUSE PROGRAMS/PROCESSING.
4. SAFETY DATA - ACCIDENTS MAJOR MINOR - INCIDENTS	AIR FORCE SAFETY CENTER (IG/SER)	NORTON AFB, CA	ACCIDENT/INCIDENT REPORTS	LISTINGS	-	1962-1976	ACCIDENT SUMMARY REPORTS FOR 1962-1976 AND INCIDENT REPORTS FOR 1976. WAS PROVIDED.

Table D-1 Data Evaluation Matrix (Cont.)

CATEGORY/ELEMENTS OF DATA	SOURCES/AGENCY	LOCATION	TYPE OF DATA OR DATA FILE	DATA QUANTITY/QUALITY			
				FORM(S)	RECORDS	YEARS	REMARKS
5. HUMAN RESOURCES DATA: MANPOWER AUTHORIZED VS ASSIGNED BY AFSC - AFSC LEVEL GRADE - YEARS EXPERIENCE - TRAINING REQUIREMENTS EXPERIENCE - EDUCATION	C-130E UNITS 62 MAW 314 TAW 317 TAW	MCCHORD AFB, WA LITTLE ROCK AFB, AR POPE AFB, NC	AUTHORIZED: UNIT DETAIL LISTINGS	LISTING	-	CURRENT	CURRENT UDL'S PROVIDED THE AUTHORIZED MANPOWER BY FUNCTIONAL AREA
			ASSIGNED: MAINTENANCE: MONTHLY MAINTENANCE DIGESTS-RCS: MAC-LGX (M)7103	DOCUMENT	-	1976	THE MONTHLY/MAINTENANCE DIGESTS PROVIDED ASSIGNED MAINTENANCE MANPOWER BY WORK CENTER FOR THE MAINTENANCE ORGANIZATIONS
			OPERATIONS	-	-	CURRENT	CREW RATIO PER UE WAS OBTAINED FROM OPERATIONS
			OTHER	-	-	-	NOT OBTAINED
	MILITARY PERSONNEL CENTER (MPC)/XPMRT	RANDOLPH AFB, TX	MANPOWER ASSIGNED BY: COMMAND/AFSC/GRADE YEARS EXPERIENCE TRAINING EXPERIENCE EDUCATION	- - - -	- - - -	- - - -	THE MILITARY PERSONNEL CENTER HAS A HISTORY FILE OF THIS TYPE DATA COVERING (1971-CURRENT). HOWEVER THE DATA WAS NOT PROVIDED FOR THIS RESEARCH TASK BECAUSE EDP PROCESSING WAS COST PROHIBITIVE
	HQ USAF/ACMCA	WASHINGTON, D.C.	ESTIMATING AND PLANNING FACTORS/AFR 173-10	DOCUMENT	-	CURRENT	PROVIDES OPERATING AND SUPPORT COST ESTIMATING AND PLANNING FACTORS FOR USAF WEAPON SYSTEMS, TO INCLUDE VARIOUS HUMAN RESOURCES DATA/FACTORS
6. MATERIAL RESOURCES: - MATERIAL CONSUMPTION - GROUND SUPPORT EQUIPMENT - TRAINING EQUIPMENT - OTHER	HQ USAF/ACMCA	WASHINGTON, D.C.	ESTIMATING AND PLANNING FACTORS/AFR 173-10	DOCUMENT	-	CURRENT	PROVIDES OPERATING AND SUPPORT COSTS ESTIMATING AND PLANNING FACTORS FOR USAF WEAPON SYSTEMS TO INCLUDE AGE, POL, MAINTENANCE-AIRCRAFT (BASE AND DEPOT LEVEL), MOD CLASS IV (INCL. INITIAL SPARES), REPLENISHMENT SPARES AND VEHICULAR EQUIPMENT COSTS

Table D-1 Data Evaluation Matrix (Cont.)

CATEGORY/ELEMENTS OF DATA	SOURCES/AGENCY	LOCATION	TYPE OF DATA OR DATA FILE	DATA QUANTITY/QUALITY			
				FORM(S)	RECORDS	YEARS	REMARKS
6. MATERIAL RESOURCES (CONT.	HQ USAF/ACMCA	WASHINGTON, D.C.	OPERATING AND SUPPORT COST REPORT (OSCR)	LISTING	-	FY 1975	PROVIDES C-130E OPERATING AND SUPPORT COST BY VARIOUS COST CATEGORIES. THIS SYSTEM WAS IMPLEMENTED WITH FY 1975. FY 76 INFORMATION NOT RELEASED AS OF THE PRINTING OF THIS DOCUMENT
	C-130E UNITS 62 MAW 314 TAW 317 TAW	MCCHORD AFB, WA LITTLE ROCK, AR POPE AFB, NC	MAINTENANCE COST SYSTEM (MCS) EXECUTIVE MANAGEMENT SUMMARIES (REF AFM 177-380)	MONTHLY REPORTS	-	JUL'75-DEC'76	PROVIDES WEAPON SYSTEM DIRECT AND INDIRECT MATERIAL COSTS BY MONTH AT BASE LEVEL. IDENTIFIES VALUE OF MATERIAL CONSUMED WITHIN WBS WITHIN MDS/NON MDS BY MONTH. MDS CATEGORIES INCLUDE AIRCRAFT, AIRFRAME, ENGINE, ACCESSORIES, ELECTRONICS, NON MDS INCLUDES SUPPLY SUPPORT, CEM, AGE AND OTHER CATEGORIES
	FUEL OFFICES C-130E UNITS 62 MAW 314 TAW 317 TAW	 MCCHORD AFB, WA LITTLE ROCK AFB, AR POPE AFB, NC	POL (FUEL) CONSUMPTION DATA	-	-	1976	PROVIDED NUMBER OF GALLONS OF FUEL C-130's CONSUMED EACH MONTH OF 1976
7. COST DATA: - RDT&E - PROCUREMENT - OPERATIONS & SUPPORT	HQ USAF/ACMCA	WASHINGTON, D.C.	ESTIMATING AND PLANNING FACTORS/AFR 173-10	DOCUMENT	-	CURRENT	PROVIDES OPERATIONS AND SUPPORT COST ESTIMATING AND PLANNING FACTORS FOR USAF WEAPON SYSTEMS
	HQ USAF/ACMCA	WASHINGTON, D.C.	OPERATING AND SUPPORT COST REPORT (OSCR)	LISTING	-	FY 1975	PROVIDES C-130E OPERATIONS AND SUPPORT COST BY VARIOUS COST CATEGORIES. THIS SYSTEM WAS IMPLEMENTED WITH FY 1975. FY 1976 INFORMATION WAS NOT RELEASED AS OF THE PRINTING OF THIS DOCUMENT.
	AFLC/ACM	WPAFB, OHIO	UNIT COSTS OF AIRCRAFT T.O. 00-25-30	TECHNICAL ORDER	-	CURRENT	PROVIDES AVERAGE AIRCRAFT UNIT FLYAWAY COST, BASED ON FUNDING APPROPRIATIONS.

Table D-1 Data Evaluation Matrix (Cont.)

CATEGORY/ELEMENTS OF DATA	SOURCES/AGENCY	LOCATION	TYPE OF DATA OR DATA FILE	DATA QUANTITY/QUALITY			
				FORM(S)	RECORDS	YEARS	REMARKS
7. COST DATA (CONT)	FROST AND SULLIVAN INC.	NEW YORK, NY	DEFENSE CONTRACTS/ COST INFORMATION	LISTING	-	1962-1975	PROVIDES HISTORICAL VISIBILITY INTO INDIVIDUAL CONTRACTS BY PRODUCT CATEGORIES AGAINST THE C-130 AIRCRAFT. SOME CONTRACTS REFLECT SPECIFIC AIR FORCE C-130E APPLICATION. INDIVIDUAL CONTRACT DOLLAR VALUE IS REFLECTED FOR MOST CONTRACTS LISTED.
	C-130E UNITS						
	62 MAW	MCCHORD AFB, WA	MAINTENANCE COST SYSTEM (MCS)	MONTHLY REPORTS		JUL'75-DEC-76	PROVIDES WEAPON SYSTEM COSTS DIRECT AND INDIRECT BY EACH INDIVIDUAL UNIT. INFORMATION OBTAINED WAS ONLY FROM THE 3 UNITS LISTED.
	314 TAW	LITTLE ROCK AFB AR	EXECUTIVE MANAGEMENT SUMMARIES				
	317 TAW	POPE AFB, NC	AFR 177-380				
	AFLC/LOLMA, SCALC/ACDCN	WPAFB, OH MCCLELLAN AFB, CA	LOGISTICS SUPPORT COST RANKING (IROS/KOSI) SYSTEM	QUARTERLY REPORTS		1973-1976	THE LOGISTIC SUPPORT COST RANKING (IROS/KOSI) REPORTS ARE DESIGNED TO PROVIDE AN ESTIMATE OF COST TO REPAIR, MAINTAIN, AND SUPPLY A SPECIFIC ITEM (WUC) FOR A GIVEN PERIOD. IT PROVIDES FIELD MANHOUR COSTS, SPECIALIZED REPAIR ACTIVITY COST, SPARES/MATERIAL COST AND PACKAGING/SHIPPING COST. IT ALSO CONTAINS OTHER DATA SUCH AS SAFETY AND AVAILABILITY. COSTS NOT INCLUDED ARE: GROUND SUPPORT EQUIPMENT, MODIFICATION HARDWARE, AND SELECTED SPARES. THE KOSI COSTS DATA WAS USED IN THIS STUDY TO DETERMINE THE TOP 10 WUC LSC RANKING. IT WILL NOT BE USED FOR LCC BECAUSE IT WAS NOT DESIGNED TO CAPTURE TOTAL COSTS OF ALL SYSTEMS ON AIRCRAFT.

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